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ENCYCLOPEDIA OF FOOD AND CULTURE

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Encyclopedia of Food and Culture

Solomon H. Katz, Editor in Chief
William Woys Weaver, Associate Editor

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PREFACE

The *Encyclopedia of Food and Culture* is all about food: a single authoritative source about the most essential element of daily life. Here you will find articles by food historians, anthropologists, chefs and bakers, nutritionists and dieticians, farmers, agronomists and horticulturists, food stylists, and specialists in the culinary arts. In developing the *Encyclopedia*, the editors took special care to make the content interesting and the organization useful for those who want to learn about a particular topic, to make the text enjoyable for those who simply want to explore the wide and wonderful world of food, and to provide sufficient authority and depth for researchers. If this *Encyclopedia* does not tell you everything you need to know about food, it will show you where to find it.

The articles are arranged in alphabetical order, but the overall work was conceived thematically to ensure treatment of all essential aspects of food (see the Systematic Outline at the back of Volume 3). For example, the *Encyclopedia* covers staple foods, such as fruit, fish, meat, and vegetables; cooked and processed foods; food production, storage, distribution, preparation, and processing; and nutrition and constituents of food, such as fats, minerals, starch, and sugar. You will also find articles on festivals and feasts and on major countries and regions of the world, on world religions and their food customs, and on people who have been influential in food history. If a topic does not appear in the table of contents, look in the index; there will likely be several mentions of the subject in different articles. In the *Encyclopedia* you will find the topics you would normally expect in a book about food—such as bread and cheese, cooking, and vitamins—but you will also find some surprises, as in the articles on "Cannibalism," "Pet Pigs of New Guinea," "Seabirds and Their Eggs," "Disgust," and "Poisoning," as well as "Spam" and "How to Read an Old (Handwritten) Recipe." The *Encyclopedia* covers human history from Stone Age nutrition to the future of food, and it reaches all around the world—geographically and culturally—from Australian Aborigines and the Inuit peoples to Pacific Ocean societies and the Inca empire; from the Japanese tea ceremony to food as a weapon of war. Each article concludes with a bibliography and cross-references pointing readers to topics of related interest. The articles are generously illustrated with many rarely seen photographs, line drawings, and old advertisements, and are supplemented by maps, tables, and informative sidebars. Each volume contains a beautiful eight-page color insert of images selected by Associate Editor William Woys Weaver.

Entries explore what constitutes food, how it is procured, where it originates, and what is in the foods we eat. You will find detailed accounts of the production of food, including fishing, hunting and gathering, and types of agriculture as they relate to ecological and environmental considerations, and you will be introduced to some of the unusual foods that are consumed around the world. You can also read about what is done to food once it is procured, including preparation and processing, distribution, storage (such as ancient and modern preservatives), food preparatory rituals (religious and secular), and the science and technology underlying food processing (including the chemistry and physics of food preparation and processing).

In a larger context, the *Encyclopedia* enables readers to trace the ways in which food affects our lives both nutritionally and socially, across the boundaries of time and place, throughout many cultures and their traditions. The articles cover the nutrition and biochemistry of food, food science, various conditions and health disorders associated with food, dietetics, constituents of food, the pharmacological effects of foods, and the physiology of eating, digestion, and nutrition.

The editors are aware, however, that people eat food and not nutrition. For most of us, food customs and preferences are influenced by social determinants that are deeply rooted in cultural values and historic traditions. The next time you eat, ask yourself, Why this food and not some other? What does this food reveal about me socially, culturally, and physiologically? Where did its ingredients come from? Why were these ingredients and not others included in the food? Does it contain any additives I should know about? As even a casual reader will note, the food we eat does not begin and end on our plates: how and when we eat, what we eat, and where and with whom we eat—all these choices display a range of behaviors about food that define and symbolize who we are. Hence, the *Encyclopedia* documents the act of eating from the perspectives of cultural history, nutrition, ethnicity, religion, psychology, anthropology, geography, economics, and aesthetics. Further, food-related behaviors are considered for their symbolic and cultural meanings, as in the entries about religion, holidays, table manners, social class, gender, sexuality, taboos, the arts, magic, and mythology.

In order to cover important cultural dimensions of food, the editors looked for experts who could discuss ethnic and national traditions across multiple disciplines and regions of the world and, where possible, provide an integrative approach to the dietary traditions of a people, nation, or region. Entries on countries with great food traditions that have had worldwide influence, such as France, Italy, and China, give attention to the foods and typical diets of the various regions of these countries, both historically and culturally, and consider important social, religious, political, economic, migration, and environmental factors.

The editors sought the contributions of authorities in a variety of fields in order to consider food from many perspectives. For instance, a chef might look at the artful arrangement of food on the plate or how it sears in a hot pan or grill. But a nutritionist is more interested in how the nutrients in a food may be affected by what the chef did to the food during preparation, what kinds of fats were added to the searing pan, or what nutrients may have been lost or altered during cooking. A food scientist may focus on the degree to which the food was safer to eat after it was heated to such a high temperature in the pan.

Authors were urged to try, within the limits of the allotted space, to write as comprehensively about their topic as possible. For example, the entry for chocolate covers the botany, history, and archaeology of cacao (chocolate bean), the principal ingredient of chocolate, and gives detailed consideration to how chocolate is produced and procured, stored, transported, and processed into various forms to be used in foods like candy and confections. The author also covers chocolate's cultural aspects, from its Mayan origin to its diffusion to the royal courts of Europe, and explains the technical discoveries that led to its commercialization and widespread availability.

The contributors give attention to the geographic origins of many foods and include their diffusion around the world and through time. Food history entries span the human evolutionary time scale, through prehistoric, ancient, and more recent periods for well-known societies and civilizations. Contemporary topics include food politics, genetic engineering, water as a resource, food supply and food shortages, advertising and marketing, the restaurant industry (including fast foods), and the commodification of various food traditions.

We believe that the *Encyclopedia* addresses a serious need for an integrated information source that encourages a greater appreciation of food, its history, and its ethnic diversity, while also explaining its nutritional significance. It is by combining a wide range of perspectives—a collaborative effort of hundreds of specialists—that this source can provide answers to many questions about health, food policy, hunger, food studies, and the food industry, while at the same time enhancing appreciation for the wonderful variety and history of the foods we eat.

We hope that by providing an integrative approach to food, nutrition, and culture over time and throughout the many regions of the world, this *Encyclopedia* will stimulate new insights about human evolution, adaptation, and creativity, and a richer appreciation of the many meanings of food and culture in our everyday lives.

*

I want to acknowledge the enormous support and patience of my wife, Pauline, the steadfast help of Jim Coleman, and the great inspiration provided by Jacob, Rachael, Micah, Noah, and Megan. I also want to acknowledge the invaluable assistance of William Woys Weaver and the editorial board; the steady support of Scribner Publisher Frank Menchaca and John Fitzpatrick; and the outstanding efforts of Mark LaFlaur and the Scribner editorial staff, including Kelly Baiseley and Georgia Maas, who got the job done. I am grateful to Stephen Wagley and Karen Day, formerly of Scribners, for their help and advice in initiating the *Encyclopedia.*

Solomon H. Katz
Philadelphia, October 2002

A

ACCEPTANCE AND REJECTION. Foods vary along a hedonic dimension, that is, in their ability to evoke pleasure. A food's hedonic value can differ significantly between individuals and among cultures. In developed countries at least, pleasure is probably the strongest determinant of diet. For most of us, most of the time, a global emotional response to the taste of a food determines whether it is consumed. Underlying this seemingly simple decision is a remarkable range of emotions—from blissful appreciation of haute cuisine to a profound rejection elicited by feelings of disgust. As with many other complex human behaviors, the development of food likes and dislikes reflects the operation of multiple influences—genetic inheritance, maternal diet, child raising practices, learning, cognition, and culture. In fact, the development of food preferences may be an ideal model of the interplay of these influences during our life span.

Foods may be selected or rejected for a variety of reasons, including their anticipated effects on health, their perceived ethical or environmental appropriateness, or practical considerations as price, availability, and convenience. However, it is our responses to the sensory properties of a food—its odor, taste, flavor, and texture—that provide the underlying basis of food acceptance. This article will focus on some of the influences that shape hedonic responses to foods, their flavors, and other sensory qualities.

Tastes

Despite evidence of innate hedonic responses to basic tastes, the vast majority of specific food likes and dislikes are not predetermined—no one is born liking blue cheese, for example. This is not to suggest that basic sensory qualities are unimportant. On the contrary, relatively fixed hedonic responses to sweet, salty, bitter, and umami (glutamate taste) tastes, and almost certainly fat, are present at or shortly after birth, and continue to exert an influence on food preferences. The strong affinity that children show for very sweet foods, and the persistence of the early development of liking for the taste of salt and salty foods throughout life appear to be universal. A majority in many Western societies also choose a diet that is high in fat.

However, innate responses do not account for the broad range of food likes and dislikes that develop beyond infancy. For instance, humans and many other mammals can detect bitterness at low levels and find it unpalatable because it is a potential sign of toxicity. Yet, while coffee and beer are typically rejected on first tasting, they are ultimately the strongest contenders for being the global beverages. The pungency of spicy foods is also initially rejected. Worldwide, though, chili is second only to salt as a food spice. Thus, although innate influences are clearly important in food selection, these are modified by our experience with foods (although both physiological makeup and culture will partly determine the extent to which experience is allowed to operate). What is more important than our innate preferences is the fact that we are predisposed to learn to like (and sometimes, dislike) foods. Some other preferences do appear to be common across cultures whose diets are very different. However, examples such as the widespread liking for vanilla and chocolate flavor are likely to reflect some degree of common experience.

Texture

Texture is a crucial criterion for sensory acceptance and rejection. Certain textures do seem to be universally liked, crispness, for example—perhaps through its association with freshness. Of course, to some extent, we will always prefer textures that are compatible with our dentition, and thus we would not expect infants to like hard foods. Foods that are difficult to manipulate in the mouth—such as soggy foods—are commonly disliked, as are foods that require excessive saliva and effort to swallow, such as dry, tough meat. While food texture is often cited as a reason for rejecting food, for example raw oysters, it is likely that such preferences are also a function of our prior expectations for specific foods.

Color

Food color is also undoubtedly a strong influence on acceptability, but again this is likely to reflect prior expectations. Whether we prefer white (U.S.) or yellow (U.K.) butter depends on what we have eaten in the past. Some colors have been thought to be inappropriate for food. The color blue, for instance, has been suggested as a candidate for a universally inappropriate food color—after all, very few foods are naturally blue. But recent marketing of brightly and "inappropriately" colored foods for children tends to undermine this notion, since the children appear receptive to unusual colors. Removing color from common foods does reliably reduce liking for those foods, perhaps by undermining our ability to identify their flavor, thus making them seem less familiar.

Fear of the New

The fact that humans are omnivores creates a paradox. On the one hand, we have access to a large range of potential nutrients; conversely (in nature at least), we are much more likely to be exposed to toxic substances. In the first two to three years of our lives, we exist in a highly protected environment, first in the context of breast or bottle feeding, and then through parental food selection and supervision. It is therefore adaptive for young infants to accept a wide variety of foods as the risk of exposure to potentially toxic nonfoods is low.

In later infancy, greater independence is typical, both in terms of the wider variety of other people encountered and also of the potential to come into contact with edible substances, which may be unsuitable for health or other reasons, outside direct parental influence. At this point, food neophobia often becomes apparent. Reluctance to consume novel foods at this age is most obviously reflected in statements of "I don't like it" to foods that have never been tried. The rejection of unfamiliar foods can now be seen as adaptive, given the wider risk of ingestion of potentially toxic substances. Food neophobia is found not just in humans, but also in a variety of non-human species, including rats, dogs, birds, and fish. Hence, it may be a universal safeguard against potential toxics.

The trait of food neophobia has been investigated in different age groups, as has the nature of the "fear" and how it can be modified. Even in adults, there often remain strong vestiges of childhood neophobia. While many welcome the chance to sample exotic foods or novel flavors, others remain unable to even consider consumption of foods beyond their usual repertoire.

Such reluctance is especially strong for foods of animal origin (unfamiliar meats, dairy products, or eggs), the same foods that elicit reactions of disgust, also thought to be a protective mechanism. Why this food-related personality trait varies so much among adults is unclear, but it might reflect the breadth of experience with different foods in childhood.

Interestingly, in both children and adults, food neophobia appears to be mediated less by any conscious awareness of the potential for danger, than by the much more immediate fear that foods will taste unpleasant. Consistent with this, willingness to try a novel food can be increased by strategies that reduce this anxiety, including providing information about the food's flavor or indicating that others have enjoyed it since. Highly neophobic individuals are more likely to choose an unfamiliar food after they have seen others select it. Specific nutritional information (such as the fact that a food is low in fat) also encourages selection of novel foods, but only for those for whom nutrition is important. In each case, the net effect is to assure the taster that the food is acceptable in terms of flavor and perhaps safety. Neophobia is a major issue for many parents concerned about the narrow range of foods that their children are willing to consume. A common strategy is to use one food as a reward for eating another food—one that the adult wants the child to eat. Unfortunately, these attempts frequently fail because the relative value of the foods is quite apparent. Rewarding the consumption of spinach by giving ice cream presents a message simple enough for any young child: ice cream is a good food (at least in terms of taste), otherwise why use it as a reward; spinach is bad, else why do I need to be rewarded for eating it? The unfortunate, if predictable, consequences of such strategies are increased liking for the reward and a decrease in liking for the target food.

Learning to Like

What does reduce neophobia and encourage consumption? In both children and adults, repeated exposure has been found to lead to increased acceptability of novel foods, with greater exposure producing greater liking. For example, three- and four-year-old children have been found to accept initially rejected cheese and fruits following ten exposures. It is possible that individuals who receive repeated exposure to a wide variety of foods as infants and children are least likely to be highly neophobic as adults, although this has yet to be established. That is, the more we experience different foods, the more we are willing to experience different foods.

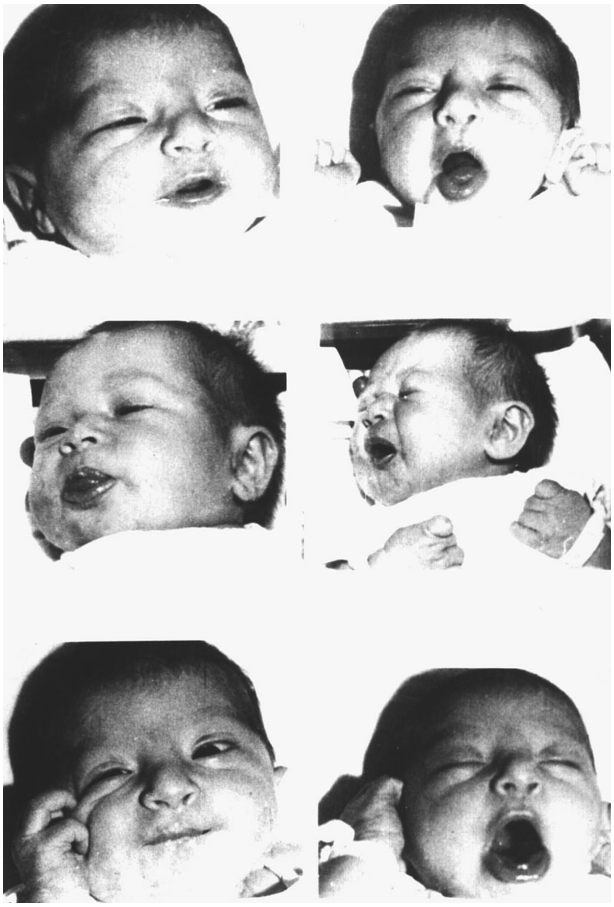
Exposure appears to be the one mechanism that is necessary for liking to increase. With novel foods or flavors, repeated consumption might lead to increased liking via a reduction in neophobia—effectively a relief from the anxiety associated with novelty. It certainly produces an increase in familiarity, an important aspect of children's likes and dislikes, and it has been recognized for some time that sensations of recognition are in themselves positive. However, changes in liking for food ingredients or ingredient levels in already familiar foods strongly suggest that exposure per se produces liking, and that a food or flavor does not need to be completely novel. There are many commonplace examples of this, including the gradual increase in liking that accompanies changing from regular to low-fat milk or low-salt soup, or reducing sugar in tea or coffee.

Although it is a necessary precondition, by itself, exposure is insufficient to explain why we end up liking some foods more than others. There appears to be a variety of other processes that operate during repeated food experiences, producing preferences for the diverse range of food odors and flavors that we encounter. Whether sniffed as aromas, or as characteristic flavor qualities in the mouth, food odors reliably inform us whether we have previously experienced a food. Odors are thus most likely to be the source of neophobic responses. However, there is nothing intrinsic to the odor or flavor of any food that means we will develop a strong like or dislike for it. During our early infancy (up to about three years old), we appear to be neutral to most if not all odors, except for those that also produce nasal irritation, such as ammonia. In contrast to those for tastes, odor preferences are almost certainly all learned, and rely upon our ability to form associations with other liked qualities. Pairing a novel flavor with a sweet taste, for example, reliably increases subsequent liking for that flavor, even when the sweetness is not present. This process, known as classical conditioning or associative learning, was first described scientifically by Ivan Pavlov. He famously demonstrated that the sound of a bell, previously associated with the presentation of food, would elicit gastric secretions in his dogs. While the principles of Pavlovian conditioning were developed using animal (especially rat) models, they appear equally applicable to explaining aspects of human food likes and dislikes.

The universal high palatability of sweetness and fat is a reflection of the ability of substances associated with these qualities to provide energy to the body. Our bodies find the provision of energy inherently rewarding. Consequently, repeatedly pairing flavors with ingested carbohydrates or fats produces increases in liking for associated flavors. Other postingestional consequences have also been described, including enhanced liking for flavors paired with the alerting effects of caffeine—a plausible mechanism, together with the energy provided by the sugar and milk fat sometimes added, for the enormous popularity of coffee.

The effects of conditioning by positive association and the absorption of energy-rich foods are broad enough mechanisms to account for very many food likes. One implication of this process and the body's response to energy is that we end up showing a liking for foods that are high in sugar and fat. Clearly, this has implications for health. We may know that high-fat foods present us with a risk in the long term, but what drives our behavior primarily is the fact that we like the fat—it gives the food a pleasant mouthfeel, it carries flavor well, and its provides the body with energy. The body's response is to promote liking for flavor associated with the fat. Eventually, it is not just the fat or sugar content that we find palatable, but the specific flavor of the food as well.

Food dislikes may also result from Pavlovian conditioning. Associating a characteristic food flavor with nausea, as sometimes occurs with food poisoning or a coincidental illness, will promote a rapid, often irreversible, "taste" aversion that actually seems to make the flavor become unpleasant. The development of aversions can be seen as highly adaptive—it makes sense to avoid foods previously associated with gastric illness. Consequently, the conditioned association tends to be very strong. In humans, taste aversions are typically both long lasting and robust enough to persist even if it is known that the food was not the source of the illness. As with neophobic responses, meat seems to be a common target when aversions do occur. An unfortunate consequence of the nausea associated with cancer chemotherapy is the development of taste aversions. Close to three-quarters of children aged two to fifteen years old undergoing treatment are reported to have at least one aversion. Taste aversions are not common enough to account for the majority of our food dislikes, since they appear to occur in only about 30 percent of people. However, they are a powerful indicator of the role that consequences of food ingestion can play in shaping our responses to a food's sensory qualities.



This sequence of pictures shows the reactions of babies from four to ten hours old prior to experiencing food of any sort. The left column shows their natural response to the sweetness of sucrose placed on the tongue, while the right column shows their response to the bitterness of quinine. Their facial expressions resemble those of adults tested for the same responses. PHOTO COURTESY OF DR. JACOB STEINER.

Odors are not the only sensory qualities in foods for which preferences are shaped by learning. Our most primitive sense is the detection of pain—unsurprisingly,

CRAVINGS FOR FOOD

At some time, most of us have experienced a craving for a specific food—something that we must have now, and which we will go out of our way to obtain. It is almost as if the body is insisting that we must have that food. There is much anecdotal information about craving and physiological needs, but less hard evidence for such specific appetites. It is clear that we get hungry and thirsty, but does the body really crave particular nutrients?

The one incontrovertible specific hunger that humans possess is for sodium chloride, common salt. Salt is metabolically essential and most of the time this need is both met and exceeded through diet. Clinical studies have demonstrated that in cases where the body is depleted of salt, humans develop strong appetites for the taste of salt, and its normal degree of palatability is increased. The same is true in experiments in which volunteers are fed low-salt diets—salty foods increase in palatability. Hence, it appears that a change in the hedonic value of the taste of salt is the mediator for increased intake when depleted.

Beyond salt appetite, however, there is little strong evidence that other specific appetites exist. There are reports suggesting an association between pica (the consumption of earth) and mineral (especially iron) deficiency. This practice appears to be most prevalent among pregnant women in poor rural communities. Pregnancy is well known to be associated with craving for foods, but it is not clear whether such "normal" cravings are related to metabolic needs.

The single most commonly craved food in Western societies is chocolate. Although chocolate contains phamacologically active compounds, there is no evidence these compounds are what is craved. Instead, the craving for chocolate is related to craving sweet foods generally and to chocolate's palatability, based on an optimal combination of sugar and fat. Chocolate craving is more common among women, and hormonal influences have been suggested as being important. The craving shows a peak around the time of menstruation and is also more common during pregnancy. While chocolate and sweet food cravings do occur among males, cravings for savory foods are more common.

A less extreme version of craving is the phenomenon of "moreishness." Again, wanting "just one more bite" appears to reflect the high palatability of certain foods, rather than a desire for any specific nutrient. Foods described as moreish also tend to be consumed in small amounts. Often their consumption is subject to a voluntary restraint determined by social mores; you may want another slice of cake, another piece of chocolate, or another potato chip, but will often hold back to avoid seeming intemperate. Because of the typically small portion sizes associated with moreish food, this may be an example of the appetizer effect, which occurs when the initial consumption of palatable foods increases appetite for further eating.

Explanations for craving, moreishness, and appetizer effects have recently focused on the brain's biochemistry, in particular those functions mediated by opioid (morphinelike) peptides. Interfering with the functioning of this biochemical system using opioid blocking drugs leads to reduced food consumption overall and also to attenuation of appetizer effects, apparently because the foods become less palatable. Conversely, it is possible that increased opioid levels may induce cravings by making foods more palatable. Such changes may occur in a variety of circumstances—dieting, stress, exercise, alcohol consumption—all of which are known to influence the brain's opioid systems.

Cravings thus tell us little about the body's nutritional needs, beyond the fact that highly palatable foods tend to be high in energy. Other evidence also points to strategies to maximize energy intake. At least in Western countries, given ample availability, we tend to consume a diet that contains 35 to 40 percent fat, well in excess of what we need to survive. Moreover, from early infancy onwards, we will attempt to compensate for reductions in calories at one meal with an increase at the next.

In addition to energy intake, we seem predisposed, as omnivores, to seek variety in our diet. As noted in the section on sensory-specific satiety, this may be one way of optimizing survival through ensuring adequate nutrient intake. Classic studies on dietary self-selection were carried out by Clara Davis in the 1920s and 1930s. She allowed recently weaned infants access to a varied selection of foods and found that they first tasted widely and then developed preferences for a selection of these foods. This research has been often misinterpreted to suggest that the body has an innate wisdom, in that the foods the infants selected represented a balanced nutrient intake. This was inevitable, however, given the range of foods available.

This is not to say that mechanisms responsive to our needs are not in operation. On the contrary, the palatability of energy and sodium sources, the avoidance of toxins through dislike of bitterness, the rapid formation of aversions to foods associated with gastric illness, and the maintenance of nutrient variety via sensory-specific satiety, are all innate predispositions that modulate the hedonic value of sensory properties of foods to help ensure survival.

since pain avoidance is the simplest key to survival. How then to explain the fact that at least a quarter of the world's population each day consume (and presumably enjoy) a meal containing an extremely potent irritant, capsaicin, which is present in chilies? Whatever the source of our increasing preference for pungency in foods, it must be a potent mechanism. Apart from the warning signals for pain, our bodies possess a built-in response to high levels of irritation. This defensive reflex, as it is known, consists of increased blood flow to the head, profuse sweating, tearing, and nasal discharge—physiological changes that are thought to have evolved as a means of rapidly eliminating toxins. Although frequent consumers of spicy foods experience somewhat less intense physiological responses and burn than infrequent users, there is no doubt that the burning sensations are actually part of the reason these foods are consumed, not something to be tolerated for other reasons.

Both regular exposure, commencing during breastfeeding, and postingestional energy conditioning are likely to play a part in the development of liking for hot foods, particularly in countries whose staple diet includes high levels of spiciness. To explain the recent increase in liking for hot foods in Western countries, though, a number of other interesting mechanisms have also been proposed. These include the hypothesis that the painful experience may activate the brain's natural opioid (morphinelike) biochemical systems, dampening pain and producing a chili eater's "high." Alternatively, it has been suggested that we derive pleasure from the "thrill" of the benign but highly stimulating experience of consuming hot foods.

Where Do Differences in Food Likes Come From?

If exposure, together with resultant learning processes, can substantially explain food preference development, what accounts for the differences in which foods we come to like? Exposure to flavors is now known to begin even prior to birth. Amniotic fluid, which comes into contact with the taste and odor receptors in the mouth and nose of the fetus, carries both taste and odor qualities. There is good evidence that the maternal diet during pregnancy can influence food preferences of the child following birth. Thus, it has been shown that infants whose mothers consumed carrot juice during pregnancy showed a greater liking for carrot-flavored cereal at six months of age than did a control group of children whose mothers consumed only water. Following birth, a wide range of flavors derived from the maternal diet is carried in breast milk, and this also influences an infant's later food preferences, including greater acceptance of novel flavors. In other words, the variety of a mother's diet can promote a varied set of food preferences in the infant. As a result, breast-fed babies are more likely to develop preferences following exposure to novel foods as infants. Whether this reflects early exposure to particular flavors, or a general effect of previous maternal dietary variety, is uncertain.

Social Influences

From childhood on, social interactions, whether within the family or with other groups, provide the context within which the majority of food experiences occur, and hence by which learning of food likes is facilitated. The pleasure associated with such interactions—the conviviality of a meal shared with friends, for example—may represent just as positive a conditioning stimulus for a new food flavor as sweetness. Thus, it may be that our estimation of the food at a restaurant has as much to do with the social environment as it does with the chef's skills. In children, pairing foods with the presence of friends, a liked celebrity, or attention by adults all increase liking for those foods, no doubt reflecting the positive hedonic value of each of these groups to the child.

This process is strongly evident in the relative impact of different social interactions on the food preferences of children. Surprisingly, despite the enormous opportunities in a family for exposing children to the foods eaten by the parents, parental preferences are poor predictors of child food preferences; in fact, they are no better predictors than the preferences of other adults. This suggests that the extent to which these sets of preferences are related has more to do with the wider culture than with any specific food habits within the family. A child's food likes and dislikes are much more likely to be associated with those of peers, especially specific friends, than those of its parents. Peers may also be as effective as families at helping to overcome neophobia, since the food choices of both friends or well-known adults strongly influence a child's food choices. The ultimate impact of social facilitation of food choice is that the liking eventually becomes internalized. That is, foods chosen because others do so become liked for their own sensory properties.

The Cultural Context

Dietary differences between cultures are almost always more pronounced than individual differences within a culture. The relatively limited amount of research that has been conducted on cross-cultural perceptions of sensory qualities finds fewer differences than are needed to explain the often markedly different preferences for foods. More plausibly, it is likely that differences in preferences reflect experiences with different foods. In addition to facilitating liking through exposure and the action of social influences, cultures act to define what substances are considered foods.

Foods that are unfamiliar to a culture may initially be seen as entirely unsuitable for consumption, while certain flavors may be regarded as inappropriate for specific foods. For example, bean paste is often used as a sweet filling in Japanese cakes, whereas in many Western countries, beans are expected to inhabit savory, not sweet, products. Again, porridge is either sweet or savory, depending on your heritage. In other cases, because of different histories of exposure, a preferred flavor in one culture may be perceived as unpleasant in another. The odor and flavor of lamb and mutton are highly liked in the West but rejected in the many parts of Asia that do not have the history of consuming sheep meat. Foods may of course be the subject of religious or cultural taboos, or even not be defined as food at all. In Western countries, we are unlikely to ever develop a taste for dog meat or snake blood.

The notion of culturally specific flavor principles has been proposed as a way of categorizing cultural differences in cuisines. Flavor principles are unique combinations of specific ingredients used in a variety of foods within a culture. This combination provides a characteristic flavor that foods within the culture share, and identifies them as originating from that culture. For example, a characteristic combination of ingredients in Japanese cooking is soy sauce, mirin (sweet rice wine) and dashi (a stock made from flakes of the bonito fish, which is high in umami taste). While Korea is geographically close to Japan, its flavor principle could not be less similar, with the intense flavors of garlic, chili, sesame, and soy dominating many dishes. Flavor principles not only define the national cuisine, they also perform a social role by acting as an expression of the individuality of the culture.

Flavor principles may help to provide a solution to the "omnivore's paradox" and the consequent neophobic response that novelty can elicit, thus limiting the foods available for consumption within a culture. A familiar flavor can provide a safe context for new foods, thus maximizing the breadth of the diet. On the individual level, recent findings suggest that a familiar sauce could increase the willingness of children to consume a novel food. A characteristic combination of flavorings may also provide variety and interest in diets dominated by bland staples such as corn or rice. Although a flavor principle might contain only a small set of characteristic seasonings, these can be combined in different ways. Moreover, what may appear to be a single ingredient or spice to an outsider may in fact have many subtle variations. Different chili varieties, for instance, vary considerably in the flavor and degree of heat that they impart to foods.

Increasingly, the food industry operates in a global setting. This is likely to mean that those foods that are purchased in your local supermarket are, or soon will be, also available on the other side of the world, perhaps within a culture whose cuisine is vastly different from your own. Whether this means that national flavor principles will ultimately be diluted or replaced is uncertain. Some evidence suggests they will not. Japanese urban populations have, for many years, enjoyed wide access to foods from other parts of the world, particularly Europe and the United States. Yet, while rice consumption has fallen and red meat and dairy food consumption has increased in recent years, there is little evidence that more traditional foods are disappearing. Moreover, Western food companies wishing to export to those cultures whose cuisines are substantially different are learning that incorporating aspects of the flavor principles of those cultures is essential for producing acceptable foods.

Food Choice: The Broader Context

Although a food's sensory properties may substantially determine what we like, they are only part of why we choose a particular food on a particular occasion. The determinants of our diet include factors that are both internal and external to the individual. Food choices are influenced by appetite, which in turn reflects when and what we last ate, and our overall state of physical and psychological health. In some extreme cases, these internal influences can render eating itself a pathological process, as in disorders such as anorexia and bulimia nervosa. Even in nonpathological circumstances, though, choosing a high-fat or -carbohydrate food may have more to do with our mood than anything else.

Liking is also heavily dependent on context. At its simplest level, cultural practices will determine whether or not we eat cooked meat or toast for breakfast. The extent to which either of these foods is acceptable will depend considerably on time of day. The same food can also vary in acceptability depending on where we experience it. Due to the influence of prior expectations, the same meal served in a restaurant is likely to be judged as more acceptable than if it is served in a student cafeteria.

Clearly, also, the reason why we first choose a food must be based on factors other than direct experience of, and therefore liking for, the sensory properties of the food. Food manufacturers and marketers rely on advertising and labeling to create a positive image for products, and attempt to create high (but not unrealistic) expectations for the product's sensory properties. If the food meets those expectations following purchase, then the consumer is likely to try the product again. Repeat consumption and the consequent associative and post-ingestive processes will then act to promote increased liking for the product.

See also **Anorexia, Bulimia**; **Appetite**; **Aversion to Food**; **Disgust**; **Sensation and the Senses**; **Taboos**.

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ADDITIVES. Food additives are regulated substances and therefore defined in law. Unfortunately, definitions vary among jurisdictions. A typical definition of a food additive may be: a substance the use of which in a food causes it to become a part of that food or to alter the characteristics of that food. A list of exceptions (Table 1) often follows because such a definition is vague and can include many substances not normally regarded as additives. Regulations are then required that control which additives can be added to which foods, and at what levels they can be added to those foods in which they are permitted.

In the U.S. Code of Federal Regulations, Title 21—Food and Drugs (21CFR170.3), the following definition appears: "Food additives includes all substances not exempted by section 201(s) of the act, the intended use of which results or may reasonably be expected to result, directly or indirectly, either in their becoming a component of food or otherwise affecting the characteristics of food."

The European Union (1994) defined a food additive as "any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food whether or not it has nutritive value, the intentional addition of which to food for a technological purpose in the manufacture, processing, preparation, treatment, packaging, transport or storage of such food results, or may be reasonably expected to result, in it or its by-products becoming directly or indirectly a component of such foods."

The Codex Alimentarius Commission (a joint Food and Agriculture Organization of the United Nations [FAO] and World Health Organization [WHO] organization established to develop uniformity of food standards for international trade) has defined a food additive as "any substance not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products becoming a component of or otherwise affecting the characteristics of such foods. The term does not include contaminants or substances added to food for maintaining or improving nutritional qualities" (Codex Alimentarius Commission, 1999).

In the Canadian Regulations, Part B, Food, Division 1, General, B.01.001, p. 16, of the Canadian Food and Drugs Act (Amendments 1999), "food additive" is defined as "any substance the use of which results, or may reasonably be expected to result, in it or its by-products becoming a part of or affecting the characteristics of a food, but does not include (a) any nutritive material that is used, recognized, or commonly sold as an article or ingredient of food, (b) vitamins, mineral nutrients and amino acids,

Exceptions Often Declared by Governments to the Definition of a “Food Additive”

Exceptions to Definition of Food Additive

- Flavoring preparations such as spices, natural extractives, oleoresins, essential oils, and seasonings
- Nutrients such as amino acids, vitamins, and mineral supplements, some of which may be regulated as to levels permitted in foods
- Any nutritive substance (that is, food ingredient) sold as an article of food or as an ingredient
- Certain permitted agricultural chemicals (used in growing plants) and drugs (administered to animals)
- Packaging materials and their components

other than thosse listed in the tables to Division 16, (c) spices, seasonings, flavouring preparations, essential oils, oleoresins and natural extractives, (d) agricultural chemicals, other than those listed in the tables to Division 16, (e) food packaging materials and components thereof, and (f) drugs recommended for administration to animals that may be consumed as food.”

These definitions differ in their specificity, and exceptions to the definitions vary from country to country and trading bloc to trading bloc. These differences can be a source of confusion in the mind of the public regarding what food additives are, as well as a source of nontariff trade barriers between countries.

In the United States, there are two categories of exemptions to the definition (Food Additives Amendment 1958): prior-sanctioned items and GRAS (generally recognized as safe) items [21CFR170.3 (k, l, n, and o)]. The former category was sanctioned by existing legislation (prior to September 6, 1958) as outlined in the Federal Food, Drug, and Cosmetic Act, the Poultry Products Inspection Act, and the Meat Inspection Act. GRAS substances, so declared based on opinions of experts and an extensive history of use, are listed in forty-two categories and include salt, alcoholic beverages, cheeses, baked goods (mixes, flours, ready-to-bake products), condiments, fats and oils, and so forth. They can very loosely be described as the “ingredients” usually found in recipes. Also exempted are thirty-two categories of GRAS food chemicals, which can broadly be classed as processing aids.

In the Directive of the European Communities the exceptions to the definition are: processing aids (which are further defined); agricultural chemicals used in conformity to European Community rules; flavorings as defined by Council Directive; and substances added to foods as nutrients.

Indirect (Unintentional) and Direct Additives and “Carry-Over”

In addition to the definition of “additive” itself, there are also definitions of direct and indirect (unintentional) additives, and the principle of carry-over. Direct additives are added directly to foods for a specific aesthetic or technological purpose. They are usually declared on labels. Indirect additives become part of the food usually in trace amounts that are harmless to consumers and are present because of packaging, storage, processing, or handling. These are also referred to as unintentional additives. Their presence in foods results from the principle of “carry-over,” that is, they are permitted agricultural chemicals used on farm products or accepted drugs and nutrients fed to animals. Such agricultural chemicals, even when used according to good husbandry practices, may end up in the food supply, or additives used as a component in ingredients may turn up in trace amounts in finished food products. Such substances are permitted only if the substance was permitted in the raw material or ingredient initially; the amount in the raw material does not exceed the maximum amount so permitted in the raw material or ingredient; and the amount carried over into the food does not exceed that expected by good manufacturing practice [see, for example, Codex Stan 192-1995 (Rev.2-1999) p. 3, Section 4].

History of Food Additives

Substances have been added to foods to achieve some desirable characteristic in a finished food product for many hundreds, if not thousands, of years. For example, salt has been used to preserve hams as well as some hard sausages and salted cod; to flavor foods; and to control the fermentation of a variety of vegetables such as sauerkraut and *sauerrüben* (fermented rutabagas), and fish products (for example, *rollmops*, Bismarck herring, fish sauce, Malaysian *nuoc-mam*, shrimp paste, *belacan*, and anchovies). Historically bakers used fats to “shorten,” that is, lubricate, dough for certain baking products. In these two examples, salt and certain fats have been used as processing aids.

Spices, herbs, and some vegetables were added to foods to develop unique and pleasing flavors, and in some cases to enhance or preserve foods. For example, Hartley, in *Food in England* (1985, p. 563), describes claims made by cider processors that straw mats (processing aids) used to separate layers of apples in presses for cider making produced the best cider because of the minerals drawn up by the straw from the soil. There are many kinds of leavening agents used in baking: yeast, sourdough starter cultures, baking soda and an acid (for example, soured milk) for soda breads, or commercially prepared baking powder which contains the previous two agents (plus others) together in one mix. Salts of sulfurous acid (sulfites) are used to control the fermentation of grape musts and were also used by fraudulent butchers to give a fresher, brighter appearance to ground meats.

Prior to the development of food science and before the establishment of a rigorous system of food inspections, food manufacturers and food retailers often took advantage of this lack of good analytical methods for food products by mixing adulterants into foods to deceive the consumers. Elisa Maria Rundell in her book, *A New System of Domestic Cookery*, describes a procedure (1828, p. 336) to determine whether bread has been adulterated with whiting or chalk, commenting that this type of adulteration was common practice.

A. H. Hassall (1817–1894), an early food analyst, determined (ca.1850) that much of the coffee sold in England had, as "additives," chicory, roasted wheat, burnt sugar for coloring matter, beans, and potato flour. An earlier chemist, Fredrick Accum (1769–1838), started one of the first training centers in practical (analytical) chemistry in England and reported such fraudulent practices as mustard adulterated with radish seed; vinegar sophisticated with sulfuric acid; cream enhanced with rice powder and arrowroot; cayenne pepper adulterated with red lead; and confectionery colored with vermilion (mercuric sulfide) (see also Skuse, c. 1900). The work of Accum, but primarily that of Hassall, led directly to the passing of food legislation preventing the adulteration of foods and drink in the U.K. (Farrer, 1996, 1997).

Traditionally, innocent additives have been added to foods. Cooking skills passed on from mothers to daughters and often to be found in some of today's older cookbooks taught the use of unripe apples (or apple skins) to assist the gelling of fruit jams; lemon juice added for acidification of foods; and Hart's horn (deer antler) shavings used for gelation. Today, the active components of these natural ingredients, pectin in the apples, citric acid in the lemons, and gelatin in the antlers are well-recognized food additives.

In many people's minds, however, food additives are considered to be a suspicious, comparatively modern invention created in large part by food manufacturers to cheapen products and hoodwink the public.

In earlier times, there was some truth to this suspicion. Today, this is far from the truth. There was, and is, an absolute need for improved processing aids to satisfy the demands by consumers for attractive, tasty, safe food products of uniformly high quality as well as for new products.

In the United States, individual states were the first to develop food legislation and a system of food inspection. In terms of federal legislation, the Federal Food and Drugs Act of 1906, popularly known as the Pure Food Law, for prevention of adulteration of foodstuffs, was passed, and came into force on January 1, 1907. It dealt largely with adulteration and misbranding of foods.

In Skuse's *Complete Confectioner* (10th ed.), published ca. 1900, the author found it necessary to list poisonous colors that confectioners should avoid. Among those he listed are chrome yellow (lead chromate), sulfate of arsenic, red lead, and copper sulfate. Skuse noted that he "knows sugar boilers who are very partial to use a little chrome yellow for stripes."

* * *

Marketing people and retailers often defend adding color and flavor to processed foods. Only safe, attractive, nutritious, and flavorful food can be marketed successfully and therefore only such foods will be purchased by consumers. It is only these foods that are ultimately consumed. Good nutrition can be maintained within the population only if attractive, wholesome foods are presented.

* * *

Chicory, considered an adulterant in ground coffee, is also used as a coffee-substitute beverage in its own right and is often added to some coffees to give a richer, stronger, roasted flavor to the final beverage.

The Need for Additives

Using such natural products as apple skins or lemon juice as food processing aids causes problems in large-scale manufacturing situations. First, the desired active ingredients in natural products are not consistent in quality, properties, versatility, or concentration in their natural state. Furthermore, they may bring both undesirable flavor attributes, associated with their source, to the finished product, as well as microbiological contamination. For example, using orange or lemon juice to acidify a food inevitably brings the flavor of oranges or lemons, which may not be desired in the finished product. It would be the rare householder who would want to make her own red color by crushing the dried insect used to make an extract of cochineal for baking or candy making.

Consumers who shop for groceries only once a week or even only once every two weeks still want their food purchases to remain as fresh, wholesome, and safe as the day they were purchased. The consumer's demand for manufactured, prepared foods that have a high uniform quality with good shelf life characteristics and are as close to the natural state as possible has been the major determinant for an increase in the use of additives. Additives preserve color and flavor as well as maintaining safety and nutritive value throughout both processing and the product's shelf life.

NEED FOR FOOD ADDITIVES IN MANUFACTURING

Quality Characteristics in Processed Foods Demanded by Consumers that Require Use of Additives in Manufacturing

- Uniformity of products sold by count, size, shape, volume, or weight
- Desire for fresh, semiprepared foods "as fresh and natural appearing as possible" with a safe, long shelf life
- Replacement of nutrients lost or reduced in processing as well as the addition of other health-giving properties equivalent to the unprocessed product
- Additions of special nutrients or other substances for foods for consumers with special nutritional needs
- Dietetic foods with same eating characteristics (flavor, taste, color, texture, and mouth feel) as the regular product
- Flavor, color, and texture (crispness, eye appeal, or moistness) of unprocessed, natural product
- Unique characteristics such a spreadability at room temperature, adherence, flow properties
- Enhancement of keeping qualities and organoleptic characteristics of processed foods for eating enjoyment

The box above lists some quality characteristics consumers prefer that require food additives to be added to foods. For example, in dietetic foods (low-salt, low-fat, low-sugar, or lactose-free foods), there must be some alternative substance (an additive) to replace the taste impact that salt provides, or to provide the mouth feel found in full-fat foods, to replace the sweetness provided by sugar, or to remove (along with the enzyme lactase) the lactose inherent in milk products. Hence there was a need for new additives that were either synthesized de novo, extracted and purified from natural sources (these additives are termed "nature identical"), or modified chemically to provide unique properties not found with nature-identical substances, for example, modified starches. Some of these properties are resistance to heat and acetic acid, constant viscosity in sauces during prolonged heating or without prolonged storage, special textures such as creaminess or pulpy granularity, or pregelatinization for "instant" rices. Thus, along with consumers' desire for a decreased use of additives there is also a need for newer and more effective additives (Smith, 1993).

Classification and Functions of Additives

Additives perform a specific and necessary aesthetic or functional role in foods. If they did not have a purpose, no government would have considered allowing them. Many additives have several different functions depending on the foods they are added to. In addition to their flavoring and nutritive properties, some herbs, spices, vegetables, and vitamins added to foods have other functional properties as processing aids. For example, vitamin C (ascorbic acid) and vitamin E (tocopherols) are both excellent antioxidants and are used to remove oxygen and prevent oxidation, thus extending the shelf life of many food products. Garlic has long been used for its antimicrobial properties. Thyme and oregano contain thymol, which has a wide spectrum of antimicrobial effectiveness (Beuchat and Golden, 1989).

The only practical way to classify additives is by the purpose for which they are added to foods. The table presents one classification of additives with some typical examples within each classification and examples of foods in which they may be found.

Colors. Colors are either water soluble or oil soluble (see Carriers, extractants, and solvents) and are designed for specific application in aqueous or oily foods. There are three categories of colors: natural or nature-identical, synthetic, and inorganic. Natural or nature-identical colors (colors extracted from natural products or synthesized to resemble their natural counterpart) have two disadvantages. They are frequently mixtures and are, in general, not as stable in foods as are the synthetic colorants. Many change color with the acidity or alkalinity of the food they are added to; many are susceptible to breakdown by oxidation and heat. Synthetic colors are preferred colorants in foods, but questions of their safety have arisen in the past and hence there is widely differing acceptance of their use in many foods by different countries. Inorganic colorants are very stable but have a limited use in foods such as sugars, jams, and confectionery.

In most instances, colorants are permitted according to "good manufacturing practices," that is, governments, working closely with food manufacturers and with the advice of experts, have established minimal, acceptable levels of usage in practice.

Enzymes. Enzymes are biological catalysts that can break down specific materials (substrates) into simpler components or cause changes in the substrate's structure. Carbohydrases break down complex sugars (for example, starches, cellulose, lactose, maltose, and so on) into simpler sugars (saccharification). Lipases break down fats into glycerol and fatty acids. Proteases break down proteins into their constituent amino acids. Other enzymes act as preservatives and scavenge oxygen that may be dissolved in plant tissues or in headspaces in packages and remove it.

TABLE 1

Classification of additives according to functions with examples and products they might be used in[a]

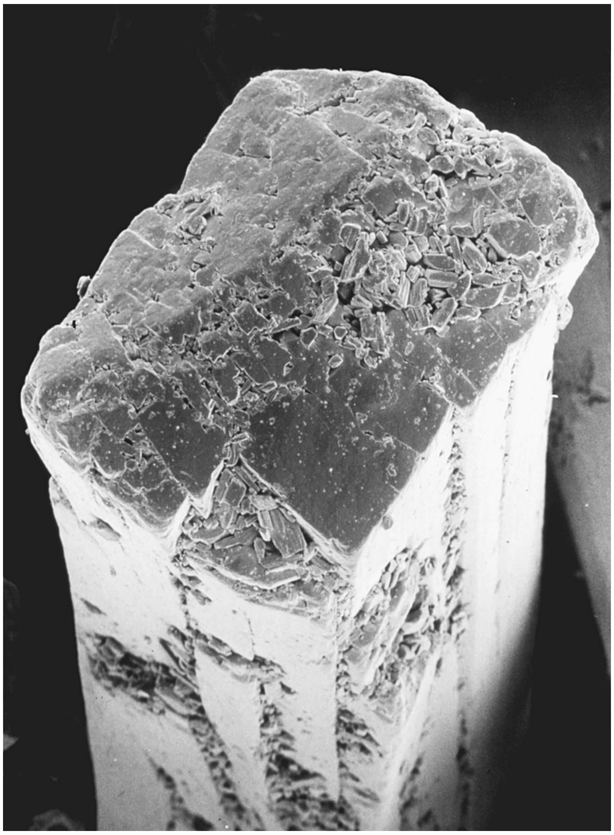
Function or category of additive	Typical examples of additive[b]	Products benefited by addition[c]
Coloring agents		
Natural or nature-identical	Annatto, carotenes, chlorophyll, cochineal, paprika, turmeric, anthocyanins	Fruit jams, jellies, and marmalades; ice cream and ice cream mixes, cheeses; pickles and relishes; butter; liqueurs and cordials
Synthetic	Tartrazine, amaranth, allura red, sunset yellow	Similar to above
Inorganic	Titanium dioxide, iron oxide, silver metal, aluminum metal	Certain sugar products, jams; surface colorants of confectionery products
Enzymes		
Carbohydrases	Amylase, cellulase, invertase, lactase, pullulanase, pentosanase, glucose isomerase	Ale, beer, malt liquor, cider wine, bread, flour; mash, coffee and tea extracts, fruit juice; liquid and soft-centered confectionery; reduced-lactose products; bread, flour, production of dextrins, maltose; ale, beer, bread, fructose syrups
Lipases	Lipase	Dairy-based flavorings, cheeses, modified fats for dietetic foods, bread, flour
Proteinase	Bromelain, ficin, papain, pancreatin, pepsin, protease, rennin	Beer, malt liquor, bread, flour, cheeses, meat-tenderizing preparations, precooked cereals, milk, animal and vegetable hydrolysates, meat pickles
Preservation	Catalase, glucose oxidase	Oxygen scavengers used in egg products and dairy products
Carriers or extractants	Acetone, benzyl alcohol, carbon dioxide, ethyl acetate, tributryrin, mono- and diglycerides, hexane	Spice extracts; flavoring preparations; added to coffee and tea for decaffeination; hops extraction, fats and oils seed meals
Sweeteners	Aspartame, mannitol, sorbitol, xylitol, isomalt, sucralose, thaumatin	Dietetic foods (low calorie), soft drinks, bakery products, confectionery
Preservatives	Acetic acid, ascorbic acid and salts, sodium and potassium nitrates, sodium and potassium nitrites, wood smoke, benzoic acid and salts, sulfurous acid and salts, propionic acid and salts, sorbic acid and salts, ascorbyl palmitate and stearate, BHA, BHT, citric acid and salts, propyl gallate, tartaric acid	Meat and meat products, cured meat and fish products, fish and fish products, ale, beer, cider, malt liquor, cheeses and cheese spreads, canned or frozen fruit and vegetable products, fruit beverages, seafood products, bread and baked goods, fats, oils, and so forth
Bleaching, maturing, and dough conditioning agents	Ammonium persulfate, ascorbic acid, benzoyl peroxide, chlorine and chlorine dioxide, sodium sulfite, potassium iodate	Flour, whole wheat flour, bread, cake mixes, some dough mixes
Anticaking agents	Silicon dioxide, magnesium stearate, cellulose, various calcium salts	Salt, baking powder, and other dry mixes and powders
Emulsifying, gelling, stabilizing, and thickening agents	Various plant and microbial gums and polysaccharides and salts thereof, gelatin, pectin, acetylated monoglycerides, lecithin, methyl cellulose, various calcium and magnesium salts	Used in a wide range of food products from alcoholic beverages to milk and dairy products, fruit and vegetable products, to meat and meat products and oils and margarines
Firming agents	Aluminum, calcium, and sodium salts of various acids, for example, aluminum sulfate of calcium lactate	Canned fish and fish products, canned fruit and vegetable products, pickles and relishes
Glazing and polishing agents	Various gums and waxes, for example, beeswax, gum arabic, mineral oil, acetylated monoglycerides	Primarily confectionery products
Buffering agents, pH adjusting agents, acid reacting materials, and water correcting agents	Acetic acid and various salts, ammonium aluminum sulfate, ammonium or calcium hydroxide, citric acid and various salts, salts of phosphoric acid, cream of tartar	Baking powder, cocoa products, cheeses, ice cream mixes, alcoholic beverages, fruit and vegetable products
Sequestering agents	EDTA and salts thereof, citric acid and its salts, phosphoric acid and its salts	Pumping pickles, alcoholic beverages, canned seafood (lobster, clams, sea snails, and so forth), dairy products, meat and poultry products
Starch modifying agents	Hydrogen peroxide, nitric acid, peracetic acid, sodium hydroxide, sulfuric acid	Starch
Yeast foods	Ammonium, calcium, potassium and zinc salts of various acids such as phosphoric, carbonic, and citric	Flour, bread, some alcoholic beverages, bacterial starter cultures

Abbreviations: BHA, butylated hydroxyanisole; BHT, butylated hydroxytoluene; EDTA, ethylenediaminetetraacetic acid.

[a] In reading this table, it is important to recognize that regulations regarding food additives (1) vary from country to country, (2) vary both with the levels of use permitted in foods and with the foods to which they may be added, and (3) are constantly being reviewed regarding their need and safety as new research emerges and newer and better additives are developed (Smith, 1993). Information provided here should not be interpreted as indicating that any food application is permissible in any specific country.

[b] The listing of examples of additives is not complete.

[c] The listing of examples of products is not complete.



Electron micrograph of a crystal of monosodium glutamate. MSG is one of the most widely used additives in food, and some people suffer reactions to it, especially a swollen liver, which extends the stomach and creates the discomforting sensation of having overeaten. COURTESY OF PHOTO RESEARCHERS, INC.

Many enzymes are derived from natural sources, for example, rennet from stomachs of calves, sheep, and goats; bromelain and papain from pineapples and papaya, respectively; ficin from latex of fig trees; pancreatin from the pancreas of pigs and oxen. However, an ever-growing number of enzymes are derived from microorganisms such as *Bacillus subtilis*, various species of molds especially *Aspergillus* varieties, and yeasts.

Carriers, extractants, and solvents. Carriers and extractants are used to extract flavoring compounds from spices and herbs to produce oleoresins; soluble solids from tea leaves; and coffee beans for the preparation of soluble drinks and for the selective extraction of caffeine in decaffeinated coffees; preparing hop extracts for beers; and extraction of cocoa powder. They are also used to extract fats and oils from oil seeds (defatting) and to dissolve oil-soluble dyes and flavorings, thereby serving as carriers to be added to other foods.

Sweeteners. There are two types of sweeteners: caloric sweeteners that provide minimal calories (usually only 1 or 2 calories) based on their sweetening power compared to that of sucrose, the sweetener they are replacing, and noncaloric sweeteners, which provide no calories. In U.S. regulations, caloric sweeteners as defined here are referred to as "non-nutritive sweeteners" and further defined as "substances having less than 2 percent of the caloric value of sucrose per equivalent unit of sweetening capacity."

Preservatives. A wide variety of additives are used for preventing or delaying spoilage and are closely restricted in respect to the foods they can be used with and the levels at which they can be used. Some preservatives, such as acetic acid, wood smoke, ascorbic and erythorbic acids, lecithin (component of egg yolk and soybeans), citric acid, and tartaric acid, are generally permitted according to good manufacturing practice. However, sulfurous acid and its salts (sulfites) can cause serious problems in some asthmatics and regulations permit only low levels to be used. Nitrite and nitrate salts, used in meat curing, have been determined to be potential sources of cancer-causing agents and only minimal levels are permitted to be used.

Bleaching, maturing, and dough conditioning agents. These agents are used for whitening flour and improving (maturing and conditioning) flour's baking characteristics in the many varieties of bakery products.

Anticaking agents. These agents reduce the tendency of granulated products (dry mixes, dried egg powders, salt, and so forth) to stick together and help them keep their free-flowing properties.

Emulsifying, gelling, stabilizing, and thickening agents. Emulsifying agents are used in the formation of stable oil-and-water or oil-and-vinegar mixtures. Gelling, stabilizing, and thickening agents form soft gelled structures, thicken suspensions of particulate foods and prevent their separating, and provide mouth feel as bulking agents in low-calorie foods. They are also used to prevent or slow crystallization (staling) in foods.

Firming agents. These agents prevent or inhibit the softening of processed fruits and vegetables, especially during the process of canning in which they receive a severe heat treatment.

Glazing and polishing agents. These agents put a protective surface or coating or polish on a food, particularly confectionery products but also some vegetables and fruits.

pH-Adjusting, acid-reacting, and water-correcting agents. These agents maintain the acid-alkali balance (that is, pH) of foods at a desired level. Many delicate products such as artichokes must be acidified in order to be thermally processed (canned) with a less severe heat process because the usual high temperatures used for canning vegetables would destroy their shape and texture. Acids are also required to release carbon dioxide from leavening agents.

Sequestering agents. These agents act as sponges to gather or reduce in concentration any trace metal ions (especially copper and iron) that might, for example, promote oxidation or otherwise cause spoilage in foods. They improve the quality, color, and stability of canned products.

Starch-modifying agents. These agents can be used only to modify the properties of starch for its use in mixes, sauces, and custards.

Yeast foods. As their name suggests, these agents are used in fermentations with yeast and serve as a food for the yeast in the preparation of the inoculum. An inoculum is a highly concentrated suspension of yeast (or other microorganisms) to be added to malt mashes for beermaking or to bread doughs for leavening purposes or wherever fermentation is desired.

Miscellaneous additives. Propellant gases for the dispensing of foams or aerosol foods are also additives.

Regulation, Control, and Safety of Food Additives

Countries with well-developed food manufacturing industries have food legislation and associated regulations governing the use of food additives. In trade, where regulations between countries may differ, countries may allow conditional entry (where safety is not a concern) requiring relabeling of an offending product or specify compliance to Codex Alimentarius Commission standards before permitting importation.

The process for revoking approval or modifying the conditions of approval of existing food additives or for approving new ones varies from country to country. As problems of public health significance emerge that are attributable to the use of an additive, that information is assessed by panels of experts in the fields of epidemiology and toxicology. Should questions of safety emerge regarding the use of any prior approved additive, an evaluation must be made of the risk/benefit problems associated with continued use (Institute of Food Technologists, 1978). An excellent example of such a risk/benefit assessment can be found in the continued use of nitrate/nitrite salts in cured meat products. Banning the use of the salts in cured meats would most certainly expose the consuming public to the greater danger of botulism poisoning. The absence of these salts would permit the growth of *Cl. botulinum* in the cured meat and certainly the associated development of the *botulinum* toxin. On the other hand, these salts are also able under some circumstances to form nitroso-compounds, which are very active carcinogens.

However, there are general principles to guide the use of food additives and the assessment of new ones. No food additive is permitted for use until its safety has been assessed by expert panels of specialists. It is up to the petitioner for use of an additive to supply toxicological data to the government-appointed panel. Evaluations, based on a generally accepted protocol, must be made of the toxicological effect of the additive (Winter and Francis, 1997). Animal testing is required to determine levels of toxicity which are then used to determine human toxicity levels, but if the additive is substantially the same as the natural prior sanctioned or GRAS product, animal testing may not be required.

GENERAL PRINCIPLES GUIDING THE USE OF FOOD ADDITIVES

Requirement for Uses of Additive

- The additive must serve a useful purpose in preparing, processing, storage, and handling of the food
- The use of the food additive should not deceive, mislead, or defraud the consumer
- The use of the additive should not pose a health hazard either to the general population or to any special segment within the population

Toxicity data that are submitted for evaluation are based on assessment of exposure; such data must also determine the level of exposure. This will be influenced by the level used in foods (which is kept to the minimum level to produce the desired effect) and the level that remains in the food after processing. Other factors affecting the dose level are the age and gender of the consumer eating the food; the physical state of that individual (that is, pregnant, lactating, convalescent, with reduced immune system, with allergies, with special diet requirements, and so on); frequency of eating the food to which the additive is added; and the composition of the rest of the diet, which can have a protective effect on the toxicity.

Prior sanctioned additives are regularly reviewed for safety. Submissions for the approval of new additives may take several years and cost many hundreds of thousands of dollars to the petitioner. Such submissions are not undertaken lightly. The consumer's demand for innovative foods with new properties and enhanced safety will certainly see the food industry develop more and functionally better additives that are safe.

See also **Adulteration of Food**; **Codex Alimentarius**; **Consumer Protests**; **Food, Composition of**; **Food Safety**; **International Agencies**; **Toxins, Unnatural, and Food Safety**.

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ADULTERATION OF FOOD. "Adulteration" is a legal term meaning that a food product fails to meet federal or state standards. Adulteration usually refers to noncompliance with health or safety standards as determined, in the United States, by the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA).

Definition of Adulterated Food

The Federal Food, Drug, and Cosmetic (FD&C) Act (1938) provides that food is "adulterated" if it meets any one of the following criteria: (1) it bears or contains any "poisonous or deleterious substance" which may render it injurious to health; (2) it bears or contains any *added* poisonous or *added* deleterious substance (other than a pesticide residue, food additive, color additive, or new animal drug, which are covered by separate provisions) that is unsafe; (3) its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health; or (4) it bears or contains a pesticide chemical residue that is unsafe. (Note: The Environmental Protection Agency [EPA] establishes tolerances for pesticide residues in foods, which are enforced by the FDA.)

Food also meets the definition of adulteration if: (5) it is, or it bears or contains, an unsafe food additive; (6) it is, or it bears or contains, an unsafe new animal drug; (7) it is, or it bears or contains, an unsafe color additive; (8) it consists, in whole or in part, of "any filthy, putrid, or decomposed substance" or is otherwise unfit for food; or (9) it has been prepared, packed, or held under unsanitary conditions (insect, rodent, or bird infestation) whereby it may have become contaminated with filth or rendered injurious to health.

Further, food is considered adulterated if: (10) it has been irradiated and the irradiation processing was not done in conformity with a regulation permitting irradiation of the food in question (Note: FDA has approved irradiation of a number of foods, including refrigerated or frozen uncooked meat, fresh or frozen uncooked poultry, and seeds for sprouting [21 C.F.R. Part 179].); (11) it contains a dietary ingredient that presents a significant or unreasonable risk of illness or injury under the conditions of use recommended in labeling (for example, foods or dietary supplements containing aristolochic acids, which have been linked to kidney failure, have been banned.); (12) a valuable constituent has been omitted in whole or in part or replaced with another substance; damage or inferiority has been concealed in any manner; or a substance has been added to increase the product's bulk or weight, reduce its quality or strength, or make it appear of greater value than it is (this is "economic adulteration"); or (13) it is offered for import into the United States and is a food that has previously been refused admission, unless the person reoffering the food establishes that it is in compliance with U.S. law [21 U.S.C. § 342].

The Federal Meat Inspection Act and the Poultry Products Inspection Act contain similar provisions for meat and poultry products. [21 U.S.C. §§ 453(g), 601(m).

Poisonous or Deleterious Substances

Generally, if a food contains a poisonous or deleterious substance that may render it injurious to health, it is adulterated. For example, apple cider contaminated with *E. coli* O157:H7 and Brie cheese contaminated with *Listeria monocytogenes* are adulterated. There are two exceptions to this general rule. First, if the poisonous substance is inherent or naturally occurring and its quantity in the food does not ordinarily render it injurious to health, the food will not be considered adulterated. Thus, a food that contains a natural toxin at very low levels that would not ordinarily be harmful (for instance, small amounts of amygdalin in apricot kernels) is not adulterated.

Second, if the poisonous or deleterious substance is unavoidable and is within an established tolerance, regulatory limit, or action level, the food will not be deemed to be adulterated. Tolerances and regulatory limits are thresholds above which a food will be considered adulterated. They are binding on FDA, the food industry, and the courts. Action levels are limits at or above which FDA *may* regard food as adulterated. They are not binding on FDA. FDA has established numerous action levels (for example, one part per million methyl mercury in fish), which are set forth in its booklet *Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed*.

If a food contains a poisonous substance in excess of a tolerance, regulatory limit, or action level, mixing it with "clean" food to reduce the level of contamination is not allowed. The deliberate mixing of adulterated food with good food renders the finished product adulterated (FDA, *Compliance Policy Guide* [CPG § 555.200]).

Filth and Foreign Matter

Filth and extraneous material include any objectionable substances in foods, such as foreign matter (for example, glass, metal, plastic, wood, stones, sand, cigarette butts), undesirable parts of the raw plant material (such as stems, pits in pitted olives, pieces of shell in canned oysters), and filth (namely, mold, rot, insect and rodent parts, excreta, decomposition). Under a strict reading of the FD&C Act, any amount of filth in a food would render it adulterated. FDA regulations, however, authorize the agency to issue Defect Action Levels (DALs) for natural, unavoidable defects that at low levels do not pose a human health hazard [21 C.F.R. § 110.110]. These DALs are advisory only; they do not have the force of law and do not bind FDA. DALs are set forth in FDA's Compliance Policy Guides and are compiled in the *FDA and Center for Food Safety and Applied Nutrition (CFSAN) Defect Action Level Handbook*.

In most cases, DALs are food-specific and defect-specific. For example, the DAL for insect fragments in peanut butter is an average of thirty or more insect fragments per 100 grams (g) [CPG § 570.300]. In the case of hard or sharp foreign objects, the DAL, which is based on the size of the object and the likelihood it will pose a risk of choking or injury, applies to all foods (see CPG § 555.425).

Economic Adulteration

A food is adulterated if it omits a valuable constituent or substitutes another substance, in whole or in part, for a valuable constituent (for instance, olive oil diluted with tea tree oil); conceals damage or inferiority in any manner (such as fresh fruit with food coloring on its surface to conceal defects); or any substance has been added to it or packed with it to increase its bulk or weight, reduce its quality or strength, or make it appear bigger or of greater value than it is (for example, scallops to which water has been added to make them heavier).

Microbiological Contamination and Adulteration

The fact that a food is contaminated with pathogens (harmful microorganisms such as bacteria, viruses, or protozoa) may, or may not, render it adulterated. Generally, for ready-to-eat foods, the presence of pathogens will render the food adulterated. For example, the presence of *Salmonella* on fresh fruits or vegetables or in ready-to-eat meat or poultry products (such as luncheon meats) will render those products adulterated.

For meat and poultry products, which are regulated by USDA, the rules are more complicated. Ready-to-eat meat and poultry products contaminated with pathogens, such as *Salmonella* or *Listeria monocytogenes*, are adulterated. (Note that hotdogs are considered ready-to-eat products.) For raw meat or poultry products, the presence of pathogens will not always render a product adulterated (because raw meat and poultry products are intended to be cooked, and proper cooking should kill pathogens). Raw poultry contaminated with *Salmonella* is not adulterated. However, USDA's Food Safety and Inspection Service (FSIS) has ruled that raw meat or poultry products contaminated with *E. coli* O157:H7 are adulterated. This is because normal cooking methods may not reduce *E. coli* O157:H7 below infectious levels. *E. coli* O157:H7 is the only pathogen that is considered an adulterant when present in raw meat or poultry products.

Enforcement Actions against Adulterated Food

If a food is adulterated, FDA and FSIS have a broad array of enforcement tools. These include *seizing* and *condemning* the product, *detaining* imported product, *enjoining* persons from manufacturing or distributing the product, or *requesting a recall* of the product. Enforcement action is usually preceded by a Warning Letter from FDA to the manufacturer or distributor of the adulterated product. In the case of an adulterated meat or poultry product, FSIS has certain additional powers. FSIS may *suspend* or *withdraw* federal inspection of an official establishment. Without federal inspection, an establishment may not produce or process meat or poultry products, and therefore must cease operations. With the exception of infant formula, neither FDA nor FSIS has the authority to require a company to recall an adulterated food product. However, the ability to generate negative publicity gives them considerable powers of persuasion.

State regulators generally have similar enforcement tools at their disposal to prevent the manufacture and distribution of adulterated food. In addition, many states have the authority to immediately embargo adulterated food and to impose civil fines. Federal agencies often will coordinate with state or local authorities to remove unsafe food from the market as quickly as possible.

See also **Additives**; **Botulism**; **Food, Safety**; **Genetic Engineering**; **Government Agencies, U.S.**; **Herbicides**; **Inspection**; **Microbiology**; **Microorganisms**; **Pesticides**; **Poultry**; **Toxins, Unnatural, and Food Safety**; **Water: Safety of Water**.

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ADVERTISING OF FOOD.

The word "advertising" is derived from the French *avertissement*, a giving notice or announcement. An advertisement is information that is publicly communicated through mass communication. The business of advertising is an aspect of commerce that is an integrated part of industrialized and affluent societies that can afford to purchase goods. Advertising brings notice to a wide range of consumer products, including food, a major consumer of advertising. In the United States in the 1990s, food and beverages together formed the most heavily advertised type of product: approximately 40 to 50 percent of television commercials are for food products, amounting to between ten and fifteen commercials every hour. Advertising takes place at a number of levels in the food marketing chain. Advertisements—ads in the United States and adverts in Britain—may be issued by manufacturers individually or as a group, by a marketing board representing a generic product, and by wholesalers, retailers, and distributors.

Although advertising has a long history, modern advertising began with the invention of printing in the sixteenth century. Early advertisements for foods, which were presented alongside those for books, medicines, cures, and remedies, tended to be for foods and drinks that were at first consumed by the upper classes. English weeklies first reported coffee in 1652, chocolate in 1657, and tea in 1658. The widespread expansion of print advertising did not take place until the eighteenth and nineteenth centuries. Its spread was stimulated and encouraged by changing and developing trade patterns, especially the rail network and the improvement of roads. Improved means of transportation allowed for the expansion of extended regional and national trade networks. As the production of goods increased, they had to be more efficiently and effectively distributed and marketed. As much of the early advertising was contained in print media, the spread of literacy, together with the steep rise in the development of newspapers and magazines, especially after 1850, stimulated its development. It is in the last hundred years that advertising has developed into a major industry. So important has it become that it is central to the production of general communications and provides the economic basis that enables them to exist. It is also central to the development and existence of many products.

Functions of Advertising

Advertising has a number of functions. It is used to launch new food products. The advertising campaign for Nescafé instant coffee granules in the 1950s allowed it to gain a foothold in a market that had strong competition from other brands such as Maxwell House, "America's favorite coffee." It is used to extend the sale of products that are already established in the marketplace. In 1956 the advertising campaign for the biscuit Snack, manufactured by Cadbury, caused an immediate increase in sales. Although its initial impact was not maintained, sales remained higher than the earlier unadvertised level for a year or so, even when there was almost no advertising support given to it. Advertising is used to promote the growth of a product. A marketing campaign for Callard & Bowser Butterscotch in 1959 and 1960 caused its consumption to expand by around 20 percent. Advertising also created a continued demand for a product when the original need to consume it had become redundant due to changing social and economic conditions. Bovril, fluid beef, was developed in the 1870s as a convalescence food and was later used as an energy food on expeditions and during sporting events. With higher incomes, better eating, changing drinking habits (for example, the increased consumption of coffee over tea, and the popularity of carbonated, or "fizzy," drinks), and the availability of new drinks, the original rationale for the consumption of Bovril had declined by the post–World War II years. An advertising campaign was introduced to remove the idea that it was an old-fashioned drink and to suggest that it was a "contemporary" one. Advertising has been used to slow down the decline in the consumption of a product. When milk consumption was falling in the postwar period in Britain, especially in the mid-1950s, the National Milk Publicity Campaign succeeded in slowing down the rate of decline and in introducing new outlets that served to stimulate consumption.

Costs of Advertising

Large sums of money are spent on food advertising. In Great Britain in 1999 the top food advertiser was Mars, a confectionery firm, which spent $99,488,921 (£63,629,000) on its advertising; the second, spending $82,966,590 (£53,062,000), was Kelloggs (GB), followed by the supermarket chain J. Sainsbury with $76,846,990 (£49,151,000). The top brand was McDonald's fast-food restaurants, which spent $66,260,524 (£42,379,000). Other highly advertised brands include the other fast-food restaurants, Kentucky Fried Chicken $19,279,797 (£12,331,000) and Burger King $17,604,550 (£11,259,000). Among the high food advertisers were supermarkets that promoted both their stores and their branded products. Sainsbury's was the top supermarket brand ($45,528,848, or £29,118,000) followed by Tesco ($28,564,912, or £18,286,000), then Asda ($25,034,171, or £16,010,000).

As these figures suggest, not all foodstuffs are advertised to the same extent. In Britain in 1999, highly advertised foods include cereal products, confectionery, ice cream, potato crisps, snacks and nuts, margarine, low-fat spreads, and cheese. By comparison, small sums are spent on herbs and spices, excluding pepper and curry. Advertising-to-sales ratios vary greatly between products. For herbs and spices and fresh vegetables the figure may be as low as 0.06 percent and 0.07 percent respectively. Many foods had less than a 1 percent ratio. Intensive advertising at 11.31 percent was noted for cereals. Generally, advertising of food products shows a lower percentage of expenditure than that of other products, including alcoholic drinks and tobacco.

Advertising Media

Food is advertised through a number of channels. As new technologies have become available, the opportunities for advertising have broadened. A number of these are especially important. Newspapers and magazines have long been a significant vehicle for advertising. Newspapers in Britain published advertisements in the seventeenth century, and, as the provincial press expanded, greater opportunities became available for food advertising. In the later nineteenth century, magazines increasingly started to carry advertisements: In the United States in the 1930s, some 20 percent of products advertised in the major print advertising media of women's and domestic magazines were for food and drink products. When radio networks were established (in 1926 and 1927 in the United States), they used advertising to bring in revenue. Food and drink manufacturers sponsored programs and also advertised their products in short "commercial breaks." In the 1950s television introduced a further medium that owes its effectiveness to the wide range of means that can be used to promote a product: moving pictures, sound (voice and music), and the written word. In the late twentieth century the introduction and extended use of the World Wide Web and e-commerce had an enormous initial growth. In the United Kingdom, growth rates for online marketing since the mid-1990s have been consistently well in excess of 100 percent, year after year. Internet advertising is undertaken through a number of means. In the year 2000, the majority (81 percent) of advertising took place through banners, and small numbers through sponsorship (9 percent), classified advertisements (7 percent), and other means (3 percent). Internet advertising includes sites from manufacturers, product manufacturing boards, supermarkets (which allow for online shopping and home delivery), and food enthusiast sites (for example, for British products in the United States).

Other media have provided further means of advertising food. Billboards and hoardings were first used for this purpose in Britain in the 1890s and are found over a wide geographical area. Light displays in cities, such as those for the carbonated drink Irn-Bru in Glasgow and Coca-Cola in London, have presented advertisements as visual images within central cityscapes. Buses and electric cars (especially since the 1890s in the United States) have carried advertising, usually on their sides or rear. Manufacturers advertise their products on their distribution vans; some also have special promotional vehicles that they use in campaigns where they take their product to public places or special shows to advertise it. Sponsorship of major public popular and sporting events is undertaken by a number of manufacturers. Flora margarine, made from sunflower oil, which is high in essential polyunsaturates, has been the sponsor of the London marathon in the late 1990s; the Bell's open golf championship is sponsored by Bell's, the whiskey manufacturer.

Advertising and promotion of foods is undertaken within the retail industry. Fancy displays draw attention to one or a range of products. In Britain, displays from the 1860s included decorative tins with hinged lids developed by the biscuit manufacturer Huntley and Palmers of Reading. As self-service supermarkets developed, largely after World War II, products could be displayed to draw special attention to them. Three-dimensional displays promoted a single product or a range, and tended to be developed by manufacturers. Supermarkets sometimes hold special testing events where customers can sample a product, thereby encouraging them to buy it. Food is also sold in special promotional packets, sometimes at a "special introductory price" or a "special promotional price." These may hold a sample of the product that can be packaged in a way that reflects the packaging on the regular-sized product.

A range of ephemeral material is distributed to food wholesalers and retailers by manufacturers and others involved in processing and distribution. Some of this, including calendars, pens, and pads of headed note paper, is intended to remind the consumer of the product on a daily basis.

Coupons, which allow the consumer to receive a discount on the product when they present one to a retailer, are found in a range of print media, especially newspapers and magazines.

The medium that is used to advertise a product is selected for its appropriateness to that product, the nature and scope of the advertising campaign, and its desired target audience. Each medium has its own values and qualities. When television started to become widely adopted in Britain in the mid-1950s, Bird's Eye decided to use this new medium to advertise its frozen food products. The company was aware that families with televisions were more likely to be interested in new ideas such as Bird's Eye's products. At that time it was recognized that there was a potentially large market for frozen food, which was a relatively new phenomenon. In the 1920s daily newspapers were best suited to advertise foods and other products that were bought on a regular basis. Magazines that were to be read by a particular social class or group carried advertisements for foods and other products that would likely be consumed by them.

Advertising Targets

Much food advertising is targeted at women, the main buyers of food in the household. As children are recognized as important persuaders in that process and as they may accompany their mothers to buy the family food, advertising is also targeted at them. Recent studies of food advertising in South Africa show the need of advertisers to monitor social changes because food advertising, like advertising in general, reflects social and cultural trends, values, and attitudes. Cultural differences are also reflected in advertising. Chinese television advertisements tend to signify family values, tradition, and technology, whereas themes in American advertisements tend to symbolize the importance of enjoyment, cost savings, and individualism. With the emergence of global culture, specific values such as global cosmopolitanism and modernity (often symbolized by the hamburger) will be spread around the world.

Food advertising reflects changing food tastes, diet, and dietary habits. The extent of the references to nutrition, health claims, and weight loss has altered in advertisements in recent decades. Research has indicated that in the United States from the 1960s to the 1980s there was an increase in references to health and weight loss in advertisements for hot and cold cereals, bread and cake mixes, frozen and pre-prepared entrees, peanut butter, canned and instant dry soup, and carbonated beverages in a range of women's magazines. There was a significant rise in health claims in the 1980s, higher than in the 1960s, and the percentage of diet claims that appeared in food advertisements in the 1980s was significantly higher than the percentage reported in the 1960s and 1970s. At the same time, between 1960 and 1980, there were substantial decreases in claims of quality, taste, status, and consumer satisfaction. These may have resulted from changes in women's consumption and dieting behavior and the increased demand for food that is low in calories but high in nutrition. Concerns about increasing prevalence of obesity in the United States and campaigns against fast-food artificiality—both within the United States and beyond—will likely influence food advertising.

Brand Names

Central to the advertising of food is the promotion of brand names and trade names that distinguish between one manufacturer's product and that of another. As the survival of these names depends on advertising, some brands and trade names have large advertising budgets allocated to them so that they can maintain their status as products and their place in the marketplace. Brands and trade names arose in the nineteenth century as a response to increased production and the need to efficiently and effectively market products. Brand names started to be promoted in the 1870s, after which their use spread quickly. Significant increases were especially noted in the early twentieth century. Even after they were rapidly adopted, the extent of their use varied geographically and throughout time. During World War II, when widespread restrictions caused materials and food shortages, brand names were abandoned in Europe and were replaced by utility products. They came into operation again once peacetime conditions were restored. In some cases this was not until well after all controls on food and other raw products were lifted. Especially developed in Western Europe, brand names were, however, prohibited in Eastern Europe.

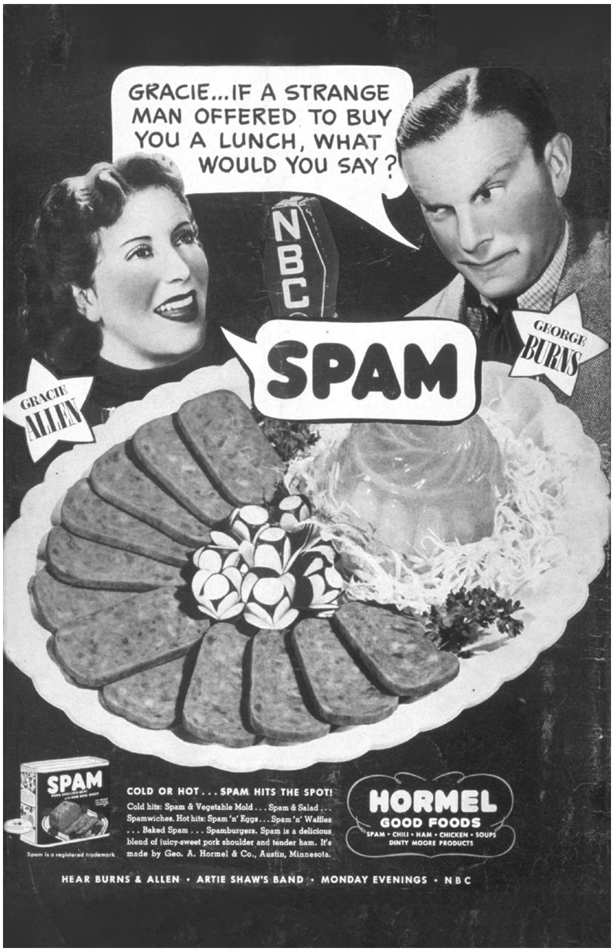
Brand names and trademarks are consciously devised by manufacturers. They are based on existing names, mainly personal names or words, or a combination of the two; few have no recognizable origin. The most common are word names that include personal names of manufacturers such as Nestlé (confectionery manufacturer) and Campbell's (the soup manufacturer), names of food-chain stores (Safeway), and the names of food products such as Mother's Pride (bread). Arbitrary names include Saxa table salt. Names often have an association with prestige and a range of desirable attributes, such as quality (Ambrosia rice pudding); wholesomeness (Eden Vale dairy products, Just Juice tropical fruit juices, and Lean Cuisine low-calorie frozen foods); and nutritional value (Marathon confectionery bars). Other names describe ingredients, as with Coca-Cola, a drink made from coca leaves and cola nuts, and Bovril, a drink of concentrated essence of beef.

Each brand name has a number of functions: it ensures consistency and quality; it has a personality that makes the consumers identify with the product; it is a social and cultural marker that helps the consumers to identify who they are and the social group they belong to; it allows the consumers to gain esteem within their consumer group. These values or aspects of them are reflected in advertising campaigns and advertisements.

Because of the importance of brands and trademarks in identifying foods and other products, they have become legally protected. The first protective legislation in the United States was passed by Congress in 1870. It was altered with different juridical rulings and received its final codification in 1905. Legislation has also been introduced throughout the world. In Britain it has included the Trade Marks Act of 1938.

Food advertisements use a range of appeals to promote a product. Rational appeals tend to be used for healthy foods. Emotional appeals, which are more likely to be remembered, are used for a range of products that includes fun products, or "sin foods," such as candy or desserts. Taste claims are especially important. Products are compared with similar products in side-by-side tests that point out the qualities their competition does not have (for example, the "Pepsi challenge"); these tests distinguish the product from its competitors by the ways in which it is beneficial to the consumer or puts the consumer at an advantage over those who do not use the product. Further, these tests suggest that the product is like an advertised brand in some way; they refer to the competition, state that the brand is at least as good as any other in a set, and they use experts to endorse the quality, taste, or value of the product so that it is given a heightened status. Nutritional claims are used particularly in advertisements for foods that benefit health and have health-giving qualities. Such claims may state that a product is "low" or reduced in calories, that it is "cholesterol-free" or has "reduced cholesterol"; food and drinks may be "lite" to distinguish them from standard foods. In the United States and some other countries, there are regulations governing the allowable fat content in foods billed as "low fat" and "reduced fat."

Especially for branded foods, advertisements often use slogans to help the consumer remember the product. They link the product and its function. For many years, the slogan for the Mars candy bar has suggested that it gives the consumer energy to undertake a range of activities throughout the day: "A Mars a day helps you work, rest, and play." The slogan "Bridge that gap with Cadbury's Snack" suggested that the biscuit could be eaten to fill in the gap between meals.


GRACIE...IF A STRANGE MAN OFFERED TO BUY YOU A LUNCH, WHAT WOULD YOU SAY ?
NBC
SPAM
GRACIE ALLEN
GEORGE BURNS
SPAM
Spam is a registered trademark
COLD OR HOT . . . SPAM HITS THE SPOT!
HORMEL
GOOD FOODS
SPAM • CHILI • HAM • CHICKEN • SOUPS
DINTY MOORE PRODUCTS
HEAR BURNS & ALLEN • ARTIE SHAW'S BAND • MONDAY EVENINGS • NBC

Cold hits: Spam & Vegetable Mold . . . Spam & Salad . . . Spamwiches. Hot hits: Spam 'n' Eggs . . . Spam 'n' Waffles . . . Baked Spam . . . Spamburgers. Spam is a delicious blend of juicy-sweet pork shoulder and tender ham. It's made by Geo. A. Hormel & Co., Austin, Minnesota.

"And now, a word from our sponsor." If radio stars George Burns and Gracie Allen endorsed Spam, it had to be good. ("Spam" has since become a derogatory term for another kind of advertisement, in the form of unwanted e-mail.) COURTESY OF THE ADVERTISING ARCHIVE LTD.

Celebrity Endorsements

Food advertisers use a range of figures who enjoy public recognition to endorse or act as spokespeople for a product and recommend it to the public. Especially after 1920 advertisers were aware of the relationship between popular culture idols and their audiences. Important early endorsers included movie stars and popular entertainers. The list was later extended to include television stars and individuals from occupations such as politics, sports, the arts, and business. In an endorsement, an endorser makes the product familiar to the public. It can be done in a number of ways: explicitly ("I endorse the product"); implicitly ("I use this product"); imperatively ("You should use the product"); and copresently (where the endorser appears with the product). In an endorsement, celebrities transfer meaning from themselves (their values, status, class, gender, age, personality, and lifestyle) to the product, and through it, to the consumer. Through that process, people consume a product that is associated with the star and their star image. Celebrities are chosen to represent values that are embodied in the product they endorse. The comedian Bill Cosby endorsed the soft drink Coca-Cola. Although there is a close relationship between the star and the product, not all star and product relations have successfully increased product sales. John Houseman failed as an endorser for McDonald's although he had been successful in other endorsement campaigns. Endorsements fail when they do not succeed in transferring meaning: the values between the celebrity and the product are too wide for the meaning to move between the endorser and the product.

Controls on Advertising

All food advertising is governed by a number of controls. Some of these regulate advertising in general. Defamatory statements, false representations, offers to contract, incitements to crime, contempt of court, breach of copyright, and infringement of trademarks are covered by legislation that governs libel, deceit, contracts, crime, and the infringements of rights. More specifically, in Britain in the late nineteenth and early twentieth centuries, legislation included the Indecent Advertisements Act of 1889 and the Advertisements Regulation Act of 1907, which was amended in 1925. At a wider level, the general law also affects all advertisements.

Codes of advertising have been issued as guidelines to advertisers. In the United States from 1911, steps were taken to provide codes of practice. Early codes were issued by the Associated Advertising Clubs of the World. Guidelines have also been expressed in a number of codes such as the British Code of Advertising. The Code, issued in 1979, embodies the principles that "all advertisements should be legal, decent, honest and truthful"; "all advertisements should be prepared with a sense of responsibility both to the consumer and to society"; and "all advertisements should conform to the principles of fair competition as generally accepted in business." The codes contain specific rules that govern food advertising, packaging, and labeling of foodstuffs. They define how foods can be described and the nature and scope of the nutritional information presented on the packaging. Nutritional information has become increasingly widespread in the European Community and the United States. In Britain, sections of the Customs and Excise Act 1952 prohibit misdescription in advertisements of beer and spirits. The Food and Drugs Act (as subsequently amended) contains certain requirements as to advertising and labeling of food. A number of regulations deal specifically with the representation of food claims. Diet foods are particularly regulated, for example in the 1970 British Labeling of Food Regulations, which require that "where a claim is made in an advertisement or on a label that any food is an aid to slimming, it must be substantiated, and a statement must be included that the food cannot aid slimming except as part of a diet in which the total intake of calories is controlled, whether by calorie counting, low carbohydrate/high protein or other means." Other aspects of "slimming" that are regulated include diet plans, aids to dieting, foods, appetite depressants, and weight-loss products in general. Parallel regulations and advertising codes have also been introduced in other countries such as the United States. In the 1980s in the United States, consumer protection remained the major rationale for the regulation of advertising. Other forces included new media technologies, issues of privacy and fairness, environmentalism, religion, changing economic conditions, the deregulation movement, and foreign regulatory initiatives made necessary by international trade agreements.

See also **Anorexia, Bulimia**; **Food Marketing: Alternative (Direct) Strategies**; **Food Politics: United States; Marketing of Food; Naming of Food; Obesity**.

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AFRICA.

This entry includes four subentries:
Central Africa
East Africa
North Africa
West Africa

CENTRAL AFRICA

Central Africa is broadly defined as the Congo River basin, plus adjoining areas in equatorial Atlantic-coast Africa. It comprises all (or parts) of Burundi, Cameroon, Central African Republic, Chad, Congo (Brazzaville), Congo (Kinshasa), Equatorial Guinea, Gabon, and Rwanda. (The list varies from one authority to another.) Where it meets Africa's Northern and Southern regions there are grassy savannas and veldts, at its juncture with East Africa, mountain ranges and great lakes. Central Africa's dominant feature, however, is equatorial rainforest and numerous rivers and swamps.

Central African gastronomy is the least known of any other similarly sized region, due partly to lack of documentation, as most Central African languages were not written down until the colonial era of the eighteenth and nineteenth centuries. Slaves, ivory, rubber, and minerals, not the region's cuisine, interested most non-Africans (Europeans and Arabs) who went there.

The First Inhabitants

The equatorial forest of Central Africa has remained unchanged by the cycles of global warming and cooling that, over tens of thousands of years, have frozen Europe and dried the Sahara. It is the home of the descendents of the first human inhabitants of the region: the Mbuti, Aka, and Efe people of the Ituri forest, the Twa of the Lake Kivu region, and related peoples. (Collectively these groups are called "Pygmy," a term that has fallen from favor, yet no other collective appellation has emerged.) When the forest people first arrived in Central Africa is unknown. One of them, taken to Egypt by an expedition that explored the area south of Egypt, is mentioned in Egyptian texts from between 2255 to 2152 B.C.E.

Unmatched in their ability to survive in the forest, the forest people live, for the most part, as they have for millennia. Using bows and poison-tipped arrows, nets, or spears—sometimes with the aid of Basenji dogs—the men hunt everything from antelope and birds to elephants and hippopotamuses. The women gather berries, fruits, insects, leaves, mushrooms, nuts, and roots. To move from campsite to campsite, they must have lightweight household goods. The most basic cooking methods are appropriate: roasting, smoking, and drying meats, and stewing meats and vegetables. When they kill a large animal, it is easier for them to move to the meat than vice-versa. The Mbuti brew a beverage called "liko" from berries, herbs, and kola nuts. A favorite sweet is wild honey.

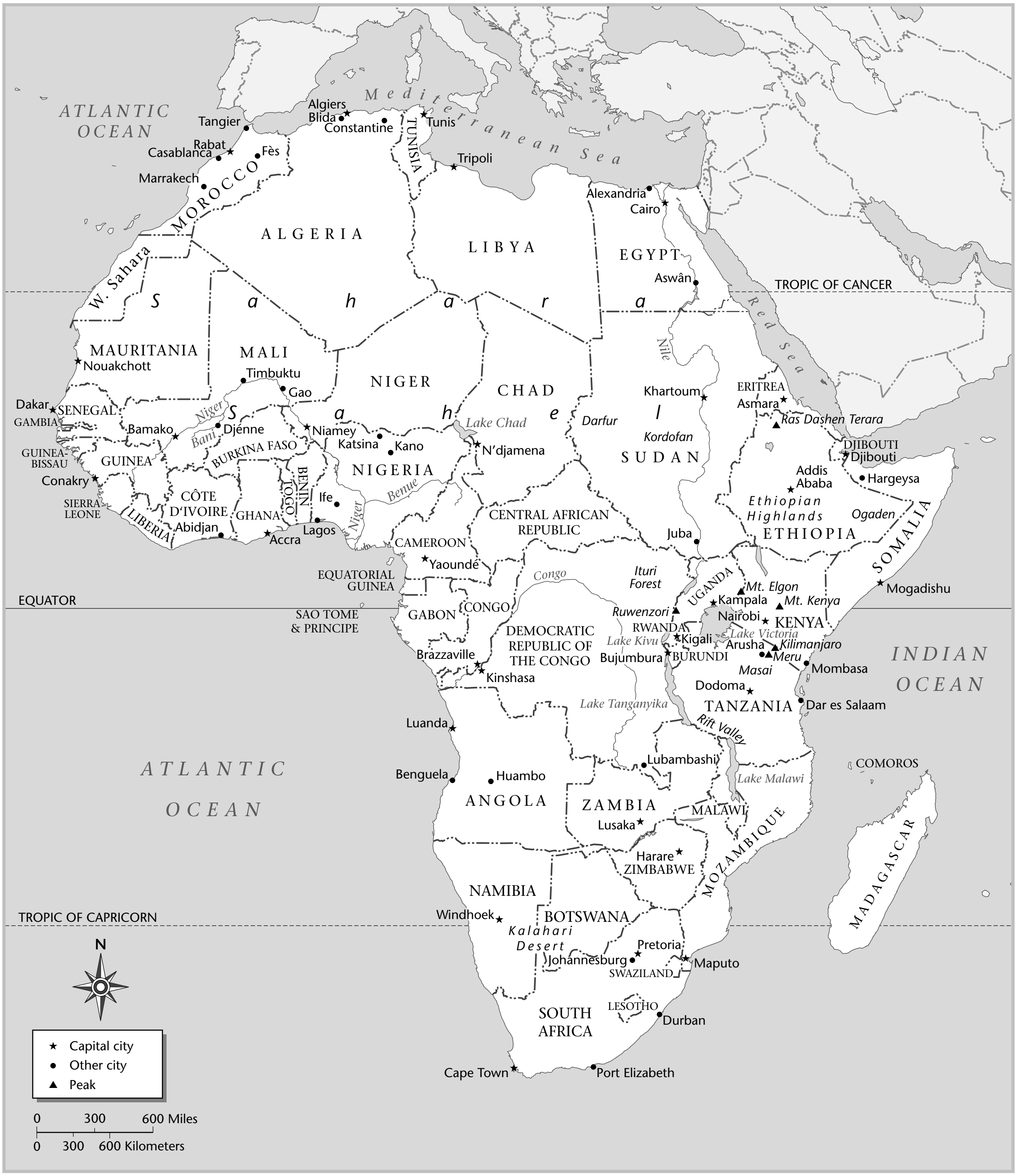
Fishermen on the shore of Lake Victoria near Nyamazugu. © PAUL ALMASY/CORBIS.

The Arrival of Agriculture and New Foods

Over the past two millennia, because they have had increasing contact with other Africans—trading with them (exchanging forest products for agricultural foods and manufactured goods) and partially adopting their languages and cultures—forest peoples also eat foods such as the leaves and tubers of cassava (manioc, *Manihot esculenta*), rice, beans, peanuts, and tomatoes, from which they prepare stews and sauces.

The "other Africans" are the present-day Kongo, Mongo, Luba, Bwaka, Kwango, Lulua, Lunda, Kasai, Douala, and related peoples (there are hundreds of Central African ethnic groups). Collectively, they are called Bantu speakers, as their languages are part of the Bantu language group. (Bantu is a linguistic designation, not a racial one, and can be misleading because many people who speak Bantu languages are not related to the original speakers.) Bantu speakers began migrating into Central Africa from around the Nigeria-Cameroon border approximately two to three thousand years ago.

Over the course of several centuries, the population of Bantu speakers increased and they spread throughout Central and Southern Africa because they did two things that the original forest inhabitants did not: they worked iron into tools and weapons (Central Africa completely skipped the Bronze Age), and they obtained food from agriculture and, to a lesser extent, domesticated animals. (Diseases carried by Africa's tsetse fly prevent keeping livestock.) The forest people had lived in and with the forest; the Bantu speakers turned forests into farms. However, food obtained by hunting and gathering remained


ATLANTIC OCEAN
Mediterranean Sea
Algiers
Blida
Constantine
Tunis
TUNISIA
Tangier
Rabat
Casablanca
Fès
Marrakech
MOROCCO
Tripoli
Alexandria
Cairo
ALGERIA
LIBYA
EGYPT
Aswân
W. Sahara
TROPIC OF CANCER
Red Sea
Sahara
Nile
MAURITANIA
Nouakchott
MALI
Timbuktu
Gao
NIGER
CHAD
Khartoum
ERITREA
Asmara
Ras Dashen Terara
Dakar
SENEGAL
GAMBIA
Niger
Sahel
Lake Chad
Darfur
Kordofan
Bamako
Djénne
Bani
Niamey
Katsina
Kano
N'djamena
BURKINA FASO
GUINEA-BISSAU
GUINEA
Conakry
NIGERIA
Benue
SUDAN
DJIBOUTI
Djibouti
Addis Ababa
Hargeysa
Ethiopian Highlands
Ogaden
ETHIOPIA
SOMALIA
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
Abidjan
GHANA
Accra
TOGO
BENIN
Ife
Lagos
CENTRAL AFRICAN REPUBLIC
Juba
CAMEROON
Yaoundé
EQUATORIAL GUINEA
Congo
Ituri Forest
UGANDA
Mt. Elgon
Kampala
Mt. Kenya
Mogadishu
EQUATOR
SAO TOME & PRINCIPE
GABON
CONGO
Ruwenzori
Nairobi
KENYA
RWANDA
Lake Victoria
DEMOCRATIC REPUBLIC OF THE CONGO
Lake Kivu
Kigali
Arusha
Kilimanjaro
Meru
Bujumbura
BURUNDI
Brazzaville
Kinshasa
Masai
Mombasa
INDIAN OCEAN
Dodoma
Lake Tanganyika
TANZANIA
Dar es Salaam
Luanda
Rift Valley
Lubambashi
COMOROS
ATLANTIC OCEAN
Benguela
Huambo
Lake Malawi
ANGOLA
ZAMBIA
MALAWI
Lusaka
MOZAMBIQUE
MADAGASCAR
Harare
ZIMBABWE
NAMIBIA
TROPIC OF CAPRICORN
Windhoek
BOTSWANA
Kalahari Desert
Pretoria
Johannesburg
Maputo
SWAZILAND
N
LESOTHO
Durban
SOUTH AFRICA
★ Capital city
● Other city
▲ Peak
Cape Town
Port Elizabeth
0 300 600 Miles
0 300 600 Kilometers

(and continues to be) an important part of their diet. In many Bantu languages, the words for "animal" and "meat" come from the same root, attesting to the close association of the two.

Contributing to Bantu expansion were Asian food crops that arrived in Africa at roughly the same time (circa the first century C.E.): bananas, plantain, and tuber crops such as yam and taro, which have been staple foods ever since. African varieties of millet, rice, sorghum, other yam species, and okra were also cultivated. Agricultural production of these high-yield crops enabled the Bantu speakers to increase their population dramatically, and they are now the overwhelming majority. More increases in population, and further migrations, occurred after the 1500s, when crops from the Americas were introduced to Africa: cassava, corn (maize), peanuts (groundnuts), tomatoes, chili peppers, sweet potatoes, papaya, pineapple, and avocado.

Central Africans have practiced swidden (slash-and-burn) agriculture for centuries. Men clear the forest and prepare the ground, but women do the rest of the work on the "plantation" or "shamba" (cultivated fields): planting, weeding, and harvesting.

Not every crop grown in Africa has been imported, but foreign crops have replaced many indigenous crops. The American peanut (*Arachis hypogaea*) replaced the Bambara groundnut (*Vigna subterranea*); Asian rice (*Oryza sativa*) replaced African rice (*Oryza glaberrima*); the chili pepper (*Capsicum*) replaced melegueta pepper (grains of paradise, *Aframomum melegueta*); and onions and garlic replaced various herbs and roots. Even the salt changed. In the Central African interior, the only salt once widely available came from various plants. It was obtained by burning leaves or bark, soaking the ashes in water, and evaporating the water in pans. Some cooks still use *sel indigène* (indigenous salt) or substitute baking soda to approximate its taste. Thus, foodways have not been static throughout history, and the larder was stocked for contemporary Central African cuisine.

Stews and Starches

Stewing has probably been the most common cooking method in Central Africa for centuries. Central African kitchens are located apart from the living and sleeping quarters. In each a large pot or cauldron for making stews rests on three stones above a wood fire. These dishes are usually simple, made with only a few ingredients. Stews are usually thickened with African oil palm fruit or crushed peanuts, but other thickeners are also used: crushed seeds of *Cucurbitaceae* (gourds, melons, and pumpkins), known by the West African name, *egusi*, and called *mbika* in Central Africa; crushed seed kernels of the *mangue sauvage* (wild mango) fruit (*Irvingia gabonensis*), called *odika*, *dika*, or *etima*; and okra, which is called *ngumbo*.

It is difficult to know whether to call these dishes stews, soups, or sauces. Part of the confusion is that they are eaten with a starchy staple dish. Many Africans believe that the only real meal is one that combines a stew or sauce with a starch. In West Africa, *fufu* is boiled pounded yam or plantain. In Central Africa the same process, pounding with mortar and pestle (often made from an entire tree trunk and limb), followed by boiling and vigorous stirring or steaming, is used to make similar starchy staples. The word *fufu* refers to a dish made by boiling any sort of flour: maize, sorghum, millet, or cassava. (Cassava flour is dried ground cassava tuber; tapioca is the same thing.) These foods, called "dumplings" or "porridges" by English speakers, are comparable to East Africa's *ugali* and Southern Africa's *nsima*, or *sadza*. Another fufu-like staple is prepared by soaking cassava tubers in water for a few days, pounding them, then wrapping the resulting pulp in leaves and steaming it. The soaking and steaming breaks down poisonous cyanide compounds in the tubers. The finished product is called *kwanga*, *chickwangue*, *bobolo*, *mboung* or *placali* (usually ball-shaped), or *baton de manioc* (manioc stick). Women prepare *kwanga* in large batches to sell, ready-to-eat, in the market. They make the flour-based dumplings and porridges, as needed, in the home. These foods are heavy and thick, much more so than mashed potatoes. Many non-Africans do not like them at first, but they often make the mistake of taking a bite of such starches without sauce. Africans eat these bland starchy foods with a stew or sauce, usually heavily seasoned. As with West African *fufu*, a bite-sized piece of the *kwanga* (or something similar) is pulled off, dipped into the stew, then eaten. Rice and European-style bread, especially French baguettes, are also eaten with stew.

Greens

One distinguishing characteristic of Central African cooking is the use of edible leaves, which Americans call "greens." Indeed, the greens of the southeastern United States—collard greens, kale, and mustard greens—have their roots in Africa. In French-speaking Central Africa these are commonly called "feuilles" (leaves). It is hard to overstate the amount and variety of greens consumed. Oftentimes greens are the main ingredient in the daily stew, cooked with only a little onion, hot pepper, meat, fish, or oil for flavoring. Some of the greens consumed in Central Africa are bitterleaf, cassava, okra, pumpkin, sorrel, sweet potato, and taro. People cultivate greens and gather them from the wild. Cassava leaves ("feuilles de manioc") are the most commonly farmed. In many tropical areas of the world cassava is grown primarily for its tubers, but Africans have a long tradition of eating both the leaves and the tubers of this plant. *Gnetum africanum*, called *okok*, *koko*, or *eru*, is a variety of greens that grows wild. Before cooking, women pound greens in a mortar and pestle, or roll them like giant cigars and use a sharp knife to shred them finely. *Saka-saka*, or *pondu*, is a dish made from cassava leaves, onion, and a bit of dried fish. *Saka-madesu* is cassava leaves cooked with beans. Another recipe, variations of which are found all over sub-Saharan Africa, calls for greens to be cooked with tomato, onion, and mashed peanuts. Other greens dishes are made with tomato, onion, chili pepper, and fresh, salted, or smoked fish, or even canned sardines. Greens and meat are also often cooked together.

Central African Cuisine

Richard Francis Burton, the nineteenth-century traveler and writer, is famous for his efforts to discover the source of the Nile and his account of a visit to Mecca. He could have been describing Central African cuisine when he described the food he encountered in Bonny River, in present-day Nigeria, near the boundary between Central Africa and West Africa . In the first sentence, Burton gives the "Anglicé" (English) names for African foods: "obeoka" = fowl; "nda" = fish; "fufu" = mashed yam; "fula" = soup; and "tomeneru" = tombo, or palm wine.

> breakfast is served. It is a little dinner, ordinarily consisting of obeoka, nda, fufu, fula and tomeneru,—Anglicé, fowl, fish, mashed yam, soup i.e. (the liquid in which stews have been boiled), and tombo, or palm-wine the latter however, hard, tasting like soapsuds, and very intoxicating. The cooking is excellent, when English dishes are not attempted. . . . Most of the dishes are boiled, and copiously peppered with cayenne and green chili pods to induce thirst. There are many savoury messes of heterogeneous compounds, fish, fresh and dried, oysters, clams, and cockles, poultry, goat and deer, salt beef or ship's pork, yams, plantains and palm oil. Smoked shrimps are pounded in a wooden pestle and mortar, with mashed yam for consistency, and are put into the soup like forcemeat balls.
>
> A dinner similar to breakfast is eaten at 4 to 5 P.M. Soup and stews are the favorite ménu, and mashed yam acts as a substitute for bread. It is also made into a spoon by a deep impression of the thumb, and thus it carries a thimblefull of soup with every mouthful of yam. The evening is passed with the aid of music, chatting with the women, and playing with the children.

SOURCE: Richard F. Burton. *Wanderings in West Africa.* Vol. 2. New York: Dover, 1991, p. 289.

Red Palm Oil

Another distinguishing characteristic of Central African cuisine is the use of red palm oil, obtained from the fruit of the African oil palm, *Elaeis guineensis* (not to be confused with the clear oil pressed from the hard kernel). Reddish and thick, it has a distinctive flavor for which there is no substitute. Women make red palm oil, or palm butter, at home by boiling and hand-squeezing fresh palm nuts. The oily pulp is cooked with chicken, onion, tomato, okra, garlic, or sorrel leaves, and chili pepper to produce a stew called *moambé* or *poulet nyembwe* (also *gnemboue*). *Moambé* is also made with other meats. This is one of many Central African dishes related to West African counterparts, in this case the West African palm oil chop, though the Central African versions tend to be simpler and made with fewer ingredients. Outside of Africa, canned palm soup base (also called *sauce graine*, *noix de palme*, or cream of palm fruit) can be used.

Peanuts

Peanuts are roasted and eaten as snacks, but they are used more interestingly in stews and sauces. The chicken-groundnut stew—made from chicken, peanuts, tomato, onion, and chili pepper—is common in Central Africa, as it is throughout sub-Saharan Africa. Peanut sauces are served with roasted meats or fried fish, or boiled yams, sweet potatoes, or rice. Greens are cooked in groundnut sauce; meat, fish, or fowl can be added to produce a variety of stews.

As with red palm oil, there are similarities between the ways peanuts are used in Central African and West African cooking. West Africa's groundnut chop is similar to the *muamba nsusu* (chicken soup) of the Kongo people, though the Central African version—made with chicken, onion, palm oil, tomato, ground peanuts, and hot chili pepper—is the less elaborate of the two. It is also the source of the peanut soups served in colonial North America. Many Americans mistakenly believe that peanuts are indigenous to Africa and were brought by Africans to the United States. After all, an American name for the peanut, "goober," comes from its Kongo name, "nguba." Africans may have brought peanuts to North America, but in fact they are indigenous to South America and were introduced to Africa in the early 1500s. (Diffusionist historians, who posit that Africans sailed between Africa and the Americas before Columbus, challenge this.) Africans quickly adopted the American peanut because it resembles an indigenous African plant, the Bambara groundnut. Like the American peanut, the seeds (legumes) of the Bambara groundnut grow and ripen underground. Africans used the Bambara groundnut in the same way they use the peanut. For various reasons, farmers and consumers preferred the American peanut, and the Bambara groundnut is a nearly forgotten crop.

Banana Leaves

An interesting Central African cooking method is steaming or grilling food wrapped in packets fashioned from the leaves of banana trees or other plants. This is an old cooking method, predating the use of iron, maybe even clay cooking pots. It is very practical when camping or traveling as it eliminates the need to carry pots, and the leaves can also be used as plates and bowls.

Certain leaves are especially favored because they give a particular flavor to food. *Kwanga*, for example, is wrapped in leaf packets before its final steaming. *Maboké* (singular *liboké*, also called *ajomba* or *jomba*)—leaf-wrapped packets of meat or fish, with onion, tomato, maybe okra, seasoned with lemon juice or hot chili pepper—are grilled over hot coals or steamed in a pot. Crushed peanuts, or *mbika*, are

DIFFUSIONISM: DID ANCIENT AFRICANS SAIL TO THE AMERICAS?

Who came to the Americas, and when, is a subject of debate between scholars who believe that ancient peoples, including Africans, sailed the world's oceans to the Americas, and others who say there is no evidence of pre-Columbian contact between the Old World and the New.

The traditional view is that Native Americans, after migrating into North America from Asia (via Beringia) tens of thousands of years ago, gradually spread south and east, developing their civilizations without input from the Old World until Christopher Columbus (or Leif Erickson) sailed across the Atlantic in recent historical times. Likewise, the traditional view holds that plants, foods, and cultural artifacts of the Western Hemisphere did not reach the Old World (and vice versa) until the post-1492 era of European conquest.

The diffusionist view of history challenges traditional scholarship. Diffusionist historians maintain that, in addition to the Asian incursion across Beringia, there were many transoceanic contacts between the Old World and the New, beginning in ancient times and continuing until the era of Columbian exploration. Supporting the diffusionist position is the life's work of Thor Heyerdahl, who proved that it is possible to sail great distances using ancient shipbuilding and navigational technology (in 1947 sailing from Peru to eastern Polynesia and in 1969 sailing from North Africa to Barbados on balsam rafts). Further support comes both from the existence of Old World artifacts in the New World (and vice versa) that evidently predate the Columbian era and from oral history. Opponents of diffusionism argue that because ancient peoples could have sailed across the ocean is no proof that they actually did, that other evidence is either coincidental, occurred after Columbus, or has not been correctly dated, and that oral history is only myth. Complicating the debate are charges of prejudice from both sides.

As concerns Africa, diffusionist scholars believe that Egyptians and Phoenicians sailed to the New World in ancient times, as did Malians (of the former Sudanese Republic) in medieval times, observing that the design of Mesoamerican pyramids is strikingly similar to those found in Egypt and that Mesoamerican statues depict African explorers. If regular trade relations between Africa and the Americas are assumed, American plants such as cassava, chili, maize, tomato, and tobacco may have been known in Africa hundreds of years before they were introduced by Europeans. Likewise, African foodways may have been brought to the Americas before Columbus. It has been a quarter century since the publication of the important (though by no means only) work in this field: *They Came before Columbus* by Ivan Van Sertima. More research and evidence are needed before this debate can be resolved.

sometimes included in the packets. Filling the leaf packets with mashed beans (such as black-eyed peas) and sautéed peppers, then steaming, produces *koki* (also called *ekoki* or *gâteau de haricots*).

Meat, Fish, and Fowl

Generally, people in Central Africa eat meat, fish, or fowl whenever possible. Every village has domesticated chickens (or guinea fowl) and goats. Wild game, *viande de brousse* or bushmeat, is very common: antelope, birds, buffalo, crocodiles, fish, monkeys, pangolins, wild boars, and many other species are hunted. Almost every type of wildlife—from insects to primates—is hunted and eaten in Africa, though individual ethnic groups have their own traditions regarding what is edible and what is not. Some will eat snake meat, for example, while others will not. There are many traditional beliefs concerning who should eat certain foods and who should not: for example, a certain food may be reserved for men because it is believed that women who eat it cannot become pregnant or will suffer other ill effects. Women in the Odzala region of the Congo Republic do not eat gorilla meat, fearing that doing so would cause their husbands to become as brutal as gorillas.

Killing a large animal means a feast for everyone. Where there is no refrigeration, drying, salting, or smoking meat or fish is used to preserve it. All sorts of bushmeat—antelope, buffalo, crocodiles, hippopotamuses—as well as fish, are preserved in this way. When meat is not plentiful, a small amount is added to stews for flavor.

Beverages, Snacks, and Desserts

Bottled beer and soft drinks, sometimes unrefrigerated, are available throughout Central Africa. Traditional beverages include *vin de palme* (palm wine), self-fermented palm tree sap. Beer is made from corn, millet, plantains, and sorghum. Cassava, yam, or plantain porridges are thinned with water to make breakfast beverages, weaning foods for infants, and nutritious drinks for convalescents. Coffee and tea are also popular beverages. Central Africans are great snackers. Vendors selling hot beignets (French-style doughnuts), fried plantain, grilled corn-on-the-cob,

Bushmeat

"Bushmeat" (or, in French, *viande de brousse*) is wild game, meat taken from wild animals of the African forest or savannah, often called "the bush." Bushmeat can come from nearly any species of wildlife including antelope, boar, buffalo, cane rat, chimpanzee, crocodile, elephant, gorilla, hippopotamus, monkey, pangolin, and porcupine, as well as various birds and reptiles. Each ethnic group has its own traditions and taboos concerning which animals can be eaten and which cannot, but hunting wild animals for meat (and other products) is an extremely old tradition, predating the development of agriculture. Certain African peoples are herders and farmers, but in parts of Africa afflicted with the tsetse fly or poor forest soil and climate the food produced from domesticated animals and plants may not be sufficient to replace what hunting can provide.

Traditionally, hunting is a sign of manhood in much of Africa, and it is considered "men's work," whereas women are expected to tend the fields and care for children. Also, as is the case with horsemeat in France, people believe that certain types of bushmeat are especially healthful or possess curative properties. Bushmeat is an important protein source in the diet of rural people; when they do not eat it, the money they earn from selling it is a significant portion of their income.

Like loss of habitat and poaching animals only for their hides or tusks (leaving the meat for vultures and insects), hunting for bushmeat threatens African wildlife with extinction. In the past, human populations were small and hunting was less of a threat to the survival of any given animal species; also, certain types of bushmeat were reserved only for the chief. Modern times have brought larger populations, the development of urban elites willing to pay high prices for favorite bushmeat, roads connecting rural villages to large cities, and airports connecting Africa to the outside world. The resultant commercial trade in bushmeat has caused many ecologists to be concerned about the possible extinction of certain species. As populations and incomes grow, the demand for bushmeat is likely to increase. Logging activities in virgin forests, which bring roads and trucks to undeveloped areas, have the unintended consequence of connecting rural hunters to urban markets, and many logging workers supplement their income by being bushmeat middlemen, in addition to consuming bushmeat themselves. Hunting is generally a laissez-faire enterprise, and national and international regulations concerning wildlife and hunting are usually ignored. Any awareness among rural people of the need to preserve wildlife is outweighed by their need for food and money. It is easy for people outside of Africa to criticize their customs and actions, but it should be remembered that Africans are not the first to hunt an animal to extinction, as the history of aurochs, dodo birds, passenger pigeons, and other species makes clear.

kola nuts, brochettes (shish kabobs), roasted peanuts, soft drinks, and various fruits are seen on urban streets and near bus and taxi stops and train depots.

Generally, the traditional Central African meal is not followed by a dessert course. Sweet snacks include sugar cane, fruits, and European-style candies.

Food and Eating Customs

Traditionally, women and girls do the cooking. Men and guests eat apart from women and children. Oftentimes, breakfast is leftovers from the prior evening, a snack is eaten during the day, and a large meal is eaten in the early afternoon. People have adopted the Western custom of three meals a day, with certain foods, like bread and coffee, eaten primarily for breakfast.

Many other Western influences are seen in Central African cuisine. In urban areas, much of the diet of well-to-do consumers would be familiar to any European or American: hamburgers, pizza, and ice cream. Even in small towns, people can obtain imported spaghetti, canned meats and vegetables, and L'Arome Maggi® bouillon cubes (which seem to be essential for cooking). In both urban and rural areas, farmers and traders sell locally produced foodstuffs in open-air markets. Cities also have sprawling markets that are busy from sunrise until late at night, while small-town markets may be open only one day a week. In rural areas, households sell farm produce and bushmeat on the roadside, displaying it on a barrel or table. It is common to see urban dwellers lugging home large sacks of food after a visit to the countryside.

Festivals and Celebrations

People in Central Africa celebrate Christmas, New Year's, the end of the school year, and marriage with parties and family gatherings. African religious festivals and ceremonies, however, vary from one group to another. Many ethnic groups celebrate the *nkanda* or *mukanda*, which are initiations for young people. They signify the beginning of adulthood and may include ceremonial songs and dances, special teachings given in seclusion, induction to secret societies, circumcision, and symbolic death and rebirth. There may be special foods that are consumed only on these occasions, and there is always an emphasis on having plenty of food, preparing elaborate dishes, and, perhaps, obtaining imported food and drink. The African-influenced Christian Kimbanguist Church prohibits eating pork or monkey or drinking alcohol.

Central African cuisine will no doubt continue to adapt to new circumstances and adopt new influences. More attention should be paid to this relatively little-known area.

See also **Banana and Plantain**; **Game**; **Hunting and Gathering**; **Nuts**; **United States: African American Foodways**.

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Ed Gibbon

EAST AFRICA

East Africa comprises ten countries: Tanzania, Burundi, Rwanda, Uganda, Sudan, Ethiopia, Eritrea, Djibouti, Somalia, and Kenya. Among residents of this region, the name Eastern Africa usually refers to these ten countries, while the name East Africa means the political region comprising Kenya, Uganda, and Tanzania. In this article East Africa refers exclusively to the ten countries mentioned. This region covers an area of about 2.3 million square miles and in 2002 had a population of about 190 million people. East Africa has over 500 linguistically distinct communities, which fall into five distinct groups: the Bantu, Nilotic, Cushitic, Sudanic, and Semitic peoples. This area is also home to many people of Arabian, Indian, and European origin.

Besides being ethnically diverse, East Africa is extremely geographically diverse. Bounded to the east by the Red Sea and the Indian Ocean, the land rises (often on a plateau) to the Ethiopian and East African highlands, which contain five of the highest mountain peaks in Africa, such as Mount Kilimanjaro. Dividing these highlands is the Great Rift Valley. In East Africa, where it forms two arms (eastern and western), the Great Rift Valley has a series of lakes on its floor and all around it. All these geographical features have a heavy influence on the climate of the region, which has extremes of temperatures, humidity, and precipitation. Most of the lowland areas are hot and dry. Djibouti, regarded as the warmest city in the world, has a mean annual temperature of 86°F. Seventy-five percent of the region is either arid or semiarid, the Horn of Africa and upper half of Sudan being extremely arid. Rainfall is erratic, and there is a high incidence of famine in the region. The highlands are generally cooler and receive more precipitation. Near the equator, the rainfall has two peaks per year.

Much of the agriculture is concentrated in the highlands and around the Great Lakes of East Africa, and these areas contain the highest concentration of people. Ninety percent of East African people are employed in agriculture and livestock, with the highlands being used mainly for crop production and the dryer lowlands for animal production.

The great diversity in East Africa's climate, physical features, and ethnic groups is reflected in its food culture. This culture is further enriched by the long history of interactions with people from other continents, especially the Arabian and Indian peninsulas.

Introduction to East African Food Culture

Perhaps some of the best and oldest evidence of what human ancestors ate can be found in Olorgesailie, a historical site on the floor of the Great Eastern Rift Valley that is about 40 miles (66 kilometers) south of Nairobi, Kenya. This hot, dusty site located in a semidesert scrub was once (during the Stone Age) a lake in a lush environment that teemed with wildlife. At this site, thousands of wedgelike stone tools (handaxes, cleavers, scrapers, knives) of varying sizes litter the ground. These were the tools that human ancestors fashioned skillfully and used to dig for food and to tear up their kill, probably antelopes, giraffes, and other ungulates that came to drink water at the shores of this lake.

About five thousand years ago, much of East Africa was occupied by hunters and gatherers, commonly referred to as *ndorobo*. Although a few of these people still exist, most of these groups were assimilated by later migrants and therefore lost their identity, including their food culture. With spears, snares, and poisoned arrows they hunted big and small game—from rabbits and dik-diks to buffalo, giraffes, and elephants, and in some cases stray cat and dog families, as well. The practice of hunting still exists in East Africa, but only at low levels since it is forbidden in most countries. Gathering wild foods—such as fruits, nuts, tubers, honey, grasshoppers, caterpillars, termites, eggs, and some birds—was also an important way of acquiring food for ancestors who lived in this region. Today the contribution of gathering is less significant but many aspects of it remain. For example, during the rain season, the flying reproductive forms of termites (*tsiswa* in Luhyia) emerge from termite mounds. These are trapped, dried or roasted, and eaten or preserved in honey, or used as a snack and occasionally in sauce. A variety of caterpillars (*maungu* in Giriama) are also harvested and eaten. Wild birds that resemble a small chicken, such as *tsisindu* in Luhyia or *aluru* in Luo, are considered delicacies. Tubers and nuts obtained from the ground are a source of energy and water among people who herd livestock. The Maasai potato (*oloiropiji* or *Ipomoea longituba*), which is characterized by a flat taste, may weigh up to nine pounds and contains enough water to last a herder a whole day.

The key animals that are raised in East Africa are cattle, sheep, goats, camels, pigs, and donkeys. Cattle, which are the most important of these, were introduced into the region from North Africa in 3000–2000 B.C.E. and are the economic base for livestock keepers/pastoralists who live in drier regions. The foods of livestock-raising groups are animal based, with milk products being by far the most important. Milk is obtained from camels, cows, goats, and occasionally sheep. It is taken fresh or is fermented in containers—mainly gourds (*kuat* in Sudan or *kibuyu* in Swahili) or hollowed-out wood, as is the case with many pastoralists to the north and east of the region. The milk is then churned to make butter and sour milk (*rob* in Arabic or *chechirot* in Dinka), which are very popular foods in southern Sudan and among pastoralists. A variety of sticks are burned in such milk containers to disinfect and to impart a nice flavor to the milk. A popular tree for this purpose is the African olive (*oloirien* in Maasai or *Olea europaea* ssp. *africana*). The Somali community adds the aromatic hoary basil (*Ocimum americanum*) to milk as a flavoring. Butter, which was a major item of barter trade in the past, is used in preparing other foods or is mixed with other foods to add flavor. Milk, which people often drink sweetened with sugar, may be used as an accompaniment for *ugali* or *sima* (*asida* in Sudan), which is a type of stiff porridge.

To most pastoralists, fresh blood obtained by darting the jugular vein of an animal (usually a cow) is an important food, especially during times of food shortage. Blood is normally mixed with milk and stirred vigorously into a uniform brown mixture. Among the Somali, fresh blood from goat (*diik*) is recommended for women after delivering babies. A more common use of blood is stuffing it in the intestines of an animal (with spices) and cooking or roasting them. This dish, called *mutura*, is usually served in the form of large sausagelike segments. Bone soup is also popular among pastoralists. Plant parts such as bark of *olkiloriti* (Maasai for *Acacia nilotica*) are used both as a flavoring for soup and as medicine. Pork is not allowed in most of Ethiopia and among the Muslim communities, and is not tolerable in many communities. Its consumption, however, is well established in fast foods.

Agriculture is, by far, the most important production system in East Africa. Agriculture in Eastern Africa was pioneered by Cushitic speakers from the Ethiopian highlands. Other cultivators came in from the south, west (Bantu), and northwest (Nilotes). The earliest food crops of most agriculturalists included sorghum, finger and pearl millets, hyacinth (lablab) beans, Bambara groundnuts, bottle gourds, cowpeas, and yams. East African farmers eventually acquired a number of Asian crops such as banana, cocoyams, and sugar cane, as well as crops from South America, such as pumpkins, cassava (manioc), groundnut, and sweet potato. In the years following the explorations of Christopher Columbus, East Africa began to receive American crops such as maize, peanuts (groundnuts), kidney beans, and potatoes, as well as European cabbage and kales. Such foods quickly spread in popularity during the colonization era (c. 1850–1960) and became the most important foods in the region. In spite of these more recent introductions, many cultural groups retained their traditional foods, but with modified preparations.

Common Foods of the East African Peoples

Over the years, East African communities have developed and adopted specific recipes. In southern Sudan the more common foods are milk (sour or fresh), *kisira* (a type of pancake), rice, *asida* (*ugali*, or stiff porridge), and fish. In Ethiopia, typical foods would be *injera/firfir*, *kichah* (spiced pancake), *dabo* (bread), and *bula* (*ensete*, or stiff porridge). These are normally served with a variety of hot sauces (*wat*, or *watt*) on one large tray for the entire family. In Somalia the more common foods include milk (camel and cow), *canjeero* (a type of *enjera*), pasta, *otkac/nyirnyir* (dried meat), *xalwa* (a type of dessert), and *labee* (blood). In Kenya the most common foods include *ugali*, *githeri* (a mixture of maize and a pulse—that is, seeds of legumes, such as chickpeas, lentils, field peas, peanuts), *pilau* (spiced rice cooked with meat), and *chapati*. In Tanzania, *wali/pilau* and *makande* (a mixture of maize and beans) are common dishes. In Uganda, a common food is steamed *matooke* (banana) and also sweet potato and cassava products served with groundnut sauce. In Uganda *ugali* is a rather recent dish and is not very popular. In Rwanda and Burundi, beans cooked with vegetables and other starchy foods such as sweet potatoes, cassava, and green bananas are most popular. A type of ugali made from cassava—*ubuswage*—is also common.

In the inland part of Kenya, food preparations tend to be simple. Frying with oil and onion is the most popular way of improving food flavor. However, preparations are more complex and time-consuming in coastal parts of Kenya and Tanzania, where the use of coconut as a flavoring is widespread. Consequently, the foods in these regions are tastier than in inland regions. In Sudan some preparations, especially those involving food fermentation, are quite elaborate and may take up to two weeks to complete. In Uganda, steaming food that is wrapped in banana leaves is popular for preparing things such as sweet potatoes, *ugali*, bananas, cassava, vegetables, yams, and cocoyams. Of all the East African countries, Ethiopia seems to have the most elaborate food preparation methods, usually involving fermentation and spicing, especially with hot pepper.

Maize, sorghum, and millets. In the last quarter of the twentieth century, maize replaced sorghum as the most important cereal in East Africa. It is common to see people in urban areas fanning a charcoal fire in the streets and roasting fresh soft maize. Passersby buy this roasted maize (*mahindi ya kuchoma*) and eat it as they walk. Green maize is also boiled in water (*amakhaye* in Kisa), with or without the inner covers, and is salted and eaten just like roasted maize. Alternatively, fresh maize is removed from the cob and boiled fresh or when dry (*inete*). Among the Somali, fresh maize (*galeey*) is fried in oil and taken as a snack. Dry maize is fried in sesame oil to make popcorn (*salol*), which is often served with coffee to men as they chew khat (*miraa*).

Another popular East African food is *githeri*. This is basically a boiled mixture of fresh or dry maize with seeds from beans, garden peas, lablab beans, groundnuts, cowpeas, and pigeon peas. *Githeri* may be consumed alone or mixed with leafy greens or stews, especially meat stew.

When *githeri* is cooked with potatoes or cocoyams and occasionally leafy greens (mainly leaves of pumpkin, cocoyams, or Malabar gourd) and mashed, the sticky green substance that results is called *mukimo*. Among the Taita of Kenya, mukimo is made by mashing cooked cassava, sweet potatoes, or plantain with leguminous seeds, and it is known as *kimanga* or *shibe*.

Muthokoi (*naamis* in Mbulu) is a dish similar to *githeri*, but it is prepared from dry maize that has been processed to remove the tough seed coat (testa). In the Arusha region of Tanzania, cooked maize (*makande*) and rice are mixed with sour milk and served. A dry mashed mixture of maize and beans is mixed with smoked, nearly ripe bananas and mashed. This food, called *mangararu* by the Meru of northern Tanzania (*makukuru* in Swahili), can last for several days.

Ugali (sima). Probably the most important food in East Africa is *ugali* or *sima* (*asida* in Arabic, *kun* in Dinka, *kawunga* in Baganda, *akaro* in Banyankore, *buro* in Banyoro). *Ugali* is a sticky, moist dish that is made by mixing flour from a starchy food (mainly cereal and usually maize, but it can also be sorghum, finger millet, pearl millet, wheat, and occasionally cassava, or a mixture of any of these) in hot water and cooking as one mixes the substance to a paste that varies in consistency from place to place. *Ugali* by itself has a mild taste. It is usually eaten with one's fingers. It may be eaten with sour fermented milk, a vegetable stew (for example, beans, cowpeas, pigeon pea, green gram), meat stew, green vegetables, chicken, or fish. In the Lake Victoria region, fish is a common accompaniment. The combination of roasted meat (commonly known as *nyama-choma*) and *ugali* is considered a delicacy in beer-drinking places. *Ugali* is very filling and is known for its ability to make people sleepy; hence it is good for the evenings.

Ugali made from finger millet (sometimes mixed with sorghum) is popular among the Banyankore, Bakiga, Batoro, and Banyoro of western Uganda. Among the Karimojong of northeast Uganda and the neighboring Turkana of Kenya, a soft type of *ugali* (locally known as *atapa*) is often made from sorghum or pearl millet and is usually taken with sour milk, which may occasionally be mixed with animal blood.

Ugali made from cassava is common in the Lake Victoria region and in Burundi (*ubuswage/ubutsima bw'imyumbati*). Large balls of this *ugali* are wrapped in banana leaves (*imitoto*) and stored in a basket. These are picked and served with fish (*ifi*). Among the Lugbara and Madi of northwest Uganda, cassava flour is often mixed with millet or sorghum flour to prepare a type of *ugali* known as *enya* (Lugbara) or *linya* (Madi). The Iteso of Eastern Uganda and neighboring Kenya make a similar type of *ugali*, which is often eaten with groundnut paste.

In Ethiopia's Oromia region, a soft type of *ugali*, locally known as *genffo*, is prepared from wheat or maize flour and is served on a plate. A hole is then made in the

A bounty of colorful, fragrant fruits and vegetables await buyers in this African market. PHOTO BY DAVID K. O'NEIL.

middle and butter and powdered pepper and some salt are added. A more elaborate preparation is that of a breakfast food known as *kijo*. These are balls or lumps of fine, half-fermented maize starch wrapped in maize leaves and cooked by dipping the balls in boiling water. Each ball is given to one person and it is eaten with fresh or sour milk, tea, or coffee.

Another type of *ugali* is *chenga*, which is made from coarsely ground maize. Chenga is usually eaten with sour milk. In southern Sudan, sorghum is used to prepare a type of chenga, which is served with sour milk (*amok, chekipiu*), fish (*rech*), or meat (*ring*). This food is served at weddings and special ceremonies surrounding the event of a woman's first menstruation. Among the Kamba of Kenya, cleaned sorghum seeds are boiled with pigeon peas (*ngima ya munyala*). In southern Sudan, millet is also used to prepare a type of chenga known as *dukun* (Arabic) or *awuo* (Dinka). It is served with groundnut sauce (*mulaa keimot*) and mixed with fish stew.

Sour *ugali* is popular among peoples of southern Sudan. It is made from fermented maize or sorghum flour (*akilamuat* or *kun ayupwach*) or sour milk in water (*akileben* or *kuncha*) or tamarind water (*asidamot/akilamot kunchuei*). *Ugali* is occasionally eaten with ghee (*zet, miok*) instead of milk. This is popular in southern Sudan (where it is called *kundiung*) and among pastoralists. It is common to find the Wambulu of Tanzania eating this dish (*faa*) as they sit on mats.

Porridge (gruel). Porridge (*uji* in Swahili) is a popular breakfast food in East Africa. It is a healthy food, especially for children and breast-feeding mothers, as it is easy to digest and provides both water and energy in readiness for the day. However, tea has replaced porridge as a breakfast food in most parts of East Africa, which has further complicated the problem of malnutrition.

Porridge is mainly made from cereals. Depending on the area, porridge may be thin or thick and may be flavored with sugar, salt, lemon, tamarind, baobab, coconut, cow ghee/butter, or milk. Probably the most delicious type of porridge is the fermented type, *obusera obupuute* (Kisa). Preparation of this dish, however, is tedious and time-consuming. In some areas this dish has cultural significance: Among the Kikuyu of central Kenya, a circumcised boy stayed in seclusion for a certain period, after which a caretaker (*mutiili*) led him to his mother's house, where the boy was served fermented porridge (*ucuru wa mukio*) as a sign of welcome. Finger millet (*wimbi*) porridge is the most popular of all porridges in East Africa.

Rice (wali). Rice is an important dish for the Ethiopian, Asian, and Muslim communities in East Africa. A common dish is *wali usambara*, which is rice prepared with coconut milk, salt, and a bit of oil. *Biriani* is a very spicy dish composed of rice (usually spiced) and spiced meat or chicken stews. *Pilau* is a spicy mixture of meat stew and rice that is popular both inland and in coastal areas. Spices in this dish include coriander, cardamom, cumin, pepper, cinnamon, cloves, onion, and garlic. *Pilau* is a popular dish in ceremonies all over the region. Preparing pilau is a delicate undertaking that requires a lot of patience and is usually performed by several women working together. *Pilau* is often eaten with spiced stews. *Wali ubwabwa* is a soft type of rice that cooks as one stirs it. *Mkate wa sinia* is made from rice flour mixed with yeast, water, sugar, and coconut milk and heated from below and above. All of these dishes are common in coastal areas.

Wheat products. Some amount of wheat is grown in the dryer highlands of East Africa, especially in Ethiopia and Kenya. Probably the most popular wheat food in the region is the Asian flat, round, thin bread widely known as *chapati*. Chapati is mainly served with stews, hot beverages, and soft drinks. In general, bread (*mkate* in Swahili, *dabo* in Amharic) has gained increasing importance in East Africa and now is the most popular starchy food for breakfast in urban areas.

The greatest variety of wheat products is found in Ethiopia. These include *kichah*, a dish made from a mixture of onions fried in oil and wheat flour. Another wheat product is *chechebsa*, which is cooked with *teff* (a type of cereal grass). Small pieces of salted dough (*lite*) are cooked on a pan without oil to a brown bread. This is buttered and spiced with pepper. *Fettira* is a thin breakfast bread made from wheat and egg and eaten with butter or yogurt.

Arakip (Arabic) or *ayup* (Dinka) is a type of dry bread prepared from maize, sorghum, wheat, or millet flour in Sudan. This bread is popular with people looking after cattle. *Kisira* (*kun pioth* in Dinka) is a Sudanese pancake like *enjera* that is prepared from maize or sorghum flour mixed with a little wheat and water. This pancake is served with beans, okra, or okra mixed with meat or *ayak* (*Corchorus*), a mucilaginous vegetable.

A whole range of wheat products, generally of European or Asian origin, are available in East African restaurants and homes. Common products include samosas (*sambusa*, *isambusa*), *kaimati*, *mandazi* and the related *mahamri*, and French bread, to name a few. *Mandazi* (*imandazi*, *ibitumbula* in Burundi), as they are called in Kiswahili, and the related mahamri are very popular types of buns served in restaurants. *Mandazi* are made by mixing dough with baking powder and sugar, while in mahamri the dough is mixed with yeast and often coconut milk. Both are cooked briefly in oil. In Dar es Salaam it is customary to eat *mandazi* with cooked beans (*maharage*). The mixture is called *zege*, and it is eaten along with tea for breakfast. *Kaimati*, on the other hand, is spherical and more solid than *mahamri*.

Cakes are most popular in formal ceremonies, especially weddings. Among the Luhyia, a popular cake is made by mixing ripe banana and maize flour, which is then kneaded into a dough, cut into balls, and wrapped in banana leaves and steamed in water. This sweet traditional cake (*omukati kwe lisotsi*) is served with tea or porridge.

Barley. *Cheko* (Ethiopia) is a type of spiced bread made from barley. Barley is also used to make a type of porridge known as *baso*. This is often flavored with honey, sugar, salt, and butter.

Teff. Teff (*Eragrostis tef*), a type of cereal grass, is grown traditionally only in Ethiopia, particularly in the western region. Most teff is made into *enjera* (*injera*), a huge, flat, flabby, rather elastic, and slightly sour pancake that is eaten with spicy meat or vegetable stews such as *doro watt* (hot, spiced chicken curry), *sega watt* (lamb sauce), and *key watt* (hot, spiced beef sauce). One tears off pieces of the pancake and uses them to scoop or roll the stews. Enjera is a typical food in Ethiopian restaurants all over the region. The Somali type of *enjera* (*canjeero*) is usually made from a mixture of maize and wheat and is often flavored with garlic and *iliki*. Sugar and milk cream are usually added to breakfast enjera. Enjera may also be made from a mixture of rice and wheat.

Cassava. Cassava is important at the coastal areas and among the Iteso and Luo of Lake Victoria basin and their relatives in Uganda, the Acholi, Langi, and Alur. Dry cassava can be roasted or boiled or eaten fresh. In the coastal region, fried cassava is flavored with lemon and powdered pepper and eaten with tea. Cassava is also deep-fried (*mgazija wa kukalanga* in Giriama). Cassava leaves (*mchicha kisamvu*) are used as a vegetable throughout the region.

Potato (English/Irish potato). Potatoes are used to make a popular stew (called *karanga* in Kenya) of carrots, tomatoes, meat, and onions. These are usually served with *ugali*, *chapati*, or *wali* (rice). Chips, or french fries, are the most popular foods in fast-food kiosks and are usually served with pork or beef sausages. In Burundi, chips are also prepared from green bananas (*ibitoke*) and sweet potatoes (*ibijumbu*).

Tannia and cocoyams or taro. Tannia (*Xanthosoma sagittifolium*, called *Marumi* in the Meru region of Tanzania) is commonly used in Uganda and parts of Tanzania, especially among the Chagga, Ameru, and Arusha peoples. The tubers may be cooked with meat, beans, and maize or boiled and eaten with tea.

Cocoyams or taro (*Colacasia esculenta*), on the other hand, are widespread in the region and are commonly planted along water courses. The tubers are prepared in the same manner as tannia. Both tannia and cocoyams are popular breakfast foods.

Yams. In East Africa yams (*Dioscorea*) come in various types and include such varieties as the aerial yam or air potato, whose tubers are borne on the stems. Yams are prepared in the same ways as tannia and cocoyams.

Bananas and plantains. Many varieties of bananas exist in East Africa. Different varieties are used for brewing beer and cooking, and others are eaten when ripe, such as *kisukari* (Swahili) or *igisukari* (Burundi). *Kisimiti* and *kibungara* (found in the Mount Meru section of Tanzania) are varieties used to make traditional beers called banana and *mbege*. Also in Mount Meru, the soft varieties of bananas called Uganda and *ng'ombe* are preferred for meat and maize dishes. A cooked mixture of *ndizi ng'ombe* and maize meal, served with milk, is known as *loshoro* and is a favorite food for the Arusha. In Tanzania, mashed beans and bananas (*kishumba*) are often served as a wedding cake with *dengelwa* (local sugar cane beer).

Green bananas (*matooke*) are the most important foods of the Baganda of Uganda. They are usually wrapped in banana leaves, steamed, and then mashed and eaten with a variety of steamed sauces usually containing groundnuts.

Ensete. Ensete (*enset*) is a bananalike plant (*Ensete edule*) exploited in southern Ethiopia for its pseudo-stem and leaf midribs—a source of a starchy product that is the staple food of parts of Ethiopia. This starch is fermented in the ground for periods lasting weeks or months. It is made into several products, including *kocho* (bread) and *bula* (porridge). *Kocho* is usually eaten with *kittifo* (*kitfo*)—hand-minced beef mixed with butter and pepper and served raw or cooked. A major disadvantage of ensete is its low protein content.

Beans (kidney bean, common bean) and peas. In Rwanda and Burundi beans are eaten for breakfast, lunch, supper, and as a snack. They are cooked with starchy foods such as sweet potatoes, green bananas, cocoyams, and cassava, as well as leafy green and fruit vegetables. In coastal parts of Tanzania, beans (*maharage*) are cooked in coconut milk (*tui*) and served with *ugali*. Among the Giriama of Kenya this stew is known as *borohowa ya maharagwe*.

Other pulses commonly made into stews are cowpeas and green grams, locally known as *pojo* or *ndengu*. Pojo stew (*borohowa ya pojo*) goes well with chapati, but it is also eaten with ugali and rice. In Ethiopia meat is prohibited during fast days. In such times, chickpeas, lentils, field peas, peanuts, and other pulses are used to make the local sauces and stews, *watt*, and *alechi*.

Bambarra groundnuts. Bambara (*Vigna subterranea*) seeds are boiled with maize (usually after overnight soaking) to make a type of githeri (*amenjera ke tsimbande* in Luhyia) usually eaten as a snack. These seeds are also fried like groundnuts.

Groundnuts and other nuts. Groundnuts (*ibiyoba* in Burundi) are the most widely grown nuts in the region and are eaten raw, roasted, boiled, or in stews. In southern Sudan, ground roasted groundnuts are mixed with honey and eaten.

Groundnuts are extremely important in Uganda as they are used to make the most commonly used sauce—groundnut sauce—that is used to eat most starch foods. The sauce is usually mixed with meat, mushrooms, fish, chicken, or just tomatoes.

Among the Somali, a mixture of *iliki*, roasted groundnuts, and sugar is fried in ghee (*subag*) to make a sticky jellylike substance called *xalwa*, which is usually served with coffee or as a dessert after meals. Cashew nuts are grown in coastal areas and are a popular snack.

Gild (*Cordeauxia edulis*) is an evergreen shrub in the bean family that produces seeds called *yeheb* (*yihib*), which are eaten like nuts. These are very popular with Somali pastoralists. The inner part of marula fruit seeds (*Sclerocarya birrea*) is eaten fresh or roasted.

Fish. The most popular type of fish (*samaki*, *rech*) in East Africa is the tilapia (mainly *Oreochromis niloticus*) or *ngege*. People along the shores of Lake Victoria often enjoy this dish with ugali. The large Nile perch (*Lates niloticus*) is not as popular as talapia, but it provides large quantities of meat, which are usually made into fish balls. Another common fish is the small sardinelike fish (*Rastrineobola argentea*) known by the names *omena* (Luo) and *dagaa* (Swahili). These cheap sources of protein are dried and sold in tins in most urban markets.

Meat. Meat (*nyama*, *ring*) is used to prepare a variety of sauces and stews (*mchuzi* in Swahili and *watt* in Amharic). In Ethiopia, *quanta* is meat that is cut in long pieces, smeared with powdered pepper, salted, and dried by hanging it above the fireplace for five to seven days. This meat is used to make a hot stew, *quanta watt*, which is served with enjera or mixed with broken pieces of enjera and eaten as *quanta firfir* (Amharic) or *sukume* (Oromic). Among the Luo of Kenya, such dried meat is known as *aliya* and is made into a stew that is eaten with ugali. Among the Somali, dried meat (*otkac* or *nyirnyir*) is usually prepared from camel meat (*hilib gel*). Strips of sun-dried meat are cut into small pieces that are fried (usually in oil with garlic and *iliki*) and immersed in camel ghee (*subag*). Nyirnyir can last for several months and is usually served with tea, honey, chapati, and enjera. During breakfast, nyirnyir is served only to men. Preserved camel's meat and dates are served during Somali weddings. The date pulp is separated from the seed, mashed, and put around the preserved meat. On the wedding day, the meat basket is covered with a white cloth as a sign of purity or virginity. The dates and meat are served by the bride's mother to her new in-laws.

In Sudan, most of the meat from a slaughtered animal is dried (*shermout*). The layer of fat around the stomach is also dried and is called *miriss*. Internal organs may also be dried, pounded, mixed with some potash, and molded into a ball that is allowed to dry slowly to make *twini-digla*. The large intestine may also be cleaned and stuffed with fat and hung to dry as a type of sausage.

A common way of serving meat is to pile pieces of meat and sweet pepper on a stick and roast them. This type of meat, known as *mshikaki* (*mshakiki*, *umushikaki* in Burundi), is very common in the streets of coastal towns in the evening.

Chicken. Most households in East Africa raise chickens, which are usually prepared for guests. The various parts of the chicken hold significance in different regions. In western Kenya, for example, the tail part of the chicken is reserved for the male head of a family. Among the Kamba of Kenya, a gizzard is served to the most important person in a group of visitors, while among the Luhyia the gizzard (*imondo*) is never shared. If two people did share it, it is believed they would always be in disagreement.

Milk and milk products. The nomadic tribes of Sudan make a type of cheese called *kush-kush* eaten with sorghum porridge. Camel herders put milk into a skin bag that is fastened to the saddle of a camel, and the milk (*gariss*) is allowed to ferment. This is a major source of food for the herders as they roam with their animals in remote areas.

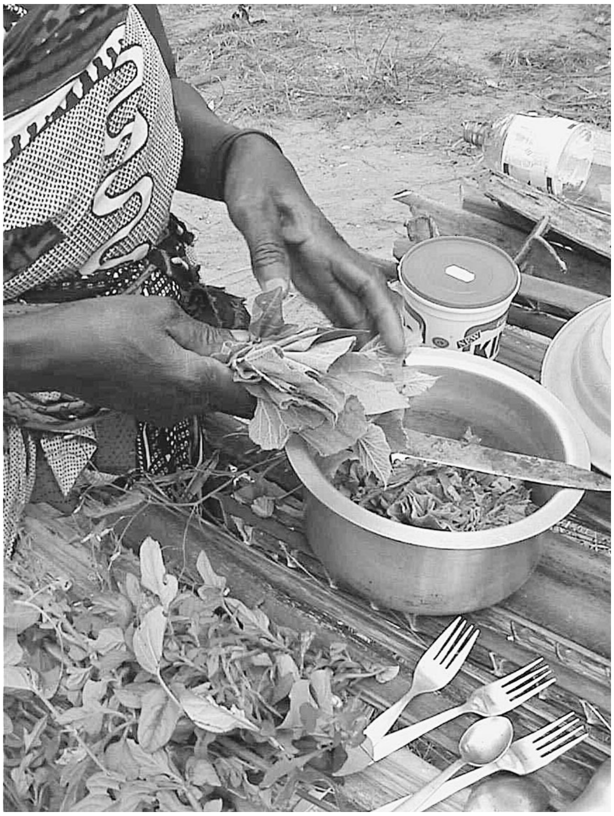
In the twentieth century many dairy products entered the Sudan from the North, including *jibnabeida* (white cheese), *zabadi* (yogurt), and black cumin-flavored *mish* (Dirar, Harper, and Collins, p. 20).

Meat substitutes. In rural western Sudan, a popular substitute for the meat flavor is *kawal*, a strong-smelling product derived from a two-week long fermentation of the pounded green leaves of the wild legume *Cassia obtusifolia*. In the same region, the oil seedcake remaining after oil extraction from sesame seed (*Sesamum orientale*) is fermented for a week to make *sigda*, another meat substitute. Sigda is usually consumed in a vegetable stew. *Furundu*, a similar meat substitute, is prepared from the seeds of *karkade* or red sorrel (*Hibiscus sabdariffa*). All these products are dried after fermentation in the form of hard, irregular, small balls and may keep for a year or so.

Leafy vegetables. Many leafy vegetables are used as an accompaniment for starchy foods such as ugali. These vegetables are prepared in a variety of ways—in many cases as a mixture. Common traditional leafy vegetables include baobab, cowpea, amaranth, vine spinach (*Basella alba*), Ethiopian kale (*Brassica carinata*), spiderplant (*Cleome gynandra*), jute (*Corchorus olitorius*), crotalaria, sweet potato, water spinach (*Ipomoea aquatica*), African nightshades (*Solanum* species), hibiscus (*Hibiscus sabdariffa*), *Oxygonum sinuatum*, African eggplants (*Solanum* species), pumpkin, cocoyam, bean, and cassava. Ethiopian kale (*gommen*) is important during fast days in Ethiopia when meat is prohibited. It is used to make local sauces, alecha. A few nontraditional leafy vegetables like cabbage have gained importance in the last few decades. Kale (*Sukuma wiki*), introduced in the twentieth century, is now the most highly consumed vegetable in urban parts of Kenya.

Fruit. A wide range of traditional and exotic fruits are consumed in East Africa, usually as snacks. Mango, citrus fruits, banana, jackfruit, papaya, melons, guava, passion fruit, custard apple, and avocado pear are all common market fruits. Many of the traditional fruits are picked in the wild, such as baobab (*Adansonia digitata*), wild custard apple, saba, carissa, dialium, flacourtia (Indian plum), marula, vangueria, tamarind, vitex, and jujube.

The dry cream-colored pulp of baobab, which is sour-to-sweet in taste, is eaten raw or may be dissolved in water and stirred to a milky state, at which time the seeds are sieved off and the juice is used as a sauce or for sour porridge. The pulp-coated seeds (*mabuyu*) are colored, sugar-coated, and sold as sweets in coastal towns (Swahili).



A Kenyan woman is shown chopping mallow leaves to make a traditional stew that is eaten with fish and *ugali*. *Ugali* is stiff cornmeal dough pressed against the elbow to make a cup, which is then used as an edible scoop. PHOTO BY Y. MORIMOTO.

Beverages. In general, traditional East African cultures do not favor the use of juices. Juice made from ripe banana (*umutobe*) is commonly served in Rwanda, and a hot drink and juice made from *karkade* (*Hibiscus sabdariffa*) are common in Sudan, but these are exceptions. However, a great variety of alcoholic drinks are made in the region. *Muratina* is a common weak beer served in rural parts of Kenya. It is prepared from honey, sugar, or sugar cane and is named after the fermenting agent, the sausage tree fruit (*Kigelia africana*). The Maasai use aloe root (*osuguroi*) in place of sausage tree fruit for fermentation.

Busaa (Luhyia) or *amarwa* (Baganda) is an alcoholic drink as well as a food. It is made mainly from sorghum, maize, or millet flour. In Rwanda, a similar type of drink—*ikigage*—is consumed as a drink and as food. Among the neighboring Bakinga of southwest Uganda, a similar drink called *omuramba* is made from sorghum. However, a more popular drink in Rwanda is *urwangwa*, which is made from ripe banana. It is popular in ceremonies and among men when discussing important issues.

In Ethiopia, *berize* (Amharic, Oromic) is prepared with honey and the boiled stems of a tree called *gesho* (*Rhamnus prinioides*). Berize is fermented to a weak, amber-colored wine called *tej* (*t'ej*). It is served in special long-necked bottles after meals in ceremonies. *Tella* (*talla*) is similar to Kenyan *busaa* but is prepared by fermenting roasted maize flour and barley.

Mnazi or *pombe ya mnazi* is palm wine. It is a popular drink in all coastal areas where coconut trees grow. *Chang'aa* is a popular but illegal spirit made by distilling fermented grain (such as maize) or banana. It has a variety of local names, such as *kumi kumi* in Nairobi and *waraj* in western Kenya and in Uganda. The Ethiopian version of it is *katikala* (in Amharic) or *areq* (Arabic) and is usually made from finger millet. Chang'aa has over the years been responsible for a number of deaths due to unscrupulous sellers who add illegal chemicals to the beverage to increase its potency.

Sorghum is used in Sudan to brew a large variety of opaque and clear beers using complex methods. Common examples are *merissaan* (opaque beer) and *assaliya* or *um-bilbila* (clear beer). Traditional wines include *sherbot*, *nebit*, and *dakkai* made from dates that are normally found in the northern dry parts of the country. In southern Sudan, *duma* (a type of wine) is made by fermenting diluted honey.

Liralira is a local spirit of the Acholi and Lango in Uganda. It is made from finger millet and cassava flour. The neighboring Sudanic communities of Lugbara and Madi have their own brew made from cassava, known locally as *ngoli*, while the Iteso of Kenya and Uganda have a version called *ajono* that is made from finger millet. Many other alcoholic drinks are found in East Africa and go by such names as *mbege* and *karubu*.

Coffee. Although Eastern Africa is one of the largest producers of coffee, the beverage is not very popular except in its original home—Ethiopia. Among the Muslim communities of the coastal region, very strong coffee (*kahawa chungu*) is served in small cups along the streets in the evenings and early in the morning.

In Ethiopia, raw coffee (*bun*) is roasted on a pan until it turns brown. It is then spiced and ground into flour on a stone. The coffee is served in an earthenware kettle (*jebena*). Coffee-drinking is an important occasion in many communities in Ethiopia, Sudan, and Somalia. Among the Somali, coffee is served in small cups with date fruits or *xalwa*.

Tea. Tea has replaced porridge as the morning drink in many homes in East Africa. In many rural restaurants it is customary to serve tea as soon as one sits down. The common way of preparing tea in homes and in most restaurants is by boiling water and adding tea leaves and milk, all mixed together (*chai ya maziwa*). Tea without milk is popularly known as *strungi* (from "strong tea") and as *shaah biiges* in Somali. The Maragoli and Taita of Kenya value tea highly.

Stimulants. *Khat* (also known as Abyssinia tea or *miraa*) is a popular stimulant in East Africa. The bark from fresh young shoots is peeled off and chewed. Khat is an important plant during wedding ceremonies among the Somali and Boran of Kenya and Ethiopia.

Spices/flavorings. Probably the most widespread item used for flavor is salt. In many traditional societies, salt is a filtrate of ashes from dry bean leaves, banana peels, water reeds, sorghum head, and normal ash. Most communities used samli or ghee to flavor food. In Tanzania and most coastal parts of the region, coconut milk is also used to flavor food. Grated coconut and water are squeezed in a woven bag to produce concentrated milk.

Tea and a few other beverages are flavored with a number of things, the common being ginger (*tangawizi*) and *masala* (a mixture of spices but usually containing coriander). Tea can also be flavored with lemon grass (*Cymbopogon citratus*), lemon (*Citrus limon*), and *mjafari* (*Zanthoxylum chalybeum*). The art of flavoring is most established in Ethiopia and among the Asian community in the region. The sauces are therefore extremely hot. In Ethiopia, the powdered spice *berbere* (also *berberi* or *awaze*) has hot pepper as the main ingredient but may contain a dozen other spices. Curry powder (*bizari*), another mixture of spices (usually cardamom, turmeric, ginger, cinnamon, and chilies) is more popular in the rest of the region. Spicing, however, seems to be more of a culture in Ethiopia and coastal regions where there has been long Islamic and Asian influence. A variety of spices are used, the more common ones being black pepper, *piper nigrum* (*pilipili manga*); cardamom, *Elettaria cardamomum* (*iliki*); chili pepper, *Capsicum annuum* (*pilipili kali*); cinnamon, *Cinnamomum verum* and *C. aromaticum* (*mdalasini*); cloves, *Syzygium aromaticum* (*karafuu*); coriander, *Coriandrum sativum* (*giligilani*); cumin, *Cuminum cyminum* (*bizari* or *nyembamba*); curry powder (*bizari*), a mixture of different spices; garlic, *Allium sativum* (*kitunguu sumu* or *kitunguu saumu*); ginger, *Zingiber officinale* (*tangawizi*); nutmeg (*kungumanga*) and mace, *Myristica fragrans* (*kungu*); sweet pepper, *Capsicum annuum* (*pilipili hoho*, *pilipili mboga*); tamarind, *Tamarindus indica* (*ukwaju*); and turmeric, *Curcuma longa* (*manjano*). Many of these are grown locally and for some, like cloves in Zanzibar Island, production is of world significance.

See also **Banana and Plantain**; **Cassava**; **Fermentation**; **Nuts**; **Stimulants**.

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NORTH AFRICA

A Moroccan proverb says: *Mâ kainsh el-kalâm cala ettacâm*, "Where there is food, there is no talking." Indeed, as a sign of respect for the food that God has provided and the host or hostess has served, North Africans consider it impolite to converse while eating. The food itself, however, does not remain silent. Food talks. Meals convey messages. Perhaps more than anything else in North African cultural praxis, food habits constitute a rich language through which the region's history is told, social distinctions are expressed, religious feasts are celebrated, and seasonal changes and transformations in the life cycle are marked.

Historical Influences

The history of North Africa comes to the fore in both particular ingredients and dishes that are shared by most Maghrebi as well as in regional differentiation between specific dishes and ingredients. Influences from the Roman presence (200 B.C.E.–300 C.E.) can, for instance, be recognized throughout the region as wheat is the basis for the two main staple foods, bread and couscous, a steamed grain of crushed wheat or coarse flour. Islamization in the seventh century can, of course, be recognized in the prohibition of pork or wine, although flourishing vineyards can be found throughout North Africa. Arab influences that accompanied early Islamization, such as the consumption of rice, native east African vegetables such okra and *mlûkhîa* Jew's mellow (*Corchorus olitorius*) and the use of *fliyu* and mint in meat and vegetable dishes, are more pronounced in east Algeria and Tunisia than in regions further removed from the Levant, such as western Algeria and Morocco. All three countries have adopted the Arab preservation technique of drying meat, called *gedîd*, in which salt and spices are rubbed into the meat, which is then left to dry in the sun.

Morocco is the only North African country that was not occupied by the Ottoman Empire during its presence in the region (1500s–1700s). Correspondingly, dolmas, stuffed vine leaves, like Turkish and Syrian puff pastries such as baklava and *brîk*, are commonly prepared in formerly Ottoman Algeria and Tunisia, but do not feature in Moroccan cuisine. On the other hand, Algerian, Tunisian and Moroccan cookery alike have been heavily influenced by the introduction of crops from the New World such as tomatoes, courgettes, sweet peppers and potatoes. These foods were introduced to North Africa before they were introduced to central Europe. Potatoes, however, never became as popular in North Africa as they would become in Europe.

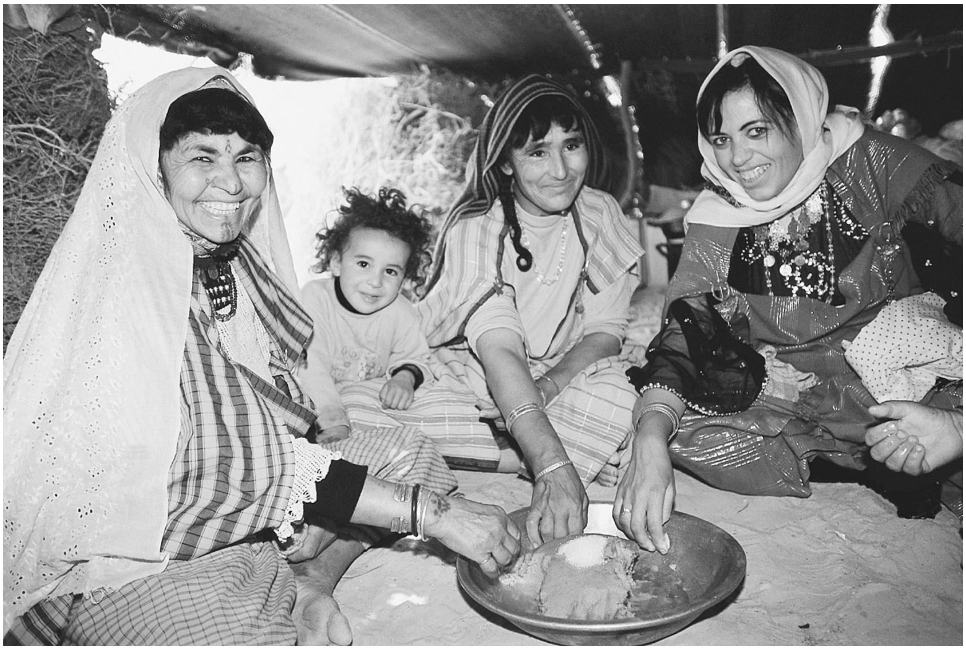
Food habits in all three North African countries discussed here have been influenced by French occupation. In Algeria, the French occupation lasted the longest (1830 to 1962). Not in the least because of the influx of a large number of French settlers, all spheres of life were influenced by it, including Algerian cuisine. Tunisia was occupied in 1881 and largely shared the same fate, at least in the cities. By the time Morocco became a French protectorate in 1912, the French occupational policy had changed. Fewer settlers were moved in, and more attention was paid to the preservation of "traditional culture." In terms of food habits, these different policies can be recognized in Morocco's being the only Magrebian country where most people still eat homemade round breads rather than bakery bought baguettes. Most city dwellers in Morocco, however, like those in Algeria and Tunisia, nowadays drink café-au-lait for breakfast. Indeed, examination of the three daily meals that are consumed throughout the Maghreb—the *ftûr* or breakfast, the *ghrdâ'* or midday meal, and the *cashâ'* or evening meal—brings to light more variations between rural and urban areas than between countries. The distinction between rural and urban food habits corresponds, albeit not exclusively, with the distinction between the poor and those who fare better economically. On the whole, for example, less meat is consumed in the countryside than in the cities, and the same is true for milk and butter. Also, in the cities, fast food chains are becoming increasingly popular and when guests come for dinner, there are always a few bottles of cola and other carbonated soft drinks on the table.

Daily Meals

In the cities breakfast usually consists of a café-au-lait with bread and butter or jam, sometimes with *La Vache Qui Rit*, wedges of processed cheese that seem to have conquered much of the developing world. The Moroccan city of Fès is famous for its *harsha*, an unleavened very thick and crusty flatbread made of crushed wheat and *arachide* or olive oil, preferably eaten with fresh cheese. Because the flatbread remains tasty for a long time, it is popular with travelers. Because it is filling, peasants are also fond of it. If leavened bread is eaten for breakfast in rural areas, it is more likely to be served with olive oil than with butter, and it is eaten with tea more often than with coffee. Heavy agricultural work demands a substantial meal, however, so that *assîda* or *bsissa*, water-based porridges of semolina or grilled barley flour, are more common rural breakfasts. Yesterday's leftovers of couscous or soup may, of course, do just as well.

Lunch. Lunch consists of a hot meal, which in Morocco is the most important meal of the day, while in Algeria and Tunisia the dishes that are served for lunch or dinner are interchangeable. Among the urban elite, especially in Algerian towns, lunch may consist of dishes from the French cuisine, such as fried meat, french fries, and salads. In Morocco and Tunisia, most people prefer to eat either a *tajîne* (tagine), a stew, also called *marqa*, or a couscous. *Marqas* tend to be more popular than couscous, especially in urban areas. Nowadays, *marqas* are almost invariably prepared in pressure cookers, but most people agree that they taste much better when prepared in a *tajîne*, the traditional cone-shaped earthenware pots that gave this kind of dish its name.

The sauce that forms the basis of a *marqa* or *tajîne* varies per region. In Morocco, saffron is traditionally used to color the basic sauce yellow. Nowadays, saffron is nearly always replaced by artificial yellow coloring powder, which is much cheaper but lacks taste. To make a *marqa*, chopped onions and garlic cloves are fried in *arachide* oil into which the (artificial) saffron is stirred. Next, fresh chopped coriander and parsley are added, then salt or "knurr," that is, stock tablets (the brand name has become the generic name) together with spices such as black pepper, paprika, cumin, and sometimes ginger and/or cinnamon. A famous mixed spice is *râs el-hânut*, "the master of the shop," which should consist of twenty spices, among which powdered rose buds and lavender, and, as tourists are meant to believe, the aphrodisiac "Spanish fly." *Râs el-hânut* is classified as a "hot" spice. Consequently, it is almost exclusively used in winter. Other "hot" spices such as black pepper, ginger, and paprika, are also used more liberally in winter than in summer, when mild spices like cumin and cinnamon are used more. After spices have been added, peeled and chopped tomatoes are put in, together with meat. Last of all, water is added, after which the sauce is left to simmer until the meat is tender.



Berber women eating traditional food from a common bowl in the Sahara Desert of Tunisia. © INGE YSPEERT/CORBIS.

Only very little water is added to the *tajîne*. The earthenware pot is placed on a charcoal burner, and it takes hours for the meat and vegetables to cook in their own juices. In Tunisia, tomatoes and *harîssa*, a chili paste, form the basis for the sauce so that the marqa is red rather than yellow. Otherwise, much the same spices are used, although cumin may be replaced with caraway. In Algeria, in regions closer to Morocco, the basic sauce is yellow, while in regions closer to Tunisia it tends to be red. Marqas are eaten with bread. In most Moroccan families, the housewife or one of her servants prepares the dough for the bread, which is then brought to the *ferrân*, the public oven, where it is preferably baked shortly before lunch, so that the bread is still slightly warm when lunch is served. Tunisian and Algerian women often reheat the bakery-bought bread before serving it.

Bread and couscous are never eaten together. While in urban areas *marqas* are prepared more often than couscous, in rural areas it is the other way around. Unlike other dishes that are associated with the countryside, however, a good couscous is considered a festive meal by urban and rural dwellers alike. Most Maghrebi eat it for Friday lunch, Friday being the most blessed day of the week. It is also a favorite dish for weddings and other big dinner parties, not in the least because it is easy to prepare in great quantities. A Friday or party couscous tends to contain more meat and a larger variety of vegetables than those eaten during the other days of the week. Meat is quite expensive in North Africa, and especially in the countryside, both daily *marqas* and different kinds of couscous consist largely of vegetables and pulses such as chickpeas, lentils, and white beans. In coastal areas, fish, mostly deep fried, is also included.

In general, pulse-based dishes are associated with poverty. *Bisâra*, for instance, a very thick sauce of cooked dried and peeled broad beans to which lots of garlic, olive oil and cumin is added, is a much loved dish, especially in winter. Yet one would not dream of serving it to guests. The same goes for *usbân*, a Tunisian couscous with offal, the cheapest "meat" there is. Instead of these cheap—albeit delicious—meals, guests should be served dishes that consist mostly of meat, such as the originally Ottoman *l-hamm el-hlû*, cinnamon- and ginger-spiced veal, served with prunes and fried almonds, or *dajâj zîtûn*, chicken with green olives, salt lemon preserve, hard-boiled eggs, and, again, fried almonds. Throughout the Maghreb, *bstîla*, originally from Fès, has also become a favorite dish to serve guests. It is savory pie made of flaky pastry filled with pigeon or chicken that is sprinkled with cinnamon and powdered sugar before serving. The latter ingredients are also used to top off sweet couscouses that are served for dessert.

Tea and evening meal. As was mentioned before, in Algeria and Tunisia the dishes that are served for lunch or dinner are interchangeable. These meals are eaten around six or seven o'clock. In Morocco, the *cashâ'* tends to be eaten somewhere between eight and nine o'clock. This allows women to visit each other in the afternoon and have tea together, which is followed by coffee just before they go home. The green tea that is flavored with fresh mint and much sugar and may be served with *el-ghraif*, flaky pastries fried in a pan and served with honey or castor sugar, or with *beghrîr*, leavened pancakes served with honey, butter or olive oil, or *sfinj*, fritters. Although men also occasionally eat sweet pastries, throughout the Maghreb they are typically associated with women.

Because the evening meal is served rather late in Morocco, women who stay at home have tea with bread or *harsha* before they prepare dinner. Except when there are guests, dinner in Moroccan cities is light, consisting of soup, small meatballs in a tomato sauce, or milk-based porridges of rice, semolina, or pasta. In rural areas where those who work on the land have not been able to come home for lunch, dinner is the main meal and more substantial.

Meals for Special Occasions: Ramadan

During the month called Ramadan, between dawn and sunset, Muslims refrain from eating, drinking, and sexual contacts. After sunset, all this is allowed again. Ramadan is as much a month of feasting as of fasting. Indeed, many people gain weight during the fasting month. Some people save money for months in order to eat meat and luxury foods during the Ramadan nights. Much like Christmas meals in Western countries, Ramadan meals are family dinners. More often than not, friends or neighbors are invited to join in as well. Some only pop in for the sunset meal, others stay until the last meal that is served an hour before dawn. Sharing extends to strangers: every day towards sunset, people bring soup and couscous to the mosque for the poor and homeless.

Ramadan breakfast. Like most Muslims in the world, North Africans follow the example of the Prophet Mohammed (570–632), who used to break the fast by eating a date and drinking a sip of water or milk. They then perform the sunset prayers, after which the *ftûr* is served. In Morocco, *harîra*, nutritious tomato soup with meat, chickpeas and lentils, has become the national dish for breaking the fast. Besides *harîra*, what should also always be present on the breakfast table are *shebbakiyyât*, also known as *grioush*, deep-fried pastries with anise and cinnamon, which are dipped in honey or caramel when still hot and are then sprinkled with sesame seeds. *Beghrîr*, pancakes, are another favorite, as are hard-boiled eggs and olives. After having eaten two or three bowls of *harîra*, coffee with much more milk than usual is drunk.

Algerians and Tunisians also have soup for a Ramadan breakfast, but do not share the Moroccan habit of eating sweet pastries with soup. They prefer to eat large quantities of cakes and sweets with the coffee that is served later in the evening. To digest breakfast, many North African city dwellers go out to attend the open air performances and other special Ramadan festivities that are organized in town, buying orange juice, buttermilk, roasted sunflower seeds, peanuts, or chickpeas from street vendors as they stroll along.

Ramadan evening meals. Tunisians and Algerians combine the Ramadan breakfast and the evening meal. They eat a date and a bowl of soup before performing the evening prayers, after which they return for the evening meal, which in all three countries should always contain a fair amount of meat during Ramadan. *L-hamm el-hlû* (sweet veal with prunes) is a favorite Ramadan dish in Algeria, while in Tunisia *keftajî*, a stew with meatballs or a well-filled *marqa* (stew) may be served. Tunisians may also eat parched fish for a Ramadan dinner. This is frowned upon by Algerians and Moroccans: fish is easily digestible and leaves you thirsty, two qualities that are not very helpful during the fast. Ramadan dinners are served with more side dishes (eggs, olives, salads) than during other months of the year, and a larger variety of fruits appear on the table for dessert.

A typically Moroccan tradition occurs on the fifteenth night of Ramadan. That night, every family wants to eat a home-slaughtered chicken or rabbit, which gives this special dinner a connotation of a sacrificial meal. No similar tradition exists in either Algeria or Tunisia. What all three countries do share is the tradition on the twenty-seventh of Ramadan to visit the graveyard, clean the graves of relatives and have prayers said for them. On the way to and from the graveyard, children in the street and poor people who have gathered at the gates of the graveyards are given *sadaqa*, alms consisting of dates, figs and sweet bread.

Meals at night during Ramadan. People who have guests stay awake until the *shûr*, the last meal before dawn, in the meantime enjoying lots of coffee and pastries such as baklava, *brîk* (sweet puff pastries) and *sefûf*, ground and grilled sugared cereals and nuts. In the old quarters of towns, those who go to sleep are awakened for the *shûr* by musicians going through the streets. Most people have a light *shûr*: French toast, a milk-based *assîda* (porridge), or a *mesfûf*, (sweet couscous). In rural areas, however, the *shûr* may consist of a more substantial meal.

The feast meal. The last few days of Ramadan, women are very busy preparing cookies, cakes and pastries for the *cîd es-saghrîr*, the feast that ends the fasting month. In rural areas, nearly every one makes *kacak*, hard biscuit rings with anise and fennel seeds. In general, townswomen make a greater variety of cakes, cookies and pastries. In Algeria, women in Constantine are the most famous cookie makers, to be followed by those of Algiers and Blida. These cities used to have large Jewish communities, and Muslim women are said to have learned the art of cookie baking from Jewish women. Particularly popular for the concluding feast of Ramadan are *maqrûd*, date- or almond-filled fried cookies made from semolina, and *qnîdelet*, marzipan cigars. In Morocco, Fès is famous for its good pastries, such as the *kacab el-ghrazâl*, “gazelle horns,” horn-shaped pies filled with almond paste.

In Morocco, many people find it important that the first meal that is eaten on the feast that ends Ramadan should be a white porridge. The color white symbolizes the purity that one has attained by fasting a whole month. The rest of the day is spent paying visits and receiving guests. In every house that they visit, people are served coffee or tea with lots of cookies and pastries. Not surprisingly, many people do not eat dinner on the first day of the feast concluding the fasting month.

The Feast of Immolation

On the tenth day of the *hajj*, the pilgrimage to Mecca two months after Ramadan, all pilgrims sacrifice a ram to commemorate how Ibrahîm (Abraham) slaughtered a ram as a last-minute substitute for the son he was willing to sacrifice as an act of obedience towards God. It is recommended by Islamic law that those Muslims elsewhere in the world who can afford it also sacrifice a ram. Voluntary fasting is recommended the day before the ritual sacrifice. Some people fast until the first meat of the sacrificed ram is served later in the day. Only men are allowed to slaughter. Female household heads call in a butcher. After the slaughtering, the rest of the day women are busy processing the meat.

Much local symbolism is attached to the various parts of the sacrificial ram. Mothers, for example, dip a finger in the blood that flows from the cut throat to mark the forehead of their children so as to ward off the evil eye. The sheepskin not only makes a perfect prayer mat, but is also thought to relieve the pain of a woman in labor who lies down on it. Of particular importance is the liver, the organ that is considered the seat of compassion. Barbecued liver is the first meat that is consumed on the day of the sacrifice. Women see to it carefully that there is a skewer for every member of the family. When someone does not make it on time for the barbecue, his or her skewer will be kept apart for them. Sharing the liver with all family members expresses and fortifies the family bond. The pieces of liver on the skewers given to girls are wrapped in the fat tissue that covered the heart of the ram, as this is believed to enhance finding a husband with a good heart.

Nowadays, pieces of meat that are not distributed among the poor can be stored in refrigerators and freezers, but the tradition of making *gedîd*, dried meat, has not disappeared. Slices of meat are put in a spicy marinate overnight. The next day, pieces of paunch are filled with the marinated chunks and then tied into bundles that are left to dry in the sun for several days. When a woman has difficulty getting pregnant, her friends may organize a lunch party for her by collecting two balls of *gedîd* from each woman who will attend, which are then served in a couscous. The chances that the honorary guest gets pregnant are thought to have improved after this ritual lunch. A tradition in Marrakesh (Morocco) is to dry the tail of the ram to save it until the *Ashûra*, the celebration of the New Year.

The *Ashûra* or Islamic New Year

Exactly one month after the Feast of Immolation, the *Ashûrâ* is celebrated on the tenth day of Muharram, the first month of the Islamic year. Traditionally this is the day on which the religious duty of performing *zakât*, the legal almsgiving, is performed. *Ashûra* concludes a transitional period of ten days between the old and new year. During this period, some people observe fasting. In Marrakesh, the fast is concluded by having a couscous with the preserved tail of the sacrificial ram, which thus comes to symbolize the farewell to the past year. In Tunisia, on the ninth day of Muharram people tend to eat chicken with very thin noodles, while on the tenth they prepare a couscous or *marqa* with mutton. In Algeria, dinner on the tenth of Muharram should be sweet, and often contains raisins, prunes and cinnamon. In Morocco, *Ashûra* is not linked to any special meal, but what is shared with the other countries is that women prepare or buy *krishlât* or *fakîya*, mix of raisins, figs, nuts, and dime-sized cookies. *Krishlât* is eaten at home and distributed among children in the neighborhood.

Despite the influence of the former French occupation, New Year celebrations according to the Christian calendar do not, as yet, receive much attention. An exception must be made for Tunisia, where people eat *mlûkhîa* or other dishes from spinach-like plants on New Year's Eve. Green is the color that symbolizes Islam. The green color of the New Year's Eve dish also symbolizes the hope for a "green," that is, prosperous, year.

The *Mûlûd* or Birthday of the Prophet

On the twelfth day of the third month of the Islamic calendar, the *mûlûd* or birth of the Prophet Muhammad is commemorated. Every country has its own special dish on this occasion. In Tunisia and Morocco, most families have *assîda* for breakfast, a semolina porridge prepared with milk and sweetened with honey. Poorer people and those in the countryside keep it simple, while people in the cities and those who are better off may add raisins and orange blossom water to the porridge. In Algeria, people in the east are known for eating *sfinj*, fritters, for breakfast, while *qatawarmi*, chicken with turnip and chickpeas, is eaten for dinner across the country. In Morocco chicken or beef with prunes and almonds is a favorite dish on the Prophet's birthday.

Life Cycle Rites

Birth. While in North African cuisine both hot and mild spices are used, the two should not be mixed. According to Tunisians, the combination of hot and sweet spices is thought to cause diarrhea, just as fish with milk is thought to cause skin diseases and tea with buttermilk stomach aches. In all three countries, dishes prepared for special occasions related to life cycle rites tend to be mild and sweet. Cinnamon, raisins, prunes, and nuts are recurring ingredients. On the occasion of a birth, for example, an Algerian new mother is offered semolina porridge with honey. In Morocco the mother is offered *sefûf*, ground and grilled cereals and nuts, flavored with sugar, anise, and fennel. *Sefûf* is considered to help her regain her strength and to pass it on to her baby through her breast milk. According to a Moroccan tradition, when the baby is a girl, a cock should be slaughtered for the first meal that the mother eats after having given birth, the cock symbolizing the future husband of the girl. If the baby is a boy, a hen is slaughtered for this dish. On the seventh day after birth, the day on which the baby is given its name, different kinds of pancakes such as *ghraif* and *beghrîr* are prepared for breakfast. In families that can afford it, a sheep is sacrificed to thank God. It is prepared for the guests who attend the name-giving party.

Marriage. According to a Moroccan custom, the last meal that a mother of a Moroccan bride prepares before her daughter leaves her parental home to join her husband should be a dish that was "stirred with no spoon," lest her husband should prove to be an easily agitated and restless man. Meanwhile, the guests at the groom's house are offered chicken with lemon preserve, almonds and hard-boiled eggs, which symbolize fertility. In Algeria, guests are served *shtetha*, "the dancing (chicken)," a name referring both to the dancing of the guests and to the movements of the chicken in the pot as is simmers in its sauce of tomatoes, potatoes, garlic, and red pepper. Often, the parents of the groom slaughter a ram or calf on behalf of the bride to serve to the wedding guests. In all North African countries the bride and groom offer each other dates and milk before they withdraw to a room to consummate the marriage. Like eggs, dates and milk symbolize fertility. For Algerians, an additional explanation is that in this way, the partners eat each other's "salt," thus becoming part of each other. On the morning after the marriage ceremony, the parents of a Moroccan bride traditionally send the newlyweds a rice porridge and *bûzelûf*, a boiled head of sheep. The whiteness of the porridge symbolizes the purity of the bride while the head expresses the wish that she uses her head in running her household. On the seventh day after the wedding, the family of the bride comes to visit her and are offered fritters (*sfinj*) and porridge (*assîda*) sweetened with honey.

Mourning. In the house where someone has died, traditionally no fire should be lit to prepare food for three days. Those who come to express their condolences bring along food for the bereaved, usually a very simple couscous and hard-boiled eggs. Besides fertility, eggs also symbolize death and mourning, particularly egg shells, which break easily. On the fortieth day after the funeral, a ram is slaughtered and its meat prepared for those who gather to recite the Qur'an on behalf of the deceased. The same ceremony is repeated a year after the death.

Jewish Food Habits

For a long time, there have been Jewish communities in North Africa. Some, such as the Algerian Bahusi have lived there since the destruction of the Temple in Jerusalem more than two thousand years ago. Others settled there after their expulsion from Spain after the Reconquista (1492). After independence in the 1960s, the majority of Jews emigrated to Israel, but all North African countries continue to have Jewish minorities.

There are only a few respects in which food habits of North African Jews differ from those of Muslims in the region, and these all pertain to religious prescriptions. Kosher cooking requires that meat and dairy products should not be mixed and that different cooking utensils should be used for each. Like most Muslims, Jews use oil to fry their meat, but unlike Muslims, they will never add *smen*, salted clarified butter. Also, when Jewish women make bread, traditionally they always throw a small piece of the dough in the fire, symbolizing the setting apart of a portion of their meals for the poor.

Furthermore, special meals are associated with particular moments in the religious calendar. On occasion of the Hebrew New Year, for example, as is the case among Algerian Muslims on the tenth of Muharram, sugar replaces salt, and sweet dishes with raisins and prunes predominate. Moroccan Jews prepare a dish with seven vegetables and a sheep's head, symbolizing merit and good fortune. During the days leading up to Yom Kippur, the fast on the tenth day of the new year, many families eat chicken, since for each family member a chicken should be sacrificed on occasion of the New Year to commemorate Abraham's sacrifice. Women also prepare "Yom Kippur bread," with almonds. To break the fast on the evening of Yom Kippur the table is set with cakes. The day after Yom Kippur, at midday Moroccan Jews eat chicken with olives, followed by *beranîya*, fried and sweetened eggplants sprinkled with sesame seeds and cinnamon.

Sukkoth, the Feast of Tabernacles, which begins five days after Yom Kippur, lasts seven days. On the first day, Jewish women in Morocco prepare a couscous. Throughout the week of the Sukkoth holiday, women serve better meals than usual. In Algeria, chicken is again a favorite, being followed by lots of fruit for dessert. On the occasion of Hanukkah, the festival of light, during which the rededication of the Temple in 165 B.C.E. is commemorated, women make their famous *qnîdelet*, marzipan cigars, and *maqrûd*, date- or almond-filled fried semolina cookies, as well as the same kind of pancakes, fritters, and puff pastries that have been mentioned above for Islamic celebrations. Tu-Bishvat, the festival of trees, is celebrated by Moroccan Jews by eating fifteen different kinds of (dry) fruits. Purim, the feast commemorating the deliverance of the Jews by Esther from a massacre, is even more a feast of pastries, and kilos of them are exchanged between women and distributed among children and the poor.

For Pesach, when the Exodus from Egypt is commemorated, the ritual meal should at least consist of a salad with *marûr*, a bitter herb, referring to the bitter life under Egyptian rule; a glass of salt water, representing the tears and sweat shed; and eggs cooked hard in ashes, a symbol of the destruction of the Temple. In Algeria, Jews eat a lamb's leg on this occasion. The lamb symbolizes the beginning of a new life, and its leg, God's "extended arm" with which the Egyptians were hit when the ten plagues fell upon them. The lamb's leg also commemorates the fact that each Jewish family in Egypt was asked to slaughter a lamb and smear its blood on the doorposts of their houses so that these could be identified as those that were to be saved. Last of all, matzos, biscuits representing unleavened bread that was eaten during the journey through the desert are eaten, as are fresh, green vegetables, also representing a new beginning. On the evening of Mimuna, the last night of the Passover festival, many people only eat milk products, but some families place fish on the table as a symbol of fertility.

Seven weeks after Pesach, Shevuoth is celebrated. According to some this was originally an agrarian festival, but later became linked to the commemoration of the covenant of Mount Sinai. On this occasion in Morocco, "Angel's Hair," a pasta sprinkled with cinnamon and surrounded by meat or chicken, is traditionally served.

On the Sabbath, all work must cease, and no fire should be lit. Therefore, women make enough bread on Fridays for two days and prepare the fish or chicken that will be eaten on the Sabbath. A special Sabbath dish in Morocco is *skhîna*, consisting of eggs, potatoes, rice, chickpeas and meat. Traditionally, *skhîna* was prepared in earthenware casseroles that were hermetically sealed and cooked overnight in the public oven or in the still glowing ashes of the fire used to heat the public bath. This way, it was still warm when eaten for lunch on Saturday. Nowadays, most women prepare *skhîna* at home.

The meals on the Sabbath tend to be better than on other days of the week, often consisting of the same dishes that Muslims eat on Fridays. The festive meals that are served on occasions that mark the life cycle also tend to be the same as those of Muslims, such as the "dancing chicken" for marriages. Indeed, North African Jewish and Muslim cuisines overlap widely, as do the meanings of foodstuffs and ingredients used. For both Jews and Muslims, salt is purifying, bread contains *baraka*, God's blessing, dates symbolize fertility, eggs both fertility and mourning, green vegetables represent the wish for a new year of abundance, and pulses are associated with poverty.

See also **Fasting and Abstinence: Islam; Islam; Judaism; Middle East; Ramadan.**

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Marjo Buitelaar

WEST AFRICA

West Africa is composed of eighteen countries occupying various climate zones. The coastal region from Guinea-Bissau to Cameroon is characterized by abundant rainfall (with a rainy season of at least six months) and a thick forest of massive evergreen trees. A drier region, the savanna, lies five hundred miles north of the forest, and receives enough rainfall to sustain vast areas of rarer trees and grasses. The semiarid zone between the Sahara Desert to the north and the savanna to the south is called the Sahel, which in some years has a dry season of over nine months. North of the Sahel lies the Sahara Desert.

Ancient West Africa

Eight thousand years ago, during Europe's Ice Age, the Sahara Desert supported large populations in a lush, fertile environment dominated by savanna grassland and woodland. Fruits and vegetables, sheep, goats, poultry, and cattle provided a reliable and abundant food supply that sustained a sedentary population as it grew and developed. Fishing populations flourished along numerous rivers and streams that flowed throughout the Sahara. As the Sahara's climate changed, becoming dry and mostly desert, migrations south to arable land increased the populations of sub-Saharan Africa.

Cultivation of crops in West Africa is theorized to have originated around the headwaters of the Niger River. Millet seems to have been the first important crop, and may have been eaten in a porridge. The techniques developed for crop cultivation of fruits, vegetables, herbs, and spices were indigenous to Africa. The Diola of Guinea-Bissau, for example, transformed most of the mangrove swamps lining a number of river estuaries into a network of paddy fields. Their techniques of dyking, desalinating, ridging, and transplanting antedate all European influence. The Yoruba and Bini and other Nigerian societies have lived in settled communities on the same sites for several hundred years, evolving agricultural systems that allow continuous cultivation of their soils without significant or permanent loss of fertility.

Traditional Sources of Sustenance

In the forests of Ghana, as well as in Cameroon, traditional crops such as the cocoyam (taro) and plantain are successfully cultivated. These plants, together with raffia and oil palms, maize, cassava, African rice, and kola, thrive in the long rainy seasons, which run approximately nine months of the year.

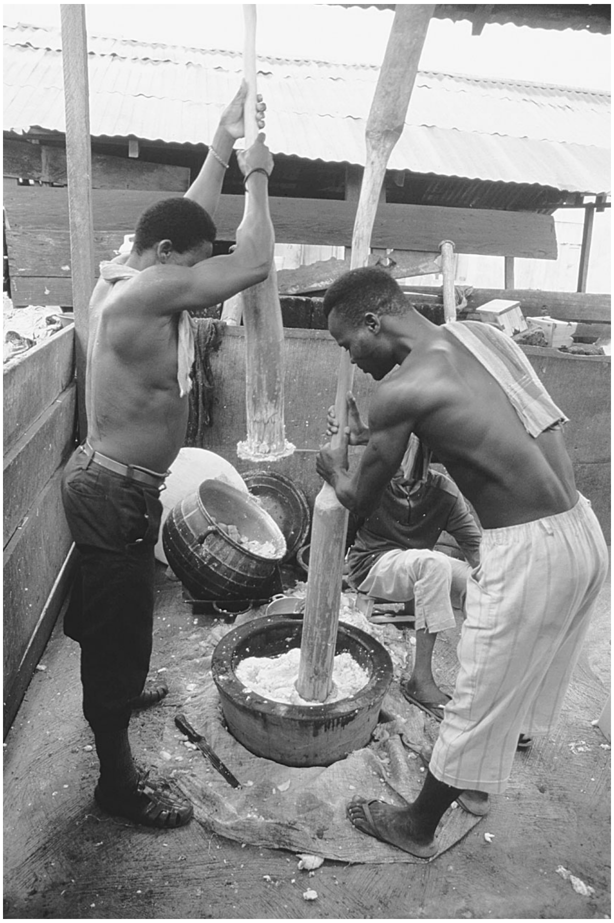
Many West Africans who were not farmers were pastoralists or fishermen. Fish were eaten raw or pickled, fried, boiled, and prepared by "gumboing." Dried shrimp and crayfish are still essential ingredients in stews and sauces, some of which combine different types of fish with coconut milk and other ingredients. Crab, lobster, cod, mackerel, sole, pike, prawn, gilthead, eel, shrimp, sprat, flounder, carp, and other varieties of seafood provided "fisher folk," such as the Twi of Ghana and the Muslim Bozo, with fish to sell at markets located well into the interior of the continent. In many West African cities these open-air retail markets were principally in the hands of women, who were economically independent traders.

The market streets were filled with stalls selling calabashes, palm oil, palm wine, ducks, chickens, fresh beef, mutton, and other meats, yams and yam fritters, guinea corn (sorghum) and millet beers, groundnuts, raw and cooked beans, thin brown cakes (said to smell like gingerbread), bean cakes, *karra* (meal dumplings), oblong bean buns called *jenkaraga*, and soups and stews. Some of the ready-made dishes included *enjibotchi* (rice with sauce), *ekoa* (durra [a sorghum grain] porridge), *killishi* (roasted meat, marinated and basted with oil, herbs, and spices), and *atchia-kara* (a yam and vegetable sauce ladled over chunks of beef, goat, and lamb).

An item used in Africa from antiquity, kola is indigenous to the forest zone of West Africa and is still preferred by Muslims who are prohibited from using alcohol and tobacco. It was valued as a refreshing stimulant and food by desert travelers during the trans-Saharan caravan trade and in the early stages of trade between the rain-forest regions, the Sahel, and beyond. In the sixteenth century, Askia Mahmoud supplied kola to his Songhai troops as an "energizer" before battle. Over forty species of kola are grown in the region between Sierra Leone and the Congo, with several varieties existing in Ghana alone. From ancient times, West Africans have also used different parts of the kola plant for treating swellings and fresh wounds. Ghanaians use it to reduce labor pain during childbirth and for treating guinea worm. In addition, kola nuts were used as primary flavorings in Coca-Cola and other beverages before kola substitutes were manufactured.

Culinary Taboos and the Social Significance of Cattle Raising

Although chicken, lamb, mutton, and goat were raised and widely consumed, some societies adhered to taboos relating to one or all of these meats and their byproducts. Egg consumption is still forbidden in some regions, as it is believed to turn young males into thieves and make childbirth difficult for women. The Mbum women of southwestern Chad, for example, do not eat any kind of eggs, chicken, or goat for fear of pain and death in childbirth, giving birth to abnormal or unhealthy children, or becoming sterile. In societies where goats were believed to have dietary value, they were bred specifically for their milk. In others, such as in the pastoral regions of the Sahel, goat milk is less favored than cows' milk as an item of trade, but is consumed by children and herders in the field. (Lactose intolerance among some West African peoples prevents them from drinking milk.) Lamb was usually grilled or barbecued and served at special feasts. Muslims prepared whole rams for the *Id el fetr*, a major festival.



Men preparing *fufu* in a mortar in Ghana. *Fufu* is used like dumplings or like pieces of bread for scooping up mouthfuls of stew. © LIBA TAYLOR/CORBIS.

Throughout Africa, cattle assumed a great importance in social, economic, and religious affairs. Cows were slaughtered and various beef dishes prepared for special occasions such as weddings, the naming of babies, festivals, or funerals. Cattle raising among the Bororo clan of the Fulani herdspeople (Fulani are dispersed throughout West Africa, from Senegal to Cameroon) is carried out by men who are charged with the herds' daily pasturing and watering, veterinary care, and seasonal movements. Women milk the cows and market the milk. The Bororo produce enough milk to support the family year-round, living primarily on dishes made with milk, cheese, and butter. They sell their milk products (or heads of cattle, if milk production decreases) to pay for other foods. Meat is not a staple part of the diet, but sometimes male or aged cattle are slaughtered and eaten on ceremonial occasions. The people of the northern regions, however, consume large amounts of barbecued beef.

Cattle are raised by the Mande peoples (numerous West African ethnic groups, including peoples of both the savanna and forest, that speak a Mande language) primarily for prestige, dowry payments, and sacrificial offerings. For other peoples, cattle not only provide meat, hides, manure, and milk, they are also needed for pulling loads.

The Legacy of Colonialism and Slavery

Slavery and colonialism sharply depleted the traditional abundance of meats and other foods after Europeans "discovered" Africa's wealth in the early sixteenth century. Colonialist control over African land and resources led to crop production almost exclusively for export. Profits from expanding agricultural exports went to foreign trading companies and colonial administrators, not to improve the lives of African peoples. "Cash crops," or the major exports, became palm oil from most of the coastal forest zone (a main source of lubricant for industrial machinery before the development of petroleum in the latter half of the nineteenth century), gum arabic from Senegal (a hardened resin substance extracted from acacia trees used to fix colored dyes in printed cloth in European textile factories), groundnuts from Guinea, coffee (the largest nonfuel export), and cocoa (primarily from Ghana, but Nigeria, Cameroon, and the Ivory Coast were also major producers). In the twentieth century, rubber from Firestone Tire plantations in Liberia was added to the list of exports.

The increases in production of export crops meant that production of food crops dropped and food prices rose. Sierra Leone, Liberia, and most of what was then called French West Africa were forced to import rice and other foods, even though they could grow their own. The market value of export crops also reduced the available land for staple foods at the expense of the native population. Another reason for the neglect of staple food crops was the depletion of the labor force. The slave trade drained an estimated forty million Africans from the continent between the fifteenth and nineteenth centuries. In addition, for those men between 18 and 60 years of age who remained, colonial law mandated that they labor a certain number of days for the state. Hundreds of thousands of young men left home to escape conscript labor laws in force in various parts of West Africa and found work on coffee, cocoa, and groundnut plantations in the Ivory Coast, Ghana, and Senegal.

In the late nineteenth and early twentieth centuries, urbanization and social change in some areas also pulled many people away from agricultural work, as the introduction of packaged and canned convenience foods made the traditional "from scratch" methods of food production and preparation almost obsolete. Still, West African holidays, feasts, and celebrations have been maintained, with some alterations, and continue to showcase the numerous dishes prepared with indigenous ingredients.

Festive and Everyday Dishes

Celebrations and festivities mark numerous occasions: the start of seasonal rains, new planting season ceremonies (between May and August), the "first fruits," the call for blessings for good harvests, the harvest, the start of the hunting and fishing seasons, weddings, the birth of a baby (mothers are celebrated as well on this day), the baby-naming ceremony, pubertal initiation rites, festival dances, the completion of the building of a new home, religious holidays, and funerals. Huge feasts are the highlight of such celebrations, and numerous special main dishes, meats, breads, and snacks are prepared. *Banga* and *jollof* rice (a spicy Ghanaian dish of chicken, ham, stewed tomatoes, and onions), *egusi* (melon seeds) and peanut stews and coconut soup, tiger-nut mold (a favorite pudding made with fish and yams), bean and *abala* (ground rice) puddings, roasted and barbecued meats, cassava dumplings (prepared with the leaves of the fluted pumpkin), *tiébou dienn* (pronounced "cheb-oo jen," Senegal's national dish, a fish and rice stew made with yams, okra, eggplant, cabbage, and chili peppers), vegetable side dishes (such as *akee* cooked with two or three varieties of greens), coconut candy, *chinchin* (twisted cakes), *abacha mmili* (cassava chips), *ipekere* (plantain chips), *meensa* (millet cakes), and banana fritters (rolled in groundnuts and sorghum or corn flour or cassava meal before frying) are just a few of the items on the celebration menus. *Poulet yassa*, chicken marinated in a lemon and onion mixture then grilled or sautéed, is one of Senegal's most famous dishes.

These are foods enjoyed in most of the countries within the Sahelian zone today (Mauritania, Senegal, The Gambia, Mali, Guinea-Bissau, Burkina Faso, Niger, Chad, and Cape Verde), where some of the dominant staple foods are millets, Bambara groundnuts, yams, Asian rice, sorghum, cassava, cowpeas (black-eyed peas; there are forty varieties), sesame (mixed with wheat for biscuits, used in chicken recipes, and in sesame *sucre* [sugar], a children's snack), maize, peanuts, and fonio (for hot breakfast cereal). Dominating the diets of the coastal countries (Guinea, Sierra Leone, Liberia, Côte d'Ivoire [Ivory Coast], Togo, Ghana, Benin, Nigeria, and Cameroon) are cassava, Asian rice, maize, cowpeas, lima beans, pigeon peas, sorghum, peanuts, plantains, cocoyam (taro), and yams. Plantain is the basic ingredient for many popular snack foods throughout Côte d'Ivoire, and, with bananas, bridges the gap between the dry season and harvest months of January to May, when other staples are unavailable or scarce. The cocoyam is rapidly becoming a major staple in coastal communities, while cultivation of yams in producer countries has been gradually decreasing. Nigeria is the world's largest producer of cocoyam, followed by Ghana. Served by themselves, or mixed with plantains, yams, or cassava and other ingredients, cocoyams are used to make the traditional dish called *fufu* (also *fou fou*): the staples are cooked and pounded into a smooth soft dough used to make dumplings.

In addition to being popular foods, cocoyams and yams have always carried social and cultural significance. In Nigeria, the cocoyam festival, *Alube*, is celebrated annually in May. Yams are intertwined in the social, cultural, and religious life of the farming communities where they are the major crop. In remote areas of West Africa, yams were an important status symbol, conferring prestige on families who consumed large quantities. Many customs dictate that yams should be used to wean babies, and special yam dishes are prepared for birth rituals and the naming ceremony for children. In some societies, yams are also important foods for funerals as ceremonial offerings to the gods and to the spirits of the departed, in others as food during the funeral feasts.

Throughout West Africa, the yam is revered by many traditional societies including the Ibo of eastern and midwestern Nigeria. Although many of their customs have been lost or modified due to European influence, it is believed that the Ibo are more devoted to yam cultivation than any other yam producers. Their religious devotion to the food has prevented its displacement by other crops.

The New Yam Festival is, in many West African regions, the most important celebration of the year. The annual festivals are associated with planting but more particularly with the yam harvest. Some of the groups that celebrate the festival include the Ashanti of Ghana, the Ibo and Yako of eastern Nigeria, the Yoruba of western Nigeria, the peoples of the eastern Ivory Coast, the Ewe of Togo, the people of Benin, the Tiv of the Benue region of northern Nigeria, and the Kalabari of the eastern Niger Delta.

Other Indigenous Foods

Yams can be stored for six to nine months, but if they begin to run low, they are usually supplemented by fruits, seeds, and nuts that grow in abundance at different times of the year. In various regions of West Africa, these crops include the African breadfruit, the African pear, the incense tree, the star apple, the African mango, the shea butter tree (*Vitelleria paradoxa*, which produces a nutlike fruit—57 percent of its seed's weight is oil), various species of gourd (many have yamlike roots that grow deep underground), and the cultivated species of sword lily or corn-flat, the *Leguminosae*, which produces tubers and edible roots, and the all-purpose baobab tree.

The baobab grows wild in the savanna regions of Mali and other areas of West Africa. Rope was made from its bark and medicines were manufactured from extracted liquids as well as from its dried leaves; the dried leaves were also used as a thickener for stews. In addition, its fruit is not only a great source of vitamin C, but is also used to make refreshing drinks containing tartaric and other acids. A meal for making bread was derived from this plant, as was a red dye.

Sorghum, another indigenous food crop, also provides a red dye that is rubbed into animal skins to make red leather, and its stems yield large amounts of sugar. Sorghum is probably one of the world's most versatile food crops with undeveloped genetic potential. In Nigeria, young children eat the yellow varieties of sorghum to prevent blindness because their diets are deficient in vitamin A. The most common food prepared in Nigeria is *tuwo*, made by stirring sorghum flour into hot water and allowing the thick paste to cool and gel. Once cooled, *tuwo* is cut or broken up and eaten with soup. In West Africa it is generally known as guinea corn, and the grains of certain varieties are popped like popcorn. Sorghum grain is made into flour for a thick pancake batter fried in groundnut oil; sorghum beer is a favorite beverage consumed at wrestling matches as *burkutu*, an alcoholic gruel, or as *pito*, with the sediment removed. *Dawaki* are flat fried cakes made with a mixture of sorghum and bean flours, and sometimes accompany soups. A flour and water batter, *akamu*, is used to flavor and thicken porridges and cereals.

Sorghum, rice, maize, yams, plantains, cassava, and taro (cocoyam) are staples along with common ingredients such as onions, tomatoes, palm fruits, *egusi* and other melon seeds (used for thickening), okra, pumpkin, coconut, coconut milk, and a variety of nuts. Fish, meat, and vegetable dishes are heavily seasoned with numerous hot peppers and spices, such as Guinea pepper grains (*melegueta*), spicy cedar (called *atiokwo* in the Ivory Coast; the seeds are roasted, ground, and used in soups or with leafy vegetables), tea bush (known as *an-gbonto* in Sierra Leone; its fragrant leaves are used to flavor meat dishes and vegetable, *egusi*, and palm nut soups), African locust bean (harvested, boiled, and fermented to produce *dawadawa*, an indispensable condiment in Nigerian and Cameroonian cuisine), and West African black pepper (known as *fukungen* to the people of The Gambia and Senegal). Several oils are used in preparing West African dishes, such as groundnut (or peanut, sometimes preferred in stews), melon seed, sesame seed (*gingelly* or *gingili*), coconut, corn, shea butter, and palm, the favorite because it imparts a reddish color to foods. Cooking methods include frying, simmering or boiling, roasting and steaming (foods are steamed in banana, plantain, miraculous berry, cocoyam leaves, or corn sheaths), and baking, or combinations of two or three of these methods. Broiling was added in the twentieth century.

Two to three very large meals are prepared and consumed daily, and West Africans eat until they are full. Breakfast can consist of *pap* (or *ogi*, a hot beverage made with corn meal, milk or sour milk, and sugar), *akara* (bean cakes made with black-eyed peas or other beans, water, salt, onions, and peppers, then fried in peanut or palm oil), *moi-moi* (steamed bean pudding, made with black-eyed peas or other beans), roasted or fried plantains, and tea or coffee. West Africans enjoy *gari* (the dried and ground form of cassava) with soup for lunch, along with okra, *egusi* or *agbono* soup (seeds from the *egusi* melon are toasted and ground; *agbono* are the dry seeds from the African mango, ground to a smooth paste before using), and *fufu* (pounded yam). All soups contain various greens, such as *ukazi* and cassava leaves, and smoked or dried shrimp and crayfish. For dinner, there is *jollof* rice or coconut rice with roasted meats, boiled rice and a chicken, beef, or fish stew (or palm nut or pepper soup) containing okra, cabbage, groundnuts (or peanuts), and other ingredients. Vegetable side dishes, including beans and rice or rice garnished with fried plantains, are very popular. An indigenous Ghanaian dish, *kenke*, is steamed pudding made with fermented maize pulp; its two varieties are served with soups and stews. Occasionally fruits are served as appetizers, but traditionally all dishes are served at the same time rather than in courses. Fruits, nuts, and snacks, such as *chinchin* (twisted cakes sold by vendors along roadside markets), are sometimes eaten between meals.

Summary

As host for centuries to fortune hunters, colonialist regimes, and migrations from Europe and other countries, West Africa has been perceived as the recipient, not the provider, of cuisine and culture. Even as French and other foreign languages began to blend with those native to the continent, thereby changing the names of certain dishes, and as minor changes in ingredients were made in those dishes (by way of foreign influence), West African cuisine remained a significant cultural force.

Archeological excavations, together with new studies on Africa's agricultural and culinary past, demonstrate that Africa had many indigenous crops. Unfortunately, emphasis is too often placed on foods brought into Africa during the period of slavery and colonization rather than on indigenous foods consumed domestically or exported to foreign countries, and most studies limit African agriculture and diet, prior to European influence, to a small number of indigenous foods: yams, cowpeas (black-eyed peas), sorghum, millets, okra, some bush greens, and whatever items were gathered. Watermelon, *akee* (*Blighia sapida*; also *ackee* or *achee*, a bright-red tropical fruit with black seeds and a creamy white flesh), tamarind, bottle gourd, fluted pumpkin, *egusi* melon, sesame, and one or two other beans have been added in a few studies.

In Volume I of its *Lost Crops of Africa*, the National Academy of Sciences reports that Africa has produced more indigenous cereal grains, including its own species of rice (nutritionally superior to Asian rice), than any other continent. Among Africa's more than two thousand currently known native food plants are grains, such as African rice, pearl and finger millets, and fonio; cultivated fruits, such as *balanites* (desert dates), butterfruit (*africado*), horned melon, ziziphus (Rhamnaceae, the buckthorn family) and *kei* apple; wild fruits, such as chocolate berries, figs, custard apples, grapes, gingerbread plums, and star apples; vegetables such as amaranths, spirulina (a nutritious blue-green algae of fresh and brackish waters), edible mushrooms, oyster nuts, Ethiopian mustard, gherkins, mock tomatoes; legumes such as *marama*, locust and sword beans, grass peas and guar; roots and tubers such as *anchote* (*Coccinea abyssinica*), Hausa potatoes, tiger nuts, several varieties of yam, and vigna roots, and a number of spices and herbs.

These foods are endangered by "botanical colonialism," the export system of "cash crops" and "one-crop agriculture" imposed on West Africa and the rest of the continent by European colonialism. In addition, "structural adjustment programs" of the 1980s, designed by the World Bank and the International Monetary Fund to increase the role of exports in the economy and reduce Africa's deepening debt crisis, have actually intensified low agricultural productivity for domestic consumption. Poor families, in an effort to meet urgent food needs, often intensively cultivate lands and forests for subsistence or exports, frequently in areas that once yielded ancient crop species or medicinal plants, or those that are sometimes erosion-prone, where crop yields drop severely after a couple of years. Food shortages, famine, disease, and widespread poverty are the result.

West Africa has been a major contributor to world cuisine in terms of the migration of its indigenous crops, methods of production of those crops, and culinary customs. Very few of Africa's currently known native food plants have received the recognition or research deserved and warranted for so vast a larder. The scientific community has not been able to provide an exact count of foods actually native to the continent nor the age of most of its crops. The history of the continent's flora is, therefore, virtually unknown. As with environments threatened with endangered species, Africa's indigenous agricultural pantry is gradually dwindling due to lack of research and interest. Many biases exist against native African foods, biases that have kept alive perceptions of the inferiority of African crops. It is therefore hoped that there will be an eventual understanding and appreciation of Africa's endangered agricultural species, as they have much to offer, not only to Africa but the rest of the world as well in terms of solving major hunger, disease, and energy problems.

See also **Agriculture, Origins of**; **Anthropology**; **Banana and Plantain**; **Cassava**; **Cattle**; **Food Archaeology**; **Food Supply, Food Shortages**; **Fruit: Tropical and Subtropical Fruit**; **Game**; **Government Agencies, U.S.**; **Hunting and Gathering**; **International Agencies**; **Nuts**; **Paleonutrition, Methods of**; **Rice**; **United States: African American Foodways**; **Vegetables**.

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Diane M. Spivey

AFRICAN AMERICAN FOOD. *See* **United States.**

AFRO-CARIBBEAN. *See* **Caribbean.**

AGENCIES. *See* **Government Agencies; International Agencies.**

AGRICULTURAL RESEARCH. Agricultural research has occurred continuously since humans began shifting food acquisition methods from hunter-gatherer to agrarian. The early goal of agricultural research was simply better methods of producing food. As humans and agriculture progressed, research widened to control of diseases and pests, better cultivars, productive fields or animal rearing facilities, improvement of food crops, and basic biological understanding of plants and animals. The early studies were empirical, that is, trial and error. Nevertheless, these were the forerunners of agricultural research and in many ways the forerunners of many forms of scientific investigation.

Beginnings

Most people place the beginnings of formal agricultural research in the late eighteenth century to the mid-nineteenth century. This relatively long initial phase was caused by several factors. First, many of the other basic sciences were in an early developmental stage. In fact the early agricultural scientists were trained chemists applying their skills to food production. Secondly, governments were reluctant to provide funding for agricultural research. In the United States both George Washington and Thomas Jefferson advocated formal agricultural research as a fundamental component of the newly developed country. However, Congress did not share either president's feeling and did not support a formal agriculture department until 1862. The U.S. Department of Agriculture did not achieve cabinet status until 1889.

Third, many of the world's great universities had not yet been founded or were also in early stages of development. The first colleges involved in agricultural research in the United States were Harvard, Yale, and Princeton. Several of the early endowed chairs in universities were in chemistry, agriculture, or a combination of the two. Fourth, agricultural principles developed were often not applicable to farms or crops in other parts of a country or continent. Thus an initial credibility problem existed with much of the early agricultural research. In the mid-1800s the concept of an experiment station developed in Europe. Some authors credit the Germans with development of the experiment station, while others credit the British. Regardless of the location of the first stations, the concept was to develop agricultural research sites near areas of agricultural production so results would be applicable to the local areas. This concept became common in all areas of agricultural production.

Justus von Liebig is often credited with writing the first book on agricultural research, *Organic Chemistry and Its Applications to Agriculture and Physiology*, published in both Germany and England in 1840. Liebig was an agricultural chemist in Giessen, Germany, one of the first experiment station sites. Liebig also established courses in agricultural chemistry and provided a site for foreign students to study under his tutelage. Numerous students from across Europe and the United States studied under him. The model Liebig developed for research sites near production areas, student training, and course offerings remained the standard for agricultural research around the world in the early twenty-first century.

Developments in the United States

The U.S. government did not establish a formal agricultural research agency until the middle part of the nineteenth century. Early agricultural research, from 1836 to 1862, was conducted by the U.S. Patent Office, which received, on an irregular basis, funds from Congress for specific purposes. Scientists trained in Europe were hired as faculty members by many of the universities and by other nongovernmental groups, such as the Smithsonian Institution. Thus it seems clear that universities in Europe, particularly in Germany and England, were the first to establish formal agricultural research programs.

As the scientific disciplines of chemistry and biology developed, those principles were increasingly applied to food production. In many cases chemical assays and principles were established in direct response to needs in the food and agriculture industries. In the second half of the nineteenth century agricultural research became a recognized discipline in institutes of higher education. The Hatch Experiment Station Act of 1887 established a formal linkage between the U.S. Department of Agriculture, which would supply funding, and state colleges of agriculture, where the research would be conducted. This collaboration between states and the federal government was an important model in governmental relations.

Through the first sixty to seventy years of the twentieth century, Hatch funds were sufficient to conduct research and to train students at universities. However, late in the century Hatch funding received no increases, and the funds diminished in real terms. In the twenty-first century, university scientists working in agriculture must compete for funds from a variety of funding sources, mostly federal government programs, by writing competitive proposals. Congress in collaboration with the president provides funds for the various federal research programs. Thus at times funding for research topics is influenced by political motivations instead of by the common good. Even with staffs and consultants well versed in current topics, this approach diminishes the dialogue on the most important topics that require research support. This change in research funding has positive and negative attributes. On the positive side, only the best research, on topics that have far-reaching implications and those that will have the largest impact on agriculture and society, is conducted. On the negative side, minor agricultural industries rarely receive any of this funding, and development of new opportunities in agriculture is difficult.

E. John Russell (1966) described five phases of agricultural research in Great Britain. While the years may differ, the concepts and general timing are similar to other parts of the world. Phase one began in the late sixteenth century with Francis Bacon and was characterized by numerous individuals conducting research in ancillary areas to agriculture without communication among themselves. This period lasted until the end of the eighteenth century.

The second phase coincided with the emergence of chemistry and lasted until the mid-nineteenth century. Numerous nongovernmental groups were established during the period to promote agriculture, and several universities established formal programs in agricultural sciences. The third phase lasted until the early twentieth century and included establishment of extension activities in university programs as well as expansion of teaching. The fourth stage was a short but important period because of the expansion of experiment stations, research funding from governments, and recognition of the role of agricultural development as an economic development tool. This phase lasted from 1920 to 1930. The fifth phase has lasted into the twenty-first century. Russell described this phase as the time of governmental laboratories and dissociation from farmers and their needs. While Russell's view is rather cynical, many farmers share his point.

As large, multinational companies became involved in agricultural research, much of the generated research results became proprietary and focused on generation of revenue. However, the range of products developed during the twentieth century was extraordinary, ranging from corn syrup to lecithin and resulting in products that literally changed lives. Breakfast cereals, sliced white bread, hot dog buns, soybean meal, and more changed the way people lived in developed countries and offered the promise of alleviating hunger and malnutrition in the remainder of the world. Agricultural research in universities focused on production of crops, both plant and animal, and on improving efficiency of production. Agricultural engineers led the Industrial Revolution and are rapidly applying space-age technology to tractors. Advanced biological lines of research, including microbiology, biochemistry, molecular biology, and developmental biology, are routine in agricultural research laboratories in the twenty-first century. Practical agricultural research funding, however, is diminishing.

Agricultural research was one of the early areas of formal scientific investigation and remained the foundation for many forms of research in the twenty-first century. Results from this research led to high-quality foods that are moderately priced, significant improvements in health, elimination of various diseases, far-reaching increases in cognitive function, and many other benefits to society.

See also **Agriculture since the Industrial Revolution**; **Agronomy**; **Genetic Engineering**; **Green Revolution**; **Horticulture**.

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AGRICULTURAL WORKERS.

In the United States, workers in agriculture include agricultural inspectors, graders and sorters, and farmworkers. While some agricultural workers find permanent, full-time positions, most will work in temporary, low-paying jobs that are seasonal and often require seven-day workweeks with days that begin before sunrise. They may work indoors or outdoors. Most work with food crops or animals. However, increasing agricultural mechanization, consolidation of farms, and urbanization have led to less growth in the number of agricultural jobs in the United States. Growth in landscape and horticultural services will require a shift to fill the need for more workers in horticulture and landscaping. According to the United States Bureau of Labor, the number of jobs in agriculture was expected to grow more slowly than the average for all occupations during the 2000–2010 period.

Agricultural Inspectors

Most agricultural inspectors work in full-time, permanent positions for the federal and state governments. Inspectors frequently examine food crops, livestock, and food processing equipment and facilities for compliance with laws and regulations that govern health, quality, and safety. Inspectors also examine nursery and greenhouse crops. In order to control or eradicate pests and diseases, they collect samples of food or plants and send them to a laboratory for further examination and analysis.

Graders and Sorters

Graders and sorters of agricultural products spend their workdays grading, sorting, and classifying food and other agricultural products such as buckwheat hulls, pickles, olives, nuts, and apples. Fresh-picked fruits and vegetables must be examined and sorted by size, weight, color, or quality before packaging for markets.

Farmworkers

Farmworkers make up 90 percent of all agricultural workers. However, according to the Economic Research Service, the number of farmworkers is difficult to determine since they tend to live in unconventional housing, or are undocumented foreign immigrants who avoid enumerators. Farmworkers include laborers who work with food, greenhouse, and nursery crops, and also caretakers of farm and ranch animals. Compared to most wage and salary workers, farmworkers tend to be younger, less educated, never married, and non-U.S. citizens. Most are male and Hispanic or belong to a minority. Most farmworkers live in poverty. Between 1999 and 2000, the real average weekly earnings of hired farmworkers decreased from $331 to $319 for full-time workers and from $289 to $280 for all hired farmworkers—and the downward trend seems to be continuing.

Migrant farmworkers. Migrant farmworkers make up a large segment of all farmworkers in the United States. Migrant workers travel across state or county boundaries to do agricultural work of a seasonal or other temporary na-

An agricultural worker applies pesticides in a greenhouse in Salinas, California. CORBIS (BELLEVUE).

ture, and often must be absent overnight from their permanent place of residence. In 2000, 36 percent of hired farmworkers were not United States citizens. Almost 78 percent of the non-U.S. citizens working as hired farmworkers were employed in the West, where they accounted for 63 percent of the hired farmworker force. Crop production accounted for 72 percent of migrant farmwork.

Migrant and other farmworkers often work physically exhausting schedules: seven days a week, thirteen hours per day, in rain, heat, and high humidity. For example, while detasseling corn in Illinois in July, a group of migrant workers will likely experience insect bites, heat exhaustion, injury, fatigue, and exposure to pesticides and fertilizers. Workers earn minimum wage and may be provided with temporary housing and access to local health care. Some workers must contend with harassment when local residents mistrust the workers. Language is a barrier, especially for older workers who have not learned English. Families that travel throughout the year must keep up with schoolwork. Local school systems may provide summer school, or students may use the Internet to stay in touch with their courses at home. Sometimes, nonprofit groups will provide migrant schoolchildren with special activities such as swimming classes, library access, or tutoring.

Migrant workers have not always received the help they needed. In the 1960s—at the same time as the civil-rights movement and opposition to the Vietnam War—an effort was made to organize farmworkers in order to improve the quality of their lives. César Chávez, a migrant worker, organized agricultural workers in a successful bid for higher wages, better working conditions, and access to social services such as citizenship classes, immigration advice, and welfare counseling. In the 1970s, the United Farm Workers of America (UFWA) had 150,000 members. By the late 1900s, illegal labor or legal "green card" workers had diminished the power of the UFWA. Few twenty-first-century agricultural workers are members of a union. Some migrant agricultural workers do not have legal authorization to work in the United States.

See also **Agriculture since the Industrial Revolution**; **Class, Social**; **Division of Labor**; **Food Production, History of**; **High-Technology Farming**.

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AGRICULTURE, ORIGINS OF. The last thirty years have seen a revolution in our understanding of the origins of agriculture. What was once seen as a pattern of unilateral human exploitation of domesticated crops and animals has now been described as a pattern of coevolution and mutual domestication between human beings and their various domesticates. What was once seen as a technological breakthrough, a new concept, or "invention" (the so-called Neolithic revolution) is now commonly viewed as the adoption of techniques and ultimately an economy long known to foragers in which "invention" played little or no role. Since many domesticates are plants that in the wild naturally accumulate around human habitation and garbage, and thrive in disturbed habitats, it seems very likely that the awareness of their growth patterns and the concepts of planting and tending would have been clear to any observant forager; thus, the techniques were not "new." They simply waited use, not discovery. In fact, the concept of domestication may have been practiced first on nonfood crops such as the bottle gourd or other crops chosen for their utility long before the domestication of food plants and the ultimate adoption of food economies based on domesticates (farming).

The question then becomes not how domestication was "invented" but why it was adopted. What was once assumed to depend on cultural diffusion of ideas and/or crops is now seen by most scholars as processes of independent local adoption of various crops.

Patterns of Domestication

The domestication of the various crops was geographically a very widespread series of parallel events. Some scholars now recognize from seven to twelve independent or "pristine" centers in which agriculture was undertaken prior to the diffusion of other crops or crop complexes (although many of these are disputed) scattered throughout Southwest, South, Southeast, and East Asia; North Africa and New Guinea; North, Central, and South America; and possibly North America. As the earliest dates for the first appearance of cultigens are pushed back; as individual "centers" of domestication are found to contain more than one "hearth" where cultivation of different crops first occurred; as different strains of a crop, for example, maize or rice, are found to have been domesticated independently in two or more regions; as an increasing range of crops are studied; and, as little-known local domestic crops are identified in various regions in periods before major crops were disseminated, the number of possible independent or "pristine" centers of domestication is increasing, and the increase seems likely to continue.

Early Domestication of Crops

Combining patterns provided by various scholars (see the bibliography) suggest that major domesticates appear in Southwest Asia or in the Near East (wheat barley, lentils) by 9,000–12,000 B.P. or even earlier; in Thailand (rice) between 12,000 and 8,000 B.P); in China (millet, soybeans, rice) ca. 9,500 B.P.; in Mesoamerica (squash, beans, and maize) between 10,000 B.P. and 5,500 B.P.; in South America (lima beans and peppers) by ca. 8,000–10,000 B.P. and, with less certainty, potatoes and manioc by 6,000 B.P.; and in North America north of Mexico (sunflowers, may grass, chenopods, sump weed, and marsh elder) by 4000–5000 B.P.; in North Africa (pearl millet, sorghum) by 5500–6800 B.P.; in Southeast Asia (taro) by 8000 B.P. and possibly much earlier. (Root crops are presumed to have had even longer histories of domestication in the moist tropics but they are poorly preserved and difficult to document archaeologically.)

As an example of the regional complexity of incipient domestication, there may have been three centers of domestication at three altitudes in South America: a lowland complex involving manioc and sweet potato; a mid-elevation complex involving amaranth, peanut, jicama, and coca; and a high-elevation group including potato and other lesser tubers such as *ullucu.*

The agriculture of particular preferred crops also spread widely by diffusion or population movement in some areas in the prehistoric period. In perhaps the best known patterns of diffusion of agricultural economies (or displacement of indigenous hunter-gatherer populations), Middle Eastern farming economies had spread to Bulgaria by 7500 B.P.; to Italy by 7000 B.P.; and to Britain by 6000–5000 B.P. Maize diffused very widely in North and South America from Mesoamerica (apparently without the significant spread of people); and rice cultivation diffused throughout South, East, and Southeast Asia.

Despite its geographical dispersal, the adoption of the various domestic crop economies occurred within a narrow time span, between about 10,000 and 3,000 B.P. The human population entered a relationship with many different plants at about the same time, implying that human activities were the prime motivator of major economic change and entry into mutual domestication in each instance.

Domestication (genetic manipulation of plants) and the adoption of agricultural economies (primary dependence on domestics as food), once seen as an "event," are now viewed as distinct from one another, each a long process in its own right. There is often a substantial time lag between incipient domestication of a crop and actual dependence on it. That is, the adoption of farming was a gradual quantitative process more than a revolutionary rapid adoption—a pattern of gradually increasing interaction, and degrees of domestication and economic interdependence.

Moreover, the adoption of agriculture was, by all accounts, the coalescence of a long, gradual series of distinctive and often independent behaviors. Techniques used by hunter-gatherers to increase food supplies, long before farming, included the use of fire to stimulate new growth; the protection of favorite plants; sowing seeds or parts of tubers without domestication; preparing soils; eliminating competitors; fertilizing; irrigating; concentration of plants; controlling of growth cycles; expansion of ranges; and ultimately domestication. By this definition, domestication means altering plants genetically to live in proximity to human settlements, enlarging desired parts, breeding out toxins, unpleasant tastes, and physical barriers to exploitation—in short, getting plants to respond to human rather than natural selection.

Dependence on Crops

Almost all authorities describe a gradual increase in the quantitative dependence on domesticated crops. Most also see a quantitative shift from high-quality to low-quality resources (a reduction in the variety and density of essential nutrients, calories, protein, vitamins, minerals, and fatty acids per unit of bulk, desirability of foods, and ease of exploitation). Most also describe a movement downward in the trophic levels of foods exploitated A common theme in almost all discussions of the origins of agriculture is the idea of increasingly "intensive" exploitation of foods (the use of increased labor to exploit smaller and smaller areas of land).

This sequence of events commonly first involved a focus on an increasing range (a "broad spectrum") of low-priority wild resources, increasing the efficiency in which space was utilized—a shift from economies focused on comparatively scarce but otherwise valuable large animals and high-quality vegetable resources to one in which new resources or different emphases included smaller game, greater reliance on fish and shellfish, and a focus on low-quality starchy seeds. There is a clear and widespread appearance of and increase in apparatus (grindstones for processing small seeds, fishing equipment, small projectile points) in most parts of the world before the adoption of agriculture, which cannot be a function of differential preservation.

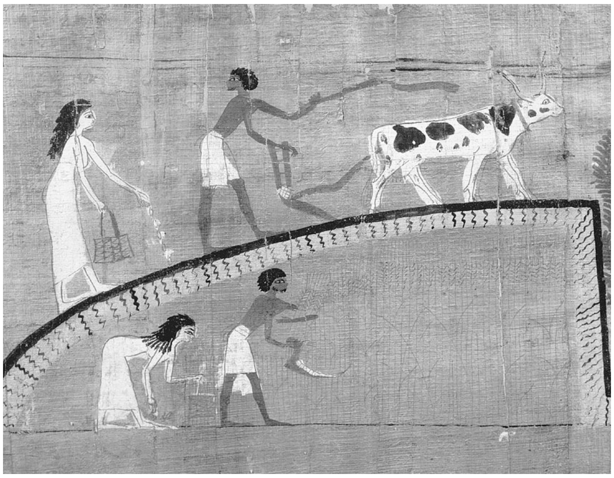
Ultimately the spectrum of exploitation seems to have narrowed again as populations shifted toward more complete modification of landscapes to permit increased dependence on particular low-priority but calorically productive starches that could be obtained in large quantities per unit of space and then stored. Such modification of the land to focus on the quantity of calories per unit of space by promoting staple crops would then eliminate some calorically marginal foods, resulting in a loss of dietary variety and of some nutrients. (The major staples—rice, maize, wheat, barley, potatoes, sweet potatoes, manioc, and taro—all cause dietary deficiencies when relied on too heavily as the sole basis of a diet. The deficiencies are likely to be exacerbated by dry storage, which destroys C and B-complex vitamins.)

Intensification of Resource Use

The intensification can probably be seen best through the eyes of optimal foraging theory, much of which has focused on caloric returns for each unit of labor provided by various foods, and has argued that human groups will go first for high-ranking resources (those that yield high returns for a unit of work including preparation). Repeated studies of comparative efficiency of food-gathering techniques in various parts of the world have routinely reported that human populations should prefer resources such as large game, which, when available, can be exploited with great efficiency. Populations turn to increasing reliance on lower-ranking, that is, less efficiently exploited, resources (small game, shellfish, most nuts, individually caught fish, and small seeds) only as those of higher rank disappear or become so scarce that the time involved in finding them becomes prohibitively high (for example, as large game becomes scarce). Such calculations by scientists do not predict the behavior of individual populations perfectly (presumably because other factors such as local food preferences or inertia come into play). But they do dramatically conform to the broad trends in prehistory relating to a Paleolithic-Mesolithic-Neolithic sequence or its equivalents in the New World. And they suggest that this sequence of economic changes is one of declining efficiency in resource exploitation.

Resources used increasingly in the intensification of individual units of land—the so-called broad-spectrum revolution—typically provided fewer calories per unit of labor than the comparative emphasis on large animal exploitation that preceded them. Small seeds such as wheat, barley rice, and maize typically are among the least productive resources (and among the lowest priority as well in taste and quality) and would presumably have come into use only as preferred resources disappeared or became prohibitively scarce. Seasonal seeds, although potentially harvested quickly and in large quantity, typically involved intensive processing and the labor of storage as well as significant storage losses. A significant point is that the adoption of low-ranking resources depended not on their availability but on the declining availability of higher resources. Cereals were adopted not because they were or had become available but because preferred resources such as large game were becoming less available.

The major cereals are relatively inefficient to exploit and process, as demonstrated by Kenneth Russell with specific reference to the Middle Eastern cradle of wheat and barley cultivation. Agriculture, therefore, may not have been "invented" so much as adopted and dropped repeatedly as a consequence of the availability or scarcity of higher-ranked resources. This pattern may in fact be visible among Natufian, or Mesolithic, populations in the Middle East whose patterns of exploitation sometimes appear to defy any attempt to recognize, naively, a simple sequence of the type described above.



Working the fields in ancient Egypt, as depicted in the Book of the Dead of Heruben, circa 1069– 945 B.C.E. © GIANNI DAGLI ORTI/CORBIS.

Technological changes were motivated by necessity or by demand, not by independent invention or technological advance. In a trend toward declining efficiency, one does not adopt new technologies simply because they are available. Such innovations may well be held in reserve until changing conditions render them the best remaining alternatives. Demand-side economics seems to have powered most of economic history; Malthusian or supply-side economics, with supply independent from demand, became the predominant pattern only when the rise of social classes prevented the needs of the poor from generating any economic "demand"—which implies not only need but entitlement (the ability to command resources).

Various sources point out, however, that such "intensification" occurred in parallel among incipient farmers and populations such as those of the West Coast of the United States, which developed an intense focus on storing starchy staples (such as acorns) but never domesticated them. The two activities may be distinguished, and centers of origin of domestication may be defined, less by human knowledge or intent as by the flexibility or recalcitrance of the intensively harvested plants toward incipient domestication. Some resources such as wheat respond readily to human manipulation; others such as acorns/oak trees defy it.

Increased demand results from population growth, climate change, and socially induced demand. Mark Cohen argues that population growth and increasing population density—or a combination of population growth and declining availability of preferred foods, which result in "population pressure" or an imbalance between population, resources, and prevalent food choices and extractive strategies—may be the main trigger of relevant economic changes. Such increasing density is ultimately traceable to the Pleistocene with the gradual density-dependent closing of cultural systems as increased density permitted groups to switch from exogamy to endogamy. According to this model, the widespread parallelism of different regions is based on the power of population flux (movement between groups) to equalize population pressure from region to region. The model has been criticized for, among other reasons, relying too much on flux as an explanatory necessity, for having the wrong time scale, and for underplaying the role of climate change.

A second category emphasizes the role of post-Pleistocene climate change in both facilitating and demanding exploitation of plants amenable to domestication. It has been argued, in fact, that farming would have been essentially impossible during the Pleistocene, but almost mandatory, at least in a competitive sense, in the Holocene. This model may provide a more powerful explanation of the regional parallelism of intensification in time than a purely population growth/flux model. The climate-based model has been criticized, however, as ignoring the fact that climate and environmental changes are zonal and therefore could not, of themselves, produce parallel economic changes in different environments undergoing different kinds of change.

A third major category that explains increased demand suggests that it resulted from enhanced social and political demand preceding and accompanying intensification. The problem is that such explanations, unless combined with data on population growth or climate change, fail to explain the parallel emergence of complex social forms.

Agriculture and the Decline in Health, Nutrition, and Food Security

Agriculture commonly has been associated with a number of social features: reduced territories, more marked social boundaries, further closing of mating systems; greater territoriality and formal definitions of property; complex social and political organization; more defined concepts of property; food storage; and sedentism. Moreover, agriculture has until recently been considered the cause or enabler of these altered social institutions. These features are only loosely bound, may be separated by long spans of time, and may occur in any of various sequences. For example, sedentism in many regions occurs long before domestication (as in parts of the Middle East), but in the New World the reverse often occurs—domesticates appearing long before settled reliance on those domesticates. Social complexity may commonly follow the origins of agriculture but precedes it in many parts of the world and, as mentioned above, occurs without domestication in some parts of the world.

Changes in Health

What was once interpreted by researchers as a transition toward improving human health, nutrition, reliability of the food supply, greater ease of food procurement, and greater longevity is now viewed as the start of declining health, nutrition, and efficiency of labor, probably declining longevity, and perhaps even declining security of food supplies. It is now commonly accepted that the adoption of farming economies and sedentism resulted in declining health and nutrition. The conclusion is based on triangulation from three sources: contemporary observation of hunting and gathering versus farming societies; theoretical patterns of nutrients and parasites in nature; and paleopathology, the analysis of health and nutrition in prehistoric skeletons representing different periods of prehistory. Many sources have found parallel trends toward declining health in prehistoric populations but challenges to quantitative methods, interpretations of some evidence, and some specific conclusions in paleopathology have been offered. Observed paleopathological trends commonly accord with expectations from other lines of evidence.

It seems probable from epidemiological considerations—and it is clear from paleopathology—for example, that farming, large concentrations of population and sedentism, the accumulation of human feces, and the attraction of stored foods to potentially disease-bearing animals markedly increased parasite loads on human populations. The increase in the prevalence of visible periostitis, osteomyelitis, treponemal infection, and tuberculosis in skeletal populations conforms both to ethnographic observations and models of probable disease history. The reduction of wild animal meat in the diet with the increasing focus on vegetable foods may initially have reduced the likelihood of food-borne diseases (of which animals are the major source). But the domestication of animals, their crowding, and their continuing proximity to human populations are likely to have raised meat-borne infections to new highs and seems responsible for epidemic diseases in human populations, many of which began as zoonotic (animal-borne) disease shared by people and domestic animals.

Consequences of Agriculture

Sedentism and farming resulted in declining quality of nutrition (or at least in the decline in the quality of nutrients available to the human populations). Indeed, some researchers have extolled the virtue of hunter-gatherer diets. Agriculture is likely to have resulted in a marked downturn in food diversity and food quality, and ultimately to a decline in nutrition. An increase in cumulative neurotoxins may have occurred as farming was adopted, the latter despite the fact that domestication itself may have bred toxic substances out of foods.

Agriculture also seems to have resulted in a change in the texture of foods toward softer foods, resulting in a decline in tooth wear but an increase in dental caries and a reduction in jaws and jaw strength. A significant advantage of soft foods based on boiling in ceramic pots, a practice largely restricted to sedentary populations, may have been the increasing potential for early weaning of children and improved food for toothless elders. But early weaning to cereals as opposed to a diet of mother's milk is well known to have serious negative effects on childhood nutrition, infection, and survival.

A dramatic increase in iron deficiency anemia (porotic hyperostosis and cribra orbitalia) is associated everywhere in the archaeological record with both sedentism, infection, and new crops. The trend is also predictable in nature, and may be observed in contemporary populations. The increased anemia probably resulted primarily from a large increase in iron-robbing hookworm associated with sedentism and with the sequestering by the body of its own iron as protection against bacterial disease.

The declining health that came with the advent of farming is also reflected in (but not universally) childhood declines in stature, osteoporosis in children, decreases in tooth size (as a result of declining maternal nutrition), and tooth defects.

Whether the adoption of broad-spectrum foraging, agriculture, storage, and sedentism increased or decreased the reliability of food supplies (and whether sedentism is itself a consequence of choice permitted by new resources or necessitated by them) is a matter of some debate. For example, it is not clear whether broad-spectrum foraging increased reliability by expanding the resource base, or decreased reliability by focusing exploitation on what had once been emergency resources.

Domestication, sedentism, and storage appear to have evened out potential seasonal shortages in resources, but they may also have reduced the reliability of the food supply by decreasing the variety of foods consumed; by preventing groups from moving in response to shortages; by creating new vulnerability of plants selected for human rather than natural needs; by moving resources beyond their natural habitats to which they are adapted for survival; and by the increase in post-harvest food loss through storage—not only because stored resources are vulnerable to rot, or theft by animals, but stores are subject to expropriation by human enemies. One possible biological clue to the resolution of this problem is that signs of episodic stress (enamel hypoplasia and microdefects in teeth in skeletal populations) generally become more common after agriculture was adopted.

Sedentary agriculture seems likely to have increased human fertility through a variety of mechanisms, including the shifting work loads for women; calorically richer diets; sedentism; and the increased marginal utility of children or the increased availability of weaning foods. Some researchers estimate that during the Mesolithic-Neolithic transition in the Iberian Peninsula fertility may have increased as much as from four to six live births per mother, which would imply very rapid acceleration of population growth. If, in fact, fertility on average increased (possibly significantly) but population growth on average accelerated only by the trivial amount calculated below, then life expectancy must on average have declined (since growth rates are a balance of both fertility and mortality). (There is little evidence from paleopathology that the adoption of sedentary farming increased on average human life expectancy and little reason to expect that it did.)

For whatever reasons, essentially all estimates of average post-domestication population growth suggest an increase in rates of population growth (calculated as compound interest rates). But on average, the increase can have been no more than from about .003 percent per year for pre-Neolithic hunter-gatherers to about 0.1 percent for Neolithic and post-Neolithic farmers. (In both cases the averages are simple mathematical calculations of what is possible based on all reasonable estimates of world population at the period of adoption of agricultural (about 5–25 million) to estimated population in 1500 C.E. (about five hundred million). Average population growth even after the onset of agriculture would therefore have been trivial to the point where it would have been almost imperceptible to the populations involved. It would have taken such populations about one thousand years to double in size. Growth and dispersal of agricultural populations and/or diffusion of domestic crops were hardly likely to have been exuberant in most locations for that reason, particularly if arguments about declining health and very low average growth rates are considered. Owing to their low rank as resources, crops would presumably have diffused only to populations facing similar levels of demand or pressure but lacking good local domesticates of their own.

On the other hand, population growth might have been comparatively quite rapid in some areas because of increased fertility and improved life expectancy. Exuberant growth in some areas, such as Europe, must have been balanced by the decline of other populations, including those of other farmers. Exuberant growth, or diffusion, perhaps based on the relative quality of some cereals such as wheat and barley among otherwise low-ranking, intensively exploited resources, is observable in areas (such as the expansion of the Middle Eastern farming complex and probable expansion of agriculture populations into Europe). But even there, in contrast to old models assuming population expansion of hunter-gatherer "bands" into areas of very low population density, expansion would, based on observed intensity of exploitation, have been expanding into areas occupied by hunter-gatherers, who would by this time have had population densities and social complexity almost equal to their own. The preexisting size and structure of groups of hunter-gatherers in areas of agricultural spread suggests that diffusion may have played a bigger role in the process than was once assumed.

Since health and nutrition seem to have declined, the primary advantage to farmers seems to have been both political and military because of the ability to concentrate population and raise larger armies. This would have conferred a considerable advantage in power at a time when few if any weapons were available that were capable of offsetting numerical superiority.

See also **Agriculture since the Industrial Revolution**; **Anthropology and Food**; **Barley**; **Food Archaeology**; **Horticulture**; **Paleonutrition, Methods of**; **Prehistoric Societies: Food Producers**; **Wheat**.

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Mark Nathan Cohen

AGRICULTURE SINCE THE INDUSTRIAL REVOLUTION.

It is difficult for people living in an advanced industrialized society to fully comprehend the life of a modern farmer, much less the life of farmers living before the Industrial Revolution. Up until the end of the eighteenth century, the vast majority of people were farmers who, as described by the English philosopher Thomas Hobbes in *Leviathan*, lived lives that were "solitary, poor, nasty, brutish and short." And so it had been since the beginning of time for the vast majority of people, until the advent of an agricultural revolution that started in Great Britain during the early 1700s, reached North America by the mid-1800s, and continues to this day in all but the most benighted of nations. Agriculture had been changing since it had first appeared thousands of years earlier, but the pace quickened during the start of the Industrial Revolution in the eighteenth century, and changes that had previously taken centuries and generations began to occur within decades. By 1750, the best English agriculture was the best in the world. The most technologically advanced agriculture, it was also fully integrated into a market economy. The dominance of the British Empire in world affairs during the eighteenth and nineteenth centuries ensured that these agricultural improvements were widely distributed.

The Europe-centered Industrial Revolution of the eighteenth and nineteenth centuries accelerated an ongoing revolution in agriculture. In the industrialized West, animal power and human labor were first augmented and than almost completely replaced with mechanized sources of power. This was only part of the changes that gathered momentum in the 1700s and then transformed the world. Spectacular developments in all areas of science and nearly two centuries of exploration and conquest in the New World caused many Europeans in the early nineteenth century to reevaluate their relationship with nature. They developed an expanded worldview; it appeared to them that humanity in general, and Europeans specifically, had acquired the wisdom, knowledge, and scientific technology to dominate nature. This conviction was reinforced by the publication in 1859 of the *Origin of Species* by Charles Darwin. While the new attitude initially produced colonialism, rampant environmental pollution, and the exploitation of poorly organized workers, it also permitted the manipulation of the entire farming environment to an extent inconceivable to previous generations, and later produced for common people a standard of living previously available only to the aristocracy.

This new point of view stripped plants, animals, and soil of their mystical "vital" attributes and made of them machines to be molded to fit human needs. Physics, chemistry, and biology became tools to dissect, examine, and then reconstruct agricultural systems to make them better than any that had previously existed on earth. This process started with improved methods of crop production, advances in livestock breeding, and the invention of new farm equipment during the latter part of the Industrial Revolution. Soil, for example, ceased to contain a vital essence that must be periodically replenished by removing it from cultivation (fallowing), and became an aggregation of mineral and organic structures and chemicals whose fertility could be maintained by the application of scientific management—crop rotation, fertilizers, irrigation, pesticides, and other new methods. Adoption of new power sources, such as steam, and increased use of chemicals followed. Today, improved plant and livestock breeding through genetic engineering promises to continue the revolution well into the future.

Agricultural advances after the Industrial Revolution greatly increased food production, but increased urbanization required food to be transported long distances from producers to consumers. As with the citizens of ancient Rome, inhabitants of the ever-expanding cities became increasingly dependent on the transport, preservation, and storage of food. People starved in one part of the world, while abundant harvests spilled from granaries in another. The storage and distribution of food, rather than its production, became crucial to millions of people.

There have been periodic learned pronouncements of impending mass starvation since the English economist Thomas Malthus first proposed in his 1798 *Essay on the Principle of Population* that food production could only increase arithmetically, while population would increase geometrically. Malthus wrote that population would exceed food production at some point, and an apocalypse would ensue. While population growth has borne out his thesis for the past two hundred years, a number of scientific advances have allowed agricultural production to keep pace with it. A few major and thousands of minor refinements in agricultural practices have steadily improved productivity.

Farming Efficiency

Before the 1700s, the problem of soil fertility had been met by letting half or a third of the land go fallow for a year in two- and three-field rotations. A new four-field rotation was now based on growing specific kinds of crops in a sequence that took from or added to the soil different nutrients. Part of the field did not have to be left fallow, and the continuous use of the land greatly increased the production of forage crops used to support livestock through the winter, thereby vastly increasing the availability of meat and dairy products. The diet of even the poorest improved as they could now afford to augment their daily bread with meat and cheese.

Another major change was a rapid acceleration in the fencing of large tracts of land to produce more efficient units of production. The enclosure movement in England did away with many traditional smallholdings, combining the land into larger tracts that could be more efficiently farmed. Earlier subdividing of land among generations of sons had produced a patchwork-quilt distribution of fields. A farmer may have had access to sufficient crop area (around twenty acres) to support his family, but it would be in small strips scattered among the holdings of other farmers, in a number of fields. This was because it was thought that each field had to remain fallow for a year to recover its fertility. From 1750 to 1831, enclosures consolidated these smallholdings into fields whose size could benefit from the application of modern methods of crop production.

Until the 1700s and 1800s peasants in most European countries could not actually own the land they farmed, but held ancestral rights to work land belonging to the proprietors of large estates. When laws were passed that allowed British landowners to abrogate these traditional agreements and combine many smallholdings, thousands of farm families were displaced. Migrating to urban areas, they furnished the labor that fueled the Industrial Revolution, and the wretched characters who populated many of Charles Dickens's novels.

Throughout Europe, similar changes produced millions of restless people with a deep-seated desire to own land. Many emigrated to North America, Australia, and New Zealand, where a variety of homestead laws granted land to those who settled and worked a farm or ranch for a number of years. Based on these policies, the family farm became an institution in North America during the nineteenth and twentieth centuries, and a social and political force that continues to shape our national character. A combination of economic and demographic changes, however, has led to the steady decline in the number of functioning family farms. Although the U.S. population doubled between 1930 and 2000, the number of farms fell from 7 to 2 million. After 1987, this decline stabilized at about one percent annually. The price farmers got for commodities such as corn and soybeans remained virtually constant between 1970 and 2000, while the price they paid for everything they bought kept pace with inflation. This produced a farming population 60 percent of whom had farm incomes below the poverty line. It also discouraged the young so much that the number of farmers under the age of twenty-five decreased 50 percent between 1990 and 2000.

The large capital inputs needed to start and run a farm have transformed the production of many agricultural crops into large businesses. Ninety percent of U.S. farms, however, continue to be classified as individual operations, accounting for 71 percent of farmland and 74 percent of gross farm sales. Partnerships and corporations comprise a very small share of American farms, and people related by blood or marriage own 90 percent of them. Average acreage is higher for corporate farms (1,165 acres) and for partnerships (856 acres) than for individual operations (373 acres). Whereas the United States in the year 2000 had 2 million farms, just 60,000 of them produced 75 percent of the nation's farm output. Fewer and fewer farms were thus producing more and more of what Americans ate. The 1.3 million farms with incomes below $20,000 comprised 60 percent of the total number of farms, but cultivated only 17 percent of the total U.S. farm acreage. In contrast, the 60,000 farms with sales over $250,000 comprised only 7 percent of the total number, yet cultivated almost 30 percent of the acreage.

The many improvements in crop production up to 1935 produced only modest increases in average yield per acre in America because of deteriorating soil fertility and poor water use. Control of erosion, soil conservation, extensive government-backed irrigation developments, and better water-use efficiency reversed this trend, leading to large increases in production.

Since 1950, the gap in efficiency between the most productive mechanized agricultural systems and the least productive manual farming systems has increased twentyfold. While in small part the result of reduced soil, water, and environmental quality in developing countries, this change really reflects the spectacular advances in agricultural technology in industrialized counties. Transference of this technology to farmers throughout the world should be a major goal, and will be a major challenge to the fortunate few in the coming decades.

Livestock Breeding

Before the eighteenth century, raising animals was slow and costly; thus, meat and dairy products were usually scarce and expensive before the Industrial Revolution. The lack of sufficient forage to keep large numbers of animals over the winter often led to the slaughter of most livestock in the fall. Celebrants at many late fall festivals not only consumed the bountiful harvest of the field, but also the animals whose progeny could have supplied them with fresh meat, milk, and cheese the following year. Each spring, herds had to be rebuilt from the survivors.

Farmers had used their intuition and observations to breed animals for millennia, but the process was slow and haphazard because the inheritance of desirable traits was poorly understood. In the late 1700s Robert Bakewell, an English farmer, showed how intensive breeding for desirable traits could produce improved cattle, horses, and sheep. In Europe, sheep had been raised mainly for wool because they fattened too slowly to provide an economic source of meat. Bakewell's Leicester breed fattened quickly and could therefore be raised for both wool and slaughter. The cost of mutton dropped so low that it became the most popular meat in England, Australia, and New Zealand.

Breeding of livestock is now a science in industrial societies, with genetic analysis an integral aspect. Accurate monitoring to detect estrus, or its induction by hormones, and the use of artificial insemination allow complete control over the reproductive cycle of most livestock. Removal of ova, their in vitro fertilization, and embryo implantation promise to allow a further level of control and manipulation of the reproductive process. For example, separation of the cells resulting from the first divisions of the fertilized ovum (zygote) may be used to produce a number of embryos that, when implanted, give rise to whole herds of genetically identical animals. These techniques are being coupled with the genetic engineering of DNA in specific chromosomes, or the replacement of the entire nucleus in a zygote with a nucleus from another individual of the same, or a related, species (cloning). While possibly replete with ethical conundrums, these procedures will surely transform livestock into units of production whose fecundity, efficiency, and vigor would marvel our ancestors.

Plant Breeding

Once Mendelian genetics was rediscovered in 1900, science gave plant and animal breeders a clear understanding of how traits were controlled by genes on chromosomes, and how they could be altered by selective breeding. Breeders made full use of this knowledge to steadily improve livestock and crops. Plants such as maize, soybeans, tomatoes, and peanuts became dietary staples in many parts of the world after their introduction from the Americas, Africa, and Asia. Identifying the sites of their origin helped locate ancestral forms of many crops, and these plants provided additional genetic resources to improve commercial varieties.

The upper limit of plant productivity is imposed by the quantum efficiency of photosynthesis and the energy content of sunlight. The photosynthate translocated from leaves not only produces the harvestable commodity, but is also used for all other plant functions. Reducing the drain of these other functions can increase yield. For example, symbiotic microorganisms in nodules on soybean roots can fix atmospheric nitrogen. It is often cheaper, however, to supply nitrogen fertilizers fixed by processes involving fossil fuels than to incur the loss of yield that would result from the soybean plant fixing a similar amount of nitrogen. Modification of the basic biochemistry and physiology underlying crop and livestock production will require levels of scientific knowledge and technical sophistication currently unavailable.

Economics of industrial-scale production require that most agriculture is monoculture, involving vast fields and herds of nearly genetically identical crops and livestock. This uniformity simplifies all aspects of production, but it also invites epidemics of plant disease. The devastating outbreak of bacterial southern corn blight in the United States in 1970, and the 2001 epidemic of viral foot-and-mouth disease in England, are examples of the seriousness of this problem. A major goal of plant and animal breeders is to stay ahead of chronic or exotic pathogens that can decimate crops and herds.

Genetic engineering has the potential to quickly create crops and livestock with unique characteristics. Rapid release of genetically modified organisms is slowed, however, because they require the same extensive field testing as new strains derived from traditional breeding. Consumer wariness has slowed the introduction of GMOs in Europe, but American consumers have readily accepted them. Most U.S. consumers have been unaware of the presence of GMOs in their food, and when they become aware, they are willing to accept claims by scientific and government sources that GMOs are safe to eat and environmentally benign. In Europe, a greater level of environmental activism and skepticism in government and scientific pronouncements has contributed to consumers' doubts about the safety and environmental impact of GMO crops. A large percentage of U.S. corn, soybean, and cotton production uses GMOs that possess pest resistance. Tailoring GMOs to the specific needs of farmers in developing countries may be the only way for food production to keep pace with their rapidly increasing populations. Crops designed with increased disease and drought resistance and better use of nutrients in the soil could supplant the strains that have been developed for use in industrialized countries and that require expensive irrigation, pesticides, and fertilizers that are unavailable in developing countries.

Development of hybrid corn was a watershed in plant breeding, heralding a change in concept from a straightforward selection of desirable characteristics to the employment of a deeper understanding of the genetics involved. Experiments by G. H. Shull in 1906 showed that crossing could reverse reductions in vigor resulting from inbreeding. Using the strategy of double-cross hybrids suggested by D. F. Jones in 1918, the first commercial corn hybrid was released in 1921. About 95 percent of the corn now grown is hybrid, and use of double-cross hybrids allows 20 percent more corn to be produced on 25 percent fewer acres than when hybrid corn first became widely available in 1930. Hybrids of many other agronomic and horticultural crops have since been developed.

The Green Revolution. The Green Revolution, a sterling example of how the development of strains suited for developing countries, and a multifaceted approach to agriculture, can greatly increase food production, was a planned international effort funded by the Rockefeller and Ford Foundations and the governments of many developing countries. In the early 1950s, wheat production in Mexico had encountered an insurmountable yield barrier because the varieties being grown became too tall, top-heavy, and lodged (fell over and were difficult to harvest) when heavily fertilized. Using short-stalked lines developed years earlier by the U.S. Department of Agriculture, Norman E. Borlaug led an effort to develop broadly adapted, short-stemmed, disease-resistant wheats that excelled at converting fertilizer and water into high yields. Mexico went from importing half its wheat in 1964 to exporting half a million tons annually within two decades.

The Green Revolution is an agricultural success story. It increased food production in Mexico tenfold from 1960 to 1990 through the use of new crop varieties, irrigation, fertilizers, pesticides, and mechanization. At the same time, famine decreased 20 percent, caloric consumption per capita increased 25 percent, and incomes and standards of living increased. The successes in Mexico led to the establishment of a rice-breeding center in the Philippines. Working at about eighteen such centers worldwide, plant breeders have produced high-yielding varieties of virtually every major crop, including potato, sorghum, maize, cassava, and beans. Increased population growth and poor husbandry of natural resources, however, have eroded many of these gains since the 1980s.

Farm Equipment

Preparing the soil with a plow, planting seeds, cultivation, harvesting, and threshing are some of the most important steps in crop production, and some of the most labor- and energy-intensive. Inventions in the eighteenth and nineteenth centuries transferred much of farm labor to machines. Before Jethro Tull invented the precision seed drill in 1701, seeds were inefficiently planted by scattering them over a prepared field. Stands were thus often erratic and almost impossible to cultivate. The uniform placement of seeds in straight rows allowed horse-drawn cultivators to move easily up and down the rows for the control of weeds.

Little cotton was grown in the United States before the late 1790s because of the difficulty of separating the lint from the seed. Development of the cotton gin by Eli Whitney in 1793 greatly reduced the cost of producing cotton fiber for the rapidly increasing British textile industry. Slumps in production of tobacco, indigo, and rice during the 1790s had undermined the economic justification for slavery, but increased production of sugarcane and upland cotton still relied on the institution. The production of cotton in America now jumped twentyfold, from 2 million pounds in 1790 to 40 million pounds in 1800, while exports increased over 1000 percent in the same period. In less than a generation, cotton became the major crop grown in the U.S. South, and it revived the moribund slave-worked plantation system.

The first successful harvester or reaper was invented by Cyrus McCormick in 1834, as was the first modern thresher, by Hiram and John Pitts. The outbreak of the American Civil War in 1861 and subsequent conscription depleted farm labor, and forced many wheat farmers to buy reaping machines. The harvesting and threshing functions were later integrated into one machine, the combine, which did not become widely used until the early 1900s. Replacement of the cast-iron plow by the self-polishing steel plow, invented by John Deere in 1837, reduced the energy needed to plow a field because soil did not adhere to the smooth surface. To reach their full potential, most of these inventions depended on mechanical sources of power, which did not become readily available until the early twentieth century.

The major functions of a machine were often perfected over years of experimentation and modification. Sometimes mechanical limitations prevented further refinements, or an existing machine could not be easily modified to accommodate a new crop. When that occurred, it might be found easier to modify the crop to fit existing machines than to build entirely new machines. Dwarf sorghum was developed so it could be harvested with only slight modifications to an existing combine, and soybeans were developed that bore pods higher on the stalk so they could more easily be harvested. Tomatoes for processing were developed that had a more uniform set and were tough enough for mechanical harvesting using existing technology.

Integration of computers, sensors, and global positioning satellites into field equipment promises to revolutionize the planting, cultivation, and harvesting of many crops. For example, the location of each corn or tomato plant in a field can be identified using sensors and GPSs, and stored in computer memory. Subsequent operations such as weeding, applications of pesticides and fertilizers, and harvesting can then be positioned to maximize the effectiveness of every operation, thereby increasing yield and quality while at the same time reducing expenditures of time, fuel, and chemicals.

Energy and Information

In essence, farming is the conversion of sunlight and other sources of energy into food. For most of recorded history the energy to plant, cultivate, harvest, and process crops was supplied by the farmer and by domesticated draft animals (such as oxen and horses). Necessarily, the energy captured by the plant and harvested as food calories had to exceed that expended in its production. Preindustrial agriculture generally returned around twenty times more calories in the food consumed than was expended during its production. This efficiency decreases as the consumed food product requires additional processing (as for white bread versus grain potage, or cheese versus milk), conversion to other forms (cornflakes versus corn used to produce beefsteak), and shipment to distant consumers. As agriculture became mechanized, greater and greater amounts of energy were expended for each unit of food produced. Currently, mechanized agriculture in developed countries uses ten times as much energy to produce food as is returned in the food consumed. But agricultural mechanization has increased productivity so much that today's farmer can feed almost 150 people, while at the beginning of the twentieth century a farmer could feed only 2.5 people. The vast input of fossil fuels to synthesize the required fertilizers and pesticides, and to power the machinery that cultivates the fields, harvests the crops, processes them, and transports them to the consumer has so increased production that a small percentage of the population can raise enough food to keep most Americans overweight.

Before the Industrial Revolution, there was localized use of wind and water power for milling grain and pumping water, but these sources were stationary, and of no use in planting or plowing a field, or harvesting a crop. The earliest tractors were basically large stationary engines equipped with a drive system. At first, steam engines were immobile and of little use for field operations because of their enormous weight. Even in the mid-1800s steam-powered tractors were so expensive and difficult to operate that most farmers continued to use horses and mules to power farm machines. The introduction of high-pressure boilers in the 1850s lightened engines, and steam tractors enjoyed significant usage between 1885 and 1914. Tractors with internal-combustion engines eventually supplanted steam tractors because they had several advantages: they were cheaper, easier to operate, and less prone to explosions and fires.

World War I (1914–1918) did for the tractor what the American Civil War had done for the reaping machine. Soon after it began, German U-boats were sinking so many British ships that it was necessary to increase food production by bringing thousands of acres of new farmland into production or face food shortages. There were not enough horses to plow this new land, and only five hundred tractors in all of Britain. The five thousand tractors ordered by the British government from Henry Ford were delivered within five months, and were soon at work on British farms. Almost overnight, British farmers, and later their conscripted American visitors, became accustomed to seeing tractors displacing teams of horses.

The labor shortage and guaranteed market for crops during World War I stimulated U.S. tractor design and manufacture; massive industrialization led to greatly increased production. It was not until after World War II, however, that tractors became widely accepted. Many farmers bought early tractors, particularly the smaller, lighter machines that could do varied field work, but the worldwide depression of the 1930s and the fact that tractors still couldn't compete with the agility of horses in the field led to the demise of many tractor companies. Most farmers would have been thrilled to be rid of draft animals and to use mechanical devices. During the period 1908–1927 Ford built over 15 million automobiles with the Model T engine. Many farmers had a car or truck that was used to supply power for nonfield operations and for trips to town, yet continued to use draft animals for fieldwork; the Sears catalog of the time listed hundreds of accessories that could be used with the drive train of a car or truck to do everything from threshing grain and pumping water to churning butter, sawing wood, and washing clothes. Only when tractors appeared with enough power and maneuverability for fieldwork and the flexibility to furnish power for other nonfield operations were they readily adopted by most farmers. It was not until the 1920s that the all-purpose tractor made its appearance and gradually replaced steam-powered machines and draft animals. By the 1930s, seven tractor companies controlled over 90 percent of the market, and North America led the world in tractor design and production. Today, tractors using gasoline or diesel engines are ubiquitous on farms throughout the world.

Most farms in Europe and Japan had electrical power by the mid-1930s. Only 10 percent of U.S. farms were so supplied, however, at the time the Federal government established the Rural Electrification Administration in 1935. The REA supplied economic incentives that stimulated rural electrification; by 1960, over 97 percent of American farms had electricity.

Electricity brought with it better communication through the telegraph, telephone, radio, television, and eventually the Internet, all of which in turn have had tremendous effects on the farmer's life. Farms are no longer isolated from the mainstream of society. Information on weather and on commodity prices is readily available, and can assist in better planning. Farming has become such a capital-, energy-, and information-intensive business that most farmers need assistance in managing it all. Most industrialized countries have government-sponsored agricultural-research and extension services. These not only engage in practical research of immediate and local importance, but also provide significant levels of basic research to address future problems. They assist farmers, marketers, and distributors through publications, interactive websites, classes, and farm visits and demonstrations. Almost more than any other aspect of modern agriculture, the extension services are responsible for today's unmatched levels of food production, nutrition, and safety.

Agricultural Chemicals

All living things are groups of simple and complex chemicals functioning together in specific and unimaginably complex ways. Since all living things are interrelated through evolution, they are very similar at the molecular level. This means that many require roughly the same resources (thus, all plants need sunlight, carbon dioxide, water, and a few common minerals), and can be food for one another (thus, the starch stored by a potato can be used for its future growth or consumed by humans). Many organisms therefore compete for the same scarce resources and develop elaborate strategies to avoid being eaten. Weeds are simply plants that out-compete crops for the resources that limit plant growth and that we apply in profusion to cultivated crops. During domestication, the elimination of many natural defense mechanisms to produce a more easily grown, harvested, or palatable crop also produces a crop more vulnerable to pests. Reintroduction of specific natural defense mechanisms through selective genetic engineering could drastically reduce the dependence of agriculture on synthetic pesticides.

Modern agriculture is based on the establishment of a monoculture in which one specific crop or animal is grown or raised over large areas to the exclusion of all potentially competing organisms. Methods of planting, cultivation, and harvesting are all geared to the growth of uniform plants and animals. An orchard is usually composed of genetically identical (cloned) trees. Each tree will flower at roughly the same time, and produce fruits that look and taste the same and ripen at the same time. Fields are often modified to provide growing conditions that are as close as possible to being identical for all plants to further limit variability. Pruning, applications of pesticide sprays, cultivations, irrigation, and harvesting can be done over the entire orchard because all trees and fruit are at similar stages of growth and will respond similarly. An orchard composed of dissimilar seedlings would have trees that flowered at different times, and have fruit that were green or red, sweet or tart, or large or small, and that ripened at different times. The susceptibility of trees and fruits to various pests would be different, so different pesticides would have to be used at different times and rates of application. As with the other field operations, harvesting would have to be done a number of times, and would have to be selective since the fruit on each tree would ripen at a different rate. Fruit, or any other agricultural commodity, produced in this way would be expensive and of variable quality—two attributes abhorrent to modern consumers.

Wheat harvest on a collective farm near Lvov, Ukraine, in 1991. © PETER TURNLEY/CORBIS.

Most undisturbed natural ecosystems are stable because they contain many species of plants and animals that are genetically diverse, that can exploit all the available niches, and that interact with one another to hinder the uncontrolled growth of a single pest or disease. In a monoculture the genetic and species diversity that provides stability is lacking, and control must be exerted by the farmer to maintain the health of the crops or animals and ensure an ample, high-quality yield.

Agricultural chemistry had become a recognized discipline by the mid-nineteenth century. Fertilizers and other products of the chemical industry became widely used early in the twentieth century, and have become indispensable in maintaining the yields of modern agriculture. Reliance on chemical answers to agricultural problems, however, has often obscured their deficiencies, as well as the existence of alternative solutions. Crop rotation and cultural practices have long been used to control pests. Since the end of World War II, however, farmers and ranchers have come to rely more heavily on chemical pesticides (such as insecticides, herbicides, fungicides, and nematocides). Shortly after DDT was found to be an effective insecticide in 1939, the United States began producing large quantities of it to control vector-borne diseases such as typhus and malaria. The dramatic success of DDT in controlling over five hundred insect pests diverted attention from traditional nonchemical methods of pest control. The publication of *Silent Spring* by Rachel Carson in 1962, however, made the public aware of the environmental drawbacks of using too many pesticides. Since then, there has been a complete shift in research emphasis, so that, whereas in 1925 three-fourths of published studies were on chemical pesticides, almost 80 percent of USDA pesticide research in 2000 was on alternatives to chemicals.

Environmental concerns, regulatory legislation, and increased costs were driving forces in the development of Integrated Pest Management (IPM) programs throughout the United States in the early 1970s. Bringing together experts from many fields, IPM programs strive to reduce the usage of chemical pesticides by integrating knowledge about the biology of the pest, the response of the crop to infestation, and the costs involved in applying or withholding treatment. Researchers have recognized that the pest population does not have to be completely eliminated, only kept below the point at which the farmer starts to lose money because of it. Implementation of these types of programs has significantly reduced the use of chemical pesticides while maintaining yield, quality, and economic return.

Fertilizers represent the single largest use of chemicals on the farm. Although nitrogen gas comprises 80 percent of the air we breathe, it is the element most commonly limiting plant growth. Atmospheric nitrogen must be fixed into ammonia or nitrates before a plant can use it. Lightning and biological activity (such as that of symbiotic microorganisms in nodules on legume roots) can fix nitrogen. The vast majority of nitrogen used in fertilizer, however, is fixed by the Haber process, an elegant method of combining nitrogen from air with hydrogen from natural gas under high pressure and temperature to produce ammonia. This process was invented by German scientists before World War I in response to a blockade of Chilean nitrate imposed by the British Royal Navy. During the war it was used to fix nitrogen for agriculture and to produce explosives. The inorganic ammonia fixed by this process now supplies about the same amount of nitrogen for crops as is fixed by all natural organic processes. The synthesis of ammonia consumes about 2 percent of the fossil fuel used worldwide. Overuse of cheap nitrogen fertilizer can lead to excessive runoff that pollutes groundwater and to eutrophication of bodies of water. But while inorganic nitrogen fertilizers remain cheap, it will cost less to apply them to crops than to have the plant divert its photosynthate from producing a crop to fixing its own nitrogen.

See also **Crop Improvement**; **Food Supply and the Global Food Market**; **Food Supply, Food Shortages**; **Green Revolution**; **High-Technology Farming**; **Horticulture**.

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Mikal E. Saltveit

AGRONOMY. Agronomy embraces the branch of agriculture that deals with the development and practical management of plants and soils to produce food, feed, and fiber crops in a manner that preserves or improves the environment. The term "agronomy" represents the disciplines of soils, crops, and related sciences. In the soils area, specialties include soil microbiology, soil conservation, soil physics, soil fertility and plant nutrition, chemistry, biochemistry, and mineralogy. Specialties in the crops area relate primarily to plant genetics and breeding, crop physiology and management, crop ecology, turfgrass management, and seed production and physiology. Researchers in agronomy often work in close cooperation with scientists from disciplines such as entomology, pathology, chemistry, and engineering in order to improve productivity and reduce environmental problems. Even though less than 2 percent of the U.S. population are farmers who actively produce farm crops, the need for agronomists by other segments of society is increasing.

In the United States, field crops consist of those plants grown on an extensive scale, which differs from horticultural crops, which are usually grown intensively in orchards, gardens, and nurseries, but the distinctions are disappearing. Some of the major agronomic crops grown in the United States are alfalfa and pasture crops, peanuts, corn, soybeans, wheat, cotton, sorghum, oats, barley, and rice. Soil management aspects of agronomy encompass soil fertility, land use, environmental preservation, and non-production uses of soil resources for building, waste disposal, and recreation. Agronomists who work as soil scientists play extremely important roles

The basic idea behind agronomy is to match crops to their environment. This means following the contours of the land as well as choosing crops best suited for maintaining soil productivity. COURTESY OF THE JOHN DEERE LIBRARY.

in helping preserve water quality and preserve natural environments.

Agronomy is not a new field. As early as 7000 B.C.E. wheat and barley were grown at Jarmo, in present-day Iran. One could argue that the first farmers were in fact agronomists. In prehistoric times, humans shifted from foraging to cultivating specific crops, probably wheat or barley, for their food value. At harvest time, plants with easily gathered grain were selected first. This natural selection eventually made these food plants better adapted to continued cultivation because they were more easily harvested. Throughout the centuries, selection also occurred for other crop characteristics, such as taste, yield, and adaptation to specific soils and climates. The goal of today's production agronomists is essentially the same: to improve the quality, adaptability, and yield of our most important crops.

The Science of Agronomy

There are both basic and applied aspects of agronomy. Agronomists examine very basic components of soils and crops at subcellular or molecular levels. For example, at the basic level, agronomists use sophisticated techniques to unravel the genetic makeup of major crops in order to change their adaptation, nutritive value, or to breed medicinal benefits into agronomic crops. Genetic improvement is an area where major breakthroughs are likely to occur. Agronomists have developed highly specialized computer models of crop growth in order to better understand how environmental and management components affect the way crops grow. These models help in the development of such things as precision fertilizer application techniques, which provide the crop with the correct amount of nutrients at the correct time in its life cycle. This technique helps reduce fertilizer overapplication, which is costly to the farmer, and may increase groundwater pollution. Models of how chemicals move in the soil also help assure proper application of animal manures, municipal waste, and soil amendments necessary for crop growth. Molecular components of soil constituents are studied to determine basic interactions affecting plant growth and nutrition, and soil and water quality.

Crop Production and Soil Management

Crop production consists of integrating all aspects of the field environment to assure an economically feasible and environmentally sound system of growing crops. At the applied level, agronomists use basic research information to help manage crop production systems and soil and water conservation programs. Agronomists provide a wealth of information to farmers to assure the soundness of their production programs.

Environmental and economic conditions vary dramatically, and crops must be adapted to the soils and climate for efficient crop production. Crops such as wheat grow best in the Great Plains of the United States, because wheat is well suited to the soils, rainfall, and length of growing season of the area. Likewise, crops such as cotton and peanuts are best adapted to the southern United States because these crops require warmer temperatures, a longer growing season, and more rainfall than does wheat.

Applications of sound principles of soil management are key to maintaining a healthy environment. Agronomists aid in identifying environmental risks and devise methods of reducing these risks. Management techniques developed by agronomists include terracing, strip cropping, and reduced tillage methods to reduce soil erosion. Developments in Global Information Systems (GIS) and site-specific technology are being used by agronomists to more precisely manage how, when, and where to apply soil amendments and fertilizers. GIS is also extremely useful in identifying type and extent of pest infestations. This helps reduce environmental pollution by pinpointing when and where to apply pest control and reducing the amount of pesticides used in crop production.

International Agronomy

Agronomy is an international discipline. Many of the problems, issues, and challenges faced by societies around the world are universal in nature, and require international cooperation. For example, a major problem facing the developed world is that of how best to use our land resources. Within the developing world, the same problems exist. The questions of how much and which land should be saved for food and fiber production and which land should be used for nonagricultural uses must be addressed by both developing and developed societies. Agronomists play a crucial role in assessing land quality to assure an environmentally friendly use of land. Studying how plants adapt to differing climates and environments has allowed plant scientists to increase food and fiber production in regions of the world where the necessities of life are most limited. Knowledge gained and disseminated by agronomists in the developed world has helped improve the human condition in the developing world. For example, plant geneticists and breeders use similar hybrid and variety development techniques in both developed and developing countries. Through plant breeding, for example, agronomists have developed high-yielding rice that is adapted to tropical climates. Breakthroughs in gene transfer permit plant breeders to improve grain quality and nutritional traits. These techniques have also contributed to increased production efficiency by genetically incorporating into food crops increased pest resistance and by broadening their range of adaptation.

See also **Agriculture, Origins of**; **Agriculture since the Industrial Revolution**; **Horticulture**; **High-Technology Farming**.

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James J. Vorst

ALCOHOL. The word "alcohol" is derived from the Arabic word *al kuhul*, meaning 'essence'. The favorite mood-altering drug in the United States, as in almost every human society, continues to be alcohol. One of the reasons for the significant use of alcohol and its health impact is its feature of being (along with nicotine) a legally available drug of abuse and dependence.

Our knowledge of alcohol rests on a heritage of myth and speculation. Many health benefits have been attributed to alcohol by ancient healers who saw ethanol as the elixir of life, but almost none of its positive benefits have stood the test of time. Alcoholic beverages have been revered, more than any other substance, as mystical and medicinal agents. In recent years, however, we have stripped away much of the mystery surrounding alcohol and now recognize it as a drug with distinct pharmacological effects. However, one of the reasons that beverages containing alcohol continue to be consumed is related to the folklore and history that surround its many combinations with other flavors and its many sources of fermentation and distillation.

Chemist's View

Today one thinks of alcohol and alcoholic spirits as being synonymous, yet to a chemist an alcohol is any of an entire class of organic compounds containing a hydroxyl (OH) group or groups. The first member of its class, methyl alcohol or methanol, is used commercially as a solvent. Isopropyl alcohol, also known as rubbing alcohol, serves as a drying agent and disinfectant. Ethyl alcohol or ethanol shares these functions but differs from other alcohols in also being suitable as a beverage ingredient and intoxicant. Ethanol also differs from other alcohols in being a palatable source of energy and euphoria. It is a small, un-ionized molecule that is completely miscible with water and also somewhat fat-soluble. The remainder of this article pertains to ethanol, but refers to it simply as alcohol.

Biology of Production

Making alcoholic beverages dates back at least eight thousand years; for example, beer was made from cereal mashes in Mesopotamia in 6000 B.C.E. and wine in Egypt in 3700 B.C.E.

Ethyl alcohol is actually a by-product of yeast metabolism. Yeast is a fungus that feeds on carbohydrates. Yeasts are present ubiquitously. For example, the white waxy surface of a grape is almost entirely composed of yeast. When, for example, the skin of a berry is broken, the yeast acts quickly and releases an enzyme that, under anaerobic conditions, converts the sugar (sucrose, $C_{12}H_{22}O_{11}$) in the berry into carbon dioxide (CO_2) and alcohol (C_2H_5OH). This process is known as fermentation (if the mixture is not protected from air, alcohol turns into acetic acid, producing vinegar). When cereal grains and potatoes are used, each requires a sprouting pretreatment (malting) to hydrolyze starch, during which diastase enzymes are produced that break down starches to simple sugars that the yeast, which lacks these enzymes, can anaerobically convert to alcohol. This process makes the sugar available for the fermentation process. The yeast then continues to feed on the sugar until it literally dies of acute alcohol intoxication.

Because yeast expires when the alcohol concentration reaches 12 to 15 percent, natural fermentation stops at this point. In beer, which is made of barley, rice, corn, and other cereals, the fermentation process is artificially halted somewhere between 3 and 6 percent alcohol. Table wine contains between 10 and 14 percent alcohol, the limit of yeast's alcohol tolerance. This amount is insufficient for complete preservation, and thus a mild pasteurization is applied.

Distillation, which was discovered about 800 C.E. in Arabia, is the man-made process designed to take over where the vulnerable yeast fungus leaves off. The distilled, or hard, liquors, including brandy, gin, whiskey, scotch, bourbon, rum, and vodka, contain between 40 and 75 percent pure alcohol. Dry wines result when nearly all the available sugar is fermented. Sweet wines still have unfermented sugar. Pure alcohol also is added to fortify wines such as port and sherry. This addition boosts their percentage of alcohol to 18 or 20 percent (such wines do not require further pasteurization). "Still wines" are bottled after complete fermentation takes place. Sparkling wines are bottled before fermentation is complete so that the formed CO_2 is retained. "White" wines are made only from the juice of the grapes; "reds" contain both the juice and pigments from skins.

The percentage of alcohol in distilled liquors commonly is expressed in degrees of "proof" rather than as a percentage of pure alcohol. This measure developed from the seventeenth-century English custom of "proving" an alcoholic drink was of sufficient strength. This was accomplished by mixing it with gunpowder and attempting to ignite it. If the drink contained 49 percent alcohol by weight (or 57 percent by volume), it could be ignited. Thus, proof is approximately double the percentage of pure alcohol (an 86 proof whiskey is 43 percent pure alcohol).

Pure alcohol is a colorless, somewhat volatile liquid with a harsh, burning taste, which is used widely as a fuel or as a solvent for various fats, oils, and resins. This simple and unpalatable chemical is made to look, taste, and smell appetizing by combining it with water and various substances called congeners (pharmacologically active molecules other than ethanol, including higher alcohols and benzene). Congeners make bourbon whiskey taste different from Scotch whiskey, distinguish one brand of beer from another, give wine its "nose" and sherry its golden glow. In trace amounts, most congeners are harmless, but their consumption has been linked to the severity of hangovers and other central nervous system symptoms that include sleepiness.

Use in Food Products

Wines, liqueurs, and distilled spirits are used to prepare main dishes, sauces, and desserts, creating new and interesting flavors. The presence of alcohol in significant amounts affects the energy value of a food. Alcohol is rich in energy (29 kJ/g, or 7.1 kcal/g). It is assumed that, because of its low boiling point, alcohol is evaporated from foods during cooking. However, almost 4 to 85 percent of alcohol can be retained in foods. Foods that require heating for prolonged periods (over two hours—for example, pot roast), retain about 4–6 percent; foods like sauces (where alcohol is typically added after the sauce has been brought to a boil) may retain as much as 85 percent.

Alcohol and Malnutrition

Alcoholism is a major cause of malnutrition. The reasons are threefold. First, alcohol interferes with central mechanisms that regulate food intake and causes food intake decreases. Second, alcohol is rich in energy (7.1 kcal/g), and like pure sugar most alcoholic beverages are relatively empty of nutrients. Increasing amounts of alcohol ingested lead to the consumption of decreasing amounts of other foods, making the nutrient content of the diet inadequate, even if total energy intake is sufficient. Thus chronic alcohol abuse causes primary malnutrition by displacing other dietary nutrients. Third, gastrointestinal and liver complications associated with alcoholism also interfere with digestion, absorption, metabolism, and activation of nutrients, and thereby cause secondary malnutrition.

It is important to note that although ethanol is rich in energy, its chronic consumption does not produce the expected gain in body weight. This may be attributed, in part, to damaged mitochondria and the resulting poor coupling of oxidation of fat metabolically utilizable with energy production. The microsomal pathways that oxidize ethanol may be partially responsible. These pathways produce heat rather than adenosine triphosphate (ATP) and thereby fail to couple ethanol oxidation to useful energy-rich intermediates such as ATP. Thus, perhaps because of these energy considerations, alcoholics

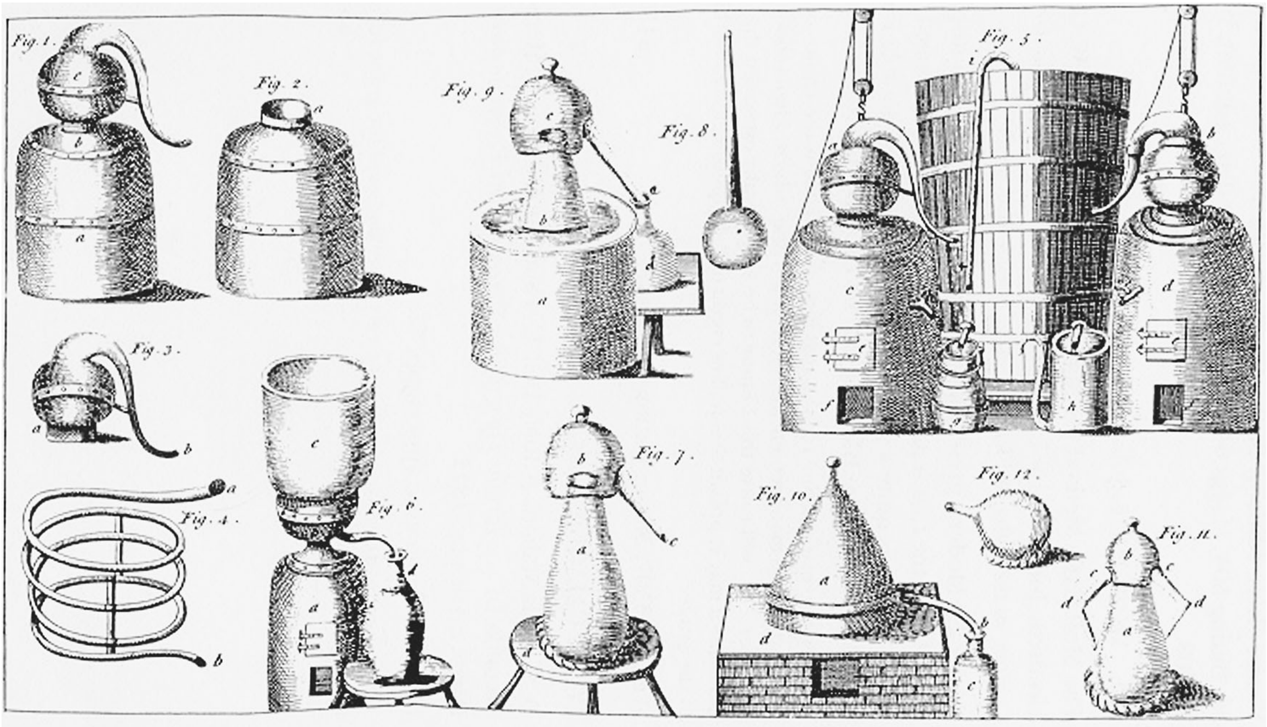
Fig. 1.
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Fig. 12.

Diagrams of alcohol-distilling equipment from Ambrose Cooper's Complete Distiller (London, 1760). Copper engraving. ROUGHWOOD COLLECTION.

with higher total caloric intake do not experience expected weight gain despite physical activity levels similar to those of the non-alcohol-consuming overweight population.

Absorption and Metabolism

Unlike foods, which require time for digestion, alcohol needs no digestion and is absorbed quickly. The presence of food in the stomach delays emptying, slowing absorption that occurs mainly in the upper small intestine.

Only 2 to 10 percent of absorbed ethanol is eliminated through the kidneys and lungs; the rest is metabolized, principally in the liver. A small amount of ethanol also is metabolized by gastric alcohol dehydrogenase (ADH) [first-pass metabolism (FPM)]. This FPM explains why, for any given dose of ethanol, blood levels are usually higher after an intravenous dose than following a similar amount taken orally. FPM is partly lost in the alcoholic.This lost function is due to decreased gastric ADH activity. Premenopausal women also have less of this gastric enzyme than do men. This difference partially explains why women become more intoxicated than men when each consume similar amounts of alcohol.

Hepatocytes are the primary cells that oxidize alcohol at significant rates. This hepatic specificity for ethanol oxidation, coupled with ethanol's high energy content and the lack of effective feedback control of alcohol hepatic metabolism, results in the displacement of up to 90 percent of the liver's normal metabolic substrates.

Oxidation. Hepatocytes contain three main pathways for ethanol metabolism. Each pathway is localized to a different subcellular compartment: (1) the alcohol dehydrogenase (ADH) pathway (soluble fraction of the cell); (2) the microsomal ethanol oxidizing system (MEOS) located in the endoplasmic reticulum; and (3) catalase located in the peroxisomes. Each of these pathways produces specific toxic and nontoxic metabolites. All three result in the production of acetaldehyde (CH_3CHO), a highly toxic metabolite. The MEOS may account for up to 40 percent of ethanol oxidation. Normally, the role of catalase is small. It is not discussed further here.

1. *The ADH pathway*. The oxidation of ethanol by the ADH results in the production of acetaldehyde (CH_3CHO) and the transformation of nicotinamide adenine dinucleotide (NAD) to nicotinamide adenine dinucleotide-reduced form (NADH). Substantial levels of acetaldehyde can result in skin flushing. Regeneration of NAD from NADH is the rate-limiting step in this ADH pathway of alcohol metabolism. It can metabolize approximately 13 to 14 grams of ethanol per hour (the amount in a typical drink). This rate is observed when blood alcohol concentrations reach 10 mg/dL. The large amounts of reducing equivalents that are generated by the alco-

hol oxidation overwhelm the hepatocyte's ability to maintain homeostasis and as a consequence a number of metabolic abnormalities ensue. Increased NADH, the primary form of reducing equivalents, promotes fatty acid synthesis, opposes lipid oxidation, and results in fat accumulation.

2. *MEOS*. This pathway also converts a portion of ethanol to acetaldehyde. Cytochrome P4502E1 (CYP2E1) is the responsible enzyme. As other microsomal oxidizing systems, this system also is inducible, that is, it increases in activity in the presence of large amounts of the target substrate. This induction contributes to the metabolic tolerance to ethanol that develops in alcoholics. This tolerance, however, should not be confused with protection against alcohol's toxic effects. It is important to note that, even though larger amounts of alcohol may be metabolized by individuals when this capability has been induced fully, most of alcohol's harmful effects remain unabated.

Physiological Effects at Different Levels

Beneficial effects. A large variety of alcoholic beverages are available, and most people can find at least one that provides gustatory and other pleasures. Alcohol is said to reduce tension, fatigue, anxiety, and pressure and to increase feelings associated with relaxation. It also has been claimed that drinking in moderation may lower the risk of coronary heart disease (mainly among men over 45 and women over age 55), but whether that putative protection is due primarily to the alcohol or some other associated factors, such as lifestyle, remains controversial. Moderate alcohol consumption provides no health benefit for younger people, and in fact may increase risks to alcohol's ill effects because the potential for alcohol abuse increases when drinking starts at an early age.

Harmful effects. The problems of individuals who occasionally become drunk differ from those who experience drinking binges at regular intervals.

"Acute" harmful effects of alcohol intoxication: Occasional excess drinking can cause nausea, vomiting, and hangovers (especially in inexperienced drinkers). The acute neurological effects of alcohol intoxication are dose-related. These progress from euphoria, relief from anxiety, and removal of inhibitions to ataxia, impaired vision, judgment, reasoning, and muscle control. When alcohol intakes continue after the appearance of these signs and symptoms, progress to lethal levels occurs very quickly, resulting in the anesthetization of the brain's circulatory and respiratory centers.

"Chronic" harmful effects of alcohol excess: Chronic excessive alcohol consumption can affect adversely virtually all tissues. Alcoholics have a mortality and suicide rate 2½ times greater, and an accident rate 7 times greater than average. Some of the dire consequences that are associated with alcohol abuse are:

1. *Cardiovascular problems*. Alcohol causes vasodilation of peripheral vessels (causing flushing), vasoconstriction (producing resistance to the flow of blood and increasing work load on the heart) and alcoholic cardiomyopathy (characterized by myocardial fiber hypertrophy, fibrosis, and congestive heart failure).
2. *Cancer*. Alcohol increases the risk of alimentary, respiratory tract, and breast cancers.
3. *Liver disease*. Alcohol can result in fatty liver, hepatitis, and cirrhosis.
4. *Central nervous system disorders*. Alcohol causes premature aging of the brain. Blackouts may occur (for example, those affected walk, talk, and act normally and appear to be aware of what is happening, yet later have no recollection of events experienced during the blackout).
5. *Gastrointestinal disorders*. Alcohol increases risk of esophageal varices, gastritis, and pancreatitis.
6. *Metabolic alterations*. Alcohol increases nutritional deficiencies (primary and secondary), and adversely affects absorption and utilization of vitamins. It impairs the intestinal absorption of B vitamins, notably thiamin, folate, and vitamin B_{12}. Wernicke's encephalopathy also may occur. This condition is the result of severe thiamine deficiency. It is characterized by visual disorders, ataxia, confusion, and coma.
7. *Immunological disorders*. Alcohol decreases immunity to infections and impairs healing of injuries.
8. *Others*. Alcohol causes personality changes, sexual frigidity or impotency, sleep disturbances, and depression.

Treatment

There are two major approaches that are used in the treatment of alcohol abuse: (1) correction of the medical, nutritional, and psychological problems; and (2) the alleviation of dependency on alcohol. Many sedatives or tranquilizers (for example, chlordiazepoxide) are effective in controlling minor withdrawal symptoms such as tremors. More serious symptoms include delirium tremens and seizures. For treatment of alcohol dependence, the anticraving agent naltrexone has shown promising results. Nutritional deficiency, such as lack of thiamine or magnesium, when present, must be corrected. Psychological approaches such as the twelve steps of Alcoholics Anonymous are also effective in achieving more sustained abstinence. These approaches, although helpful, too often come too late to revert the liver to its normal state. Other approaches, such as those focusing on prevention (utilizing biochemical markers), screening (through use of improved blood tests), and early detection are needed to impact on the prevalence of liver disease. The correction of nutritional deficiencies and supplementation with other substrates that may be produced in abnormally low quantities by affected patients, for example, *S*-adenosylmethionine (SAMe) and polyunsaturated lecithin have been shown to offset some of the adverse manifestations of alcohol's toxic effects. These and others are now being tested in humans.

Conclusion

Alcoholism, an addiction to heavy and frequent alcohol consumption, is a major public health issue. However, many believe that this condition does not attract attention that it merits from either the public or the health professions. Alcoholism is a multifaceted problem that cannot be solved by any single approach. The "consumption control approach" is a worthwhile endeavor with proven efficacy, but consumption control efforts by themselves are not sufficient. Prevention of alcohol misuse before it occurs also can be beneficial. Another prevention strategy includes establishing standards and guidelines for advertising and emphasizing responsibility and moderation in the serving and consumption of alcohol. "Behavioral" approaches focus on recognition of social and psychological factors and their correction. Finally, the "disease-control" approach provides new insights. Continued research into the pathophysiology of alcohol-induced disorders increases understanding of the condition and provides prospects of earlier recognition, and improved efforts for its early prevention and treatment, prior to the medical and social disintegration of its victims. By combining all of these approaches, chances to alleviate the suffering of the alcoholic are multiplied in a positively synergistic manner and the public health impact of alcoholism on our society can be minimized.

See also **Beer**; **Fermentation**; **Fermented Beverages Other than Wine or Beer**; **Nutrients**; **Nutrition**; **Wine**.

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ALCOHOLIC BEVERAGES. *See* **Alcohol; Beer; Spirits; Whiskey (Whisky); Wine.**

ALGAE, TOXIC.

Marine phytoplankton, or single-cell algae, are the base of the marine food chain. Phytoplankton use sunlight to convert simple inorganic molecules, such as water and carbon dioxide, to complex organic compounds, such as protein, carbohydrates, and lipids. The ocean waters that surround continental coastlines are the home of a large number of marine algae, making them the most productive areas for the harvest of marine finfish and shellfish. Much of the time, algae are present at very low numbers, but when conditions are right, they can grow rapidly and explosively, producing a noticeable discoloration in the water called a "bloom." These blooms can cover very large areas of the coastal ocean that are often visible from satellites. Large numbers of "blooming" algae can, at times, produce toxins or result in lower oxygen levels in seawater, thereby creating significant problems for shore-based businesses (e.g., hotels, restaurants), the seafood industry, and consumers.

While many of these algal blooms are merely noxious (i.e., producing smelly odors, discolored water, gelatinous masses), some produce marine toxins that enter the marine food web when consumed by shellfish or finfish. Typically, these finfish and shellfish (particularly mussels) have a capacity to concentrate and accumulate very large amounts of these toxins without apparent harm to themselves. Toxin levels can be so high that consuming only a few mussels could be lethal. When blooms produce such deleterious effects, they are called harmful algal blooms, or HABs.

A variety of human intoxication syndromes have been characterized from the consumption of seafood contaminated with algal toxins. Five will be described here. For a detailed historical and descriptive treatment of the myriad seafood intoxications, please see the extensive monograph by Halstead, the chapter by Wekell and Liston, and *Seafood Safety* (pp. 87–110) in the bibliography. In the temperate zone, three HAB intoxications are of concern to seafood consumers and industry: paralytic shellfish poisoning (PSP), amnesiac shellfish poisoning (ASP, more correctly domoic acid poisoning), and diarrhetic shellfish poisoning (DSP). In semitropical and tropical waters, two syndromes have major impacts: neurotoxic shellfish poisoning (NSP) and ciguatera fish poisoning (CFP).

PSP and ASP present the greatest health risks due to the following factors: potency of the toxins, wide geographic distribution, and large coastal populations exposed to the toxins, thereby elevating the risk of human exposure to these toxins. In addition, shellfish production has increased to meet increasing worldwide demands. Perhaps the tropical poisonings (NSP and CFP) have disproportionately greater impacts because some of the "at-risk" populations in tropical communities are poor and dependent on seafoods for daily subsistence. In these regions, illnesses from these toxins have greater impact on daily lives than those in more developed and wealthier countries due to loss of work time and limited access to medical care. Since no antidotes are available, medical treatment for all seafood intoxications is limited to providing emergency measures (e.g., gastric lavage, breathing assistance) and treating symptoms (Wekell and Liston, pp. 111–155).

The Symptoms, Toxins, and the Organisms That Produce Them

Paralytic shellfish poison (PSP). Symptoms include paralysis of the peripheral muscles including the chest, making breathing difficult (in mild cases) to impossible in the most severe cases. Along the West Coast of North America, several deaths have been reported over the past decade from recreational and subsistence shellfish consumers. The only treatment is immediate medical intervention, that is, the use of artificial respiration until the toxins are purged from the victim's body. PSP is caused by the consumption of shellfish contaminated with a suite of toxins (about a dozen individual toxins have been identified). The first toxin to be chemically identified was named "saxitoxin" because it was found in the Alaskan butter clam (*Saxidomus giganteus*). Since then, other toxins have been identified and named "gonyautoxins," after the historical name (*Gonyaulax*) for the causative organism, currently known as the *Alexandrium dinoflagellate*. The PSP toxins and associated algae are found from the sub-Arctic (and sub-Antarctic) to tropical areas, but are most common in cooler temperate waters (both in the Northern and Southern Hemispheres). In the temperate zones, the toxins are produced by the dinoflagellates in the genus *Alexandrium*: specifically *A. catenella* and *A. tamarense*. In tropical and semi-tropical areas, the dinoflagellates *Pyrodinium bahamense* var. *compressum* and *Gymnodinium catenatum* have been implicated as producers of PSP toxins.

Amnesiac shellfish poisoning (ASP or domoic acid poisoning). The first identified outbreak occurred in 1987 in eastern Canada due to the consumption of mussels contaminated with domoic acid. Symptoms varied from mild gastroenteritis to the loss of short-term memory, and in the most severe cases, death. In this incident, the elderly appeared more susceptible than younger people. The toxin binds to parts of the brain responsible for memory and learning, resulting in nerve cell death. To date, in the United States, the most common vectors of lethal levels of the toxin have been sardines and anchovies—planktivorous fish that consume phytoplankton. Consumption of these fish has resulted in the stranding and death of marine mammals and sea birds on the West Coast of the United States. So far, these are the only known poisoning victims of this toxin. Domoic acid has seriously impacted razor clam recreational fisheries (and its support industries) in Washington State and commercial crab fisheries on the West Coast of the United States. In Nova Scotia, Canada, and Maine, very high levels of domoic have been detected in mussels. However, due to an extensive and successful monitoring and surveillance programs put in place since 1987, no human illnesses have so far been reported in these areas from consumption of commercially raised shellfish. Domoic acid is produced by some of the diatoms in the genus *Pseudo-nitzschia*. However, not all species have been implicated in major domoic acid poisoning outbreaks, so far these include: *P. multiseries*, *P. australis*, and *P. pseudodelicatissima*. Globally, these organisms are quite cosmopolitan and have been identified in temperate waters of both the Northern and Southern Hemispheres. The genus is also fairly common in marine estuaries.

Diarrhetic shellfish poisoning (DSP). As the name implies, human consumption of shellfish containing the toxins associated with this syndrome causes diarrhea. Because symptoms are mild and similar to those in other common illnesses (gastrointestinal distress, nausea), many cases probably go largely unreported so that the true incidence of DSP is likely much higher than current epidemiological data indicates. However, there is a particular human health concern associated with DSP because the toxins involved (the dinophysistoxins or DTXs) are known potent tumor promoters (Fujiki et al., pp. 232–240). Toxic shellfish and causative organisms have been found in the Mediterranean Sea, off the Galician coast of Spain, and Ireland. *Dinophysis* cf. *acuminata* and *D. acuta* are believed to be the causative organism and are found in temperate waters worldwide. Recently, DSP toxins have been found in North America in eastern Canada and the northeastern coast of the United States but the primary source of the toxins appears to be *Prorocentrum lima* (Reguera et al., pp. 78–80).

Neurotoxic shellfish poisoning (NSP). People consuming shellfish containing the toxins report tingling fingers, numbness of lips, and reversal of temperature sensation, along with gastroenteritis. During heavy blooms of the causative organism of NSP, the dinoflagellate *Karenia brevis* (older name: *Gymnodinium breve*), aerosol dispersions of both the organism, and toxins can be caused by breaking waves and wind resulting in upper respiratory problems and distress in people. In some cases, victims may need to move inland to avoid exposure to the aerosols. The toxins involved are high-molecular-weight polyether toxins known as brevetoxins. *Karenia brevis* inhabits both temperate and tropical waters. In the United States, outbreaks are common in the Gulf of Mexico, where long-lasting blooms have been observed along the west coast of Florida. In the early 1990s, outbreaks of NSP were also reported on the North Island of New Zealand.

Ciguatera fish poisoning (CFP, or tropical fish poisoning). Symptoms, including gastroenteritis, that in most cases occur within a very short period of consuming the tainted fish. In severe cases, paresthesia or numbness occurs around the mouth, lips, and tongue. In extreme cases, burning sensations in mouth and death occur. Some victims report a reversal of the sensations of hot and cold. One victim was observed blowing on ice cream to cool it down. In some cases, symptoms reoccur years after the initial intoxication, usually during times of stress. In the most extreme cases of intoxication, death can occur within hours of consuming tainted fish. The toxin, ciguatoxin, and its congeners are complex fat-soluble, high-molecular-weight, polycyclic polyether compounds. The toxins are produced by the benthic dinoflagellate *Gambierdiscus toxicus* that grows on corals and other surfaces in tropical reefs. Virtually all tropical reef-dwelling fish are suspect (Halstead, pp. 325–402). Coral-eating fish (e.g., parrot fishes) consume algae on the coral including the associated *G. toxicus*, thereby accumulating toxin in their fatty tissues. Predators of these fish then concentrate the toxin. Top reef predators, such as barracuda in the Caribbean and moray eels (in the Pacific), are considered high-risk vectors of ciguatoxin. Tropical Pacific outbreaks of Ciguatera appear to be the most intense and have caused rapid deaths, while outbreaks in the Caribbean seem to be relatively mild. Treatment is largely symptomatic, entailing fluid replacement and other life support measures. Unfortunately, monitoring tests for Ciguatera toxins are complex and costly and have not been widely implemented.

Prevention, Control, and Mitigation

With all these intoxication syndromes, shellfish and fish show no clear outward signs that they might be poisonous. The presence of toxins can only be determined by appropriate chemical testing. Cooking, cleaning, or organ removal in fish and shellfish may reduce the toxin levels in some cases but cannot guarantee that the seafood has been rendered safe. Therefore, both recreational and commercial fishers must rely on monitoring and surveillance programs, usually operated by governmental agencies. Commercial seafoods, particularly shellfish, are usually monitored and tested for toxins (when reliable methods exist) as part of government safety and sanitation programs. It is wise for consumers to purchase only inspected shellfish from reliable, licensed retailers, since these businesses are usually required to maintain certification records for their shellfish stock.

For recreational fishers, it is vital that they obtain information about local closures or safe beaches. Necessary safety information should be posted on signs or made available by telephone "hotlines," websites, or news media. Unfortunately, depending on agency resources, recreational and private beaches are monitored in a more limited fashion, placing these fishers at a higher risk. Nevertheless, it is the recreational fishers' responsibility to obtain the needed information that will allow them to safely enjoy the sea's bounty.

See also **Crustaceans and Shellfish; Fish; Fishing; Mammals, Sea.**

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ALLERGIES.

Food allergy has been recognized since the time of Hippocrates. People with adverse reactions to food can be difficult to evaluate because overlap exists between true food allergy and toxic and other reactions to chemicals or other food ingredients. The incidence of food allergy is increasing in the industrialized world, raising questions about the interactive effects between environmental and genetic factors. There is a considerable burden on society in terms of cost of treatment, death from anaphylactic reactions, and the anxiety produced by real or perceived food allergy. Avoidance of the food is the current treatment, but new strategies are being developed.

Definitions

Adverse reactions to the ingestion of food that can be reproduced is termed intolerance or hypersensitivity. Since this does not imply an underlying cause, it may encompass immune or nonimmune mechanisms. For example, chemicals such as caffeine may cause reproducible symptoms, but this is not mediated by the immune system. True food allergy or food hypersensitivity is defined as a reproducible adverse reaction to food caused by the immune system creating antibodies or cellular inflammation.

Type I IgE-mediated food allergy. The classic example is immediate anaphylactic reaction to food. In susceptible individuals after exposure to the food, the immune system creates specific IgE antibodies to that food. IgE is produced by the immune system's B-lymphocytes, and is bound to receptors on the surface of mast cells. Mast cells reside in tissues at body surfaces such as the skin, eyes, nose, throat, lung, and gastrointestinal tract. Mast cells are made up of granules containing chemicals including histamine. When the food protein contacts and binds to adjacent specific IgE molecules at the mast cell surface, a cascade of events occurs leading to degranulation of mast cells and release of chemicals that cause the allergic reaction. This may include skin hives, airway swelling, wheezing, abdominal pain, vomiting and/or diarrhea. This may progress to anaphylaxis, shock, and even death. This reactivity to food can be demonstrated by skin-prick tests, which have been used to diagnose allergy since the 1870s. Food protein is placed on the skin, the skin is scratched or pricked, and a hive will develop in the presence of skin mast cells with IgE directed against the food. In the 1920s Prausnitz and Kustner showed that a substance circulating in the blood of the allergic individual was responsible for a positive skin test, because blood serum could be transferred to the skin of a nonallergic individual resulting in a positive skin test. IgE is that substance, and food-specific IgE can be measured directly in the blood, by means of the IgE RAST (radioallergosorbent) test. Diagnosis of this immediate type of food allergy rests on the history of rapid onset of symptoms, demonstration of positive skin-prick test or specific IgE RAST. Challenging an individual with the food is the ultimate way to prove a food allergy.

Non-IgE-mediated food allergy. Other immune mechanisms can be responsible for allergic reactions to foods. The classic example is celiac disease (celiac sprue or gluten-induced enteropathy). This is an immune system reaction to wheat (gluten). Patients do not have IgE antibody directed against wheat, but exposure to gluten over a period of time causes inflammation of the intestine and a characteristic atrophy or flattening of the normal intestinal villous folds. The diagnosis rests on the characteristic biopsy of the small intestine coupled with another type of antibody (IgA) against wheat protein. Any food may also cause similar intestinal inflammation, leading to varying symptoms and signs depending on the area of the intestine affected. Unlike IgE-mediated allergy or celiac disease, there are no readily available confirmatory tests for these other food allergies.

Prevalence

Food allergy is perceived as being common; however, large studies support the idea that true food allergy is less common than people think. A study of 480 infants from birth to age three revealed 28 percent were suspected by their parents as having food allergy; however, this was confirmed in only 8 percent of this group. The prevalence then decreases with age. Twenty percent of adults suspect food allergy, though allergy is confirmed in only 1 to 2 percent of adults. Although food allergies in adults tend to persist with age, many infants and children outgrow them with time.

Recently, interest has grown over the apparent increase in the prevalence and severity of food allergy. This has paralleled an increase in other atopic disorders such as asthma in industrialized nations compared with children of similar genetic background in developing countries (atopic refers to a tendency to develop allergic conditions such as hay fever, asthma, or food allergies). The "hygiene hypothesis" contends that through evolution, the human immune system has developed with a specific microbial environment, and reduced exposure to microbes in the developed world may lead to increased allergic response. Further study is needed.

Type I Immediate (IgE-Mediated) Hypersensitivity Reactions to Food

Immediate hypersensitivity reactions to foods are most common in young children, with 50 percent of these reactions occurring in the first year of life. The majority is from cow's milk and soy protein from infant formulas. Other foods begin to predominate in older children, including eggs, fish, peanuts, and wheat, and along with milk and soy account for over 90 percent of food allergy in children. Peanut, tree nut, and shellfish allergy predominate in adults. Exposures may occur inadvertently due to improper labeling, changes in product composition with time, and contamination of foods during processing. Symptoms from multiple organ systems may occur, beginning within minutes. Unfortunately, fatal anaphylactic reactions (shock) to food occur despite strict dietary avoidance and treatment of reactions. Families, caregivers, and individuals with a history of anaphylaxis to food require education in diet and in the use of self-administered epinephrine. Individuals should be observed in a hospital setting after a significant reaction. Exercise-induced anaphylaxis to food occurs when the combination of ingesting the food followed by exercise leads to anaphylaxis. Oral allergy syndrome describes symptoms of itching of the mouth and throat often attributable to eating fruits, and typically does not progress. Chronic hives or urticaria can be caused by foods, but it is a common misconception that these conditions are usually food-related; only in 1 to 2 percent of cases is urticaria or chronic hives a reaction to food. Atopic dermatitis (AD) or eczema is a chronic skin condition found in atopic individuals. Patients with AD have a 30 to 40 percent prevalence of food allergy.

Investigation and treatment of type I immediate reactions to food. The rapid onset of symptoms after ingestion correlates highly with positive skin-prick or IgE RAST tests to the offending food, making confirmation of immediate hypersensitivity straightforward. Consultation with an allergist and dietitian is recommended. Groups such as the Food Allergy and Anaphylaxis Network can provide support and educational materials.

Non-IgE-Mediated Food Allergy

The spectrum of non-IgE food allergy is quite varied, and the symptoms often parallel the area of inflammation in the gastrointestinal tract (see sidebar). Avoidance of the food will resolve symptoms and intestinal inflammation;

Manifestations of IgE Allergy to Food

- Cardiovascular (shock)
- Respiratory (wheeze, cough)
- Gastrointestinal (acute vomiting, pain, diarrhea)
- Skin (hives, atopic dermatitis)
- Eye (itching, swelling)
- Oral (itching, swelling)

Manifestations of Non-IgE Allergy to Food

- Growth delay
- Protein-losing enteropathy, edema
- Iron-deficiency anemia
- Chronic diarrhea
- Eosinophilic colitis
- Chronic vomiting/feeding intolerance
- Food protein-induced enterocolitis syndrome
- Atopic dermatitis
- Infantile colic

Manifestations of Celiac Disease (Gluten-Induced Enteropathy)

- Growth delay
- Chronic diarrhea
- Abdominal distension
- Abdominal pain
- Dermatitis herpetiformis
- Associations: Diabetes, thyroid disease, Down syndrome

rechallenge with the food will reproduce the injury. However, unlike IgE food allergy, symptoms may take days or weeks to resolve or reappear with elimination or exposure respectively, making evaluation even more difficult.

Celiac disease or gluten-induced enteropathy (see sidebar) is a chronic intestinal condition caused by non-IgE mediated allergy to gluten, a protein in wheat and other grains. Chronic exposure to gluten causes inflammation and atrophy of small intestinal folds, leading to symptoms of malabsorption of food. Typically, patients have diarrhea, weight loss, and abdominal bloating. There is a genetic predisposition to celiac disease, but onset may occur at any age, suggesting an environmental factor such as infection may be needed in some individuals to trigger the inflammatory process. The disease has a higher prevalence (up to 1 in 400–500) in individuals of eastern European descent. Celiac disease is associated with a skin condition (dermatitis herpetiformis), thyroid disease, diabetes, and Down syndrome.

Allergic or eosinophilic colitis in infants is a common manifestation of non-IgE food protein allergy. It is characterized by diarrhea with blood and mucus. It is caused by milk or soy formula and may occur in breastfed infants from dietary antigens transmitted through breast milk. Colon biopsy shows allergic inflammation.

Food protein-induced enterocolitis is a severe reaction to food, often delayed four to six hours, without evidence of IgE. Patients present with lethargy, vomiting, and diarrhea. Recovery is within six to eight hours after fluid resuscitation. A careful history usually reveals the offending food, although this may not be appreciated unless multiple episodes occur.

Chronic enteropathy from food allergy can also lead to inflammation with villous atrophy similar to celiac disease. Most patients have diarrhea, in addition to weight loss, anemia, and low albumin from protein loss from the intestine.

Allergic gastritis is inflammation of the stomach with pain and vomiting. As with other non-IgE food allergy, biopsies of the stomach demonstrate allergic (eosinophilic) inflammation.

Allergic esophagitis is characterized by intense eosinophilia of the esophagus on biopsy. Patients complain of pain and problems with swallowing, even to the point of having food impactions in the esophagus. Treatment with hypoallergenic formula has been shown to improve esophagitis in infants; however, older children and adults may require corticosteroid medication.

Infantile colic and excessive irritability can be symptoms related to allergy in a subgroup of infants. By definition, colic is a condition with increased crying behavior in infants, for which no cause can be found. However, since allergy can potentially lead to inflammation and pain, formula allergy is often considered.

Attempts have been made to associate a variety of other problems with food allergy including joint disease, migraine, and behavioral and developmental disorders such as autism. Causal relationship between food allergy and these disorders remains unproven.

Investigation and treatment of non-IgE-mediated food allergy. The diagnosis rests on the resolution of symptoms and/or biopsy findings on an elimination diet, with a return of symptoms on rechallenge. Unlike the rapid response characteristic of IgE-mediated disease, a prolonged challenge may identify delayed reactions with predominantly gastrointestinal symptoms up to six days after exposure. Elemental diets can be used to eliminate dietary protein antigens completely, then systematic rechallenge of the patient with suspected offending foods. As with IgE food allergies, avoidance of the specific food remains the mainstay of therapy.

New Frontiers

There are a number of exciting areas of research into the prevention and treatment of food allergies. Recent reports suggest that the allergic response can be altered by promoting beneficial gut flora ("probiotic therapy"). It has also been discovered that only a few sites (epitopes) on food protein molecules interact with the immune system to create an allergic reaction. Genetic engineering of foods makes it possible to alter these epitopes, creating crops that are "nonallergic." More study is needed to ensure that altering food proteins does not lead to other health concerns or different types of allergy. Other studies are under way to assess the effectiveness of promising new drug therapies for patients with food allergy.

See also **Aversion to Food**; **Baby Food**; **Health and Disease**; **Immune System Regulation and Nutrients**; **Milk, Human**; **Proteins and Amino Acids**.

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ALLIUM. *See* **Onions and Other Allium Plants.**

AMERICAN INDIANS.

This entry includes two subentries:
Prehistoric Indians and Historical Overview
Contemporary Issues

PREHISTORIC INDIANS AND HISTORICAL OVERVIEW

Native North Americans consumed a variety of foods based on the diverse plant and animal communities found throughout the continent. Regional variation in diet paralleled regional variation in the availability of these food resources. This generalization applied until around 7000 B.C.E. This entry provides an overview of Native American diet, from the northern border of Mexico to the High Arctic, from the earliest peoples in the continent to the time of European contact.

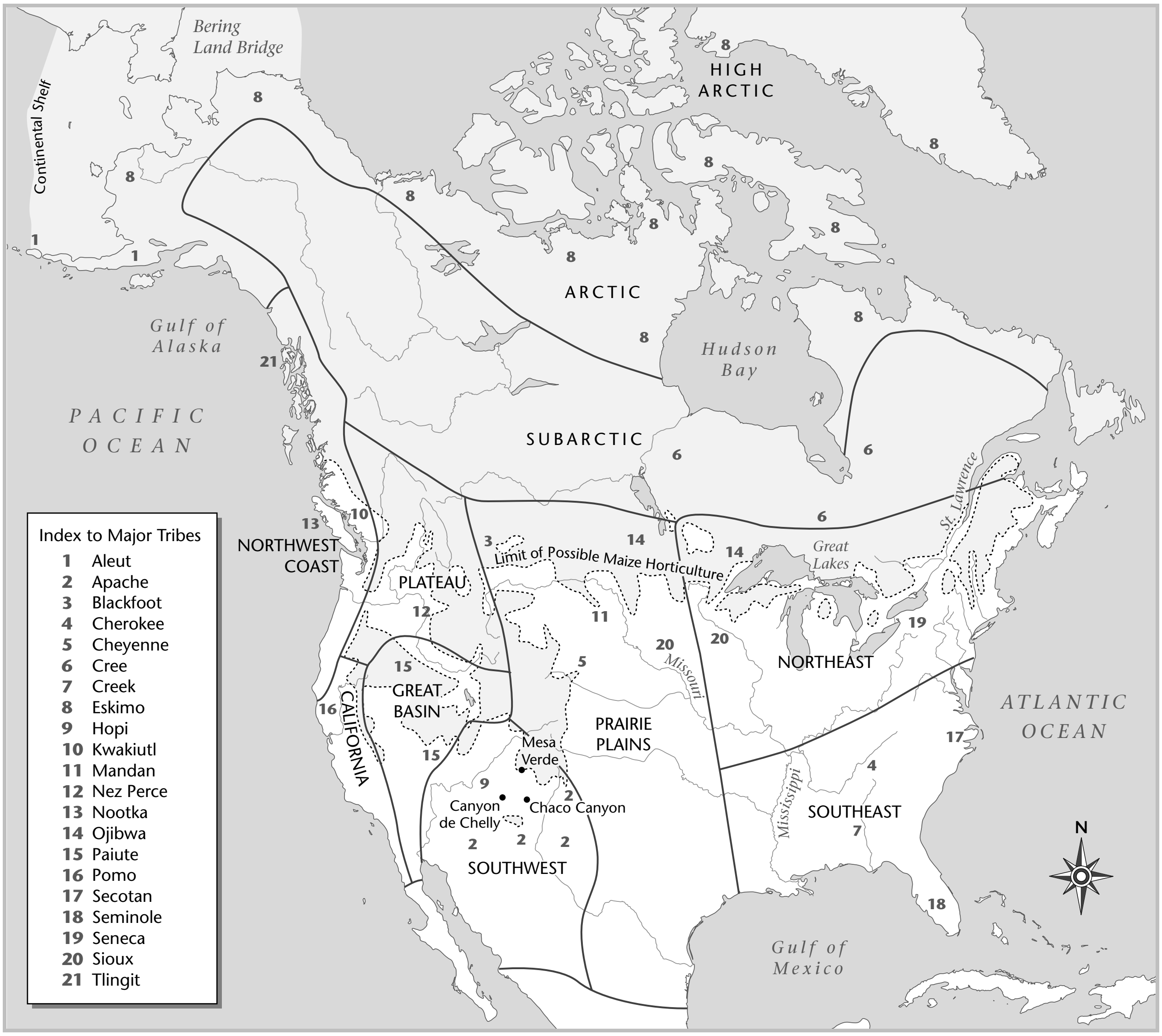
Sources of Information

How do we know about the diets of past peoples? There are three main sources of information, each with its own limitations. Working backward from the time of European contact, there is recorded information about diet. The first European people to travel to the New World provided some information about native customs, but much richer information was provided by the first Europeans to live in the New World. These people (missionaries, explorers, and early settlers) were able to record information about foods and other customs before cultural disruption altered diet and subsistence. Because contact and early settlement was more often in coastal areas or along major watercourses, there is more information about coastal peoples. By the time Europeans had made their way inland, they were already encountering cultures changed by waves of impact from coastal regions. For example, the fur trade resulted in alterations in hunting practices among northern peoples before any Europeans were able to witness daily life in some inland northern villages.

A second source of information is ethnography and oral tradition. Ethnographic information comes from anthropologists who lived among native peoples and recorded their customs, including food procurement, preparation, and storage. A vast amount of ethnographic information was collected early in the twentieth century. Since this type of study represents only one or a few points in time, it is also helpful to learn the oral traditions of people, since these can reveal long-held customs and practices.

Insights into past diets are also provided by archaeology. Archaeologists analyze remains of food items including animal bones, charred seeds and cobs, pollen, and phytoliths (siliceous secondary cell walls of certain terrestrial plants which leave a "signature" that archaeologists and paleobotanists can identify), and the tools used for food procurement and preparation (spear points, fish hooks, digging sticks, manos, and metates). Chemical analysis of human bones provides direct information on foods consumed.

There are possible errors in all of these sources of information. Historians may only record what was eaten during a particular season. Ethnographers may also miss some of the diversity of the annual round of foods due to limitations on time spent with a group of people, or variations from year to year. Some items are more likely to be preserved in the archaeological record than others (bone tools versus wooden tools; ceramic vessels versus baskets woven from fibers). However, food preferences are strongly ingrained in cultures and so it is reasonable to assume that the habits that were observed by ethnographers and early historians and that are repeated in oral traditions can be extended back into time. The exception is that a major transition, plant domestication, took place prehistorically. The timing of this transition has been studied intensively by archaeologists and physical anthropologists.


Bering Land Bridge
Continental Shelf
HIGH ARCTIC
ARCTIC
Hudson Bay
Gulf of Alaska
PACIFIC OCEAN
SUBARCTIC
NORTHWEST COAST
PLATEAU
Limit of Possible Maize Horticulture
Great Lakes
St. Lawrence
GREAT BASIN
CALIFORNIA
PRAIRIE PLAINS
Missouri
NORTHEAST
ATLANTIC OCEAN
Mesa Verde
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20 Sioux
21 Tlingit

The First North Americans

The first people to enter the New World are thought to have come from northeast Asia and are usually characterized as "big game hunters." During the late Pleistocene, large terrestrial mammals such as mammoths and mastodons were hunted, as is apparent from the association of projectile points and bones from these animals. Here researchers encounter the problem of bias in the archaeological record. Did these people only eat big game? The ethnographic information on northern peoples of the boreal forest and Arctic regions points to an emphasis on meat in the diet, and indicates that animals with fatty meat (moose and beaver) were preferred over lean animals such as hare. A number of different types of berries were collected in summer and some were preserved, but they constituted a small percentage of the total diet. As the early Asian migrants to North America moved south, they hunted other large mammals, such as bison, and they probably learned about local plants and animals. In the arid Southwest, the archaeological record is less biased toward animal remains since wood, plant fibers, and seeds are preserved by the dry conditions. The descriptions of regional diets that follow are derived from a combination of archaeological, ethnographic, and historical information. (For additional information, the reader is referred to the *Handbook of North American Indians*, which presents information on the archaeology, ethnography, linguistics, geography, and history of various regions.)

A few generalizations can be made about the diet of North America's native peoples. The edible plants and animals that are available locally constituted the diet everywhere until the beginning of the practice of plant domestication, around 7000 B.C.E. In areas where plants were domesticated, or where domesticated plants were introduced from Mexico and Central America, locally available food resources continued to be used, but were supplemented, to varying degrees, with domesticated plants. It takes approximately 120 days for a crop of Indian corn to mature. This means that in much of Canada, where the growing season is less than 120 days, cultivation of corn was not possible, and diet continued to be based on locally available resources. There is evidence of maize cultivation in the southern portions of several provinces, including Manitoba, Ontario, and Quebec. Farther north, there was an increasingly heavy reliance on foods of animal origin. Other areas, including the Eastern Woodlands and West Coast, had plentiful and diverse foods available and continued to make use of those resources after the introduction of horticulture.

Arctic

Among Arctic peoples, diets varied depending on proximity to the coast. Those in coastal regions relied on sea mammals and fish. Sea mammals were more important in the High Arctic, where they were hunted in the frozen sea. Fish were more important in the warmer regions where there is more open water. Inland groups relied on migrating caribou, smaller terrestrial mammals (hares), birds, eggs, and berries (salmonberries, cranberries, and blueberries) and roots (cotton grass root and licorice root) (Ray, 1984). While dietary diversity was greater than is generally assumed, Arctic peoples, who are well adapted to metabolizing foods high in animal fat, relied primarily on hunting. Fat is essential as a source of lightweight, storable energy for functioning in cold climates and with periodic food scarcity. Cooking was not routinely carried out among Arctic peoples since fuel is a scarce and precious commodity. Meat was usually eaten raw and fish were dried before eating. From a nutritional perspective, this means that a number of vitamins, including vitamin C, that would otherwise be lost in cooking, were available. Internal organs were also eaten, adding to the supply of vitamins and minerals.

Subarctic

In the Subarctic boreal forest there was also a heavy reliance on animal foods in comparison to plant foods. Large terrestrial herbivores, such as caribou and moose, were hunted, along with small mammals. Fish were also an important food source. Although native people did not domesticate caribou, the migration routes were well known, and caribou drives, in which the animals were herded into enclosures, allowed for large-scale hunting. Among the Hare people of the Northwest Territories, foods were cooked either by roasting or stone boiling. Some favorite dishes included caribou tongue, caribou fetus, muskrat, and beaver tail (Savishinsky and Hara, 1981, p. 317). Meat and fish were preserved either by smoking, drying, or freezing. A food that was common throughout the Subarctic and on the Great Plains is pemmican, which is made by pounding dried meat or fish with fat and sometimes with berries.

Northeast and Southeast

The peoples of the eastern Woodlands enjoyed a wide variety of both animal and plant foods. An assortment of nuts (hickory, walnut, and chestnut) were collected and served as one source of protein and fat. They could be stored over the winter and were used in a number of different ways. Among the Cherokee, nuts were pounded, then boiled, and the resulting milk was added to other foods such as corn. Fruits such as apple, cherry, peach, plum, and crabapple were used along with numerous wild greens, including dandelion, Solomon's seal, and bergamot, and berries (blackberry, strawberry, wild grape and huckleberries) (Chiltoskey, 1975). Animal foods included deer, rabbits, squirrels, and fish. Maize (corn) was introduced around 200 C.E., and it gradually became a staple (in breads, soups, and as roasted ears) to which other foods were added.

Researchers have determined that native plant species were domesticated prior to the introduction of maize in eastern North America. Sometime between three and four thousand years ago, indigenous plants were cultivated by people in the American mid-continent and Northeast. These plants include sumpweed (*Iva annua*), goosefoot (*Chenopodium berlandieri*), and sunflower (*Helianthus annuus*) (Smith, 1992). Goosefoot bears starchy seeds while sump weed and sunflower bear oily seeds. By 800 C.E., maize increased in importance relative to indigenous seed plants, and this was accompanied by an increase in population density in the American Midwest, Southeast, and Northeast.

Great Lakes

The area around the lower Great Lakes supported a large population of Iroquois and related groups, and has been studied extensively by early historians, Jesuit missionaries, ethnographers, and archaeologists. In addition, many descendents of those native groups still reside in the area. In 1916, F. W. Waugh published a monograph titled *Iroquois Foods and Food Preparation*, which provides detailed information on agricultural practices and utensils used in gathering, preparing, and eating foods, along with numerous preparation methods for various foods. Two commonly eaten foods among the Iroquois, historically, were corn bread and corn soup. Bread was made by pounding corn into flour. Boiling water was poured into a hollow in the flour. Additional ingredients may have included dried berries (huckleberries, blackberries, strawberries, elderberries), cooked beans, and nuts. A lump of the resulting dough was patted between the hands then dropped into boiling water. Prior to the introduction of copper kettles by Europeans, bread was more often baked under hot embers or on heated stones. The bread was

Cliffside pueblo of the Anasazi people in Mesa Verde National Park.

often eaten with maple sugar or syrup. The most common food at the time of historic contact was *sagamité*, a thick corn-based soup. From the basic corn broth, bits of meat or fish were added. Sometimes beans were also added. This meal would supply all essential amino acids and is a good source of carbohydrates.

Northwest Coast

The Northwest coast includes the land between the Pacific Ocean and the coastal mountains from the Bay of Alaska to southern Oregon. Food resources there are very rich, with abundant waterfowl, migrating sea mammals, and both marine and anadromous fish. In addition, over 550 different plant species have been documented as food items. Harriet Kuhnlein and Nancy Turner's *Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany and Use* (1991) covers all of Canada but with special reference to the Canadian Northwest coast. Their detailed descriptions of plant use and the nutritional value of various plant foods provides ample evidence of an archaeological bias that overestimates the importance of animal foods in the diet. Interestingly, Native Americans did not differentiate between plants used for food and those used for medicine, since some foods were eaten as a form of medicine.

California, the Great Basin, and the Plains

Peoples of interior California and the Great Basin relied on fish, local game, and a variety of seeds. They also ate insects such as ants, roasted grasshoppers, caterpillars, fly larvae, and seventeen-year cicadas (locusts) (Bodenheimer, 1951). Food was stored in pits, and cooking was generally achieved by roasting. Pine nuts were ground into a flour that could be stored and easily transported (Kehoe, 1981). Along the southern periphery, agricultural crops included maize, beans, and squash.

The Great Plains extends from southern Canada to Texas. Along the eastern margins and along the major rivers, native people practiced small-scale horticulture. Hunting was important throughout the Plains, and there is evidence of big-game hunting among the early Clovis people, and later evidence of bison hunting through controlled drives over natural features such as cliffs and arroyos (Frison, 1998). There is archaeological evidence of long-term storage of meat from such drives. Ethnographic work as well as evidence from pollen and phytoliths indicate that a wide variety of indigenous plants were used, including plums, grapes, rose hips, berries, turnips, and camas root (Wissler, 1986).

Bison meat and fat were desirable food items. There is both archaeological and nutritional evidence for selective hunting of fatter animals (not only bison, but other large mammals as well). Meals are both more satisfying and more economical when protein is accompanied by fat and carbohydrate, a readily available source of energy that spares the higher metabolic demands required to break down protein. Other animals were also hunted for food, including deer, antelope, rabbits, and hares. Pemmican was a staple food for many Plains peoples. Foods were cooked either in earth ovens lined with heated rocks, or by boiling in hide bags with heated rocks inside.

Farming was also practiced by Plains peoples, particularly along the eastern margins and along the Missouri and Mississippi Rivers. Maize, beans, and squash were cultivated, and there is also evidence of the cultivation of the indigenous species, goosefoot, marsh elder, and sunflower, similar to the Eastern Woodlands.

Southwest

The American Southwest is of special interest for two reasons. First, the earliest evidence of domestication of maize, beans, squash, and other Mesoamerican cultigens is found there. Second, due to the hot and dry climate, plant remains are preserved in the archaeological record, providing a less biased picture of past diet than in other regions of North America. Spectacular Anasazi villages that flourished from 900–1300 C.E., such as Chaco Canyon, Mesa Verde, and Canyon de Chelly, housed people who farmed in canyon bottoms and on mesa tops with the aid of irrigation (Cordell, 1984). The Anasazi also exploited antelope, white-tailed deer, jackrabbits, cotton-tailed rabbits, and wild turkeys. Along the eastern margins, maize was traded for meat with Plains peoples. Food was prepared in earth ovens, in ceramic vessels, and on open fires. Indigenous plants used for food include piñon (pine) nuts, prickly-pear cactus buds, amaranth seeds, mesquite pods, and the heart of the agave (Cordell, 1984). *Zuni Breadstuff*, an early ethnographic account of all aspects of Zuni food, is a valuable source of information (Cushing, 1920).

Impact of European Contact

Sustained European contact altered traditional foods and food preparation throughout North America. Metal cooking pots were introduced, altering traditional roasting and boiling practices. The introduction of the horse had a profound impact on hunting techniques, particularly on the Great Plains. The fur trade altered traditional subsistence practices in the north. Displacement of native peoples by European settlers was very disruptive since an intimate knowledge of local environments was so important to obtaining food. Finally, the exchange of foods between the Old and New Worlds had a profound effect on cultures on both sides of the Atlantic Ocean (Crosby, 1972).

See also **Arctic**; **Canada, Native Peoples**; **Hunting and Gathering**; **Maize**; **Mammals**; **Mammals, Sea**; **Mexico**; **Thanksgiving**; **United States**.

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CONTEMPORARY ISSUES

The terms "American Indians" and "Native Americans" (both are appropriate) refer to diverse groups of indigenous peoples that have occupied the area north of Mexico and south of Canada since at least 12,000 B.C.E. With more than 550 sovereign Indian Nations currently residing within the political boundaries of the United States, summarizing their different foods and foodways is difficult. Such an undertaking would be analogous to characterizing "European foodways" as though Europeans from Italy to England were a homogeneous group. However, it is still possible to discuss some general characteristics organized along geographic lines.

Over several millennia the foodways of Native Americans were well established and included both wild and domesticated foods, traditions that have continued to evolve through the centuries of conquest, assimilation, and resistance that began with European contact in the fifteenth century. Contrary to popular stereotypes, not all Native Americans were horse-riding bison hunters who lived in tepees. Although these elements fit some historical contexts, they ignore actual regional and cultural differences.

Given the extensive ethnographic record of American Indians and the great interest the public has in their lives, it is surprising that so little research on their foodways has been done. A great deal of work on the ethnobotany of plants they used was done in the late nineteenth and early twentieth centuries, but it often focused on the potential economic importance of the plants as food and medicine, not on their importance as foods in specific cultures.

Both hunting and gathering (foraging) made important contributions to the diet of all American Indian groups at the time of contact, whether they were horticulturalists or not. The fact that no large mammals (horses, cattle, pigs, sheep, and goats) were domesticated in Native North America—only to be introduced later by Europeans—explains in part why foraging remained important. Virtually every native plant and animal species was used to some extent for food, medicine, and/or manufacture. Animal domesticates did include dogs, turkeys, and ducks, while domesticated plants included several varieties of maize (corn), beans, squash, gourds, sunflowers, sumpweed, and goosefoot (*Chenopodium*). Maize was a central food in the diets of many regional groups, and, except for California, was grown just about everywhere it was ecologically viable. The cooking traditions of Native Americans included everything from stone-boiling in leather bags to roasting and baking in earth ovens.

Because of a mixed subsistence pattern for horticultural groups, it is not surprising that both wild and domesticated foodstuffs remain traditional American Indian foods. The extent of this relationship is recognized in rights guaranteed by treaty to forage (hunt, fish, gather) many species that are restricted by season or prohibited to non-Indians.

Traditional Native American Culture Areas

Native Americans have been traditionally divided into several culture areas related to shared geographic and environmental boundaries. This is not to say that peoples falling within these realms were all culturally the same. However, both the historical experience of these groups as well as their ways of adapting to each area have heavily influenced their traditional foodways. Regardless of academic debates about the use of the cultural-regional approach, it remains a useful way to organize the regional differences that define Native Americans and their foods. Although the focus here is the American Indian groups south of Canada and north of Mexico, there is a great deal of overlap with cultures to the north and south. Also, in addition to the hundreds of federally recognized tribes in the United States, there are dozens more who maintain cultural traditions that are not federally recognized. A few contemporary issues for each area will be discussed, but no attempt will be made to detail the foodways of specific cultural groups.

Fry bread (bread dough deep-fried in fat) is a popular food at Indian fairs and gatherings, but it is also the cause of obesity and diabetes among native Americans. The dish can actually be traced to medieval Europe. © PHIL SCHERMEISTER/CORBIS.

Eastern Woodlands. Comprising the the Northeast, Great Lakes, and Southeast United States, this area extends from the Atlantic Coast west to the eastern prairies, north to the Canadian border, and south to the Gulf of Mexico. It is a place where corn, beans, and squash, all originally from Mexico, were the central staples of life and identity. Communities ranged in size from the small dispersed villages of New England to the large urbanized mound-building cities along the Mississippi and Ohio River valleys. The degree of maize dependence varied from area to area, but its central importance to this region's Native Americans is undeniable. Maize is a fundamental element of their folklore and origin myths.

Early European colonists in eastern North America rapidly incorporated various Native American dishes into their diet. Some of the best-known examples are those of Algonquin-speaking peoples, with some alterations of the original names and meanings. "Succotash," a corrupted version of the Narragansett "misickquatash," refers to whole kernels of grain. It is often a mixture of green corn cut from the cob, beans, and perhaps another ingredient, which might be anything from meat to squash. Hominy, or "rockahominy," is made by taking shelled ripened corn and soaking it in an alkaline solution made from wood ash or lye to remove the hulls. This method also enhances the nutritional value of the maize product. Throughout the United States it is sold as yellow or white hominy or under its Latin American name, "pozole." When dried and milled into course bits, it is called "hominy grits." In some areas of the Southeast, however, the term "hominy" can also refer to grits.

Although maize is an important food item in the Great Lakes region, the gathering of wild rice takes precedence there because it is essential to maintaining the identity of many cultures in this area. In fact, in many states only American Indians can legally gather true "wild" rice (*Zizania aquatica*). Given the constant demand for this product in American cooking, it continues to be a profitable resource for these communities. Many of these groups have also been in conflict with U.S. federal agencies, environmental groups, and local non-Indian communities over their legal spearfishing rights.

From the Iroquois nations of upstate New York south to the Cherokee of the Carolinas and the Seminoles of Florida, traditional foodways for nations of the Eastern Woodlands still combine locally gathered foods with the overarching importance of what the Iroquois refer to as the "Three Sisters": corn, beans, and squash. Across this region green (unripened) corn is the central element in "Green Corn" ceremonies, including the *Busk* ceremony of the southeastern cultures, which signals the beginning of a new year, and the annual *Schemitzun* (Green Corn Festival) of the Mashantucket Pequot held near Ledyard, Connecticut, which gathers nations from across the country for a huge powwow. Green corn is now a major item of American foodways when consumed as sweet corn, a mutated variety of maize that concentrates a sugar rather than a starch component.

Great Plains and Rocky Mountains. Bison, or buffalo, were a central food item and cultural symbol to many of the peoples of the central and western regions of North America. The meat was often processed into pemmican, a dried pounded meat often mixed with fat and chokecherries. This foodstuff was stored in parfleches (leather pouches) and could sustain a mobile population for long periods of time. The introduction of the horse in the eighteenth century greatly transformed the nomadic bison hunters of these regions, including groups that engaged in seasonal small-scale horticulture as well as those who did not but traded meat for maize with horticultural societies to the south and east. The horse also facilitated the migration of groups from the eastern prairies, like the Sioux, who gave up horticulture to live in tepees and become bison hunters. They were not only able to traverse great distances, but their mobility gave them the opportunity as warriors to resist assimilation well into the late nineteenth century, when almost all other Native American groups had been placed in some type of reservation system. Their dependence on bison was also their downfall because those animals were systematically slaughtered to the brink of extinction by white men, a destruction greatly facilitated by the completion of the transcontinental railroad and U.S. policies intended to starve them into submission by eliminating their food supply.

Bison remain central to Native American cultural identity. In the Dakotas and Montana some groups have begun to raise large herds of bison on the great expanses of grassland that they once occupied. A market that demands a low-fat alternative to beef, which bison meat provides (for example, buffalo burgers), has made raising them economically valuable.

Annual gatherings at the time of the traditional bison hunts in the summer months led to the importance of powwows or social get-togethers that are still held. The dance style of the plains groups is at the core of a powwow circuit that involves Indian nations from all over the United States. These events have also spread foods central to pan-Indian identities, for example, fry bread.

Southwest. Traditionally home to pueblo farming communities and bands of foragers, this desert region exemplifies Native Americans' ability to adapt to extreme environments. The same triad of corn, beans, and squash was also central to these groups, along with a host of plants gathered from the deserts and mountains. Unlike many Native American groups who were forcibly removed from their traditional homelands, Southwest farmers from New Mexico to Arizona have been able to maintain an ongoing relationship with lands that they have cultivated since prehistoric times. Groups like the Hopi continue to practice dry-land farming in the desert of northeastern Arizona, and perform cycles of elaborate rituals to bring rain and fertility to their lands. Throughout the Southwest, water rights are a major point of concern for Native Americans whose livelihood is based on range livestock and irrigated crop production. They compete for water with growing urban centers like Albuquerque, New Mexico, and Phoenix, Arizona. The use of water by mining operations exacerbated the scarcity and critical need for this finite resource.

Even peoples who were traditionally known as foragers, like the Navajo, over time incorporated horticulture. With the introduction of sheep into the region, they continued to adapt to the desert by becoming herders. Since the 1930s the Navajo have suffered through a number of government-imposed livestock reduction programs meant to limit overgrazing of the fragile desert grasses and forage, and they continue to resent and resist attempts to regulate their livelihood and important source of food. By continually adapting to both the desert environment and changing political climates, the Navajo Nation, which completely surrounds the Hopi Nation, is the largest group of American Indians in the United States, with a population of well over 300,000.

In the harsh Sonoran Desert of southern Arizona, groups like the Tohono O'odham (Papago) and Akimel O'odham (Pima) combine ancient agricultural traditions using irrigation canals with foraging for desert plants. For example, bean pods from the mesquite tree are picked and then pounded into flour, and the fruits of the saguaro cactus are collected and boiled down to make a syrup, which was also fermented and used traditionally as a ceremonial wine.

Chili peppers, a New World cultigen from Mexico, were introduced into the Southwest by the Spanish and became central to many regional cuisines.

California, Great Basin, and Plateau. Although California is known today as a major U.S. food-producing area, in the past it was home to foragers who utilized the diverse natural ecosystems of the region (e.g., their annual gathering of acorns that were processed into flour). Many groups utilized the rich coastal resources, too. This pattern ran from the Baja region in the south north to areas that overlapped with the Northwest Coast native peoples.

Native Americans from the Great Basin area survived well into the twentieth century as foragers in one of the most extreme environments that humans inhabit on earth, the Mojave Desert, including "Death Valley." Communal rabbit and grasshopper drives brought together greatly dispersed bands. A variety of desert plants were also collected. Soshonean groups in Nevada have found it difficult to maintain many of these traditions in areas where nuclear testing and uranium mining have destroyed ecosystems.

Groups from the Plateau region of the United States are located in an area that overlaps traditions from the Great Basin, Northwest Coast, and Northern Plains. The gathering and preparation of the camas tuber (*Camassia quamash*), a type of lily, links groups like the Nez Percé to their traditional foodways.

With the vast environmental diversity of these regions, mining, logging, and commercial fishing enterprises threaten the ability of many Indian nations to continue their traditional food-getting activities. Such operations not only destroy local ecosystems but areas that are considered sacred as well.

Northwest Coast. Native American fishing and whaling communities along the Pacific coast from northern California to southeast Alaska provide a unique example of sedentary foragers who utilize both aquatic and terrestrial species of plants and animals. Salmon was a central element of their diet, smoked and also processed for oils, and provided a great source of wealth for these peoples. The anadromous nature of salmon—swimming downstream to the ocean from their birthplace and then returning to it to spawn at the end of their lives—provided an abundant and predictable source of food, allowing these foragers to become sedentary dwellers along the salmon runs. Salmon continues to be economically important to these peoples.

The operation of commercial fishing fleets as an extension of their traditional food-getting activities continually places American Indians on the Northwest Coast in direct conflict with the non-Indian commercial fishing industry as well as with U.S federal agencies regarding their fundamental right, guaranteed by treaty, to secure a livelihood. A conflict over whale hunting has also emerged. Ever since gray whales were removed from the endangered species list, some groups, like the Makah, have petitioned and won the right to conduct traditional whale hunts, to the disappointment of environmental activists who have attempted to stop them. The goal for Northwest Coast peoples is not necessarily to make whale hunting a commercial enterprise, but to engage in an important food-getting activity that has great symbolic meaning in their culture.

The Northwest Coast area is also known for the potlatch (etymologically unrelated to "potluck"), a great feast and giveaway. Wealth that was accumulated—salmon oil, for example—by the elite of a community was ceremonially given away to rival villages. Although reciprocity was an important dimension of the potlatch, gaining status and the display of a family's and community's wealth was the major point of the event. As in the past, totem poles are erected to mark the greatness of a potlatch. The potlatch remains an important community event that reinforces cultural traditions through dance, feasting, and sharing.

Contemporary Diet and Nutrition Issues

Native Americans face a host of social problems (i.e. alcohol/drug abuse and violence) at levels far above the national average, and it is alarming that the rate of adult-onset (Type 2) diabetes for American Indians is over three times that of the rest of the U.S. population as a whole.

Explanations for this phenomenon have included the "thrifty genotype" model, which posits that such a genotype would have given a genetic advantage to populations who experienced periods of feast and famine. If, during periods of feasting, they were capable of maximizing their caloric intake of fat for storage, which could be tapped during times of famine, they would have a selective advantage over other populations. Greatly increased insulin production during feasting would facilitate this process. A problem occurs when the feasting, especially in the form of high-fat, carbohydrate-rich foods, becomes full-time. The result has been high rates of obesity, insulin resistance, and diabetes.

Understanding this phenomenon is a complex issue that involves changes in diet, more sedentary lifestyles, and a movement away from traditional diets and to activities that are known to be healthier. The epidemic rise in diet-related health problems like diabetes, coronary heart disease, hypertension, and obesity has been most pronounced in the decades following World War II. The promotion of an American diet and lifestyle as one of the many facets of attempting to assimilate Native Americans into the U.S. mainstream included home economics instruction for women showing them how to utilize the surplus commodities being provided to the impoverished Indian communities. Many of these foods left out a number of micronutrients available through traditional methods of processing. For example, stone-ground maize provided a good source of iron and other minerals. Ironically, the combination of commodities—highly refined white flour, sugar, and lard—are the basis of a common Indian food, fry bread. One would be hard-pressed not to find some variant of it in communities across the United States. Go to any powwow and fry bread power will be there. A variant that includes toppings like spicy ground beef and/or beans is called an "Indian taco."

In general, the daily diet of most Native Americans does not contain traditional foods or foodways. Native Americans are just as much a part of the system of foodways as everyone else in the United States. For many, their diet reflects that of other low- to middle-income families who often buy food for its bulk, not its nutritional value. This is not to say that traditional foods are not important to their Indian identity; they are. Unfortunately, for many tribes these traditions continue to fade. The recent boom in casino gambling may benefit some groups, but the future will tell if the all-you-can-eat buffets found in most casinos represent cultural revitalization or loss.

A number of tribes have started educational programs on nutrition and campaigns that extol the benefits of their traditional foods. For example, O'odham groups (Pima and Papago) of Arizona, working in cooperation with Gary Nabhan and Native Seeds/SEARCH, have been attempting to reduce their incidence of diabetes and other diet-related health problems by promoting the growing and gathering of traditional desert foods. These programs not only stress dietary change and physical activity but also emphasize the importance of cultural traditions. The history of Native American foodways shows that, when faced with challenges, Indian peoples adapt and change while maintaining their core identities. In many cases, even when the traditional language is no longer spoken or religious rituals are no longer performed, the knowledge of traditional foods has not been forgotten.

See also **Arctic; Biodiversity; Canada: Native Peoples; Foodways; Inca Empire; Inuit; Maize; Mexico and Central America, Pre-Columbian; Potlatch; South America; United States: The Southwest.**

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AMERICAS, PRE-COLUMBIAN. *See* **American Indians; Mexico and Central America, Pre-Columbian; Inca Empire.**

AMINO ACIDS. *See* **Proteins and Amino Acids.**

AMISH FOOD. *See* **United States: Pennsylvania Dutch Food.**

ANCIENT KITCHEN, THE. The traditional and symbolic heart of the home, the kitchen is inextricably linked with humankind's discovery of cooking food with fire. The use of fire has been known for over half a million years, as indicated by the remains of hearths in the Choukowtien cave in northern China. There "Peking Man" left traces of cooking around the hearth in the charred bones of numerous animals. Using fire for food preparation was a central culinary breakthrough. Some flavors are more palatable, and some foods are made edible, when cooked. The designs of hearths and ovens and the locations of kitchens through the millennia document the evolution of ancient kitchens. The English word "kitchen" comes from the Latin *coquere*, meaning to cook.

Kitchen Design

Several related and important areas were located near ancient kitchens, including the pantry, orchard, garden, spice and medicinal herb garden, larder, icehouse, and root cellar. Ancient Chinese clay models of a household show the kitchen located near or even over the pigsty. Pigs were a main source of meat, and they provided manure for fuel and a convenient place for cleaning up any refuse from cooking and dining. In the fifth century B.C.E. ancient Greeks designed the kitchen as a separate house, and the layout continued in ancient Rome. The Romans built street stalls for quick snacks, but these were not kitchens in the full sense. Most wealthy Romans also owned country property, where grapes were pressed into wine, wheat was harvested, and olives were pressed for oil. The city kitchens provided space for these products. Kitchens were planned with clearly defined preparation areas.

Later medieval châteaus and wealthy European homes had spacious kitchens with several adjacent anterooms, including a room for utensils, a pantry, cold storage, and a buttery. For the middle class, kitchens continued as a location for communal cooking, dining, and social activities. Renaissance kitchens were often elaborate. As is common of the privileged throughout the centuries, the wealthy boasted the most modern devices for cooking, storage, and food preparation, from the spit to gridirons, ewers, salvers, and huge cauldrons. The kitchen was viewed as a workshop for food preparation for daily dining and feasts and also for preservation of food for the winter months. Ottoman kitchens of the Turkish sultans in the sixteenth century provide another look at early kitchens of the wealthy. In the Topkapi palace in Constantinople, sultans' chefs had elaborate areas categorized for food preparation. European visitors were given a tour of the kitchen, which boasted eight-foot-wide cauldrons and large spits, and prepared food for thousands on a daily basis.

Nineteenth-century kitchens changed drastically with improvements in stoves and hearth designs. The kitchen remained a workplace, separate and distinct from the rest of the house. It was sometimes located in a separate building, in the basement (popular in Victorian times), or at the end of a long hallway. Temperate and hot climates alike moved kitchens outdoors. In India the Mogul kitchens were frequently located outdoors to remove the smells and heat of cooking from the living quarters. Moroccan kitchens placed cook pots in a "roofless kitchen," a walled enclosure off the pantry. Cool-climate Bulgarian homes have traditional summer kitchens used in the hot months.

Social Use

Traditionally a woman, sometimes an older relative or matriarch, has been the cook. A woman's domain, the kitchen was also the focal point for transmission of culture and teaching younger family members and apprentices. Even the use of kitchen servants in wealthy households was tied to the housewife or housekeeper. Often the main point of connection between master and servant was between the mistress of the house and the head cook. The kitchen became a meeting place between classes; long-time family cooks were often treated with the respect due family members. In segregated societies the kitchen was a connection between whites and blacks where orders and desires were given.

Kitchen Gods

In antiquity fire was sacred. A kitchen had an altar place for prayers and offerings to the kitchen god. Mexicans honor a patron saint of kitchens. The kitchen god Zaojing was revered in China, and Japanese cooks worshiped the god of fire. Similar examples abound.

Food Storage

A great range of food and foodstuffs is available for most kitchens, and the size of the kitchen or complexity of tools does not dictate the quality or complexity of the cuisine. The earliest storage containers were animal skins, woven baskets, or gourds. Pottery's introduction allowed more variety of shapes and types of storage in a kitchen, from double-walled cooling jugs for water to tripod pots for stews and pointed amphorae for wine. Thus the larder and pantry became central to the design and layout of early kitchens. Root cellars kept foods cool and available during hot months and provided an even, temperate climate for preserves in the winter. The smokehouse adjacent to the kitchen was crucial for meat and fish preservation. In Dutch homes the chimney had an ingenious bypass for the smoke, which allowed the cook to smoke meats at the same time. Ice and snow rooms in some cultures preserved food. Grapes were hung from rafters in Mediterranean kitchens and were preserved on the stem in water in glass jars in tsarist Russian homes. The many activities of preservation, canning, pickling, smoking, and drying all had places in early kitchens, as much of this work was done at home rather than in factories.

The Stove and Hearth

Early hearths were clay or stone, and their main purpose was to enclose the fire. The risk of fire was always a worry. Fireplaces provided heat and light, and the fire required tending. Large homes had deep hearths, and foods were cooked in pots placed in banked coals or ashes. Fireplaces had rotating spits and hooks for hanging large pieces of meat. Domes gave way to hoods, with better ventilation. Russian and Dutch homes in the sixteenth century raised the hearths and created a sleeping platform around the fire. Some flat-topped Russian stoves also accommodated steam baths and drying laundry.

The invention and mass distribution of the large cast-iron stove, called the "iron sow" in early Sweden, radically changed the design of the kitchen. In the 1870s oil lamps replaced the light a fire had given, and the risk of the open fire was contained. Gone was the hearth as a symbolic and aesthetic part of the kitchen, replaced by a modern tool that required less tending and less space.

As 1900 approached, families previously self-sufficient in food production began to purchase more marketed foods. By the 1930s the need for large kitchen staffs and large kitchens was reduced in most homes. The smaller stove, the increasing availability of mass-produced foodstuffs, and a changing workforce reduced the size of pantries, even eliminating the need for root cellars and smokehouses. The kitchen was streamlined with only a hint of design nostalgia. While the kitchen changed, it remained the symbolic center of the home.

See also **Ancient Mediterranean Religions; Gardening and Kitchen Gardens; Greece, Ancient; Hearth Cookery; Rome and the Roman Empire.**

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Terrie Wright Chrones

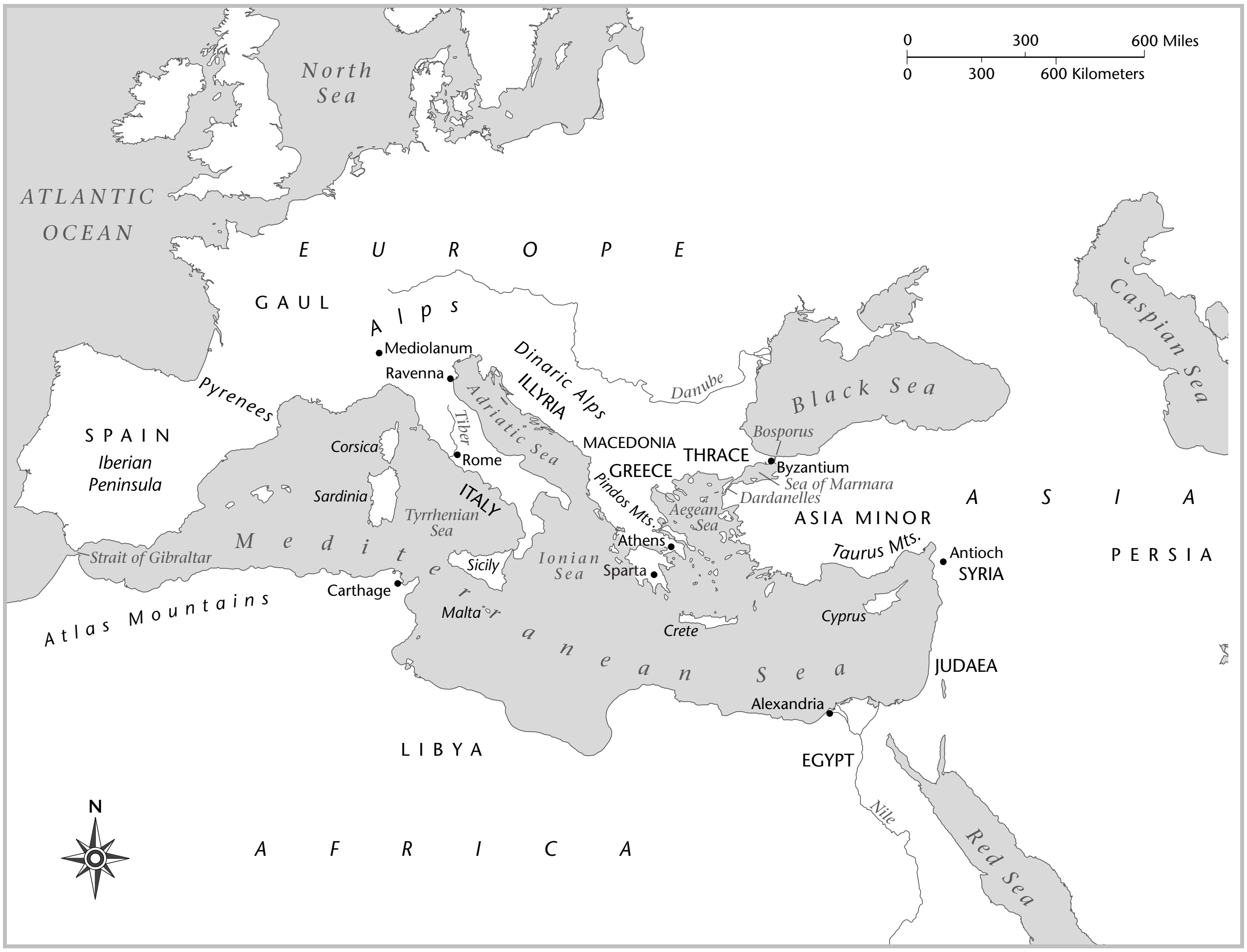
ANCIENT MEDITERRANEAN RELIGIONS.

Religion shaped both the use and conceptualization of food in the Greco-Roman Mediterranean world. This was true of the consumption of animals, cereals, and other plants. Because of the central role that food played in exchanges between gods and human beings, and between human beings themselves, food contributed to social and group identity. Ethnographers such as Herodotus distinguished Greek sacrifice from Persian, Egyptian, Scythian, and Libyan sacrifice; others distinguished Jewish and Christian rites. Ancient Greek religion located the practitioner in Greek culture and in a particular Greek community. This was important because by the end of the sixth century B.C.E., Greek cities were found around the Black Sea, along the coast of Asia Minor, in North Africa and southern Italy and Sicily—and after 300 B.C.E. in Syria, Persia, and Egypt. Similarly, as Rome came to distinguish itself from its Italic and Greek neighbors and to expand first throughout Italy and then throughout the whole Mediterranean world, it became necessary to establish how Roman culture might relate to cultures indigenous to the territory it now governed. There is ample epigraphic and literary evidence that people ate together in groups with religious affiliations throughout antiquity (*orgeones* in Greek, *collegia* in Latin), and that structures of power adapted the groups to reflect their influence, but did not greatly change the practices of eating. A major example is provided by the Ptolemys, who supported their new monarchy in Egypt after the death of Alexander by reinventing the Greek civic festival of Dionysus, with the monarch now at the center.

The basis of social and political life was the animal sacrifice, for which Prometheus supplies the most important foundation myth: he brought fire, therefore culture (in Greek thought), to mortals. Greeks and Romans slaughtered animals at altars outside the temple, with all citizens or relevant parties participating in the death and the consumption of meat. The offering to the god, combined with a communal act that reinforced equality (everyone in theory had an equal share, with special parts for the priests), provided an opportunity to eat meat. It is generally thought that in Greece little meat was eaten that had not been sacrificed. In Rome, so much meat appears to have been butchered in the imperial period that commercial slaughter may have predominated. Even in the Greek world, however, the sacred and commercial were not rigidly separated. Animals were bought for sacrifice, their skins were sold, and meat that was not distributed to participants at the temple could be taken to market and sold.

Sacrifice was a major part of many civic festivals, private associations, and family occasions. Offerings of one hundred cattle (known as a hecatomb) or more were made on major state occasions, while a piglet or lamb might be offered by a small community or family. Festivals were major occasions that shaped the civic year, and calendars specifying dates, types of offering, and the names of participants and beneficiaries survive on inscriptions and in Ovid's poem the *Fasti.*

This was the form of animal sacrifice to Olympian gods. For the gods of the underworld, the whole animal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Black Sea
Caspian Sea
Pyrenees
SPAIN
Iberian Peninsula
Corsica
Tiber
Adriatic Sea
Rome
MACEDONIA
THRACE
Bosporus
Byzantium
Sea of Marmara
Dardanelles
GREECE
Pindos Mts.
Sardinia
ITALY
Tyrrhenian Sea
Aegean Sea
ASIA MINOR
A S I A
Athens
Sparta
Strait of Gibraltar
Mediterranean Sea
Ionian Sea
Sicily
Taurus Mts.
Antioch
SYRIA
PERSIA
Carthage
Malta
Crete
Cyprus
Atlas Mountains
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was burned, and there was no consumption by human beings. Offerings of food were, however, made to the dead, and funeral feasts in their honor were eaten. The dead were also portrayed dining on couches, as they had done in life.

Cereals as well as animals played a major role in religion. They were the responsibility of the goddesses Demeter and Persephone in the Greek world, and of Ceres and other equivalents in Rome and Italy. Persephone in the related myth represented the corn. As she was abducted by Hades and later released to the upper world, so the grain is sown and sprouts in spring. The provision of grain was a major priority in all ancient states. Major festivals of Demeter were known in Sicily and Italy; there was also the Thesmophoria in many Greek cities, a festival for women only, which promoted the growth of corn and the conception of babies. (Sex and agriculture, human and plant reproduction, were often linked in Greek culture.) This festival was one of the few in the Greco-Roman world in which fasting was an element prior to feasting (in the myth, Demeter brought famine to mortals when her daughter was lost). There are a few other parallels to the formal fasting found in Judaism or the fasting to near death found in the early Christian church. Demeter also presided at the Eleusinian Mysteries, where corn (grain) and the afterlife were central concerns. Legumes were also linked with the dead, both in Pythagorean belief and in such festivals as the Roman Lemuria, while mixtures of grains and beans represented the precivilized diet in such Greek festivals as the Anthesteria and Pyanopsia.

The other major god of food was Dionysus (or Bacchus), who presided over the growth of noncereal plants. His cult was closely linked with agriculture, and his most important plant was the vine. Wine was central to the libation, the pouring of liquids to a god, which was a widespread practice in the Mediterranean world from early times and accompanied sacrifice, prayer, and many social-religious acts. The consumption of wine was circumscribed by ritual in the "symposium," where gods received drink-offerings of neat wine, and human drinking was in equal measures of wine and water, which were blended in the mixing bowl.

Animal sacrifice was complemented by nonblood sacrifices of cereals, honey, fruit, and vegetables, first fruits in particular. (The celebration of abundance, in art in particular, was often represented by the cornucopia.) Some cults specified nonblood offerings, particularly the Orphics and strict Pythagoreans, who abstained from the sacrifice and consumption of meat and fish. Less strict Pythagoreans allowed the sacrifice of some parts of some animals, since strict vegetarianism marked people as marginal and not participating in civic sacrifice.

New cults regularly arrived in the Greco-Roman world, such as the festival of Adonis, a Syrian god who died before maturity and was linked with the rapid growth of herbs and spices. Some foods rarely entered the sacred sphere. The most notable is fish. Greek and Roman authors noted the sacred fish of Syria and Egypt; in their own world, they often linked fish with luxury, since they belonged to the marketplace, and consumption was not regulated by religious constraints.

See also **Byzantine Empire; Greece, Ancient; Herodotus; Hippocrates; Mediterranean Diet; Pythagoras; Rome and the Roman Empire.**

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John Wilkins

ANCIENT WORLD.

See **Bible, Food in the; China: Ancient and Dynastic China; Greece, Ancient; Mesopotamia, Ancient; Mexico and Central America, Pre-Columbian; Rome and the Roman Empire.**

ANIMALS: PRIMATE DIETS.

The daily food quest is generally the single most important activity for any animal. For this reason, natural selection should strongly favor any feature that enhances an animal's success at food acquisition. In essence, it has been suggested that different animal species can be viewed as "natural experiments" aimed at securing some portion of the always limited dietary resources available on the planet at any one time.

Humans are members of the Primate order and are placed in the suborder Anthropoidea, along with monkeys and apes. (When speaking of Primates as an order, the word is capitalized; when speaking of primates generally, the word is lowercased.) Because of our close relationship to other anthropoids, particularly the great apes (Pongidae), the dietary behavior of wild primates is of strong interest because it can provide clues about the types of dietary problems humans may have faced and resolved in their own evolution as well as insights into the probable dietary behavior of human ancestors and the nutritional composition of their wild foods.

The Role of Diet in Primate Evolution

Most primates are highly arboreal animals and carry out most activities in the canopy of tropical forest trees. Fossil evidence suggests that the earliest Primates evolved from small insectivores, initially attracted into the canopy by pollinating insects. Many morphological traits specifically associated with Primates, as, for example, keen stereoscopic vision, manipulative, grasping fingers, and a reduced dependence on the sense of smell seem to relate to selection for features associated with the efficient capture of items such as insects in an arboreal environment. However, because insects tend to be discretely distributed in the forest canopy and are also small in size, only small and relatively solitary primate foragers can be supported on such a diet.

Perhaps to circumvent these limitations, it would appear that natural selection favored a decided change in the dietary behavior of the ancestral primate, giving rise to the anthropoids. Though insects may be scarce, any animal in the tropical forest is continuously surrounded by potential plant foods. The evolution of anthropoids appears to have resulted from some early primate's ability to penetrate the arboreal plant food niche and then radiate (diversify) such that its descendents (monkeys and apes) came to dominate a strong subset of the most nutritious and energy-rich plant foods available in the forest canopy.

The idea that monkeys and apes are basically plant eaters may come as a surprise because, when we think of plant-eating animals, primates do not generally come to mind. Rather we think of cows and horses or rabbits and kangaroos. However, a wealth of field studies on many different species of wild primate show that all extant (living) monkeys and apes take by far the greatest percentage of the daily diet from plant foods, eating small to negligible amounts of animal matter. It is fair to say that primates are omnivores (taking the diet from both animal and plant foods) because most primates do eat some animal matter each day along with plant foods, but it is important to realize that most material entering the digestive tract of monkeys and apes is of plant rather than animal origin.

Primates and Plant Foods

An orientation toward plant foods is characteristic of all anthropoids irrespective of body size. Many smaller monkeys take as much as 65 percent of the diet from concentrated plant foods such as gums and ripe fruits. For example, the smallest living monkey, the pygmy marmoset (*Cebuella pygmaea*, body weight less than 2 oz.) feeds primarily on calorie-rich plant gums and saps, supplemented with ripe fruits and insects. Larger monkeys as well as all apes take most of the diet from young leaves and fruits, supplementing these with seeds, flowers, and other plant parts, and often also eggs, insects, and small vertebrates. Orangutans and gorillas are estimated to take some 99 percent of their annual diet exclusively from plant foods—wild fruits, tender young leaves, piths, and the like—while for chimpanzees, this figure is some 94 percent. Though wild chimpanzees are known to hunt, kill, and eat small mammals, including monkeys, and also to eat termites and ants, such animal foods typically contribute only a small percentage to their annual diet, most of which is made up of ripe fruits. It is likely that many monkeys and apes would eat more animal foods if they could capture them more easily. Thus the low amount of meat in the average wild primate diet may relate more to the difficulties of getting animal food than to any aversion to eating it.

When we examine the digestive tracts of most plant-eating animals, animals such as deer, cows, or rabbits, we find that their digestive tracts show notable specializations to aid them in extracting sufficient nutrition from all of the plant foods they eat. With few exceptions, however, Primates do not show such dramatic digestive specializations—yet, Primates too are plant eaters. How are primates able to exploit plant foods successfully without the extensive digestive specializations we find in most other plant-eating animals?

Primates Solve Dietary Problems with Their Heads

The answer is simple—primates tend to specialize on only the highest quality plant foods—foods that offer the most nutrition in exchange for the time and energy invested in finding and eating them. Yet, very high-quality plant foods in the tropical canopy are bound to be less abundant than lower-quality plant foods. How then are primates able to afford the costs of their high selectivity?

To put it simply, primates use their heads. An unusually large complex brain relative to body size characterizes all primates. It is hypothesized that an unusually large brain was favored in primate evolution in part to aid in remembering the types and locations of higher quality plant foods as well as when such foods were ready to be harvested. Using their large brains, monkeys and apes can keep track of when particular important food trees are producing their nutritious new leaves or sugar-rich flowers or ripe fruits and can plan the most direct travel route to reach them at the opportune moment for harvest.

Thus primates use long-term memory and planning to lower the costs associated with seeking out the best foods in the forest canopy, and because the foods they eat are of relatively high quality, elaborate digestive specialization generally is not required to digest them efficiently. A few lineages of primates do show fairly elaborate digestive specializations. These lineages—as for example, the Colobinae or "leaf-eating" monkeys—have diets composed in large part of leaves, including many mature leaves that tend to be low in nutrients and hard to digest.

Anthropoids are also characterized by extreme sociality. Most monkeys and apes live in social groups composed of various adult females and males and their immature offspring. Each group occupies a particular area in the forest and, as a general rule, its descendents will continue to occupy more or less the same area generation after generation. For this reason, the social unit so characteristic of monkeys and apes can be regarded as a type of dietary adaptation for it enables the older individuals in the group to pass on important information to young animals about the types, locations, and seasonal patterning of the higher quality plant foods in their habitat—information essential for their survival.

Each Primate Species Has a Particular Dietary Focus

Stressing that primates are largely plant-eaters is not to imply that all monkeys and apes have exactly the same diet, for they do not. Each primate species tends to have its own characteristic mix of plant (and animal) foods. In addition, each particular species typically specializes in only a certain subset of the higher-quality dietary resources in its environment. For example, the South American capuchin monkey, *Cebus apella*, has a high degree of manual dexterity and very powerful jaws. These features aid capuchins in cracking open the hard palm nuts that form an important part of their diet, which also includes ripe fruits, insects, and small vertebrates. Another monkey species often found living in the same forests as *Cebus apella* is the spider monkey, *Ateles paniscus*. Spider monkeys are characterized by a low degree of manual dexterity and small teeth, which are useless for cracking hard-shelled palm nuts. But spider monkeys specialize in soft fruits and tender young leaves, not hard palm nuts. They are also much bigger than capuchin monkeys, and if the supply of softer fruits is limited, they can chase capuchin monkeys out of fruiting trees and monopolize the fruit crop for themselves.

The Role of Diet in Human Evolution

As discussed, the closest living relatives of humans, the great apes, all eat plant-based diets. The common ancestor giving rise both to apes and humans is likewise believed to have been primarily plant-eating. All humans and apes have the same basic digestive tract—a simple acid stomach, a small intestine, a tiny cecum, and a sacculated (folded) large intestine (or colon), though the human small intestine is longer and the human colon smaller than is the case for apes. Humans and apes also show the same pattern of food digestion, indicating that, biologically, in terms of gut form and function, humans have departed little from the ancestral condition. But, unlike apes, humans eat a wide range of different foods and have many different types of diets. What factors may have contributed to this difference between humans and apes?

Some 3 million years ago, before the first evidence of human beings, we know that climatic changes caused the vegetation in many areas of Africa to shift from tropical forest to more open savanna vegetation. This produced notable changes in the types of plant foods available in these environments. In particular, finding sufficient high-quality plant foods throughout the year probably would have been difficult for a large apelike primate such as those we envision as prehuman ancestors. One solution to this problem would be to try and find some other source of high-quality food. Animal foods are such a source: they are very high quality and, because of the huge herds of grazing and browsing animals in the African savanna, animal foods are far more abundant than is the case in the tropical forest canopy.

The association of stone tools with the earliest fossil evidence for human beings (genus *Homo*, species *Homo habilis*) suggests that early humans began to include animal as well as plant foods in the diet. Rather than just being an occasional food, as is the case for chimpanzees or other apes, meat and other animal products (tongue, bone marrow, brains, fat) appear to have become an integral part of the daily human diet. Initially, the earliest humans may have lived as scavengers and relied on meat from kills abandoned by carnivores. But increasing numbers of stone tools and processed mammal bones in the archaeological record suggest that humans gradually turned to the hunting of larger animals.

Animal protein is of high quality and easy for humans to digest. It also is a rich source of many essential vitamins and minerals. In addition, and most importantly, animal foods are volumetrically concentrated relative to plant foods and thus take up much less space in the feeder's gut. By eating some meat each day and combining this animal food with energy-rich plant foods, humans evolved as large-brained, active, and social hunter-gatherers. The fossil record shows that the human brain increased substantially over the course of human evolution. It would seem that, initially, the earliest human ancestors were somehow able to include a modest amount of animal food in the diet on a routine basis along with their usual plant foods. But these animal foods provided much high-quality nutrition and also freed up space in the gut for energy-rich plant foods, thus improving the feeder's diet in terms of both nutrients and energy. This energy was required to fuel the increasingly large human brain, which requires glucose as fuel. More astute individuals doubtless were more proficient at securing animal foods as well as energy-rich plant foods and they passed these mental abilities on to their descendents. Over time, this feedback process resulted in the gradual expansion of the human brain.

Humans as Cultural Omnivores

The evolution of humans actually follows the common primate trajectory—that is, using brain power to resolve many important dietary problems. Morphologically, humans lack the huge jaws, massive teeth, and sharp claws of true carnivores. But their increasingly large and complex brains permitted early humans to substitute technology for carnivore teeth and claws and use tools and creative intellectual solutions to capture and prepare their animal and plant foods for consumption.

In addition, early humans developed a unique form of food acquisition characterized by a division of labor. Typically, male members of the social unit sought animal prey while female members sought out higher-quality plant foods. Then all of the foods collected each day were shared with all members of the social unit, giving each person a good mix of all of the different nutrients required to remain in good health. By entering the adaptive zone of culture—cultural behavior made possible by virtue of the unusually large and complex human brain—humans gradually developed the capacity to exploit dietary resources of all types in ways not possible for any other animal. The success of this uniquely human form of dietary behavior is manifested by the fact that over time, by using their wits to devise successful diets, humans have been able to colonize almost every environment on earth. As long as all of the nutrients humans require are present in their foods, humans can thrive on an amazing variety of different diets.

See also **Agriculture, Origins of**; **Anthropology and Food**; **Cuisine, Evolution of**; **Evolution**; **Food Archaeology**; **Hunting and Gathering**; **Nutritional Anthropology**; **Paleonutrition, Methods of**; **Prehistoric Societies**.

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ANOREXIA, BULIMIA. Anorexia nervosa (AN), bulimia nervosa (BN), and Eating Disorder Not Otherwise Specified (EDNOS) are three of a spectrum of conditions, commonly known as eating disorders, associated with abnormal eating patterns and a desire to be thin. The abnormal eating patterns in these eating disorders include restriction of food intake, binge eating, and purging with laxatives or by self-induced vomiting. Persons with each of these disorders may go through periods of restriction, binge eating with purging, and binge eating without purging.

The term "eating disorders" for these conditions is both correct and misleading. These disorders center around issues of eating, or, to be more exact, food consumption, and certainly can be qualified as disorders, but more than eating is disordered in these conditions: they are associated with a complex of psychological, physiological, neurological, and hormonal changes, which may be due to the disease itself, or to the changes in weight associated with inappropriate food intakes and energy outputs, or both together.

The notion that thinness is desirable, particularly in women, and that one can never be "too rich or too thin," now permeates Western societies and is becoming increasingly common elsewhere. Teenagers, who are normally preoccupied with body image, and prone to be concerned about gaining weight, may incorrectly perceive themselves as being overweight, because puberty coincides with marked changes in body shape and, for girls, increased body fat content with fat deposition in the hips. Surveys in Western countries have shown that at any one time, up to two-thirds of female high school students either are on a weight loss diet or were on one in the recent past. In the United States, eating disorders seem to be less common among African-American and Asian females than among white females, equally common among Latina females, and surprisingly common among Native Americans. Japan seems to be the country with the highest prevalence of eating disorders. Other countries seem to be catching up, wherever there is access to food and to Western modes of behavior, as exemplified in the media.

Psychological conditions associated with eating disorders include depression, affecting 50–75 percent of people with eating problems; bipolar disorder (manic-depressive illness, 4–15 percent); obsessive-compulsive disorder, affecting as many as 25 percent of people with AN, fewer in those with BN; substance abuse, in up to one-third of patients with BN; and personality disorders, particularly avoidant, in other words, mistrusting, personality. Twenty to fifty percent of patients with BN (and to a lesser extent patients with AN and other eating disorders) have experienced sexual abuse.

A syndrome called "the female athlete triad"—consisting of disordered eating, amenorrhea (disruption of menses), and osteoporosis—is becoming more common as athletic prowess has become desirable for women and as women have better access to athletic facilities in the United States because of Title IX of the Educational Assistance Act (1974). Patients with Type I diabetes mellitus appear to be more prone than the general population to eating disorders, and may use underdosing with insulin to lose weight—when they do not take enough insulin, the body fails to use and store the calories they eat and relies on breakdown of fat and muscle for fuel.

Patients with eating disorders may become parents, may have difficulties nurturing their own children, and may transmit disordered attitudes toward eating to their children. The health care team should take these difficulties into account in treatment plans for both parent and child.

Anorexia Nervosa

Anorexia nervosa (AN) represents an extreme version of the desire for thinness. The term "anorexia" is a misnomer, for a person with this condition does have an appetite, but restricts food intake and denies the desire to eat with the apparent aim of having precise control over body shape and weight. Perhaps the German *Pubertätmagersucht*—"seeking thinness at puberty"—is a more accurate term, although the disorder has antecedents in childhood and continues into adulthood.

Epidemiology. In the United States, nearly 90 percent of patients with overt, clinically recognized AN are females between the ages of twelve and twenty-three, although younger and older patients as well as males may also develop the disease. The prevalence of AN appeared to rise during the twentieth century, with a lifetime risk among women of 0.5 percent to 3.7 percent and a male to female prevalence ratio between 1 to 6 and 1 to 10. The prevalence among young adolescent males is higher, perhaps reflecting a secular trend or an increasing emphasis on male appearance and "fitness."

The only groups among whom the disease has been recognized are groups who have easy access to food, and among whom being thin is a socially desirable state. However, conditions clinically indistinguishable from AN have existed in Western cultures prior to the twentieth century, particularly during the late Middle Ages and Renaissance, when they were associated with religious asceticism—the professed goal was to demonstrate the person's ability to deny the needs and pleasures of the flesh, rather than to be thin for social acceptance. Similar conditions associated with religious practices also occur in other cultures.

Etiology. Scientific opinion concerning the etiology of AN has vacillated between a biological and genetic explanation and a sociopsychological one. The patient's complaints lie in the psychological realm, while the disease presents features that point to biological and genetic components. There is a significantly higher concordance of anorexia nervosa among monozygotic twins (identical, that is, having the same genes) than among dizygotic twins (fraternal, that is, genetically only as close as a nontwin sibling). Family members have a higher than expected prevalence of other affective (emotional) and addictive disorders.

A host of neurohormonal changes appear once starvation has set in, but it is unclear which of these changes are causal, which are due to progression of the disease, and which are due to semistarvation. A reasonable explanation for the condition is that the person first restrains eating or performs excessive exercise for psychosocial reasons, and then develops a biologically driven self-perpetuating condition.

Development, signs, symptoms and biological findings. Anorexia nervosa develops in three phases, often preceded by picky eating and digestive problems in childhood. In Phase I the patient develops an increased consciousness about physical appearance, coupled with a loss of self-esteem, and begins dieting and exercising to lose weight. While these beliefs and behaviors have become increasingly the norm among adolescent women in developed countries, in certain people it progresses to Phase II.

Diagnostic Criteria for Anorexia Nervosa (Diagnosis Number 307.1)

A. Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than 85 percent of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85 percent of that expected).

B. Intense fear of gaining weight or becoming fat, even though underweight.

C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.

D. In postmenarcheal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, e.g., estrogen, administration.)

Specify type:

Restricting Type: during the current episode of anorexia nervosa, the person has not regularly engaged in binge-eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).

Binge-Eating/Purging Type: during the current episode of anorexia nervosa, the person has regularly engaged in binge-eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).

SOURCE: American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders,* 4th ed. Washington, D.C.: American Psychiatric Association, 1994.

During Phase II (frank AN) the person develops an "anorectic attitude": an unreasonable fear of eating coupled with pride in the ability to loss weight. Restriction of food intake begins with "fattening," "dangerous" foods such as carbohydrates and fats, while other foods, particularly vegetables, are viewed as "safe." In an effort to rationalize their restrictions, patients may develop a sophisticated fund of nutritional knowledge. They may delude parents or other caretakers into believing that they are eating when in fact food may be hidden or vomited up. Patients may also become obsessed with preparing foods, which they then refuse to eat. Some patients may have episodes of binge eating with or without purging in addition to restriction. Patients with this form of anorexia nervosa are more likely to be depressed, suicidal, and self-harming.

Patients may persist in the belief that they are eating a lot when in fact they eat very little. Sensations of hunger and satiety are impaired, with the result that these two states become confused. Further, delayed gastric emptying due to developing malnutrition may contribute to the perception of fullness after consumption of only small amounts of food. Eventually the person may reject all or nearly all foods.

The "anorectic attitude" may be self-amplifying, in that starvation itself may lead to abnormal attitudes towards food. Semistarved persons who are otherwise in good health also develop an obsession with food, linger for hours over a meal, and may feel that once they start eating, they will not be able to stop. For persons with AN, the thought that they may not be able to stop may be a terrifying prospect, confirming their worst fears about their inability to control their appetite.

The types of food that a person with AN likes appear to be normal when ascertained by questionnaire; however, a dislike for high-fat and low-carbohydrate foods is revealed. Taste testing suggests that persons with AN have an abnormally high preference for highly sweet tastes, coupled with a dislike of fatty foods. In this phase, the person may use laxatives and enemas, in the belief that these procedures will prevent absorption of ingested food, and also because anorexics may judge themselves to be constipated since the severely reduced food intake leads to formation of smaller than normal amounts of feces. Laxatives and starvation-induced changes in gut motility lead to both constipation and complaints of abdominal pain. Patients may abuse diuretics in an attempt to lose weight, although their effect is confined to water weight loss.

Patients may participate in extreme physical activity, preferably carried out alone, although it may be expressed in organized group activities such as ballet or athletic performance. This physical hyperactivity is in direct contrast to the inactivity seen in starving subjects without AN.

Depression, anxiety, obsessional traits, perfectionism, and rigidity in thinking are all found in patients in Phase II of AN. The states are often associated with social isolation.

During Phase II, nutritional status may deteriorate steadily, and if untreated, patients may not enter the recovery phase, Phase III. Death may occur from cardiovascular collapse due to starvation and electrolyte imbalance, or due to too rapid refeeding, as well as suicide. As many as 5 percent of patients may die of AN in the acute phase, and 20 percent on long-term follow-up—the highest mortality rate for a psychiatric condition.

Phase III of this disease, which is attained only with difficulty, and in some cases not at all, is the acknowledgment by the patients that they have starved themselves, and need treatment, coupled with success at alleviating the signs and symptoms of the disease.

Management. The management of anorexia nervosa is complex, requiring a concerted effort on the part of the health care team, including physician, nurse, nutritionist, social worker, and psychologist, as well as the patient and his or her family. Because patients are capable of maintaining a state of denial, it is very difficult to engage the patient into the care process. Often the patient has to be in a state of collapse before intervention is even tolerated. Indications for hospitalization are weight loss below 40 percent of normal weight; orthostatic hypotension (low blood pressure when standing); electrolyte (sodium, potassium) imbalance; dehydration; hypoglycemia (low blood sugar); infection; and marked family disturbance.

Treatment involves refeeding and psychological rehabilitation. Refeeding is critical for all patients whose weight is 85 percent or less of that expected. Depending on the severity of the patient's malnutrition, feeding may occur in the hospital, in a clinic setting, or at home. The patient should be hospitalized well before collapse is imminent. Feeding may be oral, naso-gastric, or via intravenous lines. Oral feeding is preferred but some patients may only permit refeeding if it is through a naso-gastric tube, and thus beyond their control. Intravenous feedings may be required if cardiovascular collapse is imminent. No special diets are needed, although concentrated foods may be useful in attaining adequate caloric intakes, and vitamin and mineral supplements are required. Refeeding must be slow, and performed under close medical monitoring, lest the patient develop edema and increased circulating blood volume, which can lead to electrolyte imbalances, anemia, and cardiovascular collapse. Other fatal complications of rapid refeeding include acute stomach or large bowel dilatation. Treatment protocols may also include restriction of exercise, in order to prevent the patient from exercising away the calories. Some patients are adept at finding ways to increase physical activity in the face of exercise restriction, and some patients may become severely agitated when denied the right to exercise.

Psychological treatment varies by health care team and may combine individual, family, and group therapy. Drug therapy may be used, particularly selective serotonin reuptake inhibitors (SSRIs), especially in patients who have regained weight but still are depressed or have obsessive-compulsive symptoms.

The ideal of clinical improvement consists of a return to 90 percent of normal weight, the resumption or initiation of menses in women, normalization of eating patterns, as well as the development of a mature, self-confident outlook, with a normal body image. Few patients attain this ideal. However, the short-term prognosis with respect to weight gain, return of menses, and improvement in outlook is usually good, although the food obsession and inability to control appetite may persist for weeks to months after the patient has regained an adequate amount of weight.

Unfortunately, the long-term prognosis is not so favorable: On the average, about 40 percent of patients recover more or less completely, 27 percent have ongoing endocrine abnormalities or are mildly underweight, 29 percent have a serious recurrence of the disease within a four-year period, and up to 5 percent succeed in starving themselves to death. Those who are over twenty, have prolonged illness, are depressed, have a family history of mental disturbance, have poor family relationships, who use purgatives and diuretics and who follow binges with vomiting have the worst prognosis.

Bulimia Nervosa

People with bulimia nervosa (BN) have recurring irresistible urges to consume extremely large amounts of food at one sitting (binge). The binge leads to acute feelings of gastric distension, and to sharpening of the fear of becoming fat. To relieve both problems, patients may then proceed to self-induce vomiting or purging. Persons with this condition report a sense of "cleaning out" with vomiting and purging, which may positively reinforce these behaviors. Note that binging without purging comes under the rubric of Eating Disorders Not Otherwise Specified (EDNOS), according to the Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (DSM-IV), and is described below.

Precipitants of a binge include hunger, being alone, feelings of anxiety, frustration, and worthlessness, and problems with a significant other.

Epidemiology. Like AN, BN primarily afflicts young females from food-rich backgrounds. Its prevalence is unknown because only the most severely affected come to health care. Estimates of the disorder vary from 2.5 to 20 percent of women and 1 to 5 percent of men from the ages of eighteen to twenty-one.

Etiology. The etiology of BN remains unknown. Causes may include a biological predisposition to obesity, depression, and metabolic disturbances (in particular neurohormonal abnormalities, such as abnormalities in the release of gut hormones after eating), coupled with a socially determined desire for thinness, and with bingeing and purging as a group activity, a phenomenon which is becoming increasingly common among women living together, for example in a sorority, or men as part of a team, for example wrestlers.

Diagnostic Criteria for Bulimia Nervosa (Diagnosis Number 307.51)

A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:
   (1) eating, in a discrete period of time (e.g., within any 2-hour period) an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances
   (2) a sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating)

B. Recurrent inappropriate compensatory behavior in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or excessive exercise.

C. The binge eating and inappropriate compensatory behaviors both occur, on average, at least twice a week for three months.

D. Self-evaluation is unduly influenced by body shape and weight.

E. The disturbance does not occur exclusively during episodes of anorexia nervosa.

Specify type:

Purging Type: during the current episode of bulimia nervosa, the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas.

Non-Purging Types: during the current episode of bulimia nervosa, the person has used other inappropriate compensatory behaviors, such as fasting or excessive exercise, but has not regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas.

SOURCE: American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders,* 4th ed. Washington, D.C.: American Psychiatric Association, 1994.

Families of BN patients have a high prevalence of disorders such as major depression, irritable bowel syndrome, obsessive-compulsive disorder, attention deficit disorder with hyperactivity, and migraine, all of which have been linked to abnormalities in the function of neurotransmitters (chemicals such as norepinephrine and serotonin responsible for sending messages from one nerve cell to the next) in the brain. Levels of monoamine oxidase (MAO, an enzyme responsible for degrading norepinephrine and serotonin) in the blood cell clotting fragments called platelets are lower than normal in a person with BN. Low activity of MAO has been associated with impulsiveness, intolerance of boredom and monotony, and sensation seeking, also commonly seen in bulimic individuals. SSRIs, specifically fluoxetine, which increase

TABLE 1

Physical signs and symptoms associated with anorexia nervosa and bulimia nervosa

	Anorexia nervosa	Bulimia nervosa
Body weight	Usually below normal	May be below normal, normal, or above normal
Skin and hair	Dry skin; lanugo (soft down-like hair overgrown on limbs, nape of neck, and cheeks); yellowing of skin (but not whites of eyes) due to excessive consumption of carrots and other carotene containing vegetables	Scratches on the dorsum of the hand due to rubbing of the hand against the upper teeth during self-induced vomiting
Teeth	Increased caries due to acid erosion, if patient vomits frequently	Carious due to acid erosion, if patient vomits frequently
Water and electrolytes	Low blood potassium, due to vomiting; low blood sodium due to use of laxatives	Low blood potassium due to frequent vomiting
Bones	Osteoporosis leading to irreversible vertebral collapse, due to lack of estrogen, and to reduced consumption and to malabsorption of minerals and fat soluble vitamins	Incidence of osteoporosis variable
Amenorrhea	Characteristic	Variable
Brain	Brain damage in long-term disease, which may be irreversible	Unknown
Gastro-intestinal tract	Slow gastric emptying and slow intestinal transit time, due to starvation	An enlarged stomach with stomach cramping, leading to digestive difficulties; esophageal irritation, due to regurgitation of stomach acid; dysmotility of the esophagus (poor coordination of esophageal movement); slow stomach emptying; injury to the nerves in the gut wall, leading to permanent loss of bowel reactivity; constipation and diarrhea.
Metabolic rate	Reduced	Mildly reduced
Body temperature	Reduced, with difficulty maintaining a steady body temperature in cold or warm conditions; an occasional patient has an elevated metabolic rate	Variable
Cardiovascular system	Hypotension (abnormally low blood pressure); bradycardia (slow heart rate); decreased heart size and cardiac output	Variable, depending on body weight; if body weight is low, the signs are similar to those seen in Anorexia nervosa.
Blood	Anemia and leukopenia (low white blood cell count) due to inadequate mineral intake and to starvation	Anemia, due to frequent small upper gastrointestinal tract bleeds, leading to iron loss
Causes of death	Cardiovascular collapse, suicide	Cardiovascular collapse, suicide

responsiveness to endogenous serotonin, are moderately effective in treatment of BN. Abnormalities in other hormones and neurotransmitters, including cholecystokinin (CKK), which is released in response to fat in the intestine and depresses appetite, neuropeptide YY, which is involved in activating appetite, and leptin, are under investigation.

Development, diagnosis, and clinical manifestations. The phases of development of BN are far less clear than those of AN, though, as children, patients with this condition may have had pica (the consumption of nonfood items such as dirt or paint chips), and may have suffered through mealtimes in which there was a great deal of commotion and distress. Some bulimics have been severely abused physically, sexually, or both and may show signs and symptoms of post-traumatic stress disorder, including multiple personality disorder.

It is difficult to determine when bingeing becomes an overt pathological state. Binge episodes may vary from several times daily to once a month or less, and 20 percent of female college students are estimated to have participated at least once in a binge-purge episode.

A binge-purge episode starts with a craving for high-calorie food, usually those high in carbohydrates and fat but low in protein, particularly junk food, which does not have to be cooked. The food is obtained and consumed at one sitting. Thus, a patient may consume a box of cookies, a bag of doughnuts, and a half-gallon of ice cream in a single binge. The binge may then be followed by self-induced vomiting, and/or laxative use. Binges and purges most often occur in private, although there is an increase in group binge-purge episodes among young people who live in communal settings, for example in boarding school or in college. The frequency of episodes increases with increasing stress. Some patients may fast between episodes of bingeing, and may in fact have the binge-eating/purging form of AN. Other patients may binge without purging.

In BN, eating patterns outside a binge-purge episode are usually characterized by a degree of restrained eating. Nevertheless, when bulimics perceive that they have "violated" the restraint, that is, eaten more than "allowed," they will eat more than a normal person in a test meal situation. Increased postmeal hunger is also experienced by individuals with BN. The restrained eating may therefore be the result of conscious attempts to compensate for the inability to feel satiety, and may be a mechanism for maintaining normal weight in the face of episodes of great hunger and craving. Patients have larger than normal stomachs, which results in both slower than normal stomach emptying and failure to sense fullness, due to excessive relaxation of the stomach, and lower than normal levels of the hormone cholecystokinin (CCK) after a meal. CCK is produced in the intestinal tract in response to fatty food, and signals to the brain that the person has eaten enough. As a result of these changes, the person may fail to be aware of satiety. It may be that once binge-purge episodes have begun, these anatomical and physiological changes will amplify the perceived need to binge, and the consequent need to purge.

In taste tests, persons with BN have a higher than normal preference for very sweet and very fatty foods. Normally, the more a person eats of a sweet food at a single sitting, the less pleasant it becomes. Bulimics may not experience this decrease in pleasantness, as a result of which they may be able to eat large amounts of highly sweet food.

The hypothalamus normally senses when blood glucose levels have risen following food ingestion, which also contributes to the feeling of satiety. Persons with BN appear to have mild insulin resistance, which may prevent their hypothalamus from sensing that rise in blood glucose levels.

Persons with BN are less likely than persons with AN to have a distorted body image, though persons with BN do express an overvaluation of thinness and a fear of becoming overweight. A person with BN may be depressed and agitated, but, unlike a person with AN, usually does not participate compulsively in physical activity.

The most striking complaints and physical and biochemical findings regarding BN are related to the frequent vomiting (Table 1). The ability to taste with the palate may be destroyed due to the stomach acid, although taste by the tongue is little affected. Whether these taste changes contribute to bingeing is unknown.

Management. Bulimia nervosa requires long-term, continuous, nonjudgmental psychological management, nutritional counseling, and rehabilitation, and may include medications, particularly SSRIs. Cognitive behavioral therapy approaches that redirect the person's attention away from food and eating, and which address the person's other psychological problems, are the most successful. Patients may have other conditions, such as drug abuse or personality disorders, which need to be addressed before the eating disorder. Both depressed and nondepressed patients with BN may benefit from medications such as SSRIs. These drugs may help with interpersonal functioning, mood, and anxiety symptoms.

Diagnostic Criteria for Eating Disorder Not Otherwise Specified (Diagnosis Number 307.50)

The Eating Disorder Not Otherwise Specified category is for disorders of eating that do not meet the criteria for any specific Eating Disorder. Examples include

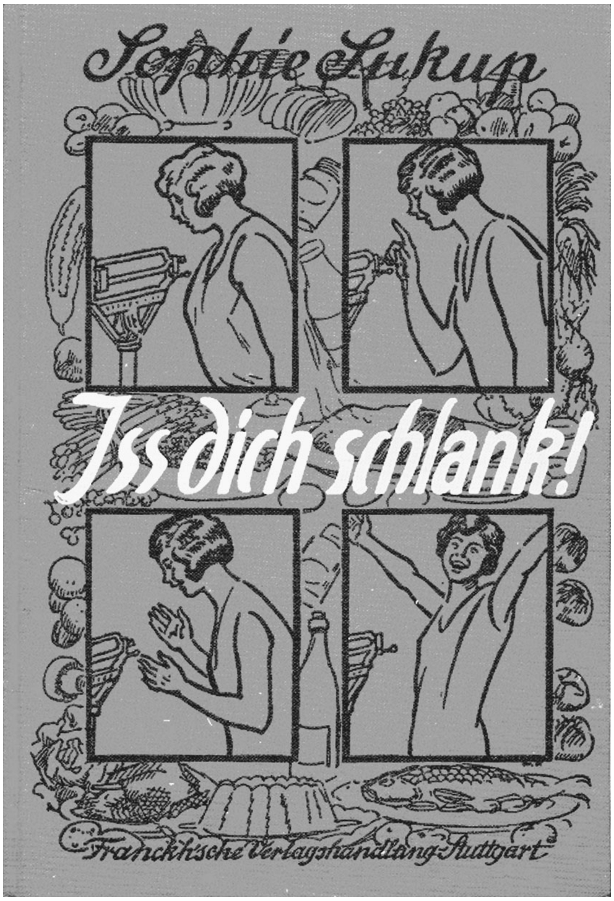
1. For females, all of the criteria for anorexia nervosa are met except that the individual has regular menses.
2. All of the criteria for anorexia nervosa are met except that, despite significant weight loss, the individual's current weight is in the normal range.
3. All of the criteria for bulimia nervosa are met except that the binge eating and inappropriate compensatory mechanisms occur at a frequency of less than twice a week or for a duration of less than 3 months.
4. The regular use of inappropriate compensatory behavior by an individual of normal body weight after eating small amounts of food (e.g., self-induced vomiting after the consumption of two cookies).
5. Repeatedly chewing and spitting out, but not swallowing, large amounts of food.
6. Binge-eating disorder: recurrent episodes of binge eating in the absence of the regular use of inappropriate compensatory behaviors characteristic of bulimia nervosa.

SOURCE: American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders,* 4th ed. Washington, D.C.: American Psychiatric Association, 1994.

Eating Disorder Not Otherwise Specified

Eating Disorder Not Otherwise Specified (EDNOS) is the term applied to conditions that have some characteristics of the classic eating disorders AN and BN, but which do not meet all the diagnostic criteria outlined in the DSM-IV. Multiple combinations of signs and symptoms are possible, as noted in Table 1. Persons who abuse weight-reduction medications and other regimens, and who are trying to lose large amounts of weight for reasons of beauty rather than health, as well as persons with binge-eating disorder, also fall under this rubric, as do people who use disordered eating behaviors in an attempt to correct the size of what they perceive as abnormally large (or abnormally small) body parts.

Binge-eating disorder is characterized by binges that are not followed by efforts to get rid of the extra calories. It is estimated that about 2 percent of the general population suffers from this condition, with a male to fe-



Sophie Sukup's *Iss dich schlank!* (Eat Yourself Thin!), published in Stuttgart, Germany, in 1927, promised overweight readers that they could get immediate results by eating the fat away. The cover design of the book makes it clear that the new ideal physique is no longer that of the Rubenesque maiden of pre-1918 Germany. ROUGHWOOD COLLECTION.

male ratio of 1 to 3, in contrast with frank bulimia nervosa, where the proportion is closer to 1 in 6. Because people who have this disorder do not vomit or purge, they are often obese; they compose about a third of the patients visiting weight reduction clinics. They also may have body image dissatisfaction, low self-esteem, and depression. Active psychotherapy can reduce binge frequency, but once therapy is discontinued, relapse rates are high, and weight lost due to the decrease in binge frequency is often readily regained. Approaches that emphasize self-acceptance, improvement of body image, and better overall health, rather than focusing on weight loss, appear to have the best long-term success rate. It is likely that similar approaches may be effective for people who abuse weight-loss regimens.

See also **Aversion to Food**; **Body**; **Body Composition**; **Caloric Intake**; **Eating, Anatomy and Physiology of Eating**; **Fasting and Abstinence**; **Hunger, Physiology of**; **Obesity.**

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Virginia Utermohlen

ANTHROPOLOGY AND FOOD. What distinguishes the anthropological study of food from that of other disciplines is its focus on food within a cultural and often cross-cultural context. Anthropologists study humans and human culture across space and evolutionary time; this includes the study of their own culture and social institutions. Subfields of the anthropological study of food include cultural, linguistic, biological, and archaeological anthropology. Research in nutritional anthropology cuts across these subfields. Food requires hunting, gathering, growing, storage, distribution, preparation, display, serving, and disposal, all of which are social activities. Topics for the anthropological study of food within a cultural system include economy, inequality, gender, status, hunter-gatherers, and food as a symbol.

Of basic interest to archaeologists is the diet or subsistence pattern of the peoples they study. Since seasonal patterns of movement are often linked to subsistence regimes, archaeologists frequently study the overall settlement-subsistence pattern. Other major topics of study related to food are the origins of agriculture, the process of plant and animal domestication, and the study of foodways (food in a social and cultural setting). With the help of interdisciplinary teams of specialists, archaeologists examine a variety of evidence such as animal bones (faunal analysis or zooarchaeology), plant remains (paleoethnobotany or archaeobotany), human bones (osteology), residues (chemistry), and the settlement system. Faunal and paleoethnobotanical analyses are able to determine diet (which animals and plants were eaten) as well as hunting, gathering, butchering, and preparation techniques, the identity of preferred or high-status foods, the seasonality of site occupation and diet items, and whether the animals/plants were domesticated. The phrase "You are what you eat" is true in that what you eat forms the

The !Kung hunter Gumtsa digs up a plant for food. The !Kung peoples live in the Ngamiland District of Botswana. Their primitive lifestyle and simple foodways are of great interest to anthropologists. © Peter Johnson/CORBIS.

bones and organs in your body, leaving behind chemical signatures. Human bones reflect the general health and nutrition of the individual, and may be chemically analyzed to reveal diet through isotopic (heavy element) or chemical signatures.

Biological Anthropology

Topics in biological anthropology range from biological and nutritional questions about humans and primates (e.g., questions of nutrition, health, and evolution of human and primate physiology and diet) to cultural practices and choices that affect biology and nutrition (e.g., dietary strategies and food selection choices). Cross-disciplinary themes include the process of human adaptation, population variation, and health. In many societies, medicine is not distinguished from food. Human digestive systems, the substances upon which humans feed, and medicinal natural substances are closely intertwined and are the result of a co-evolution.

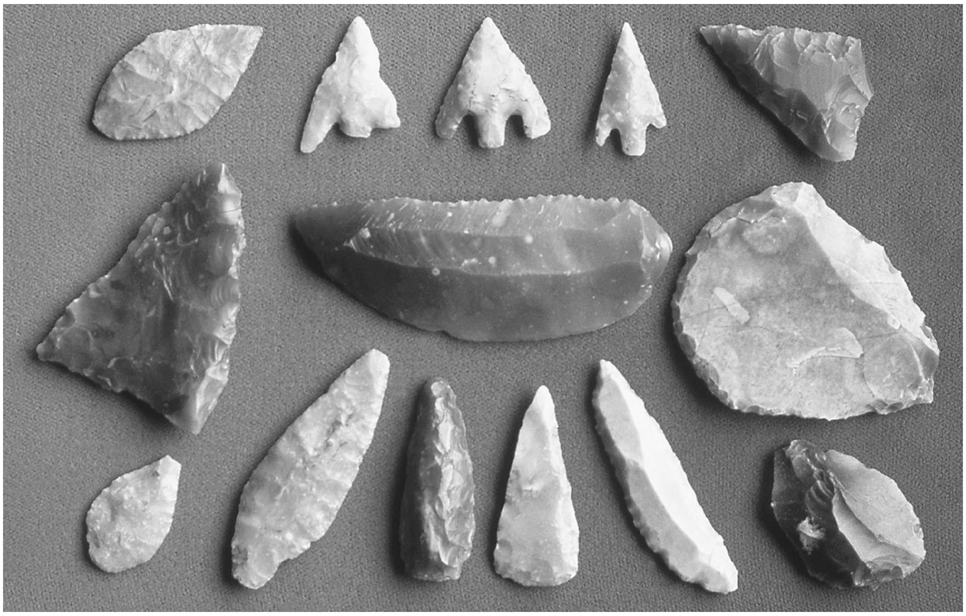
ARCHAEOLOGICAL FOODWAYS

Foodways is a subdiscipline of cultural anthropology that studies food in its social and cultural setting. Foodways studies were pioneered in the 1990s by archaeologists who study hierarchical, stratified societies in the southeastern United States. A foodways approach combines studies of food remains, the ceramic vessels used to prepare and serve food, and other aspects of the food system with settlement patterns to answer questions about cultural change and the production, storage, distribution, preparation, and serving of food within social contexts. Two examples illustrate the cultural richness that such research may provide. In her study of the people who lived in the central Mississippi River Valley between 500 and 1100 C.E., Sissel Johannessen examined multiple lines of evidence to understand the relationship between shifts in diet and social changes. Her work combines summaries of internal community patterning, food storage facilities, paleoethnobotanical remains, and ratios of different types of ceramic vessels and sets them within the six-hundred-year period during which this farming society adopted maize agriculture. Johannessen documented how change in diet, accompanied by changes in food production, distribution, storage, and consumption, reflected a basic shift in social interaction and people's perception of their place in the world. They went from living as isolated families in the sixth century to group solidarity and affiliation with mound centers. As the locus of power shifted from household to center, food storage shifted from household pits to above-ground granaries, and greater variation arose in the ways food was cooked and served.

Another example is the study by Paul D. Welch and C. Margaret Scarry, who used a foodways approach to examine the intricacies of the social relationships within a chiefdom in the southeastern United States dating between 1050 and 1550 C.E. The ratios of food processing by-products (maize cobs and nutshells) and food consumption evidence (maize kernels) differ between low-status (farmstead) and high-status (civic/ceremonial mound center) locations, as do the types and cuts of meat and the ratios of cooking to storage or serving vessels. Furthermore, analysis of the ceramic vessel ratios from the various locations allowed distinction between types of high-status activities.

Linguistic Anthropology

Linguistic anthropologists study human perception and communication, finding a close connection between how



These prehistoric flint tools were used for hunting and preparing food. © Maurice Nimmo; Frank Lane Picture Agency/CORBIS.

people perceive their world and the structure of their language. The field of folk taxonomy recognizes regularities in how humans perceive and categorize their natural world. A society's closeness to nature and sources of food will be reflected in how finely they are able to categorize plants and animals, and more salient plants and animals will be marked linguistically. Linguists who study folk taxonomy usually consider themselves ethnobotanists or ethnobiologists (see below).

Cultural Anthropology

Cultural anthropologists pioneered the method of ethnographic data collection wherein the anthropologist lives among and participates in the daily life of the native culture over a period of months or years. Ethnographers attempt to situate the study of food within a community or culture, seeking to explain the interrelation between food systems and human behavior. Frameworks for the study of food include but are not limited to economy, political economy, cultural ecology, inequality, gender, ethnicity, households, policy formulation, biodiversity, hunter-gatherers, urbanization, and food as symbol. Cross-cultural research compares food and food systems in different cultures, most recently through multisited studies.

Ethnobotany and Ethnobiology

Ethnobotany (study of the relationships between plants and peoples) and ethnobiology (study of the relationships between living organisms and humans) draw on the resources of each of the subdisciplines of anthropology as well as from other fields such as chemistry, botany, pharmacology, zoology, entomology, engineering, and so on. A major concern of these disciplines is intellectual property rights—who should be compensated, and how they should be compensated, for sharing their traditional knowledge about plants and animals or for sharing the results of breeding plants or animals.

See also **Agriculture, Origins of**; **Ethnobotany**; **Ethnopharmacology**; **Food Production, History of**; **Foodways**; **Nutritional Anthropology**; **Paleonutrition, Methods of**; **Prehistoric Societies**.

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ANTIOXIDANTS. Antioxidants are specific organic compounds that are active in the prevention of very rapid harmful chemical chain reactions with oxygen or nitric oxide, that is, oxidation reactions. In the body, oxidation reactions generally involve highly reactive molecules called free radicals. Free radicals reside primarily in the mitochondria of cells. When free radicals are released from the mitochondria in numbers sufficient to overwhelm the protective biochemical systems of the body, they become a threat to some cellular structures such as lipids, proteins, carbohydrates, and nucleic acids in cell membranes. Compromised cellular structure alters cellular function, and may lead to the initiation of the disease process. In severe oxidative stress, cell death may occur. Antioxidants react with the free radicals before they are able to react with other molecules, thus providing protection from oxidation reactions (Cross et al.).

Chemistry 101: How and Why Cells and Other Molecules Interact

The human body is made up of many different types of cells that are composed of multiple diverse types of molecules. Molecules are put together in such a way that one or more atoms of one or more elements are joined by chemical bonds. Atoms have a nucleus of neutrons and protons which is surrounded by electrons. It is the number of protons (positively charged particles) in the nucleus of the atom that determines the number of orbiting electrons (negatively charged particles). Electrons are involved in chemical reactions and are the substances that bond atoms together to form molecules. Electrons orbit the atom in one or more of the atom's shells. The innermost shell is full when it has two electrons. When the first shell is full, electrons begin to fill the second shell. When the second shell has eight electrons, it is full, and electrons begin to fill the third shell, and so on. The electrons surrounding antioxidants react with the electrons surrounding free radicals, causing them to become much less reactive. Antioxidants may be more effective when one antioxidant is used in combination with another. This synergistic relationship between several antioxidants occurs when, for example, vitamin E donates an electron from its outer shell to a free radical and vitamin C donates an electron to vitamin E, maintaining the ability of vitamin E to continue donating electrons to free radicals. Vitamin C may then receive an electron from glutathione that would enable vitamin C to remain active as an antioxidant. Therefore in this type of situation, an attack on membranes by a free radical results in the participation of three different antioxidants.

In What Forms Are Antioxidants Found and How Are They Metabolized?

Antioxidants are found in many forms. The principal vitamins with antioxidant properties are vitamins E and C, and beta-carotene. Vitamin E (*d*-alpha tocopherol) is a fat-soluble antioxidant, which means it is stored in body fat and works within the lipid portion of cell membranes to provide an alternative binding site for free radicals, preventing the oxidation of polyunsaturated fatty acids (Chow). Vitamin E is a family of eight compounds synthesized by plants in nature: four tocopherols (alpha, beta, gamma, delta) and four tocotrienols (alpha, beta, gamma, delta). Each has different levels of bioactivity in the body over quite a wide range, but generally speaking, alpha-tocopherol has greater bioactivity than beta-tocopherol, which has greater bioactivity than gamma-tocopherol, which has greater bioactivity than delta-tocopherol. Only alpha-tocotrienol has bioactivity of any significant amount, which is slightly less than that of beta-tocopherol. Digestion and absorption of vitamin E is greatly improved when consumption is accompanied with dietary lipids or fats. Absorption of vitamin E ranges from 20 to 50 percent, but may be as high as 80 percent, with absorption decreasing as intake increases (Bender, 1992). Dietary vitamin E absorption requires bile and pancreatic enzymes in the small intestine, where it is incorporated into micelles within the lumen of the small intestine. The micelles carry the vitamin E across the brush border of the small intestine and the vitamin E is then taken up by chylomicrons, which are transported by the lymph system to tissues and the liver. Vitamin E may be stored in the liver, adipose tissues, and skeletal muscle. When needed, vitamin E places itself in cell membranes. Excretion of vitamin E is by way of urine, feces, and bile (Wardlaw and Kessel).

Vitamin C (ascorbic acid) is a water-soluble antioxidant and is found in the water compartments of the body where it interacts with free radicals. It has been shown that short-term supplementation of vitamin C lasting two to four weeks can significantly reduce the level of free radicals in the body (Naidoo and Lux). Dietary vitamin C is absorbed primarily by active transport in the small intestine, with absorption decreasing as intake increases. Approximately 70 to 90 percent of vitamin C is absorbed when dietary intake is between 30 and 180 mg/day. The kidneys excrete excess dietary vitamin C in urine, but excrete virtually no vitamin C when intake of the vitamin is very low (Wardlaw and Kessel). After absorption in the small intestine, vitamin C is transported in the blood to cells in its reduced form, ascorbic acid or ascorbate. The concentration of vitamin C varies in different tissues in the body. For instance, vitamin C concentrations are highest in the adrenal and pituitary glands, intermediate in the liver, spleen, heart, kidneys, lungs, pancreas, and white blood cells, and lowest in the muscles and red blood cells (Olson and Hodges). This vitamin may also possess some prooxidant properties, meaning it can participate in oxidizing other molecules such as iron in the blood stream (Alhadeff et al.).

Beta-carotene is a precursor to vitamin A (retinol). Beta-carotene is the most widely known compound in a group known as carotenoids, which are pigment materials in fruits and vegetables that range from yellow to orange to red in color. Carotenoids are also called proformed vitamin A because they can be made into vitamin A by the body when necessary. Carotenoids are pigments that are responsible for the orange color of many fruits and vegetables such as oranges and squash. Other carotenoids present in foods include antheraxanthin, lutein, zeaxanthin, and lycopene. Dietary retinol is usually found bound to fatty acid esters, which are in turn bound to proteins, and must undergo a process called hydrolysis that frees the retinol from the esters, enabling the retinol to then be absorbed in the small intestine. Proteolytic enzymes in the small intestine, such as pepsin, hydrolyze the retinol from the proteins. Approximately 70 to 90 percent of dietary retinol is absorbed provided there is adequate (10 grams or more) fat in the meal consumed (Olson). Carotenoids are absorbed at much lower levels, sometimes at levels as low as 3 percent, with absorption decreasing as intake increases (Brubacher and Weisler). Retinol and the carotenoids are carried through the absorptive cells of the small intestine by micelles for transport through the lymph system to the liver, which then can "repackage" the vitamins to send to other tissues, or act as the storage facility for the vitamins until needed by the body.

There are also enzymes that possess antioxidant properties. Glutathione peroxidase, superoxide dismutase, and catalase are the most well known. Glutathione peroxidase breaks down peroxidized fatty acids, converting them into less harmful substances. Peroxidized fatty acids tend to become free radicals, so the action of glutathione peroxidase serves to protect cells. The activity of glutathione peroxidase is dependent on the mineral selenium, which is the functional part of this enzyme, or the part of the enzyme that makes it have antioxidant activity. Therefore, selenium is considered to have antioxidant properties. Superoxide dismutase and catalase react with free radicals directly, reducing their ability to oxidize molecules and cause cellular damage.

A class of compounds termed isoflavones, which are derived from soy, also have antioxidant activity. Genistein, daidzein, and prunectin are all able to prevent the production of free radicals. Isoflavone activity as an antioxidant plays an important role in the aging process and cancer prevention primarily due to having estrogen-related biologic activities in humans (Shils et al.).

The polyphenols (epicatechin, epicatechin-3-gallate, epigallocatechin, and epigallocatechin-3-gallate) found in jasmine green tea also possess natural antioxidant properties. Studies have shown that these polyphenols are able to protect red blood cells from destruction upon attack by free radicals (Shils et al.). The polyphenols present in red wine have also been found to be protective against the oxidation of low-density lipoproteins and high-density lipoproteins, which are very important factors in the prevention of the development of atherosclerosis or coronary artery disease (Ivanov et al.).

A final group of compounds, synthetic antioxidants, are often added to foods to prevent discoloration and delay oxidation of the foods after exposure to oxygen. They also help protect fats from rancidity. Rancidity causes fats to develop an unappealing flavor and odor. Most of the antioxidants used in foods are phenolic compounds. There are four antioxidants that are approved for use in foods, particularly fats. They are propyl gallate (PG), tertiary butylhydroquinone (TBHQ), butylated hydroxyanisole (BHA), and butylated hydroxytoluene (BHT) (Charley and Weaver). Sulfites, which are sulfur-based chemicals, are also used as antioxidants in foods. However, because some people may be very sensitive to sulfites and have adverse reactions to them in foods, the Food and Drug Administration has required that labels on foods containing sulfites alert the public to their presence.

Dietary Sources of Antioxidants

Vitamin E is found in egg yolks, milk, plant and vegetable oils (including margarine and to a lesser extent butter), nuts, seeds, fortified whole-grain cereals, flatfish, halibut, shrimp, canned tuna in oil, asparagus, peas, tomatoes, apples, canned apricots in light syrup, blueberries, grapefruit, oranges, peaches, and pears. The milling process of whole grains causes most of the dietary vitamin E to be lost. The Recommended Dietary Allowance (RDA) as established by the U.S. Department of Agriculture currently is 15 International Units (IU) per day for men and 12 IU/day for women. In order for toxic effects to be produced, the amount of vitamin E consumed from foods would have to be 15 to 100 times the amount recommended for humans and this is extremely unlikely to occur (Wardlaw and Kessel). Symptoms and effects of toxicity are discussed in detail in Signs and Symptoms of Antioxidant Deficiency and Toxicity, below.

Vitamin C is present in large amounts in broccoli, asparagus, cabbage, cauliflower, potatoes, tomatoes, apples, applesauce, apricots, bananas, blueberries, cherries, grapefruit, lemons, oranges, peaches, strawberries, kiwi, pineapples, pears, cranberries, and the juices and jams made from these fruits. The Recommended Dietary Allowance for vitamin C currently is 60 mg/day for both males and females. Vitamin C obtained from foods rarely can be consumed in amounts large enough to be toxic to humans (Wardlaw and Kessel).

Beta-carotene is found in liver (primary storage organ in animals for vitamin A), egg yolk, fortified milk, butter, spinach, carrots, squash, sweet potatoes, broccoli, tomatoes, peaches, mangoes, apricots, papaya, cantaloupes, and fortified breakfast cereals. Because beta-carotene is converted to vitamin A by the body, there is no set requirement. However, the RDA for vitamin A is set in Retinol Equivalents (RE) at the level of 625 μg/day RE for men and 500 μg/day RE for women (Wardlaw and Kessel).

Diets High or Low in Antioxidants

Diets that are rich in antioxidants focus on high intakes of a variety of foods, especially large amounts of fruits, vegetables, and foods made from whole grains. Vegetarian diets, especially vegan diets (diets that exclude all foods from animal sources), are made up primarily from fruits, vegetables, whole grains, and legumes, and are an example of the types of diets that incorporate high levels of antioxidants. Another example of a diet that provides optimal levels of antioxidants is the Mediterranean diet. The Mediterranean diet is based on traditional eating habits in Greece, southern Italy, and Crete. This diet is rich in olive oil, foods from whole grains, and tomatoes, and minimizes the daily intake of poultry, eggs, sweets, and red meat. Red wine often accompanies meals in the Mediterranean diet and possesses some antioxidant activity (Murcia and Martinez-Tome). Furthermore, many of the spices used in Mediterranean cooking also have been observed to have some level of antioxidant properties (Martinez-Tome et al.). Asian-American diets also focus primarily on fruits, legumes, nuts, seeds, vegetables, and whole-grain food products, with liberal use of vegetable oils, while a minimum of meat is eaten. The traditional healthy Latin American diet provides beans, whole grains, nuts, fruits, and vegetables at every meal, with fish or shellfish, milk products, plant oils, and poultry being optional for daily intake.

Unfortunately, the typical American diet does not involve adequate intakes of fruits, vegetables, and whole-grain food products. This is not due to the lack of foods that fall into those categories but rather to the fact that too many Americans prefer fast foods and processed foods that are not rich sources of antioxidants. The Food Guide Pyramid developed by the United States Department of Agriculture recommends that six to eleven servings of bread cereal, rice, and pasta be consumed daily; three to five servings of vegetables per day; two to four servings of fruit per day; two to three servings of milk products per day; two to three servings of meat, poultry, fish, dry beans, eggs, and nuts per day; and that the use of fats, oils, and sweets be sparse (Wardlaw and Kessel). Most Americans do not adhere to the guidelines of the Food Guide Pyramid and therefore do not receive adequate amounts of foods that provide large quantities of antioxidants.

Certain disease states make it difficult to obtain adequate amounts of fat-soluble vitamins due to an inability to digest foods with fat properly. The digestion and absorption of fat in foods is required for digesting and absorbing fat-soluble vitamins such as vitamins A and E. Individuals with cystic fibrosis, celiac disease, and Crohn's disease absorb fat very poorly, which also means that the fat-soluble vitamins are poorly absorbed. As the unabsorbed fat passes through the small and large intestine, it carries the fat-soluble vitamins along with it, and is eventually excreted in the feces (Wardlaw and Kessel). Chronic alcoholics are also at risk for not obtaining adequate amounts of antioxidants due to a marked decrease in food intake in favor of the consumption of alcohol. Alcoholism may also result in liver disease, which leads to an inability of the liver to store the fat-soluble antioxidants.

Signs and Symptoms of Antioxidant Deficiency and Toxicity

Obtaining dietary intakes of vitamin E, vitamin C, and vitamin A from foods to meet the recommendations of the Food Guide Pyramid will prevent most healthy individuals from experiencing any deficiencies of these antioxidants. However, in diets that do not provide adequate amounts of fruits, vegetables, and whole grains, deficiencies may occur. It takes longer to develop a deficiency of the fat-soluble antioxidants, vitamins E and A, than it does to develop a deficiency of the water-soluble vitamin C.

Failure to obtain adequate vitamin E in the diet may cause certain medical conditions. Hemolytic anemia is caused by vitamin E deficiency, with an increased breakdown of red blood cells or hemolysis. Premature infants are most susceptible to vitamin E deficiency due to very small stores of the vitamin at birth and the frequently required use of oxygen to accommodate immature lungs. Premature infants are also growing very rapidly and need increased intakes of vitamin E. Special formulas are used to provide vitamin E to help prevent deficiency (Wardlaw and Kessel).

The disease caused by vitamin C deficiency is scurvy. The symptoms of scurvy are fatigue and small, purple spots or hemorrhages (petechiae) that appear around hair follicles on the back of the arms and legs. There are also bleeding gums and joints, impaired wound healing, pain in the bones, fractures, and diarrhea. Consuming a vitamin C–free diet for as little as 20 days may cause scurvy, but resuming vitamin C intake for one week can cause the reversal of the disease and accompanying symptoms (Wardlaw and Kessel).

Vitamin E toxicity may result from intakes of more than 1,500 IU/day of vitamin E isolated from natural sources and 1,100 IU/day for synthetic vitamin E for adults nineteen years or older. It is only possible to acquire such high doses of either form of vitamin E via supplementation. Use of supplemental vitamin E at such high doses in persons with a compromised health status may lead to complications such as hemorrhaging in individuals who are taking anticoagulants or are vitamin K-deficient (vitamin K is important in blood coagulation) (Wardlaw and Kessel).

Vitamin C toxicity may occur at intakes of 2 g/day or higher. The symptoms of vitamin C toxicity are nausea, abdominal cramps, and osmotic diarrhea. Because vitamin C is a water-soluble vitamin, much of excess vitamin C obtained from supplemental megadoses is excreted in urine (Wardlaw and Kessel).

Small children who do not eat enough vegetables are at an increased risk for vitamin A deficiency. In fact, individuals with very low incomes and the elderly are also at risk for deficiency due to an inability to obtain adequate intakes of foods that are good sources of vitamin A and to the decreased gastrointestinal function that may occur with age. Night blindness is a symptom of vitamin A deficiency, causing the rod cells in the eye to take a longer period of time to recover from flashes of light. Another symptom of vitamin A deficiency is dry eyes caused by deterioration of the mucus-forming cells in the body. In an individual with dry eyes, dirt and other contaminants are not washed away, and this may lead to eye infections. If vitamin A deficiency is not corrected, the condition of the eyes worsens, leading to more serious disorders of the eye; eventually irreversible blindness may result. The skin is also affected by a compromised vitamin A status. Primary symptoms are very dry skin and rough and bumpy texture of the skin surface. When vitamin A supplements are taken long-term at three times the RDA a condition called hypervitaminosis A may develop. This condition can cause spontaneous abortions in pregnant women or birth defects in infants and therefore women of child-bearing age wishing to become pregnant should avoid using high doses of vitamin A supplements (Wardlaw and Kessel).

Maintaining Antioxidant Content in the Foods You Eat

Antioxidants in foods are a valuable addition to a healthy diet and steps can be taken to preserve the antioxidant content of foods until they are ready to be ingested. Keeping fruits and vegetables refrigerated or in a cool, dry place helps to slow down the natural breakdown by enzymes that begins to occur as soon as the foods are picked. Fruits and vegetables should not be trimmed or cut until they are ready to be consumed to prevent unnecessary exposure to oxygen. Cooking by steaming, microwaving, or stir-frying in small amounts of fat for short amounts of time also helps to preserve the vitamin content of foods. If liquids are used to cook fruits or vegetables, do not add fat while cooking if you are planning to discard the liquid before eating the fruits or vegetables, to avoid losing the fat-soluble vitamins that may be in the liquids. Finally, it is important to remember that the skin of some fruits and vegetables contains a higher vitamin content than the inner parts, such as the skin of an apple (Wardlaw and Kessel).

See also: **Dietary Assessment**; **Dietary Guidelines**; **Natural Foods**; **Niacin Deficiency (Pellagra)**; **Nutrition Transition: Worldwide Diet Change**; **Vitamin C**; **Vitamins: Overview**; **Vitamins: Water-soluble and Fat-soluble Vitamins.**

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APHRODISIACS. Throughout the centuries, emperors and everyday folk alike have ingested, imbibed, sprinkled, or applied almost every conceivable substance—from almond paste to zebra tongues—in the hope of arousing sexual desire. Whether to woo a reluctant lover, revive a flagging libido, or pique carnal pleasure and performance, lovers the world over have relied on aphrodisiacs to do the trick. But which ones have the greatest reputations for potency (and why?) and do any of them really work?

Aphrodisiacs through the Ages

The association between food and eroticism is primal, but some foods have more aphrodisiacal qualities than others. Biblical heroines, ancient Egyptians, and Homeric sorceresses all swore by the root and fruit of the mandrake plant. The grape figured prominently in the sensual rites of Greek Dionysian cults, and well-trained geishas have been known to peel plump grapes for their pampered customers. Fermented, of course, grape juice yields wine, renowned for loosening inhibitions and enhancing attraction (though as Shakespeare's porter wryly notes in *Macbeth*, alcohol "provokes the desire, but it takes away the performance"). Honey sweetens the nectarlike philters prescribed in the *Kama Sutra* to promote sexual vigor, and the modern "honeymoon" harks back to the old custom for newlyweds to drink honeyed mead in their first month of marriage. Grains like rice and wheat have long been associated with fertility if not with love, and *Avena sativa* (green oats), an ingredient in many over-the-counter sexual stimulants, may explain why young people are advised to "sow their wild oats." Numerous herbs and spices—basil, mint, cinnamon, cardamom, fenugreek, ginger, pepper, saffron, and vanilla, to name a few—appear in ancient and medieval recipes for love potions, as well as in lists of foodstuffs forbidden in convents because of their aphrodisiac properties.

Among other delicacies banned by the Church in centuries past were black beans, avocados, and chocolate, presumably all threats to chastity. And truffles—both earthy black and ethereal white—caused religious consternation in the days of the Arab empire. One story has it that the *muhtasib* of Seville tried to prohibit their sale anywhere near a mosque, for fear they would corrupt the morals of good Muslims. For those who held debauchery in higher esteem, the list of favored aphrodisiacs was bound only by the imagination. The herb valerian, noted for its stimulant properties at lower doses, was long a brothel favorite, and *yūjo*, professional women of pleasure in feudal Japan, supplemented their charms with the aphrodisiacal powers of eels, lotus root, and charred newts.

From Symbol to Science

How did certain foods come to be regarded as aphrodisiacs in the first place? In some cases, legendary associations play a likely role: Cleopatra is rumored to have rubbed her private parts with a honey-almond mixture that drove Mark Antony mad. Some believe that the Aztec ruler Montezuma fortified himself with upwards of fifty cups of chocolate before visiting his harem (though more scholarly reports contend it was the conquistadors who sought such reinforcement). Casanova famously boasted of seducing a virgin by slipping a raw oyster into her mouth. Madame du Barry is said to have used ginger in a custardy concoction that stirred Louis XV to passion. And because Aphrodite, Greek goddess of sexual love, was said in myth to be born from the sea, a beguiling array of seafoods have been deemed aphrodisiacs (her very name is the source of the word).

STOLICHNAYA
Genuine Russian Vodka
Stolichnaya vodka
RUSSIAN VODKA

Aphrodisiacs flirt with the libido, and in this advertisement for vodka, the message is clear, yet subtle. Sparkling crystal, silver glasses, and caviar imply indulgent luxury, yet it is the glasses for two and the beautiful woman in the background that tells us that this intimate indulgence will also lead to love. PHOTO COURTESY OF STOLICHNAYA RUSSIAN VODKA.

Symbolism, too, plays an obvious part. During the Middle Ages, the Law of Similarities, or Doctrine of Signatures, held that in God's universe "like causes like," so suggestively shaped and textured substances were believed to enhance virility and fertility by virtue of their resemblance to sexual organs. Firm, elongated asparagus, sea cucumbers, and ginseng (literally, "manroot") and moist, fleshy figs, peaches, and oysters are prime examples. Other symbolic aphrodisiacs are rhinoceros horn and deer antler and the sex organs of animals known for their virility or procreative fervor, such as the tiger or rabbit.

Some foods are exalted as aphrodisiacs by virtue of their rarity or luxury. Bird's nest soup, *foie gras*, caviar,

The Notorious Spanish Fly

Cantharides, a potent preparation made from the crushed dried bodies of the green blister beetle, has been famed throughout history as an aphrodisiac. The Marquis de Sade reportedly favored Spanish fly to enhance virility, and an entire legion of nineteenth-century French soldiers "stood at attention" for prolonged periods after feasting on frogs that had themselves been dining on cantharidin-laden beetles.

Spanish fly does indeed produce erections, but one might die for the pleasure: the French legionnaires in question suffered from priapism, persistent painful erections that, untreated, can result in scarring and permanent loss of erectile function. Antonio Gamoneda in *The Book of Poisons* noted that "Great injury befalls those who take the Spanish Fly, because they will feel a burning corrosion in almost all their body. . . . They will suffer from swoons, surfeit, and lightheadedness, and will fall to the floor and gnaw table legs." This urogenital-tract irritant can be deadly and should be avoided.

Fortunately, safer drugs are now available to aid impotence, and people experiencing sexual dysfunction are well advised to seek medical advice.

truffles, and champagne are all, even if no longer necessarily difficult to obtain, still suggestive of wealth and largesse, playing into the age-old association among food, sex, and the provision of resources. Certain foods also lend themselves to particularly sensual dining rituals and modes of eating. Preparing food tableside with competence and élan, consuming whole ripe fruits or succulent birds or crustaceans, eating with the hands, licking fingers coated in delectable juices, feeding one's partner, sharing food from a common platter, sucking and slurping seductively—such acts and rituals constitute true foreplay for culinarily inclined lovers.

"No one has ever succeeded at seduction by means of food alone," wrote Manuel Vázquez Montalbán in his *Immoral Recipes*, "but there's a long list of those who have seduced by talking about that which was about to be eaten." Certainly, stimulating the mind helps stoke the sexual appetite, and it is our social and cultural associations that imbue certain foods with erotic meanings. But is there solid scientific evidence to support the claims made for aphrodisiacs beyond their placebo effect?

Proponents of chocolate point out that it contains phenylethylamine, or PEA, the brain chemical believed to underlie the euphoric sensation of being "in love." But eating chocolate has not been found to actually increase PEA levels in the body. The chili pepper may have a stronger claim to its fiery reputation: it quickens the pulse and induces sweating, mimicking the state of sexual arousal, and has also been shown to stimulate the release of endorphins, naturally occurring opiates that play a role in sexual pleasure. Ginkgo biloba, said to boost both mental and sexual performance, may restore or enhance physical function by increasing blood flow to the genitals, but the safety and efficacy of this herbal enhancer are still unclear (heart patients and those on aspirin need to be especially cautious). Garlic may promote potency through a similar mechanism, with its high content of arginine, an amino acid that enhances blood flow and could thereby augment erections. The lure of the elusive truffle may derive in part from a pheromonelike chemical it contains, similar to one secreted in the saliva of male pigs to attract sows. And the oyster, that consummate aphrodisiac, is noted not only for its fleshy, briny sensuality but also for its rich supply of zinc, which may aid normal sperm production and libido (though it is unlikely that oysters make a difference in any but the most zinc-deficient diets).

The Ultimate Aphrodisiac

Overall, aphrodisiacs seem to be more the stuff of folklore than of science. But in the realm of food and love, the power of the imagination is not to be ignored—believing something's an aphrodisiac may well make it so. Yet all the oysters in the world cannot take the place of the ultimate aphrodisiac. As the Roman philosopher Seneca once promised, "I will show you a philter without potions, without herbs, without any witch's incantation—if you wish to be loved, love."

See also **Art, Food in**; **Chocolate**; **Greece, Ancient**; **Rome and the Roman Empire**; **Sex and Food**; **Symbol, Food as**.

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APICIUS. The proverbial gastronomer Apicius (M. Gavius Apicius, c. 25 B.C.E–c. 37 C.E.), who lived at the time of the emperor Tiberius, gives his name to the most complete cookbook that has come down from antiquity, one that reflects an ancient Roman cuisine that survives, in part, in early-twenty-first-century Italian traditional practice and that has also shaped European cookery, whenever cooks—or their employers—wished to touch base with ancestral foodways. The book, *De re coquinaria* (On Cookery), is actually the product of a Late Antique compiler, writing about 400 C.E., who drew from an agricultural treatise, a work on household economy, and a Greek study of dietetics, in addition to two genuine publications by Apicius: a general cookbook plus a more specialized one on sauces. Over the years, scholars have been able to establish the true name of Apicius; in the past he was known as Apitius Caelius. Because of abbreviations in the headings of one of the ninth-century manuscripts that preserved the text, his identity was further confused by "ghosts" created through scribal errors of transmission (Three gourmets of that name did not exist, as some authors still have it).

Copying over 450 recipes, our anonymous "editor" organized his gleanings into ten books or chapters, giving each a pretentious Greek name: *Epimeles*, the prudent housekeeper (conserves and preservation advice); *Sarcoptes* (minced meats such as sausages, quenelles, and the like); *Cepuros*, the gardener (vegetables); *Pandecter* (compound dishes of many ingredients); *Ospreon* (legumes, such as peas, beans, chick-peas, and lentils); *Aeropetes* or *Trophetes* (fowl, both wild and domestic); *Politeles*, gourmet dishes (including eggs and limited sweets for *bellaria* or the dessert course); *Tetrapus* (quadripeds both wild and domestic); *Thalassa*, the sea (shellfish, crustaceans, cephalopods); and *Halieus*, the fisherman. An independent selection of thirty-one Apician recipes, recorded in an early medieval manuscript, represents *excerpta* made by one Vinidarius, apparently an Ostrogoth of the period of King Theodoric at the end of the fifth or early sixth century, and includes an impressive list of the herbs, roots, and seeds (spices) that should be at hand in a prosperous kitchen.

From Carolingian manuscripts of *De re coquinaria*—two of which survive in the New York Academy of Medicine and in the Biblioteca Apostolica of the Vatican—Italian Renaissance humanists commissioned numerous copies. The first printed edition of 1498 was shared in two issues between the printers G. Le Signerre in Milan and Ioannes de Legnano, the latter reprinted anonymously in Venice at the end of the century, and again by Tacuinus in 1503. Physicians stand out among subsequent editors: G. Humelberg of Zurich (1542) and Martin Lister (1705).

Seneca tells of Apicius committing suicide when he discovered that his assets—still representing considerable wealth—seemed not enough to enable him to continue dining with his accustomed extravagance, while the elder Pliny castigates his gluttony by reference to his partiality for flamingo tongues. Anecdotes accrued to his reputation long after his death, such as the tale of his storm-tossed voyage to the coast of Libya in search of the largest, most succulent prawns; when the shrimp did not meet expectations he ordered the hired ship to turn back to home port without his setting foot on land to recover from the journey. One indulgence of Apicius is enshrined in the Italian language. His invention of feeding swine on figs, thus engorging their livers, and then giving them honeyed wine (the Roman apertif *mulsum*) so that the pigs might die in ecstasy, their livers deliciously *ficcatum* (literally, "figged"), gave rise to the word for all liver, *fegato*.

ANCIENT *CASSOULET*

Conchic[u]la à la Apicius (one of several ancestors of a cassoulet)

Conchiclam Apicianam: accipies Cumanam mundam, ubi coques pisam. Cui mittis Lucanicas concisas, esiciola porcina, pulpas petasonis. Teres piper, ligusticum, origanum, anethum, cepam siccam, coriandrum viridem, suffundis liquamen [garum], vino et liquamine temperabis. Mittis in Cumanam, cui adicies oleum, pungis ubique, ut combibat oleum. Igni lento coques ita ut ferveat et inferes. (V, iv, 2)

Take a clean Cumaean pot [earthenware from Cumae] in which you cook the [dried] peas. Into this add Lucanian sausages, cut up; little pork meatballs; and pieces of pork shoulder. Pound [in a mortar] pepper, lovage, oregano, dill, dried onion, green coriander and moisten with *liquamen* [oriental fish sauce, for saltiness]; blend with wine and *liquamen.* Put this in the Cumaean pot, to which you add [olive] oil and prick [the seasoned meats and peas] all over so that the oil is absorbed. Cook over a low fire that it may simmer, and serve.

ED. NOTE: The dried whole peas, or beans, should be soaked overnight before cooking; in other dishes of this chapter the peas are first cooked with leeks, coriander [cilantro], and mallow flowers. Elsewhere Apicius gives a recipe for preparing Lucanian sausage in which the minced meat is seasoned with pepper, cumin, savory, rue, parsley, bay leaves, and *garum* [oriental fish sauce such as *nuoc mam* etc.], plus "condiments"; the latter justifying the use of preserved duck, comparable to certain French cassoulets; finally whole peppercorns, pine nuts, and bits of fat are added before the meat is packed into intestines and hung to smoke. It is possible to use Italian sausage like that from Abruzzi, or even Chinese sausages. Bake in a slow oven.

Apicius's recipes, without proportions or details of procedure, reveal the extent to which Roman cookery, although lacking such New World products as quintessentially Italian as tomatoes and capsicum peppers, or medieval Arabic imports like spinach and eggplant, nevertheless survives in Italian *agrodolce* tastes, a love of pasta and farro, an ingenuity in sausage making, and the use of drastically reduced wine or must in sauces (from ancient *passum* to *sapa*, for example). It also provides both name and concept to Mediterranean dishes such as paella, tian, and cassoulet.

See also **Ancient Kitchen**; **Cookbooks**; **Rome and the Roman Empire**.

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APPETITE. Appetite is a term implying a strong desire to acquire or participate in, exemplified by terms such as sexual appetite or appetite for life. In the context of food, appetite is used to describe a wanting or liking for particular foods, usually on the basis of their sensory properties (taste and texture) or a psychological attribute (perceived value or symbolic status). In this way appetite is usually distinguished from hunger, which implies a desire or seeking for food arising from a state of need or nutritional deficit. At the beginning of the twenty-first century the understanding of appetite achieves special importance because of its potential role in the worldwide epidemic of obesity, sometimes called a pandemic. Given that, in many parts of the world, people are surrounded by a plentiful supply of food that prevents chronic hunger (though permitting normal meal-to-meal hunger), the capacity to eat food in the absence of hunger or in a low state of hunger assumes special importance. Consequently, understanding appetite and how it can be controlled are urgent tasks in the fight against the obesity epidemic.

Appetite can therefore be defined as a liking for particular foods, or an attraction for foods based on their perceived pleasantness. This is normally referred to as the hedonic dimension of food selection. This characteristic can be described as the subjective pleasure that is derived from the consumption of food; in turn, this can be measured by asking people to rate the magnitude or intensity of pleasure associated with eating or tasting foods. This pleasure arises from the interaction between the person's perceptual capacity (acuity of taste, smell, and sensory feedback from the mouth) and the physical properties of foods. The intensity of the pleasure therefore depends in part on internal (personal) and external (food-related) factors. These food factors can be natural, such as the presence of sweet carbohydrates in fruits or, and much more common now, the deliberate construction of powerful properties in the manufacturing process. It can be hypothesized that the industrial production of foods (designed to possess a combination of properties, for example, sweetness, fattiness, flakiness) has saturated the food supply in many parts of the world with an abundance of appetite-stimulating products. These products include chocolates and desserts, cheese, meat, and pastry combinations, and many types of fried snacks. The inherent attractiveness of such products can stimulate eating in the absence of any obvious need for nutrients.

Biological Basis of Appetite

Is there a biological basis for appetite and for the degree of attractiveness of specific types of foods? It does seem that human beings derive pleasure from particular food properties—the qualities of sweetness and fattiness are prominent. It is generally understood that, during the course of human evolution, a preference for foods with these properties would lead people to consume foods that possessed energy—yielding value, for example, the nutritional value of carbohydrates and the energy value of fats. Consequently the value of these traits for survival has almost certainly persisted until the present day, at which stage these genetic dispositions may be detrimental in the current "obesigenic" environment (but useful when foods with these properties were scarce). The word "obesigenic" was coined around the end of the twentieth century to suggest an environment that promoted weight gain through the abundance, attractiveness, and marketing of food consumption, together with reduced opportunities for physical activity. It is recognized that most cultures contain highly prized food habits based on foods that are either sweet or fatty, and sometimes a combination of both—when the palatability can be intense.

Do these genetic traits based on the pleasurable qualities of food have a basis in brain processes? The intrinsic sensory attractiveness of food is mediated by "reward" pathways in the brain. These pathways promote various types of pleasure and can be artificially stimulated by drugs. By using drugs as tools it has been found that particular neurochemical transmitters are involved in the process of reward; these transmitters include dopamine, opioid, and cannabinoid molecules together with their specific receptors. It can also be demonstrated empirically that the areas of the brain that subserve the most intense pleasure can be stimulated both by food sensations (arising from sensory pathways), and modulated by signals of need (arising from the body's energy stores). This means that a nutritional deficit, indicated by a low body weight, for example, can sensitize the reward system so as to increase the measured pleasantness of foods. In practice this would mean that a person who had been coerced into losing substantial body weight would display an increased rating of pleasantness for certain foods. This can be seen as a useful biological mechanism and is given credibility via the long-known phenomenon called alliesthesia, which is perceiving an external stimulus as pleasant or not, depending on internal stimuli. This concept is based on the biological notion of pleasure being a useful trait.

However, it seems certain that another mechanism must also be at work. This mechanism is based on the recognition that some people who gain weight easily and become obese possess traits that lead them to derive a high degree of pleasure from food. Consequently, foods with potent sensory properties are attractive targets for such people and this increasing pleasantness can lead to overconsumption and weight gain. There is clear evidence that obese women rate sweet/fatty foods very highly and consume substantial quantities; other studies have shown that obese people show preferences for fatty foods and for the taste of fat. After eating, obese subjects frequently rate the same food as being more pleasant than do lean subjects. In this way the expression of appetite—a heightened pleasure of eating—can be seen to contribute to increasing body weight and obesity. This arises from endogenous traits to derive pleasure from food (sometimes specific foods) in conjunction with an abundance of foods possessing a profile of pleasure-stimulating properties.

Hedonics and Hunger

The identification of the pleasure response of appetite with a neurochemical substrate also helps to differentiate the hedonic dimension of food from the hunger dimension. The term "hedonic," derived from the Greek word *hedone*, refers to the seeking of pleasure. Experimental studies in human subjects have shown that a drug called naloxone that blocks opioid receptors can reduce the perceived pleasantness of food without diminishing hunger. In contrast a drug such as fenfluramine, that acts upon serotonin receptors, can substantially reduce hunger without changing the perceived pleasantness of food. This type of pharmacological dissection indicates that the overall control of food intake depends upon both appetite (signals of pleasure) and hunger (signals of absence of food). However, the separation of the systems is not complete since experimental investigations have shown that while people are eating very good-tasting food their hunger is elevated. This elevation serves to prolong the meal so that more food is consumed. The relationship is, however, asymmetrical: although pleasantness increases hunger, a state of satiety does not reduce the perception of pleasure. Indeed, even when people report feeling full, a very palatable food can often still be eaten. Surveys have shown that foods rated as most palatable (pleasant) are associated with the largest meal sizes and with the greatest amount of food consumed. The results of scientific observations are therefore consistent with the widespread belief that people eat more of good-tasting food. However, people do not always choose to eat the most delectable or most pleasure-giving food; eating also depends on the appropriateness of the food for the particular social context. This is a good example of a cultural rule overcoming a biological response. However, much overeating in certain cultures arises from the strength of the biological response or perceived intensity of pleasure overcoming the cultural convention.

The Palatability Dilemma

The potency of appetite in stimulating food consumption creates a problem in the present climate of escalating levels of obesity. There are now strong intentions in the nutraceutical sector of the food industry to encourage the production of functional foods for appetite control; that is, foods that possess satiety-inducing or hunger-suppressing properties. The word "nutraceutical" was coined to resemble the word "pharmaceutical" and refers to those foods that may have specific functional effects generated in a manner similar to the way in which drugs work. However, advances in food technology have, over the years, been able to bring about an increase in the overall pleasantness (palatability) of foods entering the market-place. Indeed, one of the legitimate goals of the food industry is to make eating a source of pleasure. It can be observed that for many people, eating is the cheapest form of pleasure available on a day-to-day basis. However, improving palatability means increasing the sensory attractiveness of foods and the willingness of people to consume such foods. Satiety implies reducing the willingness of people to consume. The question therefore arises whether it is possible for the food industry to increase the palatability of foods without weakening satiety—and vice versa. The balance between palatability and satiety is the essence of the interaction between hunger and hedonics in the control of food intake. It remains to be determined how the interplay between these factors contributes to the current obesity epidemic.

See also **Acceptance and Rejection**; **Anorexia, Bulimia**; **Eating: Anatomy and Physiology of Eating**; **Hunger, Physiology of**; **Obesity**; **Sensation and the Senses**.

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APPLE. Picking apples on a clear, crisp, sunny autumn day provides a cornucopia of pleasures. The enjoyment of being outdoors and savoring another harvest has been part of the human experience for centuries. Biting into a crunchy, sweetly flavored apple or quaffing a big glass of fresh cider reminds one why apples are a part of fairy tales and folk history. Remember Snow White and Johnny Appleseed? Apples have sustained humans with beverages—hard and sweet cider—innumerable culinary dishes, winter provisions, and even foodstuffs for hogs and cattle, and they are still an integral part of American culture and commerce. Apple pie is the quintessential American dessert, and bins of fresh apples are present year-round in every supermarket. An apple variety exists for every taste bud, and eating apples has a lot of health benefits, too. They are a good source of antioxidants and fiber, and an individual apple contains about 80 calories, 5 grams of fiber, 6 milligrams of vitamin C, and 170 milligrams of potassium.

Origin of Apples

Botanists theorize that apples originated somewhere in central and southern China. This area is home to around twenty *Malus* species, whose seeds were gradually spread by birds throughout the Northern Hemisphere. Ornamental crab apples are also descendants of these smaller, bitter-fruited species. It was thought that the edible apple (*Malus domestica*) evolved as a complex hybrid from a number of these wild apple species. However, Barrie Juniper, emeritus fellow in the Department of Plant Sciences at Oxford University, has suggested that a small population of a single *Malus* species from the wild forests of the Tian Shan (the Heavenly Mountains) along the border of western China and Kazakhstan is the progenitor of all modern apple cultivars. These Tian Shan forests became isolated by biological and climatic changes about 4.5 million years ago and evolved in isolation. Juniper theorizes that as bears and wild pigs, horses, and donkeys gradually began to occupy the area and to eat the largest and sweetest fruits, they aided in the process of natural selection for larger, sweeter fruit. Because apples do not breed "true to type" from seed, these wild plantings from dispersed seeds gradually contributed to a diversity of apple varieties from this one species. Later, around ten thousand years ago, humans began to travel through the area and also began to eat these fruits and to carry them westward. Juniper and other researchers are studying the remnants of these forests of wild fruit trees and are collecting samples for DNA analysis. These wild fruit trees are a fruit breeder's paradise for genetic material.

Ancient History

By 2500 B.C.E. apples were cultivated throughout northern Mesopotamia and Persia. The walled gardens of Persia included fruit trees for their ornamental beauty as well as for their culinary delights. The ancient Greeks and Romans also cultivated apple orchards, and their wealthy citizens enjoyed apples as part of the dessert course at banquets. The Greeks, well advanced in horticultural knowledge, understood grafting and propagated specific varieties for their orchards. The Greek writer Theophrastos knew that apples would not grow true to type from seeds, writing, "Seedlings of . . . apples produce an inferior kind which is acid instead of sweet . . . and this is why men graft." In the first century C.E. the Roman writer Pliny described over twenty named varieties in his *Natural History*. Apple orchards were established throughout continental Europe and in Britain as the Romans extended their empire, culture, and crops. An indicator of the importance of the apple in these ancient cultures is its prevalence in Greek and Roman mythology. The Roman goddess Pomona tended her orchards and bestowed gifts of fruit on her favorites as rewards for favorable acts.

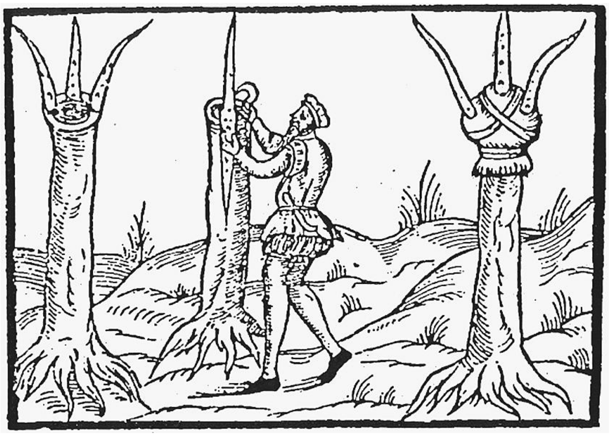
After the collapse of the Roman Empire, many of the favorite dessert apple varieties of the day disappeared. Charlemagne's rise to power in 771 brought a measure of peace and prosperity and an increased interest in horticultural pursuits. His *Capitulare de Villis* (Rules of Land Use) decreed that every city should include apples, cherries, plums, peaches, and pears. Charlemagne also issued an edict that brewers (which included cider makers) should be encouraged to develop their trade. Apple cultivation and varietal development progressed in Europe during the Renaissance. Varieties were selected, named, and propagated, and orchard plantings increased. These improved varieties were included in beautiful displays of fresh fruit at Renaissance banquets, where fresh apples were enjoyed as part of the dessert course.

North American History

Apples have been part of American life from the first arrival of European settlers. One of the first documented orchards in the New World belonged to William Blaxstone, a well-known horticulturalist and clergyman. He planted his orchard around 1625 on the slope of what became Beacon Hill in Boston. Blaxstone, who was described as an eccentric, saddle-trained a bull and distributed apples to his friends on his rides. One of his apples, Sweet Rhode Island Greening, is probably the first named variety from the United States.

Colonial America. A one- to six-acre apple orchard was an important part of farmsteads in seventeenth- and eighteenth-century America. Apples were grown primarily for hard cider, which was the beverage of choice because water was regarded as unsafe. Everyone in the family drank cider, and each family produced twenty to fifty barrels of cider each autumn for its own consumption and to use as barter for needed goods and services. Cider was not considered prime until it had aged over a year. Applejack, made from distilled cider, was even stronger. The first cider mills were built around 1745. Prior to this cider was made by pounding apples in a trough and draining the pomace. By the late eighteenth century cider mills dotted the countryside. In New England one in ten farms had a cider mill.

Cider was also used in cooking apple butter. Sweet cider (the unfermented, freshly pressed juice) was combined with peeled and boiled apples and cooked until the mixture had been reduced to a thick paste through evaporation. It was then put up in earthen jars for later use. Some cider was allowed to become vinegar and was used for food preservation. Apples were also dried for winter preservation. Michel Crèvecoeur, author of *Letters from an American Farmer* (1782), described drying apple slices on wooden platforms erected on poles. The fruit was spread out on wooden boards, where it was soon covered with "all the bees and wasps and sucking insects of the neighborhood," which he felt accelerated the drying process. The dried apples were used for apple pies and dumplings throughout the year. Peaches and plums were also dried but were considered more of a delicacy and were saved for special occasions. The dried apples, also called schnitz, were stored in bags hung in the attic rafters to keep them dry and away from mice. The Pennsylvania Dutch, German settlers in eastern Pennsylvania, were prodigious apple growers and developed a brisk business in colonial America selling schnitz, apple butter, and cider. A traditional Pennsylvania Dutch apple dish, called schnitz pie, consists of dried apples first cooked in water; then sugar and spices are added to the pot, and finally the mixture is baked in a lidded pie crust. *Schnitz and knepp* is a dish of ham, potatoes, and dried apples cooked together; dumpling dough is added and cooked briefly right before serving.



Cleft grafting on fruit trees according to a medieval method described by Pietro Crescenzi (ca. 1233–ca. 1320). From a woodcut in the *De Omnibus agriculturae partibus.* ROUGHWOOD COLLECTION.

After the Revolution, grafting and nurseries became more commonplace. Still, until the mid-nineteenth century most plantings in home orchards were of seedling trees that were not pruned. The fruit was primarily used for cider and fed to hogs. Pork was cheap, and the abundant apples and peaches were an inexpensive way to fatten pigs. Cider was even part of political campaigning and was dispensed freely during voting time. During one election, George Washington's agent is said to have dispensed 3.75 gallons of beer, wine, cider, or rum to every voter.

Insect pests and diseases were not quite as prevalent in colonial times as they later became. Some key fruit pests had not yet made the trip to the New World, and other native insects had not yet discovered apples. Pest-damaged fruit was also accepted as natural and unavoidable. Still-life paintings of fruit from this and earlier eras clearly show insect and disease damage on the fruit. In 1806 Bernard McMahon, in *The American Gardener's Calendar*, instructed readers to pick the worst of the leaves off the tree and dash the branches with water in dry weather to prevent insect damage from spreading.

Johnny Appleseed, whose real name was John Chapman, was a popular folk character in early nineteenth-century America. Born in Leominster, Massachusetts, in 1774, Johnny Appleseed started seedling apple tree nurseries throughout Pennsylvania, Ohio, and Indiana. Traveling by canoe or on foot, he gave apple seeds from cider mills to any farmer who promised to plant them and take care of them. On his travels he also planted seedling nurseries in clearings. At his death in 1847, he had established apple trees over 100,000 square miles of territory.

Nineteenth-century apple growing. Agricultural settlement of midwestern and western states by European settlers began in the mid-1820s. Home orchards were planted in Washington State by the first European immigrants from the eastern states in the mid-1800s. Commercial orchard plantings did not take hold until the

Harvested apples at Brogden Farm in Kent, England, are being boxed for distribution to the London market. Kent lies at the center of Britain's apple-growing region. © HULTON-DEUTSCH COLLECTION/CORBIS.

advent of the big irrigation projects in the late nineteenth century. By 1850 five hundred named varieties were cultivated. The seedling nurseries started by Johnny Appleseed and settlers across the country were the start of unique American varieties like Baldwin, Esopus, Spitzenburg, Green Newton, Jonathan, Hawley, Newton Spitzenburg, Swaar, Winesap, and York Imperial.

The mid-nineteenth century saw changes in American agriculture as urban populations grew and a smaller percentage of people were involved in agriculture. Apple growing was no longer primarily the purview of the self-sufficient homestead. Alcoholic cider fell into disrepute with the spread of the temperance movement, and the cider industry declined. Larger commercial orchards were established for growing and selling fresh apples. The apple industry was affected between 1880 and 1930 by the development of the refrigerated railroad car that allowed fruit growers in the western states to ship fruit east. The development between 1910 and 1920 of refrigerated storage meant that long-keeping winter apples were not as necessary, so fewer varieties were grown by commercial orchards. At the beginning of the twentieth century seven thousand named varieties of apples existed, but five thousand of these varieties were extinct by the beginning of the twenty-first century. Prior to refrigerated storage, apple cultivars grown in small orchards varied from early-season baking apples to winter-keeper types with a thick, waxy skin that would store well in root cellars.

Pest Management

Pesticides were not developed or widely used until the late nineteenth century, when growers began producing fruit more for market and for fresh eating rather than for cider and for home consumption. Orchardists experienced increasing pest damage from codling moth, a larval fruit pest accidentally introduced from Europe by early settlers, and from other pests and diseases. The first arsenical insecticide, Paris green (copper acetoarsenite), was developed in the 1870s to control codling moth. Lead arsenate was developed as an insecticide in 1892. Growers also began using nicotine sulfate to fortify the lead arsenate applications. At first these broad spectrum, toxic pesticides were applied one to three times during a growing season, but the number of applications increased as codling moth became more difficult to control. By 1945 orchardists were using up to seven applications of lead arsenate each season. DDT, developed during World War II, was hailed for its effectiveness against insect pests and low toxicity to humans. Not until later did scientists discover that DDT persisted in the food chain. Still, these new pest controls were not without concerns. DDT successfully controlled codling moth but wiped out natural predators that kept other pests in check, so the number of pests that needed to be controlled greatly increased as the number of pesticides increased.

Public debate over pesticide use grew with the increasing use of pesticides. In 1937 the U.S. Congress directed the U.S. Public Health Service to investigate the possible harmful effects of spray residues on fruits and vegetables. Although the Service's report, finished in 1940, concluded that harmful effects were minimal, the dialog about pesticide use continued, reflected in various scientific studies and public debates through the decades. The 1962 publication of *Silent Spring* by Rachel Carson galvanized public opinion about the environmental consequences of pesticide use.

Apple Orchards in the Twenty-First Century

The introduction of integrated pest management in the 1970s placed more emphasis on understanding pest and disease life cycles and pest populations as the basis for pesticide applications instead of touting the benefits of applying sprays on a routine basis. Still, fruit growers must meet the demand for inexpensive, blemish-free fruit in a competitive marketplace. Pesticide use on apples remains higher than on most other crops. Researchers continue to study pest- and disease-monitoring techniques, biological controls, and new targeted pesticides to develop more ecologically based production systems and to lower the pesticide risk for agricultural workers and consumers. Consumer demand for organic fruits and vegetables produced without synthetic pesticides and fertilizers has increased. Organic apple production is growing, particularly in the Northwest, which has fewer insects and diseases than the Northeast.

In the early twenty-first century Washington State produced 50 percent of the apple crop in the United States, followed by New York, California, Michigan, and Pennsylvania. Although over two thousand varieties of apples are grown in the United States, commercial orchards produce about 90 percent of the crop from ten varieties of apples—Red Delicious, Golden Delicious, Granny Smith, Rome, Fuji, McIntosh, Gala, Jonathan, Idared, and Empire. Controlled atmosphere storage, where the oxygen level is decreased and additional nitrogen is introduced into refrigerated storage, means apples can be stored from one season to the next and hold their quality. Approximately 50 percent of the crop is sold for fresh eating; 20 percent is processed for vinegar, cider, juice, jelly, and apple butter; 17 percent is canned as applesauce and pie filling; and 13 percent is exported. Internationally apples are the most widely cultivated tree fruit. Annual world apple production stands at approximately fifty-seven metric tons of apples. China is now the world's largest producer of apples, followed by the United States, Turkey, Italy, Germany, France, Iran, Poland, Argentina, and India.

Horticultural Requirements

Commercial apple orchards require skilled management. Apples are adaptable but grow best in cool temperate climates from about 35 to 50 degrees latitude. Most apple varieties require full sun, good soil drainage, and a chilling period (1,000 to 1,600 hours of temperatures below 45ºF) and 120 to 180 frost-free days to produce a crop. Fruit quality is highest when day temperatures are warm but nights are cool. Orchardists favor trees that have been propagated on size-controlling rootstocks. These rootstocks produce smaller trees that can be planted more intensively, yield more per acre, and bear fruit earlier (two to four years) than full-sized standard rootstocks. Trees are pruned annually, and pests, diseases, soil fertility, and water needs are monitored to maximize fruit quality, size, and color. Growers must also pay attention to market demands and price fluctuations to maintain viable businesses in a highly competitive international arena.

One option for smaller family farm operations is to focus on direct marketing to the consumer. Roadside marketing, farm markets, and pick-your-own operations can emphasize locally grown, unique apple varieties. Large-scale supermarkets tend to carry only a few varieties, while the several thousand apple varieties once grown in the United States are unknown to many consumers. Apple aficionados can search out regional favorites like Smokehouse, a fine, old Delaware and Pennsylvania apple from 1837; Grime Golden, the rich, distinctive apple from the mountains of West Virginia; or Blue Permain, a large, dark purplish-red fruit that will keep all winter in a root cellar. The best baking apples are found at farmer's markets. The tart Lodi ripens early in the season, Fallawater is an old favorite for both baking and eating, and the yellow-fleshed Smokehouse is juicy and firm for pies.

Preserving the rich heritage and genetic diversity of these varieties is a concern of the Seed Savers Exchange, a nonprofit organization devoted to saving heirloom varieties of vegetables and fruits. The organization maintains a historic orchard of seven hundred apple varieties at its Heritage Farm in Decorah, Iowa, and aims to obtain cuttings of all existing nineteenth-century apples. The U.S. Department of Agriculture also maintains an apple germ plasm collection of more than three thousand varieties in orchard plantings or in tissue culture storage. These collections offer genetic characteristics, such as insect and disease resistance, flavor, fruit size, and cold hardiness, that are important in breeding new apple cultivars.

Home Gardening

The general perception among gardeners is that apple growing is too complicated and is best left to experts. Backyard apple-growing enthusiasts know that, while apple growing does take an investment of time and knowledge, it really is not difficult. Some homework will determine the varieties and size-controlling rootstocks that thrive in an area. Local agricultural extension agents are good resources for information on which pests and diseases might present problems. The North American Fruit Explorers (NAFEX) is a network of fruit-growing enthusiasts who publish a quarterly journal of helpful varietal and growing information. Disease-resistant varieties, such as Liberty, Redfree, Gold Rush, and William's Pride, are an absolute boon for backyard orchardists. Gardeners can combine the disease-resistant varieties with insect-trapping techniques, like the apple maggot trap, which is a red apple-sized sphere coated with sticky tanglefoot to attract apple maggots, and kaolin clay, a fine clay particle spray material, to produce a good-quality apple without inundating a backyard with pesticide materials. Harvesting a basket of crisp, delicious apples from a backyard orchard should be on every gardener's wish list.

See also **Fruit: Temperate Fruit**; **Pie**; **United States: Pennsylvania Dutch Food**.

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Sarah Wolfgang Heffner

AQUACULTURE. Aquaculture, the controlled or semi-controlled production of aquatic plants and animals, has increased at double-digit percentage rates since the early 1980s. This increase has been in response to declines in commercial harvests of wild stocks of fish and shellfish. Oceans of the world are currently at maximum sustainable yield. Since the late 1980s, there has been a concerted effort to maintain global commercial harvest of ocean fish at approximately 100 million metric tons (mmt). However, as global population grows, demand for fish and shellfish increases, and the percentage of aquatic products grown in aquaculture must likewise rise to meet the supply of those products. Projections for increased production are in the range of 40–100 mmt of new aquaculture production by about the year 2030. The lower range assumes only increases in world population; the upper figure represents increases in world population plus a 1 percent per year increase in per capita consumption. To put this number in perspective, the 1995 world production figures for soybeans was 137 mmt, swine was 83 mmt, and chickens was 46 mmt. Thus, to meet demand in the first part of the twenty-first century, we must realize significant growth. This increase in production will not be accomplished with a single species.

There are fewer than thirty large species-specific aquaculture industries globally, and the fourteen largest industries are listed in the table. However, there are over twenty-five thousand species of fish and there are estimates that one thousand new species are being evaluated for their culture potential. The small percentage of species raised relative to the total number available is an indication that aquaculture is a new concept in many parts of the world. As a subsistence enterprise, aquaculture has been practiced for over four thousand years. As a series of large industries, aquaculture is less than fifty years old, often stimulated by declining wild stocks of fish. The channel catfish industry, which only began in the late 1960s in the southern United States, is illustrative of a relatively young industry. Today, over 90 percent of the U.S. supply of Atlantic salmon is cultured. In 1980, that figure was a fraction of 1 percent, at most. The global supply and demand characteristics created a good deal of volatility in production, which has only increased over time. Additional factors such as identification of new diseases and movement of those diseases contribute to the volatility in production. Inevitably, as new aquaculture species are brought into culture settings, new diseases are identified that were previously unknown. In the past ten years, new viral diseases have been identified in shrimp and salmon, both of which caused large-scale losses from production facilities.

TABLE 1

The largest aquaculture industries, by volume, in 1999

Values are in million metric tons

Species	Volume
Giant tiger prawn	3,651,782
Pacific cupped oyster	3,312,713
Japanese kelp	3,023,240
Silver carp	2,837,420
Grass carp	2,743,194
Atlantic salmon	2,448,280
Japanese carpet shell	2,194,521
Roho labeo	1,493,884
Rainbow trout	1,350,168
Japanese amberjack	1,282,090
Yesso scallop	1,252,448
Nori	1,249,923
Whiteleg shrimp	1,062,774
Nile tilapia	1,025,739

Of the approximately 25 mmt of global aquaculture production, there are only a few industries that produced over 1 mmt in 1996. Several of the species of Asian carp and the common carp account for the largest industries. Silver carp production was 2.2 mmt, grass carp production was 1.8 mmt, bighead carp production was 1.1 mmt, and common carp production was 1.5 mmt. Virtually all of this production occurred in China with the exception of common carp, which is raised throughout Europe, its native range. Of the species typically available in U.S. markets, pen-raised Atlantic salmon accounted for 0.4 mmt, rainbow trout production for 0.3 mmt, channel catfish production for 0.2 mmt, and tilapia for 0.6 mmt. Production of several invertebrates was significant. Scallop production was 1.0 mmt, shrimp production was 0.9 mmt, oyster production was 1.1 mmt, mussel production was 1.0 mmt, and clam production was 1.0 mmt. Production of brown seaweeds was 4.5 mmt and red seaweed production was 1.6 mmt. Thus, the largest aquaculture industry is the production of brown seaweeds, largely for nonfood use. In the twenty-first century, greater demand will likely result in increased production.

There are only a few production systems in use for aquaculture, and they include earthen ponds, raceways, cages or net pens, and indoor recirculating systems. Earthen ponds or cages placed in existing bodies of water are the oldest production system and the indoor recirculating systems are the newest. For successful culture, considerable technical expertise is required when us-

Fish culture technicians working in a fish hatchery in the early spring. PHOTO COURTESY OF UNITED STATES DEPARTMENT OF AGRICULTURE.

ing a recirculating system. All of the current industries use earthen ponds (catfish, tilapia, Asian carps, shrimp), raceways (rainbow trout), or cages/net pens (Atlantic salmon, yellowtail, an amberjack from Southeast Asia). Producers are experimenting with indoor recirculating systems using a wide variety of species. There are a few successful producers using indoor systems, but the number will inevitably grow as both the systems themselves and information on targeted species increase. Successful aquaculture can be viewed as the correct match of species under a certain set of market conditions with production system. Some species do not tolerate some of the production systems or do not thrive in those systems. Behavioral characteristics of the various species often point toward the appropriate culture systems. For example, sedentary fish (bluegill, catfish, and flounder) should probably be raised in systems without significant water flow (earthen ponds, cages/net pens), whereas those that typically swim a great deal (tuna, trout, and striped bass) can be raised in raceway systems with a constant flow of water.

Fish are generally considered good quality food for human consumption because of the low saturated fat levels and generally high levels of n-3 fatty acids. Fish tend to retain the fatty acids that are in their diet. Thus, we can manipulate the fatty acid concentrations of fish and produce "designer fish" for targeted markets. Further, we can control the fat concentration in muscle through selected feed and produce a low-fat or high-fat fish depending on the demands of the market. Cultured aquatic animals can be safer products for consumption than wild fish because they are raised in a defined environment, and pollutants can be eliminated. Wild fish can be exposed to environmental pollutants and retain those they encounter. Organoleptic properties (taste) of fish and shellfish raised in aquaculture can be quite different from wild stocks. Fish flavor can be manipulated by dietary ingredients fed to the target species. If the diet contains a relatively high percentage of fish meal, the fish can taste fishier than if the diet contains a relatively high percentage of corn and soybean products. Fish fed the latter diets are often described as "milder" tasting, which is a desirable characteristic in certain markets. There is also a taste consideration with environment. Some species can survive both fresh- and saltwater, but osmoregulation changes to meet the challenges of those environments. This physiological change affects taste because of the chemical compounds used to regulate ionic balance. A good example of this is the freshwater shrimp. When raised in freshwater, taste has been described as mild, whereas if the shrimp is placed in saltwater for one to two weeks, it will taste more like a marine shrimp. Even with these positive attributes, aquaculture is experiencing growing pains.

Culture of aquatic animals produces the same wastes as other animal production industries. The problem is confounded by the fact that those wastes are discharged as rearing water is renewed. There have been incidences of environmental degradation resulting from aquaculture. One of the focal points of aquacultural research is waste management, focusing on phosphorus and nitrogen dynamics originating in the diet. Those efforts, as well as efforts related to siting aquaculture operations, land-use practices, and economic development, have become the focal point of sustainable aquaculture development. Along with the overall focus on sustainability, there are significant concerns about the feed used to achieve aquaculture's successes. Fish meal is a high-quality ingredient, yet it is a finite resource similar to all other species in the oceans. Ingredients made from soybeans, corn, canola, wheat, legumes, peanuts, and barley, as well as the by-products of the brewing industries and animal packing operations, are needed.

Growth of aquaculture in the twenty-first century will most likely be similar to growth in terrestrial animal production seen in the twentieth century. Fish and shellfish are the last major food item humans still hunt and gather from wild populations. The sustainable nature of aquacultural production probably will be the focal point of research in the early part of the twenty-first century and those results should facilitate the production increases necessary for sufficient quantities of fish and shellfish in the future.

See also **Crustaceans and Shellfish; Fish,** *subentries on* **Freshwater Fish** *and* **Sea Fish.**

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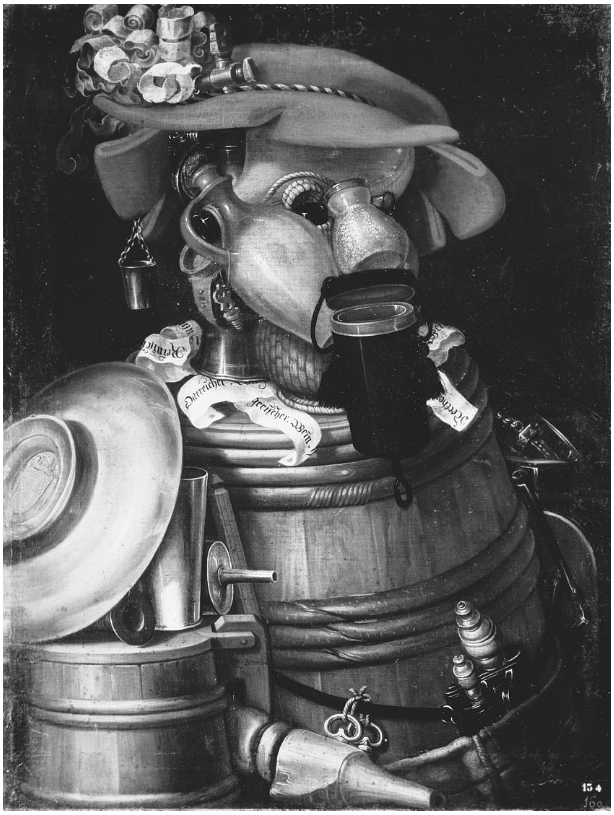
Paul B. Brown



"The Waiter," an anthropomorphic assembly of objects related to winemaking by Giuseppe Arcimboldo. © CHRISTIE'S IMAGES/CORBIS.

ARAB SOCIETIES.

See **Iran; Islam; Middle East; Africa: North Africa; Ramadan.**

ARCIMBOLDO, GIUSEPPE.

Giuseppe Arcimboldo (also spelled Arcimboldi), was an Italian artist in Milan, Italy, between 1527 or 1530 and 1593. A painter, he also designed the stained glass windows for Milan's duomo. Arcimboldo's artwork, especially famous for its fragments of landscapes, flowers, herbs, vegetables, noodles, and cookware, was fashionable during the sixteenth century. His work became especially well known throughout Europe after the Austrian Holy Roman Emperor Rudolf II exhibited Arcimboldo's paintings in the many residences of the Habsburg imperial family. In fact Arcimboldo's bizarre pieces and grotesque portraits pleased the Habsburg emperor so much that he appointed the Italian painter Habsburg court painter at Vienna and Prague and also made him a count palatine. Arcimboldo also created the illusionistic sceneries for the Habsburg court theater.

Arcimboldo's most famous paintings had contemporary allegorical meanings and were unique compositions of edibles and culinary objects placed together in such a way as to represent the contours or heads of cooks, innkeepers, fishmongers, and symbolic figures related to the world of arts and sciences. He was not prolific, but his paintings of fantastic heads and social satirical subjects were popular. Many surrealists, including the Spanish artist Salvador Dalí, claim Arcimboldo as a surrealistic ancestor.

Arcimboldo's paintings and drawings in Austria are in Vienna's Kunsthistorisches Museum, in Graz, and in Innsbruck's Habsburg Schloss Amras. In Italy his works are preserved in Cremona, in Brescia, and in Florence's Uffizi Gallery. In the United States the Wadsworth Atheneum in Hartford, Connecticut, houses some of Arcimboldo's work.

See also **Art, Food in: Painting and the Visual Arts**; **Italy**.

Elisabeth Giacon Castleman

ARCTIC.

The Arctic lies north of 70° latitude, marked by the tree line of the Subarctic. Few cultural groups occupy the Arctic: the Inuit live across the circumpolar region from northern Siberia throughout Greenland; the Aleuts and Yu'pik live on the coast and islands of southwestern Alaska; and six major Saami groups live in the northern reaches of Scandinavia and western Russia. Arctic diets are unique because animal products are staples and plants are seasonal supplements. Inuit diets traditionally are composed of marine mammals, fish, caribou, small game, birds, and plants, while Saami depend on herded reindeer for milk and meat, fishing, gathering plants, and hunting small game and birds. The diets of Aleuts and Yu'pik are similar to that of the Inuit.

Inuit Food Lists and Categories

Inuit are famous for eating marine mammals, mostly seal (*natsiq*). Bearded seal (*oodguk*), walrus, polar bear (*nanuk*), narwhal (*tuugalik*), beluga (*qilalugaq*), and the large plankton-eating whales are preferred foods. Seabird, goose, and duck eggs (*maniq*), ptarmigan, ducks, and geese are also eaten. Arctic char (*iqaluk*), an anadromous fish, is preferred above sculpin (*kanuyak*) and cod (*oogak*). Shellfish are consumed, but are not a major food resource. Land mammals, caribou (*tuktu*, or reindeer), and Arctic hare are eaten to achieve a culturally desirable balance in the diet. Commonly eaten plants include kelp, sorrel, willow, blueberry, crowberry, soapberry, wintergreen, lichens, Eskimo carrots, and Eskimo peanuts. The vegetable matter from herbivore's stomachs is also consumed.

Animal foods are divided into those associated with the sea or ice and those associated with the land. Inuit are subsistence hunters and divide themselves into two categories, *Sikumiut* are "people of the ice" and *Taramiut* are "people of the land." These categories relate as well to hunting on the sea and on the land. For a community to maintain an ecological balance in the animals, subsistence rules are practiced. One rule is that, whenever possible, hunters seek to provide a mixed diet with animals of the sea and animals of the land. If this balance is not maintained in hunting, it is believed that the animals may disappear. Some years the seal are more prolific and available, so more seal is eaten. Other years more caribou or char will be abundant and consumed. The diet reflects this balance among land and sea animals. Hunters carefully respect the animals by maintaining the balance and thus ensure their future harvests. Plants are considered separately in the diet as treats that complement the standard animal fare when they are available. The most culturally desirable diet of the Inuit varies by mixing sea mammals, caribou, and Arctic char. The relative proportion of these three staples in the diet depends on the geographic location and local foraging practices of the group.

During the contact periods, European dry and canned staples were introduced as trade items across the Arctic. These new foods were slowly adopted into the Inuit diet. Foods became divided into two categories, "country" or foraged food produced by Inuit themselves, and store-bought or imported foods, obtained by trading furs or for cash. Common store-bought foods include tea, sugar, flour, biscuits, and breads. Other imported foods include canned fruit and jam, meats, fish, and vegetables. Store foods are considered inferior and incapable of sustaining health for anyone raised eating country food.

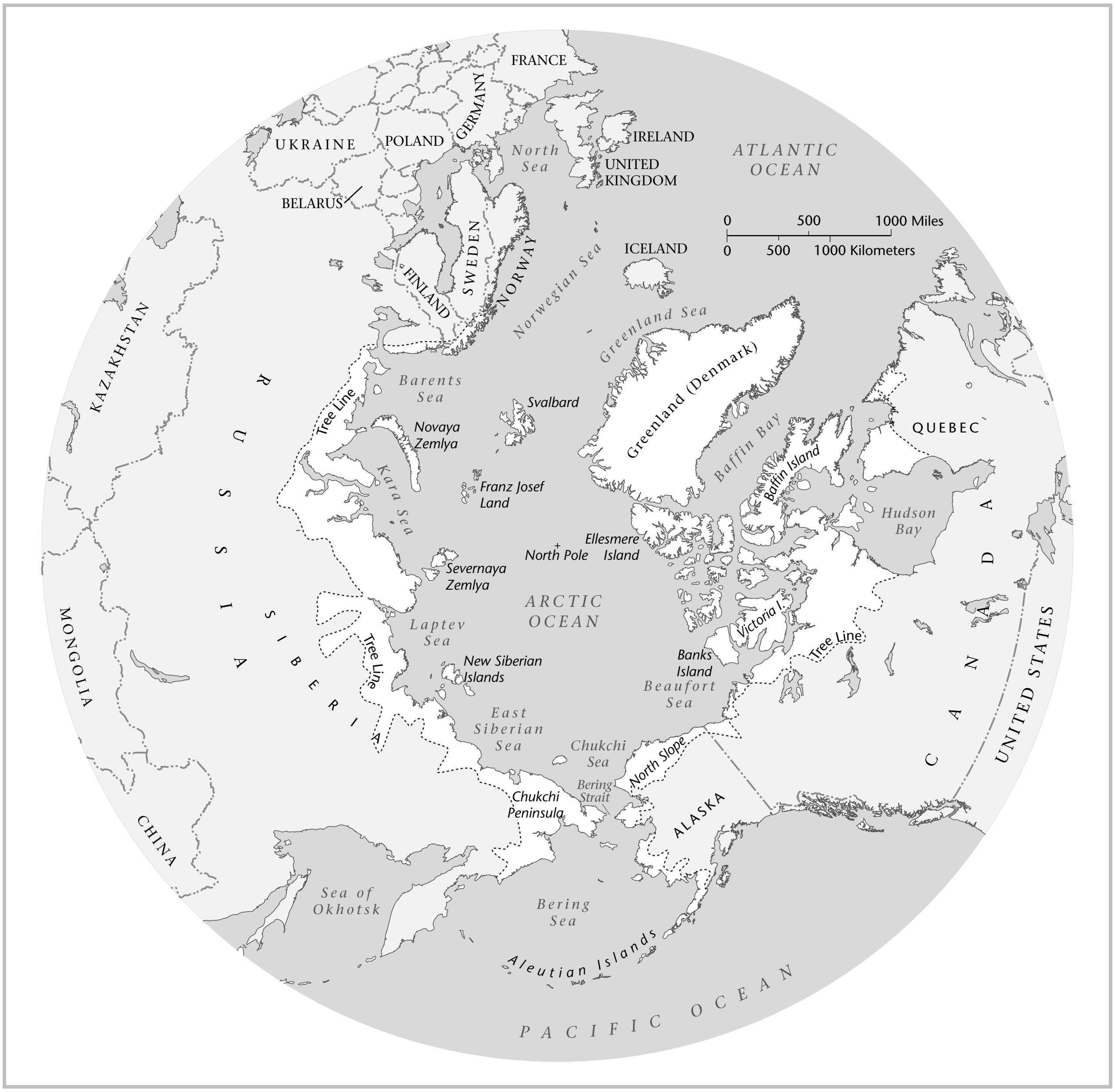
Meal customs and food distribution. Hunting and food sharing form the core of Inuit society. When hunters return with fresh game or fish, it is distributed for consumption according to social rules. This occurs at least several times a week. Meals are communal and all animal foods are shared, distributed first within the community and then within the household. During the distribution, fresh, or uncooked, meats are eaten by anyone who is hungry. The remaining portions are distributed according to the kinship or friendship relationship of the receiver to the hunter. The hunter, his wife, father, mother, or a related elder conducts this process. While this food remains in the household, family members eat it communally at least once a day.

The typical traditional meal includes fresh, boiled, fried, or grilled meats, organs, and soft bones. The food is served on the ground outdoors or on the floor of the shelter. The animal food is cut away from the butchered carcass with the personal knife of the individual and eaten without any other utensils. If the animal food is boiled, its broth is drunk after eating the meat. Everyone is expected to eat until hunger subsides. All visitors to a home are expected to partake of whatever game is available. Hoarding or overeating food is not acceptable. Birds, eggs, plants, and small fish or shellfish are usually eaten by individuals, but are shared on demand with anyone who is hungry.

As a result of contact with Europeans, drinking heavily sugared tea and eating bannock or some form of bread has come to follow the consumption of animal food. The bannock is made from flour, water or milk, and fat (lard, vegetable shortening, or caribou or seal fat) and baked on a rock or in a frying pan over a fire. Tobacco is then shared. Before black tea was introduced, herbs were collected for making teas.

Meal patterns are guided by hunger and age. Young children and babies are fed frequently on demand until they reach five or six. The adult demand for food varies, but fewer meals are eaten in winter than in spring, summer, and fall. On average, one full meal and two or three tea breaks are taken between sleeping. Elders eat less as they grow older, but drink sweetened tea more often. Immature seal, cached meat, and fish are favored by the very old individuals.

Men, women, and children eat together. The men eat with long knives (*sevik*) as they squat near the animal food, and women use the *ulu*, the traditional curved knife of Inuit women. Children use smaller versions of adult knives as soon as they can control them. Older infants and toddlers eat premasticated foods from their mothers, but are typically breast-fed until they are four or five. Orphaned or adopted babies are fed seal broth.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SWEDEN
NORWAY
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Norwegian Sea
KAZAKHSTAN
Greenland Sea
Barents Sea
Svalbard
Greenland (Denmark)
RUSSIA
Tree Line
Novaya Zemlya
Baffin Bay
QUEBEC
Baffin Island
Kara Sea
Franz Josef Land
Hudson Bay
Ellesmere Island
North Pole
Severnaya Zemlya
ARCTIC OCEAN
MONGOLIA
SIBERIA
Laptev Sea
Victoria I.
Tree Line
CANADA
UNITED STATES
New Siberian Islands
Banks Island
Beaufort Sea
East Siberian Sea
Chukchi Sea
North Slope
Bering Strait
Chukchi Peninsula
ALASKA
CHINA
Sea of Okhotsk
Bering Sea
Aleutian Islands
PACIFIC OCEAN

Food preparation. Food preparation varies by season and environment. At camp, Inuit share the communal feast daily. "Fresh" (uncooked) seal (*mikiayak*) or other marine mammals are prepared within a short time after the animal is captured. Camp dwellers are called by children to the feast. The hunter or a designated relative, typically his wife, opens the animal after the body has had time to "cool." Those who are feeling cold would eat first, as the rich blood (*auok*) and warm chunks of exposed liver (*tingook*) warm the individuals' bodies and restore health and well-being. The blood not consumed is drained and the animal gutted. Organ meats, especially kidney (*taktu*), are eaten or fed to dogs along with the fat scraped from the skin and other waste. Intestines are saved, and the outer covering chewed. A delicacy among the North Baffin Inuit is chopped fat and brains mixed with the animal's blood (*allupiauoq*) in the body cavity before the meat is eaten. Eyeballs are sucked but not swallowed. The skin is saved for household and clothing use. During hungry periods, when animals are scarce, the skin, scraped on both sides, can also be eaten. Seal "hips" are preferred by men in the Eastern Arctic, while women enjoy the tenderloin along the spine, the backbone, and the ribs. Shoulders, flippers, and forelimbs are eaten by both men and women.

Marine mammals can also be eaten frozen (*quok*), sliced thin as the individual eats from the carcass, or the meat can be aged. To prepare aged seal, for example, seal is packed in its skin and stored a few days or as long as three weeks. Rotted seal is cached in the fall for consumption the next spring or summer. *Ooyuk* is soup made by boiling meat in fresh water, and seasoned with kelp. Salt or dry soup mix often replaces kelp. Chunks of meat are eaten out of the pot, which is usually set over a seal oil lamp or an open hearth. Cupfuls of rich broth (*kiyuk*) are drunk. Seal is deep-fat fried in the summer or grilled on flat rocks over heather fires. Seal oil is produced by pounding the fat. This rendered oil is then stored in a seal bladder to be eaten with plants or raw or dried fish. In spring and summer, foods are cooked on heather fires, which gives them a wonderful herbal taste. Polar bear and walrus were once consumed fresh, or raw, but they are only eaten cooked, due to concern about Arctic trichinosis. Narwhal and beluga whale are prized for their sweet skin (*muqtuq*). The meats of these animals and other whales can also be eaten prepared as other meats are. Polar bear organ meats are never eaten.

While seal typically dominates the diet, caribou (*tuqtu*) is also widely consumed, prepared in ways similar to the seal. Caribou meat is also cut into pieces and hung to air-dry for storage. Birds are captured, their feathers plucked, and then eaten uncooked. Eggs are sucked. Arctic hare is boiled as *ooyuk*, never eaten uncooked. Arctic char are eaten fresh, filleted into three boneless pieces hung from the head, or partially air-dried (*serata*) or freeze-dried (*pisi*). The fish can be boiled as *ooyuk* or fried (*satoya*), or grilled as well. Shellfish are eaten raw or boiled, but are rare in the Eastern Arctic.

Seasonal variation. Seal, walrus, and polar bear typically dominate winter foods. *Ooyuk* is popular in winter, as are frozen foods. As the sun returns daylight to the land, spring begins and groups of related Inuit begin to congregate for camping and hunting seal. Short hunting trips include fresh seal picnics. Easter is marked by the spring caribou hunt and feast. Once the ice begins to break up, Inuit cannot travel safely. Whatever foods can be captured near land-based camps are eaten. When dried caribou, fish, and cached marine mammals are exhausted, the diet is aged seal oil with plants and, perhaps, fresh fish. Summer continues with full daylight, marked by open-water sealing and whale hunts, and *muqtuq* is prepared and consumed. Summer fish camps produce large numbers of char to eat fresh, frozen, or dried. Plants are gathered during long walks, mostly by women and children. Seal and caribou are fried and grilled. In August, the sun begins to leave the northern sky and early fall begins. A fall caribou hunt culls the migrating herds. Bulls are especially desired because of their rich fat. The quiet winter season returns and the annual cycle begins again.

Foods of the Saami

Saami occupy the Arctic and Subarctic. These people were colonized in the thirteenth century and little is known about their indigenous foodways prior to colonization.

Saami lived traditionally by following the herds of reindeer seasonally as the animals fed on lowland lichens and mushrooms in early spring and winter and highland grasses in summer. The bulls were culled from the herds in October, December, and January to provide meat for fall and winter feasting and storage by smoking and drying.

Saami, like Inuit, eat caribou, or reindeer, using all the edible parts of the animal. Like the Inuit, they eat their foods cooked, boiled, smoked, and roasted. Reindeer meat is boiled in a thick soup that resembles Inuit *ooyuk*. Meat is eaten out of hand from the pot and the gravy scooped up in a cup to be drunk. Saami drink reindeer milk and use it to make cheese, which is often smoked, something Inuit do not do. While some Saami are known for reindeer herding, other groups and frequently eat fish. Both Saami groups, however, consume fish, land mammals, plants, and birds. Saami diets have been greatly influenced by northern European cooking patterns and foods for the past seven hundred years.

See also **Canada: Native Peoples**; **Fish**; **Fishing**; **Inuit**; **Lapps**; **Mammals, Sea**; **Siberia**.

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Kristen Borré

ART, FOOD IN.

This entry includes five subentries:
Film and Television
Literature
Opera
Painting and the Visual Arts
Poetry

FILM AND TELEVISION

Food has been a popular and versatile film prop since the silent film era. It's a perfect cinematic prop—simple to prepare, readily understood by the viewer, and able to provide countless ways to move a story line along and advance the theme of a film, be it political, sexual, interpersonal, historical, or even mystery. At times food plays a supporting role enabling the main character to further the plot. At other times food itself plays a starring role.

The first and most enduring food prop is probably the pie, largely because it is easy to make and easily aimed at a person we don't necessarily want to hurt but whose dignity is at stake. According to Lorna Woodsum Riley's *Reel Meals Movie Lover's Cookbook*, Mabel Normand launched the first pie in film when she spontaneously threw someone's custard cream pie at Fatty Arbuckle in a Keystone Studio silent film, *A Noise from the Deep* (1913). This act garnered lots of laughs so Keystone studios, under the direction of Mack Sennett, repeated it in numerous other films, as did such silent film stars as Laurel and Hardy, Buster Keaton, the Three Stooges, and Charlie Chaplin. Blake Edwards, in an homage to the silent era, placed Tony Curtis in the midst of an enormous number of flying pies in *The Great Race* (1965), and Nora Ephron in *Heartburn*, her semiautobiographical novel that was made into a film in 1986, tells her philandering husband just what she thinks of him by squishing a Key lime pie in his face.

Pies weren't the only food used in early films. Laurel and Hardy were major advocates of food in film, as best revealed in *A Swank Dinner Party*. Since they were the waiters at that party, it was, of course, anything but swank. Hardy slips on a banana peel while carrying a huge cake, and even the swanky guests wreak havoc trying to nab the cherry in their fruit cocktail.

The scenes most remembered in some films are those in which food has played a supporting role. In *The Gold Rush* (1925, reedited in 1942) writer, director, and star Charlie Chaplin best demonstrated the dramatic possibilities of food. Finding himself freezing, starving, and snowbound in an Alaskan cabin with another prospector at Thanksgiving, Chaplin is unwilling to spend the holiday without an appropriate meal. So he boils one of his boots, carves and delicately plates it, offers his companion the choice of "sole" or "boot," and proceeds to eat the shoelace as though it were spaghetti. Simultaneously funny and touching, it is the film's most remarkable scene. Chaplin used food to make a political statement in *Modern Times* (1936) by showing the plight of the worker, in this case an assembly-line worker, and the heartlessness of management. To speed things up, a robot is devised to feed workers so they can continue working. In a hilarious scene Chaplin is given a meal of soup and corn on the cob by a robot that eventually runs amok.

The seduction scene in the Oscar-winning *Tom Jones* (1963) created a big stir because of the way in which food was used in an overtly sexual manner. Albert Finney, at his best as the womanizing Tom Jones, seduces actress Joyce Redman whom he has just met. Dining together, they consume chicken, oysters, and wine in a manner that grows more deliberate and increasingly sensual.

Woody Allen used food in *Annie Hall* (1977) to illustrate the cultural and ethnic differences of the film's protagonists. Midwestern WASP Diane Keaton is shown ordering a pastrami sandwich on white bread with mayo and tomatoes—a shock to Allen's New York Jewish character (pastrami sandwiches are always on rye with mustard). In *Five Easy Pieces* (1970), restaurant dining was difficult for Jack Nicholson, who had to use convoluted means just to get some toast, while Meg Ryan in *When Harry Met Sally* (1989) dictated in no uncertain terms exactly the way she wanted food served to her during lunch in a deli with Billy Crystal. This same dining scene also provided the perfect background for the film's most memorable scene—the fake orgasm.

Food and murder occur in equal proportion in Mafia movies. Francis Ford Coppola used lots of food in the first (1972) and third (1990) installments of *The Godfather.* Marlon Brando playing Don Corleone is shot while choosing fruit at an outdoor stand. And, after a rubout, Clemenza shows his priorities when he tells his partner "leave the gun, take the cannoli." Later Clemenza shows young Michael Corleone how to cook spaghetti with meatballs and sausage just in case he goes to jail and needs to know how. Near the end of the third *Godfather* film, Eli Wallach as Don Altobello waxes nostalgic about the virtues of olive oil just before he dies from eating a poisoned cannoli.

Director Martin Scorsese in *GoodFellas* (1990) presented a jail scene with actor Paul Sorvino carefully slicing garlic with a razorblade while a cellmate is preparing spaghetti sauce with beef, veal, and pork. Also on the menu are bread, cheese, prosciutto, steak, salami, peppers, and onions. This well-fed group of Mafia jailbirds sits down to eat a lavish meal with Frank Sinatra crooning in the background. Scorsese also showed he could film elegant dining. In *The Age of Innocence* (1993) there is a well-researched banquet scene resplendent with a floral and ice sculpture centerpiece, elaborate English bone china and silver tableware, impeccable service, and restrained table manners reflective of the late 1800s. The diners enjoyed oysters, fish, and other perfectly presented delicacies.

A septet of films has had particular success in casting food in a starring role. First among them is *Babette's Feast* (1987). Drawing from Isak Dinesen's short story, Gabriel Alex directed and wrote the screenplay for this Oscar-winning best foreign film set in nineteenth-century Denmark. Two adult sisters, the daughters of a pastor, live in a remote village where they have dedicated themselves to the service of God and relinquished all worldly desires. Babette, played by Stéphane Audran, is a French political refugee who is taken in by the sisters in return for working as their housekeeper and cook. Their meals consist largely of a humble gruel of bread soaked in ale. Some years after Babette's arrival, the sisters decide to hold a dinner to honor the hundredth anniversary of their father's birth and ask Babette to cook. She has recently won the lottery and sends her nephew to Paris to collect the necessary ingredients. Unknown to the sisters, she is a former chef, and she cooks for the sisters and the members of their little church the best feast ever shown on film. It begins with Potage à la Tortue, followed by Blini Demidoff aux Caviar Russe, Caille en Sarcophage avec Sauce Perigourdine, La Salade, Les Fromages, Baba au Rhum et Fruits Confit, Champagne Veuve Cliquot 1860, Clos de Vougeot 1845 wine, and coffee. Although her humble and religious diners had vowed to remain unaffected by the food, they are quickly overwhelmed by the mastery of this culinary artist who forever changed their lives.

Tampopo (1986), kind of a spaghetti western with a culinary theme, which was directed by Juzo Itami, demonstrated Japan's seriousness about food. Tampopo, a widow with a son, seeks the recipe for the perfect noodle to serve in her restaurant. Assisted by a truck driver who would have looked more comfortable on a horse, there is much intrigue along the way to noodle perfection. What makes this such a good food movie is the inclusion of a series of unrelated but very smart food vignettes ranging from sexual seduction to a lesson in the proper way for the Japanese to eat Italian noodles.

Charlie Chaplin in the 1925 movie *The Gold Rush* demonstrates the art of eating a boiled shoe. © BETTMANN/CORBIS.

Taiwanese writer and director Ang Lee serves up a multitude of enticing dishes in *Eat Drink Man Woman* (1994). The film opens with five minutes of master chef Chu, played by Sihung Lung, chopping, dicing, steaming, and frying in what is, to date, the best sequence of food preparation on film. Chef Chu, a widower with three grown daughters, tries to keep his family together by serving sumptuous Sunday dinners. He prepares enormous meals including steamed deer spareribs with ginger in a pumpkin pot and lotus flower soup plus one hundred other dishes all prepared for the film by famous Taiwanese chefs. Lee said he had to shoot each dish within eight seconds to capture perfect steam, a requirement he found very stressful.

La Grand Bouffe (1973) is a French film in which four men gather at a country house to eat themselves to death with fabulous food prepared by one of them who, fortunately, is a chef. A nonstop display of gorgeous food both cooked and uncooked includes the best wild boar, lamb from Mont-Saint-Michel, oysters, calves' heads, cod, beautiful pâtés, tarts, quail on skewers, pastas, pizzas, pullets, and pigs to name just a few. This film is an amalgam of beautiful food, ongoing sex, and a dismaying array of bodily reactions to too much food. Although it remains unknown why these four successful men want to eat themselves to death, the film does portray the horrors of excess. A food credit is given to the French store Fauchon.

Master chef Paul Bocuse is credited for the beautiful food in *Who Is Killing the Great Chefs of Europe?* (1978), a whodunit filmed in some of Europe's best restaurants. Worth viewing just to see Robert Morley play Max Vandevere, the disdainful and pretentious editor of *Epicurious Magazine*, the film portrays the trouble that begins when he selects four chefs to prepare a dinner for the queen of England. Jealousy sets in, murder ensues, and chefs are killed in the manner in which they prepare their signature dishes. There are beautiful shots of baked pigeon en croûte, pressed duck, the fish market in Venice, and the interiors of legendary restaurants

The Cook, the Thief, His Wife, and Her Lover (1989) is a complex and beautiful film in every way. Directed by Peter Greenaway, each frame looks like a Dutch genre painting. Costumes designed by Jean Paul Gaultier and a haunting musical score add to the film's lavishness. Here food provides the basis for magnificent still life frames while the lush red restaurant and eerie kitchen provide ongoing tableaux and the setting for a story about a loutish thief who thinks that dining in a fine restaurant elevates him to a higher social class. Not all is beautiful, however, in this film that also portrays denigrating sex scenes and cannibalism.

Laura Esquivel's novel *Like Water for Chocolate* (1993) was written as a prelude to a screenplay and includes recipes. In the film, directed by Alfonso Arau, Mexican family food is the star, and much of it has mystical properties that can start fires and evoke passion, sorrow, and uncontrollable yearning when it is cooked by the romantically unfulfilled Tita.

The decade of the nineties brought hefty expense accounts and ambitious restaurant dining in the United States. Coincident with this came three American films that explore restaurant life in remarkably different ways. *Big Night*, produced by Stanley Tucci in 1996, again explores the cook as an artist, much as *Babette's Feast* did, but within the difficult framework of cooking authentic ethnic cuisine in 1950s America. In 1998 Shari Springer Berman and Robert Pulcini directed a documentary entitled *Off the Menu: The Last Days of Chasen's*. Filmed just before the closing of the famed Los Angeles restaurant, it is a close look at a bygone era of Hollywood glamour when stars and movie moguls, dressed to the nines, made nightly appearances at their regular tables in this family restaurant where they were treated like valued family members and catered to in ways unimaginable in today's restaurant. *Dinner Rush* captured a very different restaurant scene, that of New York circa 2001. Directed by Bob Giraldi and shot in his own Tribeca restaurant, Gigino, *Dinner Rush* forthrightly portrays the downside of the restaurant business with its intrigues, food fads, trendiness, fickle customers, power struggles, critic corruption, and more. What with all of this, the film is edgy and fascinating and most likely tells it like it is.

Television

Food in television has mostly been of the "how to" cooking show genre. Gerry Schremp notes in *Celebration of American Food* (p. 99) that James Beard led the parade of cooking shows with weekly appearances in 1946, followed by Dione Lucas in 1947. Television pictures were black-and-white then, and only eight thousand homes had sets. Julia Child jump-started cooking shows with her 1963 inaugural series for public television, which was the leader in the production of such programs. Popular among viewers were the *Victory Garden* series and Jeff Smith as the *Frugal Gourmet*. Public television tends to feature cooking teachers and cookbook writers who are basically home cooks, creating food meant to be replicated at home. Capitalizing on an undeniable interest in good food, the genre catapulted to new and different levels when an entire cable network devoted only to food, the Television Food Network, was launched in November 1993, initially reaching three million homes and expanding to more than sixty million by the year 2002. The network experimented with a restaurant review show, a call-in show devoted to dieting and healthy eating, and, most notably, a one-hour live news show entitled "Food News and Views" that was, as its name suggests, devoted solely to the topic of food and drink. As the genre has matured, more attention has been given to the entertainment value of "cooking" shows, giving way to contests such as *Ready, Set, Cook* and Japan's entry, called *Iron Chef*, which features some unusual food video and involves a panel that judges the best dishes created during the time frame of the show. Attractive and youthful celebrity chefs have replaced home cooks on these shows, and celebrity food with refined ingredients and architectural presentation has replaced the homier presentations of earlier public television shows. A notably successful Food Network show has been that of Emeril Lagasse, whose catch phrases and natural good humor have made him its star. The Food Network, in turn, has given Emeril a live audience with which to interact, a band, and numerous other gimmicks to hold viewer attention. Martha Stewart became a television network cooking star in the late 1990s, combining her talents into a multimedia television, radio, cookbook, and magazine package.

Cooking shows are rarely done in real time. The standard format has the cook combining ready-to-cook ingredients, then going to a finished dish to show how it should look—which is usually splendid since television studios have state-of-the-art kitchens staffed with professional cooks and stylists who turn out elegant creations that either inspire or intimidate the viewer.

The History Channel broke new ground by presenting a series of documentaries entitled *America Eats: History on a Bun* (1999). More than just bun food, the histories of fried chicken, ice cream, soda pop, and pizza were explored with excellent use of archival footage showing how food and eaters alike used to look in America.

See also **Beard, James**; **Child, Julia**; **Humor, Food in**; **Styling of Food**.

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LITERATURE

François Rabelais in his irreverent and influential sixteenth-century novel *Gargantua and Pantagruel* writes "[t]he satirist is correct when he says that Messer Gaster—Sir Belly—is the true master of all the arts. . . . To this chivalrous monarch we are all bound to show reverence, swear obedience, and give honour" (pp. 570–571). According to twentieth-century literary critic Mikhail Bakhtin, Gaster is portrayed by Rabelais not as the creator of society, but more as the embodiment of the organized human collective. Because appetite is located in the viscera, "[t]he bowels study the world in order to conquer and subjugate it" (p. 301).

What better place to begin a discussion of food in literature than with Rabelais's novel in which references to food appear on nearly every page. This novel pokes fun at the sanctimoniousness of the hierarchy of the Catholic Church and the feudal elite by drawing on the humorous and vulgar language of the marketplace and the carnivalesque imagery of clowns, fools, giants, and dwarfs that were an integral part of medieval society. In carnival, the social hierarchy of everyday life is leveled, and individuals become united in a festival in which all participants are actors, and communal laughter mocks everyday society.

It is the belly and its appetites that give rise to the festival, and feasts of course inevitably accompany any festival. Such feasts celebrate the human encounter with and triumph over the world, in which food represents the entire process of cultivation, harvest, storage, trade, and preparation. Humanity devours the products of nature without being devoured by the world. This encounter takes place in "the open, biting, chewing, rending mouth" during carnival festivities (Bakhtin, p. 281).

Because of the excesses characteristic of celebratory feasting, Rabelais portrays his larger-than-life characters as capable of devouring much more than was humanly possible. Listen, for example, as the giant Pantagruel calls forth a feast for his men—with their grotesque bellies and wide-open throats—after a military victory in which only one opponent survived:

> He had refreshment brought and a feast spread for them on the shore with great jollity; and he made them drink too, with their bellies to the ground, and their prisoner as well . . . except that the poor devil was not sure whether Pantagruel was not going to devour him whole; which he might have done, so wide was his throat . . . and the poor fellow, once in his mouth, would not have amounted to more than a grain of millet in an ass's throat. (p. 250)

Food imagery in *Gargantua and Pantagruel* is just one of the more extreme examples of the feast in literature. The jovial, celebratory feast, the culmination of the process of growing food, in which humankind in social solidarity encounters the world with an open mouth, naturally gives rise to excellence in conversation, to wise speech, and therefore to literature.

In Plato's *Symposium*, for example, a group of prominent Athenians gather to discuss the nature of love over an elaborate meal, during which Socrates is both lauded for his wisdom and mocked for his homeliness. The feast also is a celebration and validation of a community, and a celebration of victory, such as a successful marriage, military victory, or treaty. Feasts, therefore, bring to a close several of Shakespeare's romantic comedies, such as *As You Like It* and the *Tempest.*

In Fielding's eighteenth-century novel *The History of Tom Jones, a Foundling*, for example, the hero's general lust for life is portrayed through his appetite for food and sex together. In the nineteenth century, when Victorian British society developed ambivalent feelings toward human appetites in general, Charles Dickens portrays one of his best-known characters, Oliver Twist, being thrown out of an orphanage for having more of an appetite than the authorities deem fitting.

Food in Culture and Memory

Feasts and food in literature, however, portray more than the mere physical appetite for food and a human triumph over nature in festivals. Each culture, with its own tradition of literature, also maintains its own distinct cuisine and distinct traditional rules that govern acts of eating. The food traditions of a community are composed not just of recipes, but of the methods and technologies by which foods are grown, gathered, stored, prepared, served, and thrown out. Such traditions include also culturally transmitted rules that govern ideas of health and cleanliness as related to food. Furthermore, each community that gives rise to a distinct literature necessarily also maintains culturally specific rules governing foods that are especially valued and foods that are especially shunned and controlling the contexts in which particular foods may or may not be eaten.

In events that involve the serving of food—from snacks to meals to festival feasts—networks of reciprocity among food preparers, as well as the relationships between those doing the cooking and those being served, become articulated. Food and events in which food is served, therefore, help define the social organization and cultural identity of the very communities that give rise to distinct literary traditions.

Because food customs call forth such a labyrinth of associations on the part of individual writers, and because the inherent sensuality of food involves not only the senses of smell and taste, but also the other senses, food is capable of evoking an avalanche of memories and feelings. Food imagery may appear, therefore, in literature as a source of deeply embedded associations that lead into the depths of individual and cultural memory. Perhaps showing the influence of Freudian thought, Marcel Proust's *In Search of Lost Time* (commonly known as *Remembrance of Things Past*) evolves from the narrator's memories brought out of the unconscious and into his conscious mind as he ate crumbs of "squat, plump little cakes called 'petites madeleines'," that he had dipped in a cup of tea:

> And soon, mechanically, dispirited after a dreary day with the prospect of a depressing morrow, I raised to my lips a spoonful of the tea in which I had soaked a morsel of the cake. No sooner had the warm liquid mixed with the crumbs touched my palate than a shudder ran through me and I stopped, intent upon the extraordinary thing that was happening to me. . . .
>
> Undoubtedly what is thus palpitating in the depths of my being must be the image, the visual memory which, being linked to taste, is trying to follow it into my conscious mind. . . .
>
> And suddenly the memory reveals itself. The taste was that of the little piece of madeleine which on Sunday mornings at Combray (because on those mornings I did not go out before mass), when I went to say good morning to her in her bedroom, my aunt Léonie used to give me, dipping it first in her own cup of tea or tisane. (pp. 60–63)

The Meal as Communion

Despite the availability of individual associations about food to a writer, it is the sharing of food within distinct food cultures that continues to be the major focus of literature about food. Furthermore, this sharing of food continues to be commonly portrayed in literature as a communion, even though the public festival of the late Middle Ages has, in modern society, become private. The famous Christmas feast that concludes Dickens's sentimental children's story, *A Christmas Carol*, with its flaming plum pudding and its transformation of the miserly Ebenezer Scrooge into a more generous soul, is a prototype.

The family dinner as a private religious festival is perhaps more clearly seen in Virginia Woolf's novel *To the Lighthouse*, in which a private dinner of *boeuf en daube* gives a well-housed coherence to an otherwise dark and fragmented world outside of the home. The cook and main character, Mrs. Ramsay, leads in this communion. In preparation, Mrs. Ramsay lights the candles,

> and the faces on both sides of the table were brought nearer by the candlelight, and composed, as they had not been in the twilight, into a party round a table, for the night was now shut off by panes of glass, which, far from giving any accurate view of the outside world, rippled it so strangely that here, inside the room, seemed to be order and dry land; there, outside, a reflection in which things wavered and vanished, waterily. (p. 108)

Expanding on the idea of the meal as a private festive occasion, Woolf writes that Mrs. Ramsay serves the main course of beef:

> And she peered into the dish, with its shiny walls and its confusion of savoury brown and yellow meats, and its bay leaves and its wine, and thought, This will celebrate the occasion—a curious sense rising in her, at once freakish and tender, of celebrating a festival. (p. 111)

A description of a fruit basket in the center of the table—the literary equivalent of a painting of a still life, writes Bettina Knapp, author of an essay about this dinner scene—concludes the description of the whole meal. The still shapes and the rich textures and colors in the basket of fruit represent, in peaceful form, the emotional complexities contained within the character of Mrs. Ramsay herself, and the serenity born of that particular meal.

Meals portrayed in literature as moments of light and warmth in the dark and cold are not uncommon. In Herman Melville's *Moby Dick*, Ishmael and Queequeg, the Fijian cannibal, share a meal of clam chowder in a jovial inn in cold and wintry Nantucket, Mass., just as they had shared a warm bed together earlier in New Bedford on a bitter New England night. Ishmael comments that to appreciate warmth it is best to feel as if you are "the one warm spark in the heart of an arctic crystal" (p. 48).

In perfect contrast to the social solidarity of the shared meal, Captain Ahab compares the life of isolation that he has led with the life of community that could have been his had he not been obsessed with the white whale. He states this contrast in the language of food as metaphor, and shared food—in this case, the breaking of bread—as communion:

> When I think of this life I have led; the desolation of solitude it has been; the masoned, walled-town of a Captain's exclusiveness, which admits but small entrance to any sympathy from the green country without—oh, weariness! heaviness! . . . and how for forty years, I have fed on dry salted fare—fit emblem of the dry nourishment of my soul!—when the poorest landsman has had fresh fruit to his daily hand, and broken the world's fresh bread to my mouldy crusts . . . aye, aye! What a forty-years' fool—fool—old fool has Ahab been! (pp. 477–78)

The Feast as a Focal Point of Plot

While plot in literature most often focuses on the vicissitudes of human relationships, on love, conquest, betrayal, and loss, rather than food, the feast—as both the culmination of one process and the beginning of another—naturally appears as a fulcrum on which plots can turn. Meals and feasts, then, often provide the framework for events. Meals that are not portrayed as placid communions, therefore, reveal the contradictions brewing in the plot. In Homer's *Odyssey*, it is just after a feast of the suitors, which the hero attends disguised as a beggar, that Odysseus announces his return and slaughters his rivals. In Shakespeare's *Hamlet*, the juxtaposition of the wedding of the bereaved queen too soon after the funeral of her husband elicits from Hamlet himself the ominous quip that "the funeral bak'd meats did coldly furnish forth the marriage tables" (Act I, scene ii, lines 180–181). By juxtaposing two antithetical feasts, Shakespeare warns the reader that foul play, yet to be revealed in full, has taken place.

In *Beloved*, the 1987 novel by Toni Morrison, the central tragic episode of the story—an escaped slave's murder of her own young daughter to prevent her from being taken back into slavery—is immediately preceded by a feast that celebrates the young mother's freedom. This feast begins innocently enough when the man who ferried the woman across the Ohio River to freedom brings two buckets of blackberries to the family to be made into pies. To the pies, the family incrementally adds turkey, rabbit, fried perch, corn pudding, peas, various breads, and desserts, and invites the whole community to attend. "Ninety people . . . ate so well and laughed so much, it made them angry," Morrison writes (p. 136). They were angered that this family would celebrate so proudly while others still suffered. Yet the reader knows from the beginning that the celebration is premature and therefore doomed: the young woman's husband, the son of the older woman with whom she has come to live, remains in slavery and in danger. The plot turns from victory to tragedy on the fulcrum of the feast.

An excessive meal can betray other excesses latent in the personalities of the characters. In *Anna Karenina* by Leo Tolstoy, the characters Levin and Oblonsky share a meal that seems vulgar in its quantity. During this meal of three dozen oysters, *soupe printanière*, turbot with sauce Beaumarchaise, roast beef, *poulard à l'estragon*, parmesan cheese, *macédoine de fruits*, vodka, champagne, and two bottles of Chablis—a gustatory metaphor for Tolstoy's opinion of the excesses of nineteenth-century Russian aristocrats—Levin speaks of his desire to propose to a woman half his age. Oblonsky, who himself has just been caught being unfaithful to his wife, encourages him. The food and conversation at the table encapsulate the magnitude of human desire that Tolstoy lays out in his novel as a whole, and cautions of the price that all pay for seeking the satiation of their desires.

Meals, Communion, and Counterculture in the American Novel

While in modern Western literature communion and meaning can be found around the dinner table, in the tradition of the American antihero, the bourgeois dinner table has sometimes been portrayed as stuffy and stultifying. Mark Twain perhaps began this tradition in *Huckleberry Finn* when he describes Huck complaining about having to abide by social manners at the Widow Douglas's house:

> When you got to the table, you couldn't go right to eating, but you had to wait for the widow to tuck down her head and grumble a little over the victuals, though there warn't really anything the matter with them,—that is, nothing only everything was cooked by itself. In a barrel of odds and ends it is different; things get mixed up, and the juice kind of swaps around, and the things go better. (p. 4)

Countercultural characters similar to Huck appear recurrently in American literature. In this tradition, the wild out-of-doors, away from the social conventions of the dinner table, engender their own religious sensibility. In its suspicion of conventional modernity, this countercultural sensibility relates to the conventional the way that the carnivalesque related to feudal culture. Sometimes this suspicion of the conventional can also be symbolized by food, by a countercultural communion of sorts.

Ray Smith in Jack Kerouac's *Dharma Bums* speaks of himself as a religious wanderer, hops a train going north from Los Angeles, and shares a counter-communion in the freight car with an old hobo:

> The little bum was sitting crosslegged at his end before a pitiful repast of one can of sardines. I took pity on him and went over and said, "How about a little wine to warm you up? Maybe you'd like some bread and cheese with your sardines?" (p. 4)

The communion on the freight train ends with the little bum "warming up to the wine and talking and finally whipping out a tiny slip of paper which contained a prayer by Saint Teresa announcing that after her death she will return to the earth by showering it with roses from heaven, forever, for all living creatures." (p. 5).

Whether in a public festival, a private bourgeois home, or in a distinctly nonbourgeois boxcar, the sharing of food in harmony is indeed a blessing, as the saintly shower of roses ending this one literary meal indicates.

Food and Social Healing

Finally, another strand of food literature in the United States is represented by *Dinner at the Homesick Restaurant* by Anne Tyler and *Home at the End of the World* by Michael Cunningham. In Tyler's work, Ezra, the youngest child of a broken home, opens a restaurant called Homesick Restaurant, where he fervently hopes the world's emotionally wounded will find healing in the nurturing environment of a restaurant that serves home-style cooking. In *Home at the End of the World*, a nontraditional family opens the Home Café in Woodstock, N.Y., hoping to offer the world honest, home-cooked food, when traditional fare has become so processed and standardized that it fails to meet the needs of a materialistic, spiritually bereft American nation.

See also **Brillat-Savarin, Anthelme**; **Etymology of Food**; **Feasts, Festivals, and Fasts**; **Folklore, Food in**; **Herodotus**; **Language about Food**; **Luxury**; **Metaphor, Food as**; **Petronius**; **Rabelais, François**; **Sensation and the Senses**; **Shrove Tuesday**; **Symbol, Food as**.

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Jonathan C. David

OPERA

Just as one cannot separate words and music to get at the mystery of opera, food and opera are more compelling together than they are apart. The most immediate connection between the two is at the mouth and throat. Singers are understandably focused on these areas and seek gustatory gratification as a means of dealing with preperformance jitters and postperformance elation and exhaustion. It is not uncommon for a singer to lose five pounds during a long evening of exertion while wearing a thirty-pound costume under hot lights.

Singers and audience members both have their dining traditions. Each tends to eat sparingly before a performance: singers to avoid feeling full (although Beverly Sills famously ate steak before going onstage) and operagoers so that they will not doze off while digesting a large meal. At intermissions some audience members have a light snack and a refreshment. Singers will seek liquid refreshment during performances—Birgit Nilsson often had a beer waiting at the side of the stage to slake her thirst. American tenor Richard Leech chomps on ice cubes to keep his mouth and throat cool.

Following performances, there is—especially in Europe—a tradition known as "souper." This is late-night eating in which the food is more festive than gastronomically challenging. The idea is to continue the sense of occasion that a night at the opera can foster. At a souper meal, whether attended by musicians, audience members, or both, dishes might include smoked fish, boiled shrimp with piquant sauces, rollmops, broths, risotto or pasta with truffles and cheese, boiled beef, and cakes, all washed down with copious amounts of wine, beer, and, especially, sparkling wine. The goal is that the food be tasty and arrive quickly. The most famous operatic depiction of souper is in the second act of *Die Fledermaus* by Johann Strauss Jr., in which party guests dance, sup, and sing in praise of champagne.

It is not surprising that chefs vied to create dishes to honor singers, composers, and opera characters. While performing at Covent Garden in London, the famous Australian opera singer Dame Nellie Melba dined at the nearby Savoy Hotel where the French chef Georges-Auguste Escoffier created in her honor both a form of well-browned, very dry "Melba" toast and a dessert he called "Peach Melba," consisting of a poached peach covered with vanilla ice cream and a special raspberry sauce and a garnish of chopped pistachios. Escoffier also created Sole Otello, combining the dark hues of truffle and mushroom (for Othello) with the pure white fish (for Desdemona). Luisa Tetrazzini had her famous turkey and noodles, and Gioacchino Rossini (opera's greatest gourmand) lent his name to any dish that featured truffles and foie gras. Enrico Caruso loved chicken livers, so preparations that included them bore his name. Wagner, a vegetarian, did not inspire chefs. Nor did Beethoven, who resented having to periodically stop composing to seek sustenance.

Although many operas seem to have drinking songs and choruses (in part because singers willingly consume thirst-quenching beverages onstage), there are not many eating scenes for the simple reason that food would obstruct the singers' vocal equipment. Mozart's Don Giovanni, who satisfies many appetites in the course of the opera, does dine heartily in the second act, although most interpreters of the role mime eating and ingest very little. Puccini's Tosca plays with her food in the second act until she discovers the knife that she will use to kill Scarpia. The funniest eating scene in opera comes in Rossini's *L'Italiana in Algeri*, in which the Italian Isabella feeds copious amounts of spaghetti to Mustafà, her Algerian captor, to distract him as she engineers her escape. As she runs to a ship in the harbor, Mustafà is dutifully twirling his pasta as he has been instructed. Surely the mezzo-soprano, once the curtain falls, will seek a bowl of noodles all her own.

See also **Escoffier, Georges-Auguste**; **Italy**.

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Fred Plotkin

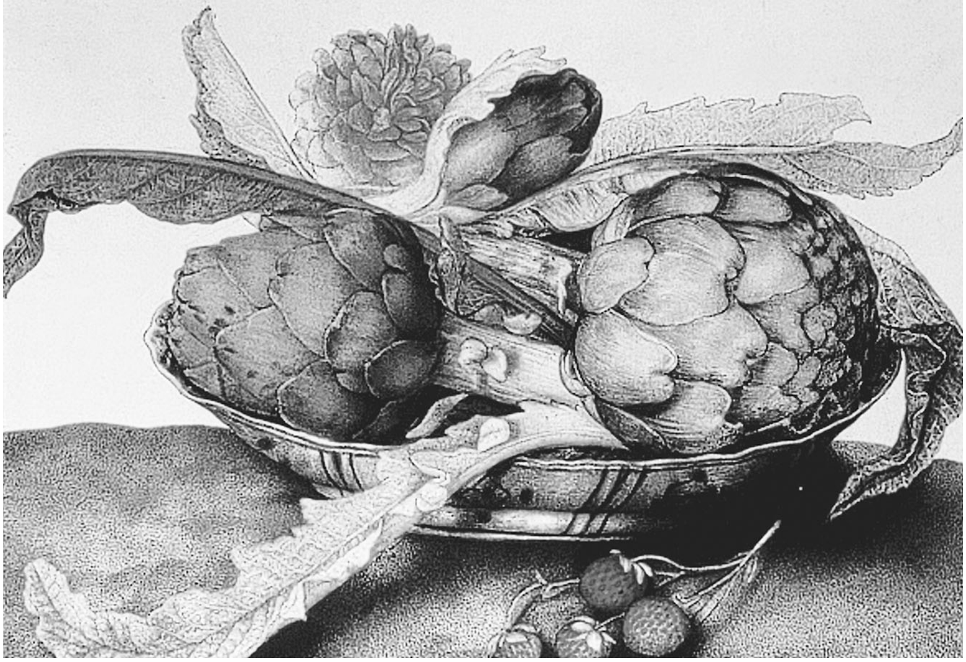
Painting and the Visual Arts

Within the purview of world cultures, the vast majority do not address the subject of food in art in a gustatory manner or, at least, not to any great extent. When the subject emerged in the Mediterranean Basin, it was the Italians—one of whose bequests was the very concept of *cives* (or civilization)—who have had the longest history of a preoccupation with food. This being said, all art about food for eating in the West can be divided into three parts: leftovers on the floor, food displayed in preparation for the meal, and completed dishes, whether cooked or ripe, set out on a table, ledge, or some other flat surface. The ancient Greek beginnings were preserved by the Romans and feature the *rhopoi*, the trivial remains of a meal found in a floor mosaic that call to mind the excesses imagined by Petronius for the feast of the ex-slave Trimalchio in the *Satyricon*. Alternatively, there is the *xenion*, the gift of food laid out on a ledge and painted on the wall in trompe l'oeil to tempt and tease a tired traveler.

With the establishment of Christianity as the official religion of a declining Roman Empire, secular subject matter went into eclipse. However, there was still food on the table in the proper sanctified contexts, such as the *Feast in the House of Levi*, the *Wedding at Cana*, *Christ in the House of Mary and Martha*, the *Last Supper*, and the *Supper at Emmaus*. Medieval renderings of these subjects feature food only in its rudiments. But from the Renaissance through the Baroque periods, there is a resurgence of worldliness, manifesting itself in a considerable interest in the menu and the table setting. Tintoretto's *Last Supper*, in the Church of San Giorgio Maggiore, Venice, is a case in point. Here, the serving of a wide range of foodstuffs by assembled servants distracts from Christ's proleptically offering the Host to his disciples. Another example is Veronese's huge *Last Supper* for the Monastery of Santi Giovanni e Paolo, Venice. Wine in large bottles, wrapped in leather or raffia, is poured into hand-blown Murano goblets. A large bowl holding fowl is set before Jesus; a mercenary walks away from the table with a plate full of food, tipping his head back to down his wine. Veronese even records that cutlery invention borrowed from Byzantium, the fork. When the Inquisition objected, Veronese pled artistic license, but changed the title to *Christ in the House of Levi*.

A very important entrepôt for the depiction of food and its cultivation is found in the calendar pages and borders of the Books of Hours of the early Renaissance. In the *Book of Hours* of Catherine of Cleves, the cooked, pricked biscuits and pretzels, and the raw mussels, a crab, and fish eating fish, border the images of individual saints. A notable instance of calendar events is found in the Limbourg Brothers' *Les Très Riches Heures du Duc de Berry*. In January, Berry sits at a groaning board to celebrate the Feast of the Epiphany; in September, the grapes are harvested at his favorite chateau. A second broadcasting of seed occupies a peasant in October, while by November, peasants are tasked with shaking down acorns to fatten the boars that will be consumed at Christmas. This tradition of seasonal occupations and festivities carried over into oil painting in the five great landscapes by Pieter Brueghel the Elder. His *Return of the Hunters* illustrates a perennial activity in the dead of winter, the slaughtering and singeing of a hog. Brueghel also essayed the novel subject of Carnival battling with Lent, who proffers the fasting foods of pretzels and herring on a peel in opposition to the skewered viands of gluttony.

In the secular realm, Renaissance Italy set the tone for the rest of Europe in art, in horticulture, in cuisine, and in prolonged, elaborate feasting that was both a political statement and a gastronomic assault. Paintings of interiors of vast noble kitchens filled with activity provide visual complements to the descriptions of state banquets set down by the professional cook Bartolomeo Scappi in his monumental *Opera* (1570). At the opposite end of the spectrum are the exquisite watercolors on parchment created by Giovanna Garzoni, many of them for the Medici, who were avid innovators in gardening. Frequently, her figs, broad beans, artichokes, or cherries, painted life-size, are set out in bowls lined with grape



Still life with artichokes in a Chinese dish by Giovanna Garzoni (1600–1670). Collection of the Pitti Palace, Florence. PHOTO COURTESY OF DR. PHOEBE LLOYD.

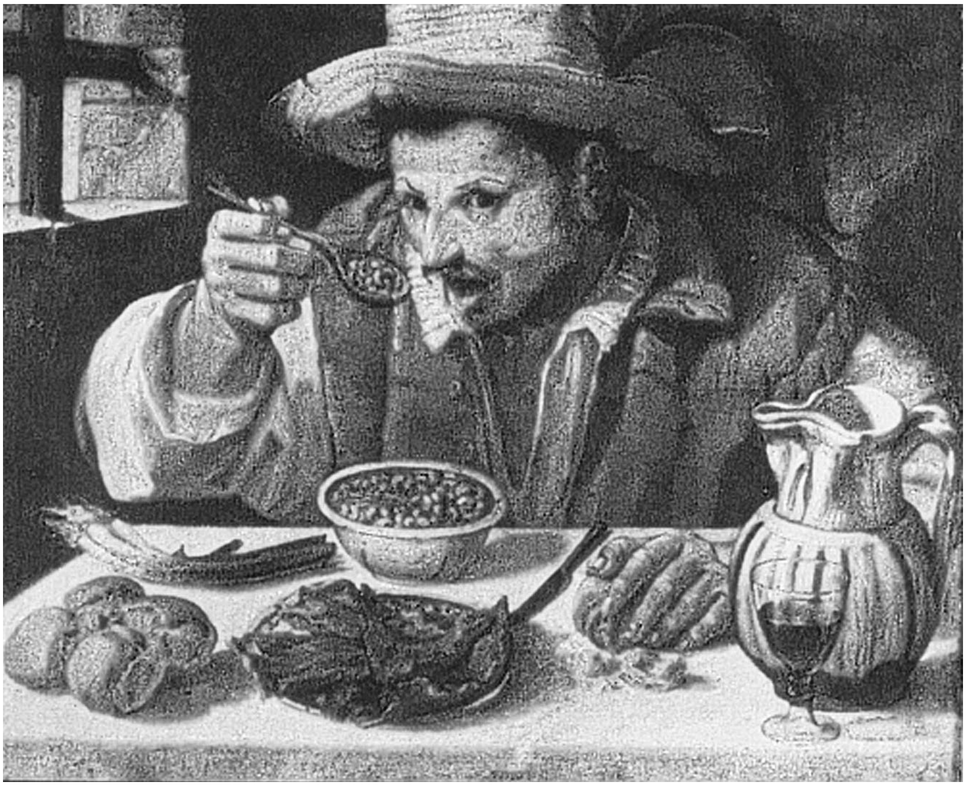
leaves that are placed on Mother Earth to honor the Tuscan preference for rustic food fresh from the land. A contemporary foil to Italy's gastronomic bliss is Anthonius Claesson's painting of an English family of ten saying grace at a table, where a roast of beef holds center stage framed by two great salts. There is a round loaf of bread on the table, but no vegetables, and an old-fashioned cut of bacon is being carried to the table.

It is this Italian absorption with food that prompted Annibale Carracci to invent the first genre paintings in the 1580s. Although he excelled as a history painter, Carracci departed from this exalted calling when he painted two scenes of meat stalls, where butchers were plying their trade, and another of a peasant *mangiafagiolo* (bean eater), mouth agape, hungrily shoveling in beans. Following on the heels of Carracci, the archrebel Caravaggio revived the *xenion* tradition in the 1590s with his *Basket of Fruit*. The fruit is piled high in a wicker basket that extends over a ledge. A similar basket of fruit at the table's edge graces his *Supper at Emmaus*, where the realism of the well-accoutred table is balanced against the miraculous moment of Christ's revelation.

By the seventeenth century, the Dutch, whose country was arguably the wealthiest in Europe at that time, rivaled the Italians in prolonged feasting and in paintings about comestibles characterized by spillage and overabundance. That Dutch still life of the interrupted meal and genre paintings of market scenes and the stalls of fishmongers and butchers may be vanitas symbols or allegories of gluttony, or the five senses, respectively, is much debated. Whatever their symbolic charge, they, nevertheless, reveal what went onto the Dutch table and into the Dutch stomach. In stark contrast to these paintings that become touchstones for everyday experience is Rembrandt's depiction of the *Slaughtered Ox*, where the stilled life of the carcass, slit down the belly, splayed and hung, functions on the level of metaphor.

The Dutch and the Spanish, who were united under Habsburg rule until 1581, diverge in their depictions of food. Spanish art's distinctive contribution is the *bodegón*, where food is displayed on a ledge in stark raking light. The *bodegón* replicates the environment in which Spanish food was often placed, since in that hot Mediterranean country the kitchen was located in the basement with windows placed high in the wall. Outstanding examples of the *bodegón* aesthetic are found in the oeuvre of Sanchez Cotan, whose works have been rightly pronounced "solemn, magical larders." *Bodegóns* are for contemplation, not consumption.

The French, who from Gallic times had displayed an especial affinity for food's preparation, did not produce distinctive still lifes and genre paintings with foodstuffs until the eighteenth century. Then Chardin, whose subject matter so often addresses the domestic worlds of working-class maids and middle-class mothers, masterfully crafted works that reflected their domain in the kitchen and at table. Some of his still lifes can even be read as a list of ingredients that make up a particular dish.



The Bean Man shows an Italian peasant enjoying a bowl of beans. Painting in the collection of the Galleria Colonna, Via della Pilotta, Rome. REPRODUCED BY PERMISSION.

Concurrently, Boucher introduced the subject that was destined to become a French preoccupation, the *déjeuner*.

Although the Philadelphia still life painter Raphaelle Peale probably did not know the work of Chardin, he, too, assembled and painted raw ingredients for a meal. His other specialty was depicting a variety of skillfully decorated cakes. It is germane that, by the Federal era, Philadelphia was not only America's most culturally sophisticated and ethnically diverse city, but also her culinary capital.

On the Spanish front, the early nineteenth century witnessed Napoleon's Peninsular War and the retaliatory tactics of guerrilla warfare. In this brutal atmosphere, Francisco Goya also pursued the idea of still life as metaphor. His three gutted salmon slices, rendered a pulsating deep pinkish red, are not set forth in anticipation of a meal. The painting is about evisceration.

By contrast, there are numerous instances when it becomes clear that artists have been preoccupied with food's pleasures. The record goes back to Michelangelo. His illustrated list for a Lenten menu, though restricted to bread, fish, and wine, expands as he contemplates the happy possibilities. Not surprisingly, it is in nineteenth-century France, in the era when French haute cuisine was perfected, that the joys of the table begin to proliferate in art. Renoir's *Luncheon of the Boating Party*, which takes place at the Restaurant Fournaise on an island that divided the Seine at Chatou, celebrates a meal that has advanced to the dessert course. Renoir's friend Monet was equally taken with the subject of mealtime; it is significant in this regard that at one point Renoir stole bread so that the Monet family would not go hungry. Early in his career, Monet depicted the *déjeuner* as it was consumed by family or friends on four occasions. Later in life, when Monet was established in his career and could afford to buy a house in Giverny, he would give special consideration to the interior decoration of the chrome yellow dining room, down to the detail of two sets of china. His cooking journals record what was placed on those plates. Bonnard is another French artist who depicted the pleasures of the table. Nor should it be forgotten that the painting that launched the Impressionist rebellion was about—and not about—lunch: Édouard Manet's *Le Déjeuner sur l'Herbe*.

Matisse helped usher in modern art by serving up the resplendent *Harmony in Red* (1908–1909). Against a red wall decorated with blue floral arrangements, a motif that flows onto a red table holding two wine decanters, fruit, and rolls, a maid bends slightly to arrange more fruit on a compote. A riveting instance of a Surrealist's preoccupation with food on the table is René Magritte's

1935 *Portrait*. Magritte's scene is set in a bistro with a bottle of wine and a place setting for one gracing the table. In keeping with his conviction that images are treacherous, Magritte fills the plate with a round slice of ham containing one centered eye looking up at the diner, hence the artist's title. Another Surrealist contribution is Meret Oppenheim's *Objet*: *Déjeuner en fourrure*, a fur-lined teacup and spoon that has become a veritable icon.

As the twentieth century progressed and people became more removed from food's involved preparation, art about food lost its celebratory aspect. Edward Hopper's *Night Hawks* (1942), though set in a diner, is hardly about the enjoyable consumption of food. Rather it exudes the grim impersonality found in film noir. As the availability of food came to be taken for granted on account of mass production, art about food dwindled into banality. Several 1960s Pop artists addressed the topic. Wayne Thiebaud's deliberately monotonous pies and cakes, so synthetic looking, are reminiscent of the days of the Automat. A further distancing of food from contexts of nurture and nature is found in Andy Warhol's obsession with highly commercialized processed food in his images of soup cans and bottles of Coke that unfold repetitiously. Claes Oldenberg's response was to transmogrify junk food. In 1979, Judy Chicago completed *Dinner Party*, a tribute to famous women that took the form of a particularized place setting representing each woman, the settings themselves laid out along the raised rim of a triangular table. It fell to a farm girl born in Sun Prairie, Wisconsin, in 1887, to hold to tradition. Although Georgia O'Keeffe never painted food and did not cook herself, she appreciated others who did and would prepare superbly the fresh, simple foods she relished; and she enshrined their recipes just as Monet or Alice B. Toklas had, by keeping a food journal.

See also **Arcimboldo, Giuseppe**; **France**; **Italy**; **Low Countries**; **United States**.

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Phoebe Lloyd

POETRY

Food has been a topic of poetry for many centuries and in many cultures; the notion that food writing and poetry writing are totally separate ventures is a recent development. Much of our knowledge of eating habits, culinary practices, and food taboos throughout history and around the world comes from poetry. Food in poetry also functions as a powerful symbol of spiritual and moral states, and at other times it is used as a sexual symbol.

The Chinese have a long tradition of including food in poetry, going as far back as the Chou Dynasty (from the 12th century B.C.E. to 221 B.C.E.). There are Chou poems celebrating festive foods of the time, including stewed turtle, fried honey cakes, duck, quail, and good wine, and discussing the preparation of rice. The *Shih Ching* (Book of Songs) includes food scenes such as lamb sacrifice, in which the aroma of the roasting meat is described and fruit and wine are offered; verses on a feast of rabbit and plenty of wine; a song rejoicing in family togetherness at a feast including such meats as lamb, ox, and tripe, and an abundance of wine; agricultural songs celebrating wheat, millet, barley, plums, cherries, dates, melons, gourds, beans, garlic, and rice (from which wine is made). The culinary abundance of the T'ang Dynasty (618–907) is strongly evident in its poetry, which contains paeans to plums, pears, persimmons, jujubes, many kinds of melons, spring wine, and peaches, which were a traditional symbol of immortality in Chinese poetry and painting. Poems were also forums for discussing differences between foods. For instance, the eighth-century poet Chang Chiu-ling used poetry to address the many ways in which lychees and longans are not similar fruits at all, despite their superficial similarities. Poems written during another prosperous period, the Ch'ing Dynasty (1644–1922), link food and sex, with female beauty and sexuality compared to melons, cherries, and grapes.

Food is also an important presence in classical Western poetry. Homer's *Iliad* and *Odyssey* are rich with scenes of feasting, as well as of ordinary eating. In a famous scene from the *Odyssey*, Odysseus and his crew, trying to return by sea to Ithaca, stop at an unknown land whose inhabitants, the Lotus Eaters, offer a lavish banquet to the three men who are sent to explore. The fruit (or the juice from the fruit) that the men consume gives them great pleasure and also makes them forget all thoughts of home and family so that the other crew members must drag them away by force. Homer also describes the feast of roast meat served to Odysseus by Achilles. The Greek poet Hesiod wrote about enjoying good wine with meat and bread. The Roman poet Martial wrote a great deal about foods, such as figs, olives, parsnips, chicken, fish, cheese, eggs, chives, shallots, and onions, to name a few. Virgil described milk and cheese in his *Georgics*, which celebrates the agricultural life and mourns the dissolution of Italy's farms after famers were sent to war. Ovid wrote about olives and grapes in the *Amores*. In Greek mythology, the six pomegranate seeds eaten by Persephone (daughter of Demeter, goddess of agriculture) in the underworld after her abduction by Hades, are the mythical reason for winter: For each seed consumed, Persephone must spend a month of the year in the underworld, causing her mother to grieve and neglect her work. The story of Persephone and the pomegranate seeds continues to influence contemporary writers. In her collection *Mother Love*, the American poet Rita Dove writes of a modern young woman's journey to Paris that parallels Persephone's descent into the underworld. Her meal at "the Bistro Styx" includes Chateaubriand, Camembert, pears, figs, parsley, bread, and Pinot Noir. A mourning modern Demeter has a Spartan breakfast of cereal and raisins and puts stones into it.

Roman poets, including Catullus, Horace, and Martial, also wrote dinner-invitation poems. In the invitation poem, the poet cajoles the addressee into coming for dinner. He may describe the foods that are going to be served, talk about the wine that is going to be poured, and describe the entertainments that will be offered. Invitation poems are not only a source of information on what the Romans ate, but also literary documents in themselves. This tradition did not end with the Roman Empire. In the style of the classical invitation poem, Ben Jonson's "Inviting a Friend to Supper" describes a meal of salad, mutton, fowl, cheese, fruit, pastry, and wine. Another, more extensive food catalogue occurs in Jonson's "To Penshurst," which includes pheasant, carp, eels, cherries, plums, figs, grapes, quinces, apricots, peaches, cake, nuts, apples, cheeses, pears, beer, bread, and wine.

Food in Ovid's *Art of Love*

The Roman love poetry of Ovid (43 B.C.E.–17 C.E.) reminds us of the ways in which food can serve erotic or aphrodisiac purposes. He talks of signals exchanged between secret lovers across a dinner table, and of messages written with a finger in spilt wine. He imagines a rival carefully mixing wine for a girlfriend, selecting the tastiest morsels from a serving dish for her to enjoy (Ovid, *Amores*, book 1 poem 4, and book 2 poem 5; see Ovid, *The Erotic Poems*, translated by Peter Green, Harmondsworth and New York: Penguin, 1982).

Ovid makes fun of aphrodisiac foods in a tongue-in-cheek didactic poem on love and seduction, in which he conscientiously lists several of such foods that Romans believed to be effective:

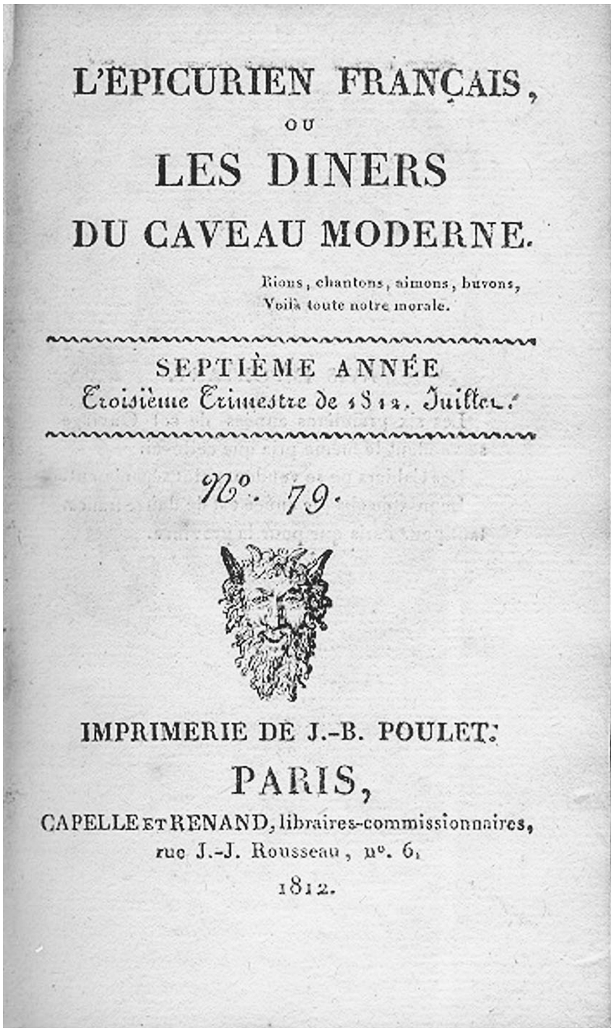
> Some old women will tell you to take dangerous herbs and salep (I judge these to be poisons), or they will mix for you pepper and stinging-nettle seed and pellitory chopped into vintage wine. But the Love Goddess . . . does not permit her pleasures to be forced in that way. You can try the white bulb that comes from Megara; try the lascivious rocket leaf grown in gardens; try eggs; try honey from Mount Hymettus; try the nuts that are found in prickly pine-tree cones (Ovid, *Art of Love*, book 2, lines 415–424. Translation by Andrew Dalby).

Salep is the ground root of an orchid (*Orchis mas* and other species) that is familiar as a hot winter drink in Turkey and the Balkans. Pellitory-of-Spain or Spanish chamomile is an ancient medicinal herb (*Anacyclus pyrethrum*). Rocket leaf (*Oruca sativa*) is the spicey-leafed plant arugula. The grape-hyacinth bulb (*Muscari comosum*), once a speciality of Megara in central Greece, is often served as an appetizer: it is known as *volvi* in modern Greek and *lampascioni* in Italian. Mount Hymettus, near Athens, is a source of fine honey.

Andrew Dalby

In the medieval Arab world, among those with sufficient resources, poetry and food were enjoyed in tandem, in lavish fashion. At banquets given by the caliphs, poems naming each dish—and recounting the spices and herbs used in its preparation, as well as the method of cooking—were recited during the dinners, so that the guests might savor the poetry along with the food.

There is food poetry in the Bible, as well. Throughout the Song of Solomon, the male and female narrators compare one another to fruits and other foods. The man's cheeks are compared to a "bed of spices"; the woman's breasts are described as "clusters of grapes" and her nose



L'EPICURIEN FRANÇAIS,
OU
LES DINERS
DU CAVEAU MODERNE.

Rions, chantons, aimons, buvons,
Voilà toute notre morale.

SEPTIÈME ANNÉE
Troisième Trimestre de 1812. Juillet.

Nº. 79.

IMPRIMERIE DE J.-B. POULET.
PARIS,
CAPELLE ET RENAND, libraires-commissionnaires,
rue J.-J. Rousseau, nº. 6,
1812.

Title page of *L'épicurien français,* a popular collection of poems and stories with food themes from early-nineteenth-century Paris. ROUGHWOOD COLLECTION.

as smelling like apples. Figs, grapes, vines, and pomegranates are used to describe their love for each other. The apple tree, standing out among other trees, represents the beloved's standing out among men. Other foods mentioned in the exchange include honey, milk, saffron, and cinnamon.

Food is inherent to many traditional songs and poems of the Celtic world and in England. For instance, an Irish saying goes: "Rye bread will do you good, / Barley bread will do you no harm, / Wheat bread will sweeten your blood, / Oat bread will strengthen your arm." Early Celtic poems tell of affection for such foods as mushrooms, milk, and colcannon, the Irish dish of mashed potatoes with cabbage or kale. In England, a song once accompanied the churning of butter: "Come, butter, come, / Come, butter, come, / Peter stands at the gate / Waiting for a buttered cake, / Come, butter, come."

In the sonnets, Shakespeare invokes appetite and eating as metaphors for human behavior, beginning with images of famine and gluttony in Sonnet 1, "From fairest creatures we desire increase." In Sonnets 56 ("Sweet love, renew thy force") and 110 ("Alas! 'tis true, I have gone here and there"), appetite represents desire. In Sonnet 75, which opens with "So are you to my thoughts as food to life," appreciation of the beloved is compared to feasting, and the speaker without the beloved is "starvèd for a look." In Sonnet 52, infrequency of "feasts" gives them meaning, and in Sonnet 118, the eating of "eager compounds" and "bitter sauces" is contrasted with the sweetness of the beloved.

Jonathan Swift, whose concern with matters of hunger reached its most famous height with "A Modest Proposal," the essay in which he ironically suggests fighting hunger by eating children, saw fit to write poetry about onions, oysters, and fishmongers. Robert Burns's "Address to a Haggis" is traditionally recited with the serving of the Scottish dish. The English writer Sydney Smith composed recipes in verse, giving instructions for preparing salad dressing and roasting mutton, for instance.

In the twelfth-century Celtic poem "The Vision of Mac Conglinne," Mac Conglinne helps a king overcome his gluttony. The poem, delectable not only to poetry lovers but also to scholars of medieval Ireland, catalogues an outrageous abundance of foods, including salmon, kale, hazelnuts, sausages, bread, cheese, bacon, and especially milk, which is described as being so thick that it must be chewed.

Food in poetry sometimes carries moral significance. In an archetypal episode in Ovid's *Metamorphoses*, the poor couple Baucis and Philemon share their meager food supply with beggars, who turn out to be gods in disguise and reward the couple with abundance. The biblical story of Eve's eating of the forbidden fruit, said to be an apple but possibly a pomegranate, is portrayed as the first human sin and the reason for man's state of sin. The story of Eve's giving in to the tempting fruit also starts off John Milton's epic on the fall of mankind, *Paradise Lost*. In Chaucer's *Canterbury Tales*, food is an important element in maintaining the balance of bodily humors, and gluttony is addressed as one of the Seven Deadly Sins. Gluttony is severely punished in Dante's hell. And food taboos are part of the human struggle: In Byron's *Don Juan*, a starving crew of seamen resort to cannibalism, but only after a long and horrible effort to avoid it.

Food in poetry can have transformative, and sometimes destructive, powers. In the English epic *Beowulf*, feasting (which always involves plenty of drinking) is generally followed by sleep, which makes the men vulnerable to attacks by the monster Grendel, who feasts on men. (Feasts in *Beowulf* are also given to honor people, and are the backdrop against which many discussions and confrontations take place.) In Samuel Taylor Coleridge’s “Kubla Khan,” the consumption of milk and honey is linked to an altered state of mind. John Keats paid close attention to food in his poems and letters; in his poem “La Belle Dame Sans Merci,” the beautiful woman destroys a knight by feeding and seducing him. The food, like the sexual attraction, is central to his undoing.

Some poets invoke food to convey matters of the spirit. T. S. Eliot’s question “Do I dare to eat a peach?” conveys the jaded frame of mind of the speaker of “The Love Song of J. Alfred Prufrock.” Emily Dickinson uses hunger metaphorically; in the poem “Hunger,” hunger and dining express loneliness and love. Another poem, “Forbidden Fruit,” makes a pithy statement about human nature: “Forbidden fruit a flavor has / That lawful orchards mocks; How luscious lies the pea within / The pod that Duty locks!”

Some poets simply delight in the discussing of food. Pablo Neruda, in his *Elemental Odes*, writes about artichokes, lemons, and olive oil (and the use of the oil in mayonnaise and salad dressing). Ogden Nash has a book of light verse about food. D. H. Lawrence wrote poems entitled “Pomegranate,” “Peach,” “Medlars and Sorb-Apples,” “Figs,” and “Grapes.” A. E. Housman celebrates the cherry tree in “Loveliest of Trees, the Cherry Now.” William Carlos Williams’s famous “This Is Just to Say” has immortalized some irresistible plums in an icebox; the savoring of plums occurs also in his “To a Poor Old Woman.” The contemporary American poet Robert Hass weaves lush California cuisine into many poems.

Poetry and food may be coming back together, as they were in ancient times. Enough contemporary poets have written poems about food to fill a number of anthologies of food poems, including one devoted exclusively to poems about potatoes (*Spud Songs*, ed. Gloria Vando and Robert Stewart).

See also **Bible, Food in the**; **Folklore, Food in**; **Myth and Legend, Food in**.

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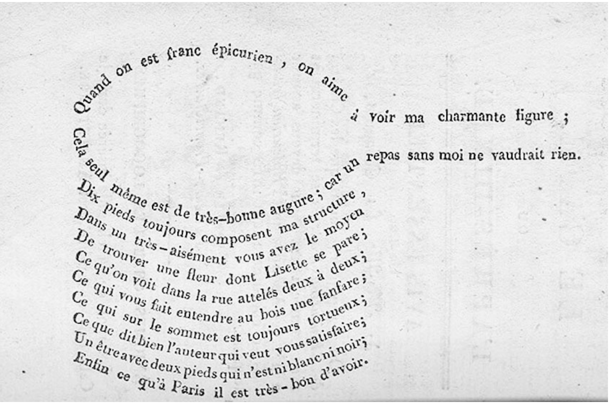

Quand on est franc épicurien , on aime
à voir ma charmante figure ;
Cela seul même est de très-bonne augure ; car un
repas sans moi ne vaudrait rien.
Dix pieds toujours composent ma structure ,
Dans un très-aisément vous avez le moyen
De trouver une fleur dont Lisette se pare ;
Ce qu’on voit dans la rue attelés deux à deux ;
Ce qui vous fait entendre au bois une fanfare ;
Ce qui sur le sommet est toujours tortueux ;
Ce que dit bien l’auteur qui veut vous satisfaire ;
Un être avec deux pieds qui n’est ni blanc ni noir ;
Enfin ce qu’à Paris il est très-bon d’avoir.

A poem about food in the shape of a saucepan. From *L’épicurien français* (Paris, 1812). ROUGHWOOD COLLECTION.

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Adrienne Su

ARTHROPODS: INSECTS, ARACHNIDS, AND CRUSTACEANS. Arthropods are animals with exoskeletons (external skeletons), segmented bodies, and jointed legs. They are the largest group of animals on Earth and include insects, crustaceans, and arachnids. Insects include organisms such as beetles, grasshoppers, and butterflies. They are mostly terrestrial, small in size, and typically herbivorous. Many species of insects are used as food, and they are traditional food sources in many areas of the tropics. Crustaceans include lobsters, crabs, crayfish, and shrimp. They are mostly aquatic animals, and some, like lobsters and crabs, are relatively large animals. (Crustaceans are discussed below, and are covered in further detail in the article “Crustaceans and Shellfish.”) Throughout history, the larger crustacean species have been highly prized food sources. Arachnids include spiders and scorpions, some forms of which are used as food.

The arthropod’s exoskeleton is a tough cuticle made of chitin that protects the organism and provides anchor points for muscles. The exoskeleton in crustaceans is rich with calcium carbonate and is particularly hard and thick. The exoskeleton limits an organism’s ability to grow in size and must be periodically shed (molted) as the organism grows. Most arthropods go through a series of molts and become more adultlike with each succeeding one.

Some insects, like flies, wasps, beetles, and butterflies, go through larval and pupal stages that are quite different from the adult stages of those species. As embryos, these organisms develop into a larva that is relatively immobile and specializes in eating and storing fat. The larva then transforms into a pupa (an intermediate stage between larva and adult), and finally into an adult that is highly mobile and specializes in reproduction. In insects that undergo such a metamorphosis, the larva is generally the largest form and the one that humans typically prefer as food. The advantage, for humans, of consuming larval insects is that during immature stages of development, insects are soft-bodied and typically high in fat; in addition, the larval stage is often the stage of the life cycle in which individual insects can be found in the greatest aggregations. For example, in the order Lepidoptera (butterflies and moths), insects are in their largest form and have the highest energy (caloric) value during the larval stage of the life cycle. In contrast, the adult forms of Lepidoptera have lower body mass, a hardened exoskeleton, and are more mobile and widely dispersed than larvae.

The crustaceans used as food are aquatic animals that are widespread geographically. Shrimp, lobsters, and crabs inhabit marine ecosystems, and crayfish inhabit freshwater ecosystems. Shrimp are the smallest crustacean and range in size from that of a small insect to over twenty centimeters (seven to eight inches). They tend to live close to the bottom, or in midwater, and feed on plants and small animals. They are food for predatory fish like cod, pollock, and flounder. Lobsters, crabs, and crayfish are larger than shrimp and are important benthic (bottom-dwelling) predators in local ecosystems. The American (*Homarus americanus*) and European (*Homarus gammarus*) species of lobster are found in the northern Atlantic Ocean. Adults feed on plant material, shellfish, sea urchins, and crabs. They are solitary animals that defend territory around their shelter (spaces under rocks or large crevices), and they are most active in foraging at night. Spiny (rock) lobsters are found in warm tropical and temperate seas. They feed on snails and clams and small crustaceans and are prey for sharks, octopus, and finfish. They lack the larger claws of the American and European lobsters and are gregarious animals that sometimes migrate long distances.

Crabs are the rounder bodied (compared to shrimp and lobsters) crustaceans that walk sideways; some even swim. The species of crab used as food vary in size from less than two pounds for the Dungeness crabs (*Cancer magister*) to up to twenty-five pounds for the Alaskan king crab (*Paralithodes camtschaticus*). Adult crabs are omnivores and dominant predators in local food webs. They feed on shellfish, finfish, and other crustaceans, as well as on detritus (debris). Crabs are widely distributed geographically: Species like the gazami crab (*Portunus trituberculatus*), the swimming crab (*Portunus pelagicus*), and the blue crab (*Callinectus sapidus*) are tropical or subtropical in distribution. The snow or queen crab (*Cheonoecetes opilio*) is found in the cold seas of the North Atlantic and Pacific Oceans and the Sea of Japan. The most spectacular crabs are the king crabs that live off the coast of Alaska. The red king crab (*Paralithodes camtschaticus*) is the largest: males of this species can grow to up to twenty-five pounds and have a leg span of five feet across. The blue and the golden king crabs (*Paralithodes platypus* and *Lithodes aequispinus*) are somewhat smaller than the red king crab, but they are still king-sized.

Crayfish (or crawfish) look somewhat like lobsters, but they inhabit freshwater ecosystems and are primarily temperate in distribution. North America contains the greatest species diversity of crayfish. They feed on aquatic and semiaquatic vegetation, invertebrates, and detritus. North American species range in size from two to three ounces (50 to 80 grams), but much larger species exist in Australia.

History of Consumption

European populations and European-derived populations in North America historically have placed taboos on entomophagous eating practices (the consumption of insects) and continue to do so. This is notwithstanding the repeated attempts by entomologists to make insects more appealing. One of the best-known attempts is Ronald Taylor's 1975 book *Butterflies in My Stomach*, and the accompanying recipe guide, *Entertaining with Insects* (1976).

Although entomophagous eating practices have ceased in Europe, insects were at one time frequently eaten throughout the continent. Rural inhabitants of Europe consumed Cockchafer grubs until the 1800s, and these grubs were an important source of protein in Ireland during the famine of 1688. The Greeks and Romans also held some insects in high esteem as a food source. Ancient Greeks considered grasshoppers a delicacy, and even Aristotle wrote of eating cicadas. He considered them tastiest just before the final instar (stage between two molts), but females laden with eggs were also considered to be very good. The Greeks and Romans also ate a large Melolonthid grub, possibly *Lucanus cervus*, which Pliny wrote was fattened before consumption.

For many other populations the consumption of insects has continued into the early twenty-first century, or not long before that time. In Mexico a well-known example of cuisine involving insects is *ahauatle*, a mixture of hemiptera eggs, that Francisco Hernandez first described in 1649. The eggs were also dried and used as a condiment in the preparation of a traditional Christmas Eve dish, *revoltijo*. In Colombia the giant queen ants of the genus *Atta* are considered a gastronomical delicacy. There the consumption of giant queen ants can be traced to precolonial times: Gonzalo Jimenez de Quesada, founder of the Colombian capital city Santa Fe de Bogotá, first described their use by local peoples in the highlands in 1555.

The consumption of a wide variety of insects has been reported among Amerindian groups in South American rain forests, and insects have probably been part of that region's diet for a very long time. The insects that appear to be consumed most commonly are ants of the genus *Atta*, palm grubs, and caterpillars of various sorts. The naturalist Alfred Wallace first described the consumption of Atta queen ants in 1854:

> They are eaten alive; the insect being held by the head as we hold a strawberry by its stalk, and the abdomen being bitten off, the body, wings and legs are thrown down to the floor, where they continue to crawl along apparently unaware of the loss of their posterior extremities.

Palm grubs, the large, fatty, legless larvae of wood-boring weevils (*Rhynchophorus*) found in the pith of felled palm trees, are a highly esteemed food among Amerindians. Bancroft, writing in the eighteenth century, claimed that palm grubs were equally highly esteemed by Europeans in Surinam, particularly by the French.

In Africa the use of insects as food is quite widespread and probably has deep historical roots. The mopane worm (*Gonimbrasia belina*), the so-called snack that crawls, is one of the best known edible caterpillars. Termites are also utilized as food, especially in the early rainy season when the reproductive forms swarm from the nest. At one time, termites were such an important addition to the diet that their mounds were often disputed as property. Locusts (grasshoppers that go into a swarming phase), in particular the desert locust (*Schistocerca gregaria*), also play a large role in the diet of Africans. In African history the locusts were so popular that people actually welcomed the arrival of swarms.

In the Middle East the desert locust was also a major source of food historically. Perhaps the most well-known incident involving locust eating was John the Baptist's ordeal in the desert during which he survived on locusts (St. John's bread) and honey. By using locusts as food he was observing the decree of Moses, "These ye may eat; the locust after his kind and the bald locust after his kind, and the cricket after his kind and the grasshopper after his kind" (Leviticus 9:22).

In Asia the consumption of insects as food was described from the Chung-Qiu dynasty (770–475 B.C.E.) and continues to the present day. The most commonly consumed food insects in that region are bee brood (larvae and pupae), beetles such as *Dytiscid* and *Hydrophilid* beetles, and the giant water beetle (*Lethocerus indicus*), the larvae of weevils like *Rhynchophorus*, and locusts of the genera *Oxya* and *Locusta*. Perhaps the most well-known insect eaten in the region is the pupa of the silkworm *Bombyx mori*.

In Australia the black honey ant (*Camponotus inflatus*) is a highly sought-after food of Aboriginal Australians and is even considered a totem animal by some clans. It is similar to the honey ant found throughout North and Central America: a modified worker ant with an enlarged body the size of a grape that is full of nectar. Digging up these ants is still considered an important traditional practice and is still taught to children. Witchetty grubs were also an important food of Australian Aborigines. The name witchetty grub refers to any number of root-boring larvae and probably includes Cossid moth larvae (*Xyleutes leuchomochla*), giant ghost moth larvae (*Hepialidae*), and longicorn beetle larvae (*Cerambycidae*). One of the most unique and well-documented examples of entomophagous eating habits in Australia was the annual feast of bugong moths (*Agrotis infusa*), which occurred until the 1890s. These moths migrate from the plains to aestivate (the summer equivalent of hibernation) in the rock crevices of the Bugong Mountains. Aboriginal Australians from many different tribes traditionally gathered to feast on them. Evidence of these feasts has been carbon-dated as early as 1000 C.E.

Collecting bamboo grubs for food in rural Thailand. © MICHAEL FREEMAN/CORBIS.

Procurement and Capture

The harvesting of insects varies greatly by species because it is tailored to the ecological and behavioral characteristics of different species, as well as the stage of the life cycle sought. Harvesting is typically done for subsistence or to satisfy the demands of a local market.

The harvesting of larval forms like grubs and caterpillars is relatively easy as long as the food source is known. Caterpillars like mopane worms can be picked from their host trees (mopane trees), or for species like the Pandora moth (*Colorado Pandora lindseyi*), gathered as they descend from their host trees to pupate in the soil. The larva of wood-boring weevils like *Rhynchophorus* can be harvested by splitting open the palm trees they inhabit, and the larva of root-boring grubs like wichetty grubs can be harvested from the roots of their host plant.

Harvesting mobile adults is more of a challenge. One strategy is to harvest at a point of high aggregation. The giant queen ants of the genus *Atta* can be collected as they swarm from the nest on nuptial flights early in the rainy season. Some termites, like *Macrotermes*, can be harvested in the same way. The bogong moths are smoked out of the rock crevices where they gather to aestivate. Social insects that live in large colonies, like ants and termites, can be dug out or lured out by intruding smoke or by inserting a probe, which the soldiers defending the colony will attack. At least one arachnid, the tarantula, can also be attracted out of its burrow using a probe.

Another strategy is to create an aggregation. For grasshoppers and crickets this is done by surrounding them by hunters carrying sticks and driving them into holes or trenches. They can also be captured by dragging bags or nets along the ground and collecting them. A third strategy is to attract the insects to a flame or a light. One species of giant queen ants, as well as some termites and dragonflies, can be attracted to a flame that conveniently singes their wings and makes them very easy to collect. At lease one species of beetle can be attracted to a black light.

Preparation and Consumption

In areas where insects are a traditional part of the diet, they are typically consumed raw or are prepared like other foods, especially other animal food. For example, in Japan grasshoppers, silkworm pupae, and bee pupae are cooked in soy sauce and sugar and served as appetizers. In other parts of Asia, larvae of various sorts, beetles, scorpions, and tarantulas are served fried or stir-fried with vegetables and typical seasonings. In Africa, mopani worms are eaten raw, fried, or cooked in a typical stew after they have been squeezed to remove gut contents.

In general, soft-bodied forms like larvae and pupae are typically fried, grilled, or stewed with local vegetables and seasonings. Larger, hard-bodied forms (such as adults with exoskeletons) like grasshoppers and locusts are typically soaked or cooked in salted water and then sun-dried, or even grilled like shrimp. The legs and wings are typically removed before they are consumed. The exoskeleton of these organisms is retained and provides a certain crunchiness. Smaller organisms with exoskeletons, like ants and termites, are often roasted or fried. In the past, Native North Americans roasted both grasshoppers and crickets and pounded them together with seeds and berries to make a cake called a "desert fruitcake," which could be sun-dried and stored.

Relations to Human Biology

Arthropods are animals and are therefore generally comparable to other animal foods in terms of their nutritional composition. Insects have protein content similar to that of meats like beef and pork. The quality of the protein, however, appears to vary greatly among species; in most cases it is better in terms of amino acid composition than that of plant foods like grains and legumes. The larval stages of arthropods like palm grubs and wichetty grubs are quite high in fat and are similar in that regard to U.S.-style hot dogs. Caterpillars tend to be more muscular and, hence, higher in protein. In terms of micronutrients, insects generally have reasonable quantities of iron, calcium, and B vitamins. As mentioned earlier, the crunchy exoskeleton of insects like grasshoppers is partially composed of chitin, a substance not digested by humans. Little is known about the potential toxic or anti-nutritional factors of insects, although in areas where pesticides are used, toxicity may be of serious concern for all species.

Contemporary Issues

There is a worldwide general trend towards the reduction of entomophagous eating practices. This may be due to the increased use of pesticides to control insects in agricultural zones or the trend toward the adoption of westernized diets (in other words, diets like those of North Americans and Europeans) in which insects have extremely low status as food or are taboo. Despite the general reduction in the consumption of insects as food, there have been efforts to commercialize some food insects. Entrepreneurs in Australia have introduced some local delicacies like black honey ants, witchetty grubs, bardi grubs (the larvae of a Cerambycid beetle), and Trigona bees to the commercial food market, and some Australian restaurants include insects on their menus. Entrepreneurs in South Africa market mopani worms, and the appearance of caterpillars as ingredients has been a general trend on menus in Africa. Some Asian countries also export food insects as specialty items: Thailand exports frozen steamed ant larvae and pupae, Korea exports pupa of the silkworm *Bombyx mori*, and Japan exports bee pupae in soy to the United States.

There has also been research and development into the rearing of insects as "mini-livestock" in order to meet the subsistence needs, especially the protein needs, of impoverished rural populations. The idea of purposefully raising insects for food is not as far-fetched as it might seem: for example, many societies have been raising bees for a long time.

See also **Australian Aborigines**; **Crustaceans and Shellfish**; **Hunting and Gathering**; **Proteins and Amino Acids**.

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Darna L. Dufour

ARTIFICIAL FOODS. The term "artificial" refers to something produced to imitate nature. Some artificial foods created with rubber or similar materials are incredibly lifelike. People have even placed them on a table when they are away to fool robbers into believing someone is home and ready to eat. These food models are more commonly used in educational settings to help people understand reasonable portion sizes. They are also used in displays, such as restaurant windows, as food spoilage is not an issue. A computer search using the term "artificial food" will locate retail vendors of these food models.

Edible Food

The term "artificial food" also creates images of edible food made from substances that do not occur naturally. No wholly artificial foods exist in the strict sense, but some foods are called artificial or seem artificial to some people. Viewing a food as artificial is most likely if it contains ingredients, such as colorings or flavorings, that are not inherent in the food. An example is artificial strawberry flavoring created in the laboratory to mimic the natural taste of fresh strawberries.

Foods may also be "artificial" for medical reasons or to suit personal beliefs. For example, artificial milk is created for infants born with a genetic disease called phenylketonuria (PKU). The artificial milk replicates the

TANG®

Tang®, a powdered orange drink meant to mimic orange juice, was introduced in 1957 and went into national distribution in 1959. It rose in popularity in 1965, when it became part of the diets of the astronauts in the space program. Tang® has been on every manned space flight since *Gemini 4,* including Apollo flights, *Sky Lab,* and the space shuttles. The National Aeronautics and Space Administration (NASA) chose it because of its compact nature as a powder, its convenience, its storage qualities, and its required nutrients, such as vitamins A and C.

Tang® obviously appealed to kids who wanted what astronauts were eating, and hundreds of other powdered beverages followed. Sugar-free Tang became available in March 1985, driven by consumer demand for sugar-free low-calorie beverages.

The popularity of the powdered orange juice substitute gradually dwindled as the convenience of fresh orange juice at a reasonable price rose. For a brief time in the 1990s the popularity of Tang® increased with "Generation X" due to a "Tang and Toast" advertising campaign. Tang® is popular when a convenient dried food is required, such as on camping trips and in the military. It is usually carried by suppliers of dried and dehydrated foods for long-term food storage or specialty grocery stores with a nostalgic supply. The original purpose of Tang® as a convenient, inexpensive powdered drink has been forgotten. After 1999 it was available in pouches, ready to drink, in flavors such as Fruit Frenzy and Orange Uproar.

Rumors abound that some consumers have used Tang® Drink Mix to clean their dishwashers. Tang® does contain citric acid, which can act as cleaning agent. Kraft Foods has taken the position that Tang® Drink Mix is intended to be a food product, and the company does not advocate its use for any other purpose.

Artificial foods are popular in Japan, where they are widely used in restaurant window displays to help customers make decisions. The food is often so realistically made that it cannot be differentiated from the actual product it is imitating. Shown here is an elaborate window display in the Shinjuku District of Tokyo. © MICHAEL S. YAMASHITA/CORBIS.

nutritional content of real milk but lacks a specific amino acid, phenylalanine, not tolerated by an infant with PKU. Without this artificial milk, infants with PKU would develop severe mental retardation.

Vegetarian food substitutes, such as imitation bologna, may be viewed as "artificial" by some because they imitate nature. They may look and taste similar to a meat product, yet they contain no meat. Others argue that the term "artificial food" may not apply here, as many vegetarian meat substitutes contain only all-natural ingredients. Most would conclude that the consumer definition of artificial food relates more to the presence of any artificial ingredient, such as nutrients, artificial coloring, or artificial flavoring, that possesses ingredients or attributes that simulate another food.

Sometimes artificial ingredients are added to provide a nutrient that would be in the food in its natural state. For example, orange juice has vitamin C, so Tang® Drink Mix is fortified to contain at least 100 percent of the daily value for vitamin C (see sidebar on Tang®). Sometimes ingredients are added but not to the same level the natural product would contain. For example, potassium is added to Tang®, primarily in the form of potassium citrate. A small amount of potassium is contributed by orange juice solids and other ingredients. The body uses the potassium in Tang® from potassium citrate just as it would use the naturally occurring potassium in foods and beverages. The quantity, though, is different from that of natural orange juice. The potassium content of Tang® Drink Mix is 50 milligrams per 8 fluid ounces. Orange juice contains approximately 470 milligrams per 8 fluid ounces.

Foods Containing Artificial Flavor or Color

The consumer looks for the term "artificial" on food labels to distinguish between foods that are in their natural states and those that have been modified in some way. On the label the term "artificial" is applied to flavor or color as defined by the federal government. For example, this is the federal definition of artificial flavor:

> The term artificial flavor or artificial flavoring means any substance, the function of which is to impart flavor, which is not derived from a spice, fruit or fruit juice, vegetable or vegetable juice, edible yeast, herb, bark, bud, root, leaf or similar plant material, meat, fish, poultry, eggs, dairy products, or fermentation products thereof. Artificial flavor includes the substances listed in Secs. 172.515(b) and 182.60 of this chapter except where these are derived from natural sources (*Code of Federal Regulations*, Title 21, vol. 2, 2001, pp. 73–78).

In simpler terms, for the purposes of nutrition labeling, artificial flavor means anything added to food for flavor that is not taken directly from whole foods.

The federal definition of artificial color or artificial coloring means any "color additive" as defined in Sec. 70.3(f) of the food code. Some food colors obtained largely from mineral, plant, or animal sources may be listed on the label with the general term "artificial color." Regulations require certification of colors derived primarily from petroleum, known as coal-tar dyes. Some color additives must be listed by name on the label. These are additives that are safe for most people but have been identified as a problem for a small number of consumers. For example, FD&C Yellow No. 5, listed as tartrazine on medicine labels, must be individually labeled because it causes hives and itching in a small proportion of consumers.

Though reactions to color additives are rare, the Food and Drug Administration (FDA) wants to know about them. The agency operates the Adverse Reaction Monitoring System (ARMS) to collect and act on complaints concerning all food ingredients, including color additives. Consumers can register complaints by contacting the FDA district offices in their local phone directories or by sending written reports to the ARMS at the Food and Drug Administration in Washington, D.C.

Determining if Food Has Artificial Flavor or Color

Artificial ingredients in the food supply are generally considered safe for individuals without specialized medical conditions such as specific food allergies. Some consumers prefer to avoid foods deemed artificial anyway, as a precaution that fits with their own beliefs. Thus nutrition labeling assists these consumers in following their personal preferences.

Grocery stores usually have mechanisms that allow consumers to decide if they want to purchase the food. For example, if a strawberry shortcake contains flavoring from strawberries enhanced by artificial flavor, the box will be labeled "natural and artificial strawberry flavor." If the food contains solely artificial flavors, it will be labeled "artificial strawberry flavor."

Foods packaged in bulk containers for retail stores may not contain a nutrition label. The labeling information for the food, however, should be displayed plainly in view or on a counter sign. Restaurant food is more challenging, as restaurants are not required to provide nutrition labeling.

See also **Additives; Allergies; Coloring, Food; Fads in Food.**

Irene Berman-Levine

ASIA. *See* **Asia, Central; China; India; Japan; Korea; Southeast Asia.**

ASIA, CENTRAL. The mention of Central Asian foodways usually conjures up competing images of nomadic and sedentary lifestyles. In one, the roving sheepherder astride a brawny steed, between base camp and mountain pasture, clutches a leather pouch of fermented milk. The other vision includes the long-beard in his colorful robe and headdress, enjoying perfumed pilaf in a tranquil teahouse. While scholars quibble over cultural and physical boundaries of Central Asia, culinary cultures of the region represent an intriguing mix of steppe and settlement, highlands and lowlands, Turkic and Iranian.

Culinary Culture and Geographic Setting

Generally speaking, hospitality is the defining feature of this underpublicized cuisine. For all the ethnic and geographic variations in Central Asia, the food of the region exhibits more homogeneity than disparity. Basic methods of preparation, main ingredients, common dishes, and predominant cultural traditions of Islam all reflect the enriching exchange along the heart of the storied Silk Road. The regional larder consists of mutton, rice, cumin, coriander, cilantro, dill, nuts, tea, dried fruits, and yogurt, distinguishing it from Chinese and European fare. Meal preparation is often conducted outside over fire, with cast-iron cauldrons *(kazan)* for frying, simmering, and steaming; open-flame braziers for grilling; and *tandir* ovens for roasting meats and baking breads. Customary dishes throughout the region include soups and stews, pilafs, noodles, steamed dumplings, grilled meats on skewers, flatbread, savory pastries, and halvah.

The geographical limits of Central Asia, once called Turkistan, include the Soviet successor states (Uzbekistan, Turkmenistan, Tajikistan, Kazakhstan, and Kyrgyzstan), and Xinjiang in northwest China. Others do not hesitate to add other Turkic-language areas, like the Caucasus, Turkey, and parts of Siberia, while some embrace Mongolia, Iran, Afghanistan, northern India, Pakistan, and even Tibet in the Central Asian cultural orbit.

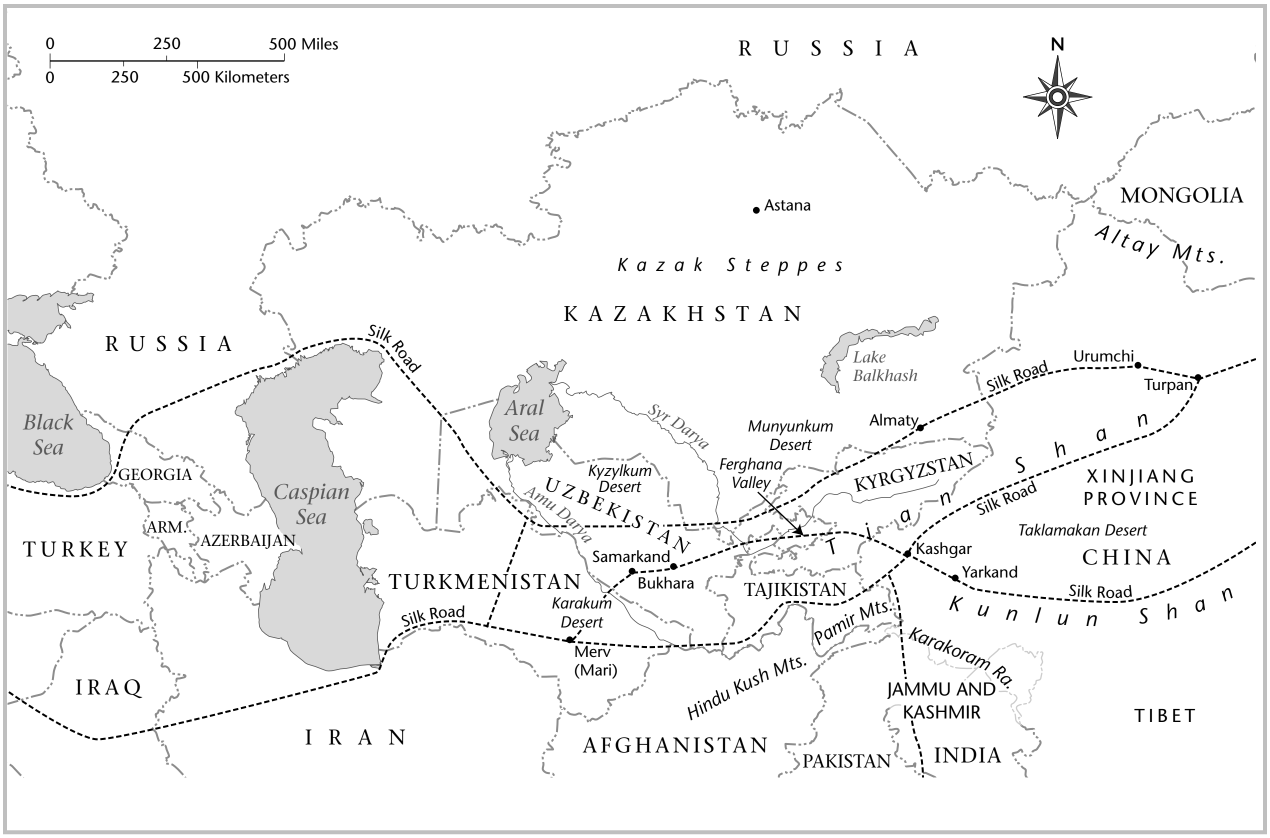
The thriving culture of Iran was the primary influence on Central Asian society, with later Arabic and Mongol contributions. One hundred and fifty years of Russian power and fifty years of intensive Chinese subjugation of the region have considerably altered the foodways. Well-documented Soviet problems of collectivization and distribution homogenized local diets. The turbulent history of Xinjiang continues, with Chinese migrants and laborers, particularly from Sichuan, flooding the region after the 1960s, dropping the Turkic Uighur population from roughly 75 percent to less than 50 percent. In China proper, Uighur cuisine is segregated and disparagingly referred to as Muslim food.

Diet and Foodstuffs

Greek humoral theory, as propagated by ibn Sina of the eleventh century, still affects the diet of millions in the region. Combined with traditional Chinese thought, Central Asians consider food to have either "hot" or "cold" (Farsi, *sardi* or *garmi*) qualities, serving both medicinal and nutritive functions. Three meals a day are standard, each including tea and flatbread (*nan* or *naan*). The largest meal is usually taken in the evening.

The spirited bazaars of Central Asia—part marketplace, part carnival, and part town square—capture the Silk Road mystique. Aromatic spices take center stage, though only cumin, red and black pepper, and coriander seeds are used in abundance. Herbs of distinction include cilantro, dill, parsley, and celeriac leaves. Seasoning is generally mild, but sauces, relishes, and even whole peppers are added for punch. Other flavor enhancers are white grape vinegar and fermented milk products. Rendered sheep fat is the general cooking oil, though vegetable oil and cottonseed oil are widely used. Olive oil and butter are not traditional cooking fats.

The Asian sun sweetens market produce. Delicious tomatoes, peppers, onions, cucumbers, and eggplants comprise the basic vegetables. The area also offers unique varieties of pungent green radishes *(turup)*, yellow carrots (actually turnips), and a prodigious selection of pumpkin and squash. Dolma, meaning "stuffed" in Turkish, may be created from any vegetable—cabbage, grape leaves, peppers, tomatoes, and so forth—by hollowing it out or wrapping it around a filling. Spring fruits traditionally include grapes, apricots, strawberries, cherries, figs, and peaches. The tree harvest in autumn brings apples, quinces, persimmons, and pears. Winter delivers lemons, mandarins, pomegranates, and smooth-skinned melons. Melon slices are also sun-dried and braided into long ropes to take their place alongside dried apricots, figs, dates, and raisins.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IRAQ
Hindu Kush Mts.
JAMMU AND KASHMIR
TIBET
IRAN
AFGHANISTAN
PAKISTAN
INDIA

Core Cuisine

Meat and rice. Lamb and mutton, mainly fatty-tailed sheep, are the favorite protein of Central Asians. The fat, which imparts a sweet and rich quality to a dish, is valued more than the meat itself. Beef and chicken are consumed in substantial quantities, and horse, camel, and goat are not uncommon. Fish, though not eschewed, is rarely available, and Islamic dietary law forbids pork. *Shashlyk* (shish kebab), the standard street food, is prepared with beef, mutton, or minced meat and served with flatbread and lightly pickled onions. A kebab of fresh sheep liver and tail fat is a true luxury. While Westerners forget their charcuterie traditions, no part of an animal in Central Asia is ever wasted. There are still dishes made of lungs, intestines, and sheep's head and trotters.

Pilaf *(palov)* epitomizes Central Asian cuisine. A ceremonial dish for guests and family days, pilaf is so ubiquitous that there is sometimes a mistaken impression that it is their only dish. Meat, onions, and carrots are sautéed, then simmered to a broth, and covered with rice. Raisins, barberries, chickpeas, or dried fruit may be added for variety. Cumin is often the sole spice, while turmeric is added on special occasions for its golden color. Similar to an American barbecue, pilaf preparation is considered a manly challenge. Working with only a woklike *kazan* and spatula *(kapkir)*, an *oshpaz*, master pilaf chef, can serve up to a thousand people from a single cauldron, making him much in demand for festivals and weddings.

Bread and noodles. Flatbread is baked daily at home or in communal ovens. Bread is considered holy and accompanies each meal. Most baked goods are made with wheat flour, though mung bean and corn flour are used also. Some flatbreads are topped with onions, pieces of sheep's fat, or even meat. Others are glazed with *kalonji*, anise, poppy, or sesame seeds. In Xinjiang the round plump breads astoundingly resemble New York City bagels. *Katlama*, related to the Indian *paratha*, is flaky unleavened bread cooked on a skillet.

The steppe nomads have added flour and dough to their soups for centuries. A dish of square flat noodles topped with boiled meat is called *beshbarmak* in Kazak-Kyrgyz areas. From farther east come steamed dumplings, *manty* (Korean *mandoo*), vying with pilaf for the national dish in Kyrgyzstan, Kazakhstan, Uzbekistan, and Chinese Turkistan. Uighurs have mastered hand-pulled noodles, common in Korea and China proper. Made with only soft wheat, water, and salt, the transformation of a ball of dough into noodle threads in a matter of minutes is both compelling performance art and a dying culinary method.

PROVERBIAL LAND OF MILK AND HONEY

Although God did not mention Central Asia when promising Moses a "good and spacious land, a land flowing with milk and honey," the region certainly fits the description. The Eurasian herders, having domesticated sheep and goats roughly ten thousand years ago, realized that milk, in addition to the meat and wool of their flocks, was essential to their survival. The pastoralists took advantage of microbiology to improve the flavor of fresh milk, make it more digestible and nutritious, and increase its shelf life. The resulting dairy product is determined by controlling the action of bacteria, enzyme, or yeast. Milk, either fresh or skimmed of cream, may be of several sources—ewe, goat, cow, camel, mare, and dri (yak). The first step is simply separating fresh cream from the milk to make a soured clotted cream, or *kaimak,* enjoyed with flatbread and honey. The honey is imbued with a marvelous flavor due to the nectar gathered from cotton and grape blossoms and the varied mountain valley flowers, grasses, and trees.

Fresh milk quickly sours through fermentation in warm conditions, essentially the same bacterial process employed for pickles, olives, or sourdough bread. Yogurt *(katyk)* is used in soups, beverages, and even doughs to add a pleasant sourness, with the lactic acid produced by bacteria breaking down the milk sugar. With reduced lactose, the cultured products become more digestible for most Central Asians, who, along with 70 percent of the world, have a dairy intolerance. Fermented camel milk is *shubat,* and *agaran* is its cream. Mixing *katyk* and water creates a refreshing salty drink, *ayran* or *chalop* (Kyr), similar to the Indian *lassi.* Drained yogurt results in *suzma,* a fresh curd cheese eaten plain, in salads, or with soups and main courses as a garnish. Adding a rennet enzyme to milk makes *panir* or soft cheese, unaged, white, and rindless.

Kumys, fermented camel's or mare's milk, made famous by numerous Western travelers, including Marco Polo, has been subjected to both bacterial and yeast fermentation. Caucasian kefir is made with a similar process. *Kumys* or *ayrag* (Mongolian), primarily made with mare's milk, is the mildly alcoholic drink (up to 4 or 5 percent) of the nomads and may also be slightly fizzy with carbonic acid. *Saba* is a Kazak leather sack for making *kumys* that imparts a smoky, earthy quality. Refusing an offer of *kumys* may cause offense. Mare's milk has four times more vitamin C than cow's milk, aiding a pastoral diet scarce in fruits and vegetables. The remaining milk or whey from *kumys* or *suzma* is salted and sun-dried, formed into balls or bricks, and called *qurut* or *qurt.* This form, which is eaten often as a snack, lasts the winter months and may be added to soups or reconstituted as a drink.

A casing of dough with a typical filling of fatty mutton and onions becomes a number of other dishes simply by varying the cooking technique. If the dough is fried, the dish is called *belyashi* (Kazan Tartar) or *chebureki* (Crimean Tartar). The Turkish *borek*, also a fried savory pastry, may be related to the Slavic *pirog*, *piroshki*, and *pierogi*. Baked in a *tandir*, the dish is called *samsa* (Uzbek) or *sambusa* (Tajik), like Indian *samosa*. Steamed *manty* or *hoshan* (Kazak) are usually topped with a sauce of tomatoes, potatoes, and diced mutton. Smaller boiled versions of *manty* are *chuchvara*, *pelmeni* (Siberian), *tushbera* (Tajik), and *joshpara* (Farsi).

Hospitality and Traditions

Meals and customs. Central Asian cookery often requires great sacrifices on the part of the host. The Uzbek adage "*Mehmon otanda ulugh*" (the guest is greater than the father) remains accurate for most of the Muslim East. Generally, guests remove their shoes before entering the house and are seated at a low table *(takhta)* or on the floor with a *kurpacha*, or cushion. Diners gather around a *dastarkhan* (literally, tablecloth), which is an enormous assortment of food offered to the honored guest. On some occasions, men and women are separated. Special meals are eaten commensally by hand and can last for several hours with multiple courses and endless cups *(piala)* of tea. Though most of the region embraces Islam, alcohol is widely accepted in the successor states.

In addition to the ever-present pilaf, some distinct dishes are served during Islamic holidays. Navrus, the Muslim New Year, corresponds to the spring equinox. *Halim*, wheat porridge, is prepared from boiled meat and wheat grains, seasoned with black pepper and cinnamon. A children's favorite, *nishalda*, popular during Ramadan, is made with whipped egg whites, sugar, and licorice flavoring. *Sumalak*, symbolic of friendship and tolerance, is among the most traditional dishes. Prepared only by women, overnight, wheat sprouts are blended with oil, flour, and sugar and cooked on low heat. Eid-ul-Fitr marks the end of Ramadan with three days of feasting.

Collecting mare's milk in Tourgut, Kyrgyzstan. PHOTO COURTESY OF GLENN R. MACK.

Tea and dessert. Freshly made green tea, the drink of hospitality, complements every meal. Teatime, which may occur at the slightest cause, often includes flatbread, sweets, fruits, and pastries. Dried fruit with nuts—walnuts, pistachios, and almonds—is also a perfect accompaniment. Black tea is common in the Russian regions. Both teas are served with sugar, milk, salt, butter, or even fruit preserves. Uzbeks have a custom called *shapirish*, whereby the hostess returns the first two cups back into the teapot to stir the infusion. Thus the tea is described as going from mud *(loy)* to tea *(choy)* to wine *(moy)*.

As sugar cane originated in India, sweets are a gift from the south, via Iran. This tradition produces tea sweets such *chakchak*, fried dough with honey; *urama*, fried spiraled strips of dough with powdered sugar; sugar-coated almonds; and *novvot*, crystallized sugar. More familiar halvah and *paklava* are also common desserts. *Sharbat* is fruit juice that migrated to Europe as frozen sherbet.

Food available outside the home includes street food and that from cafés, modern restaurants, and the traditional *chai-khana* (tearoom). Ideally near a poplar-lined stream or in a cool courtyard orchard, it is a gathering place for fraternity and socializing. The *chai-khana* in many ways functions like a community center and helps preserve certain aspects of Central Asian identity obscured by colonial powers.

Regional Variations and Specialties

The cuisines of Central Asia may be divided into three overlapping groups: Tajiks, Turks, and nomadic Turko-Mongol tribes. However simplistic, this categorization provides a more coherent approach to understanding the culinary cultures of Central Asia than organization along the arbitrary national boundaries. Numerous subcuisines from other ethnic minorities, such as Koreans, Tartars, Dungans (Chinese Muslims), Slavs, and Germans add to the culinary diversity of the area.

Sedentary cuisine. The Iranian-Tajik influence extends from Tajikistan and southern Uzbekistan to Iran and Afghanistan and beyond to northern Pakistan and Jammu-Kashmir in India. These cuisines employ more vegetables and legumes, resort to complex seasonings, and boast elaborate sweets. Years of civil strife in Tajikistan and Afghanistan have devastated food supplies and interrupted traditional foodways. Generally, the farther away from the nomadic steppe, the more complex the spice blends and seasoning of the dishes. In Tajikistan and Uzbekistan, an unusual dish is *tuhum barak*, an egg-filled ravioli flavored with sesame-seed oil. Tamerlane and his entourage of craftspeople from Samarkand, cooks included, brought the meat-eating tradition to India along with many fruits, particularly the melon and grape. The descendants of these cooks—the Wazas—are the master chefs of Kashmir.

The Turkic group of languages claims roughly 125 million speakers and stretches from Siberia to the Balkans. Uzbeks and Uighurs, as settled Turks, favor pilafs, noodles, and stews. Since the oasis civilization is a middle ground, literally and figuratively, between the Iranian courtly cuisine and the pastoral nomads, their food has become most representative of Central Asian cuisine. In Uzbekistan, *moshkichiri* and *moshhurda* are common meat and mung bean gruels. *Dimlama* is braised meat and vegetables cooked in a pot sealed with dough. Its origins may be tied to *dumpukht* in Farsi, signifying food cooked in its own steam, shortened also in India to *dum*, as in *dum-aloo.* Apricot seeds are specially treated and roasted in ash to produce an exceptional snack. Because of linguistic ties, Azerbaijan and Turkey are often included in Central Asian culinary culture, as these countries share roots, not to mention cooking methods and many dishes, with the Eurasian nomads.

Nomadic cuisine. Of all the Central Asian peoples, none has experienced such dramatic cultural upheaval due to colonization, industrialization, and urbanization as have the nomads. The traditional meal of steppe and highlands was meat on occasion, milk products, and the stray onion. As Turkmenistan is mostly desert, vegetable and grain cultivation is challenging. *Chorek* (flatbread), gruel, and tea remain typical for most meals.

In Soviet times the Turkmen, Kazaks, and Kyrgyz were forcefully settled into dreary apartment blocks. Separated from the land and their herds, the nomads adopted many Russian or Uzbek foods and customs. Kazaks and Kyrgyz claim as national dishes *beshbarmak* and *kumys*, fermented mare's milk. Horsemeat sausage *(kazy)*, when served with cold noodles, is called *naryn.* Barley, wheat, and millet are quite common; from them comes *dzarma*, fermented barley flour. *Boso*, or fermented millet, and *boorsak*, a ritual dish made from small pieces of deep-fat-fried dough, are also found in Tibet by the same name. When the Uighurs and Dungans fled China in the late nineteenth century, they brought *laghman*, other noodle dishes, and spicy peppers that were quickly embraced by the Kazaks and Kyrgyz.

The diminished state of traditional foodways in Central Asia is often decried, particularly when judging the cuisine through the distorting prism of Western restaurant culture. These Eurasian civilizations were completely transformed during the colonial experience. However, the trend of globalization triggers entrenchment of cultural heritage and local foodways. As borders open, outside interest is countered with a pronounced revival and demonstration of ethnic identity. If domestic traditions and hospitality persevere, the Central Asian culinary arts and its foodways are bound to flourish.

See also **China; Iran; Islam; Middle East; Noodles of Asia; Rice; Russia; Tea.**

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Glenn R. Mack

ASIA, SOUTHEAST. *See* **Southeast Asia.**

ASSESSMENT OF NUTRITIONAL STATUS.

Nutritional status is the balance between the intake of nutrients by an organism and the expenditure of these in the processes of growth, reproduction, and health maintenance. Because this process is highly complex and quite individualized, nutritional status assessment can be directed at a wide variety of aspects of nutriture. These range from nutrient levels in the body, to the products of their metabolism, and to the functional processes they regulate. Nutritional status can be measured for individuals as well as for populations. Accurate measurement of individual nutritional status is required in clinical practice. Population measures are more important in research. They can be used to describe nutritional status of the group, to identify populations or population segments at risk for nutrition-related health consequences, and to evaluate interventions.

The choice of nutritional status assessment method must be made mindful of the level at which one wants information, as well as of the validity and reliability of the method. All methods have error. All methods produce imperfect measures that are indirect approximations of the process. Whatever method is chosen for assessment of nutritional status, the data obtained must be compared with reference data to produce an indicator of nutritional status. The quality of the available reference data is, therefore, another factor that affects the assessment data.

Ideal methods are sensitive and specific. Unfortunately, it is difficult to achieve both in the assessment of nutritional status. Sensitivity refers to the ability of a technique to correctly identify those affected by a condition (for example, undernutrition) as having that condition. Specificity refers to the ability of a technique to correctly classify normal individuals as having normal nutritional status. Body mass index (wt/[ht]^2) is a global measure of nutritional status that illustrates the difference between these two constructs. Most persons who consume insufficient energy have low body mass index, so the measure is sensitive. However, there are other causes of low body mass index, including genetics and disease, so body mass index is not specific to nutritional status.

The assessment of nutritional status is commonly summarized by the mnemonic "ABCD," which stands for anthropometric measurement, biochemical or laboratory tests, clinical indicators, and dietary assessment. This review will focus on anthropometric and dietary techniques.

Anthropometric Approaches to Nutritional Status Assessment

Anthropometric approaches are, for the most part, relatively noninvasive methods that assess the size or body composition of an individual. For adults, body weight and height are used to evaluate overall nutritional status and to classify individuals as at healthy or nonhealthy weights. In the United States of America and other industrialized countries, the emphasis for unhealthy weight is overweight and obesity. The standards for these have changed over time. The most recent classification is to use body mass index (BMI, in kg/m^2) (Kuczmarski and Flegal, 2000). BMI, regardless of age or population, is normal at 18.5 to 25.0 kg/m^2, overweight at 25.0 to 29.9 kg/m^2, and obese at over 30.0 kg/m^2 (USDA & USDHHS, 2000). In general BMI greater than 30 is assumed to be due to excessive adiposity.

In children, growth charts have been developed to allow researchers and clinicians to assess weight- and height-for-age, as well as weight-for-height. For children, low height-for-age is considered stunting, while low weight-for-height indicates wasting. In addition to weight and height, measures of mid-arm circumference and skinfold measured over the triceps muscle at the mid-arm are used to estimate fat and muscle mass. Anthropometric measures of nutritional status can be compromised by other health conditions. For example, edema characteristic of some forms of malnutrition and other disease states can conceal wasting by increasing body weight. Head circumference can be used in children 36 months and younger to monitor brain growth in the presence of malnutrition. Brain growth is better spared than either height or weight during malnutrition.

To interpret anthropometric data, they must be compared with reference data. The choice of the appropriate reference has been discussed by Johnston and Ouyang. Because well-nourished children in all populations follow similar patterns of growth, reference data need not come from the same population as the children of interest. It is of greater importance that reference data be based on well-defined, large samples, collected in populations that are healthy and adequately nourished. Reference growth charts (Kuczmarski et al., 2002) have been compiled from cross-sectional data collected from population surveys of U.S. children. These have been adopted as international standards by the World Health Organization.

Choosing a Dietary Approach to Nutritional Status Assessment

Several techniques exist for collecting dietary data with which to estimate nutritional status. Because these techniques vary in cost for data collection, burden on the respondent, and which aspects of diet they are designed to measure, it is important to clearly articulate the goals of dietary assessment of nutritional status before choosing an assessment strategy.

The primary consideration in choosing a dietary assessment method is the specific type of data needed. Is the research intended to document intake of "foods" or of "nutrients"? If the answer is foods, the method must take account of the population's foodways. These include variability in food intake patterns (for example, day-to-day, seasonal, ritual cycles); differences in food consumption by sex, age, and ethnicity; and what items the population considers to be legitimate "food." If the objective is to measure nutrient intake, the method must take into account several additional factors: food preparation techniques, including the addition of condiments and the effects of the technique on nutrient composition of the food; sources of error in the determination of amounts of foods consumed; differentiation distribution of nutrients among foods; and the contribution of "nonfood" consumption (such as betel nut, laundry starch, and vitamin and mineral supplements) to total nutrient consumption.

Another important consideration is the time period the data are intended to represent. If the period is a relatively discrete one, it may be possible to document diet quite precisely. However, if the interest is in measuring "usual" diet, the methods must allow this abstract concept to be estimated statistically.

Population measures of dietary status can be derived either from data describing the entire population or population sub-group, or from data describing samples of individuals. Population-wide data include food availability figures, which allow the assessment of food balance—the amount of food produced or imported by a population less that exported or used as nonhuman food. Such measures are necessarily crude, as they do not measure consumption directly. Another approach to measuring dietary status of groups has been to focus on the household. Indirect data on household food intake can be derived from records of foods brought into the household or from pantry inventories. Because of variations in intrahousehold distribution of foods, such techniques cannot be used to estimate individual intakes.

By far the most precise way of measuring dietary intake is to gather data on individuals. These methods depend on identifying a period of time for which data are needed, measuring food quantities consumed, and then translating these into nutrient amounts, either through direct chemical analysis or (more commonly) using food composition tables.

Common Methods for Dietary Data Collection

The most valid, or accurate, dietary methods are prospective methods. These involve keeping records of foods consumed over the period of time of interest. This can be done by individuals themselves, or by others observing them. Sometimes the foods are weighed before eating and then plate waste is weighed and subtracted. A similar method is to prepare two duplicate meals; one is consumed by the subject and the other is analyzed for nutrient content. Another method is the dietary record, in which the subject records estimated amounts of foods consumed. In any case, these methods are highly reactive because individuals may alter usual behavior to make their diet more socially desirable or to simplify the process of record keeping.

Recall methods are the most widely used type of dietary data collection method. They are less reactive, but also less accurate than record methods. Twenty-four hour recalls, in which the previous day's intake is queried in detail (for instance, foods, amounts, preparation techniques, condiments) are easiest for individuals to complete. The data reported are converted from foods to nutrients with the use of food composition tables. Because a single day is not representative of usual intake, multiple twenty-four hour recalls are frequently used. These multiple recalls can be thought of as sampling from an individual's ongoing food behavior. The number necessary to reliably measure diet depends on the nutrient of interest. Nutrients widely distributed in food (such as carbohydrates) require fewer days than nutrients not widely distributed (such as cholesterol). The number of recalls needed also depends on the nature of the diet. In societies where day-to-day and season-to-season food intake varies, more days are needed than where diets are more monotonous.

The semiquantitative food frequency is a recall method in which an individual summarizes the diet to produce a measure of usual intake. For a list of foods commonly eaten, the individual estimates how frequently the food has been eaten in the time period in question (often, one year) and in what amount. Food composition tables are then used to estimate the usual daily intake. This method combines low burden on the individual with low cost. It has been widely used and studied, as it is the foremost method used in nutritional epidemiology. Research has examined how best to formulate a list of foods, how to present the foods to the subject, and whether portion sizes should be included.

Because the act of estimating frequency of intake is assumed to be based on cognitive processes, research has examined how best to maximize reliability and validity of food frequency data by focusing on the cognitive tasks experienced in the course of completing a food frequency questionnaire. This includes questions such as whether a long list of individual foods should be presented (for example, skim milk, 2 percent milk, whole milk) or whether foods should be nested (for example, questions about the presence or absence of milk in the diet separated from the variety of milk). The results of these analyses have been mixed but suggest that incorporation of formatting changes based on cognitive theory will enhance the accuracy of reporting.

There has also been recent discussion of the actual task of summarizing and estimating intake experienced by the subject. The traditional explanation that persons completing a food frequency questionnaire actually retrieve and integrate past behavior to achieve an average dietary intake has been challenged by arguments that persons answer food frequency questionnaires in terms of a composite image of themselves and their diet, rather than a statistical estimate. If the latter is the case, one might expect that attempts to minimize error will reach a threshold of error that is unlikely to be crossed without a major conceptual shift in dietary data collection techniques for nutritional status assessment.

See also **Caloric Intake; Dietary Assessment; Food Consumption Surveys; Nutrition.**

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ASSYRIA, ANCIENT. *See* **Mesopotamia, Ancient.**

AUSTRALIA AND NEW ZEALAND. Australasian neighbors, once part of the same vast land mass known as Gondwanaland, Australia and New Zealand share a similar recent history. Both were British colonies settled largely by emigrants from England, Scotland, and Ireland, and both experienced rapid agricultural expansion in the 1800s. The initial prosperity of both was built on primary production, a high proportion of which—wool, meat, wheat, dairy products, fresh fruits such as apples and pears, and dried fruits such as raisins, sultanas, and currants—was exported, principally to Britain (until the formation of the European Economic Community).

One significant difference between the two countries is in their indigenous populations; the original inhabitants of Australia, for over forty thousand years before white settlement, were nomadic hunter-gathering Aborigines, while in New Zealand the first people were relatively stable semiagrarian communities of Maoris who arrived from eastern Polynesia in the seventh or eighth century. Both groups exploited indigenous food resources, but the Maoris also brought with them plant foods such as yams, taro, and kumara (sweet potato), which they cultivated.

Early Colonial Food and Cooking

The convict colony of New South Wales, founded in 1788, was at first heavily reliant on imported rations. Gradually, however, emancipated convicts and free settlers, many with farming experience, settled the land, often establishing orchards and gardens around the homesteads and becoming largely self-sufficient. These initial farming experiences benefited later colonies, including New Zealand.

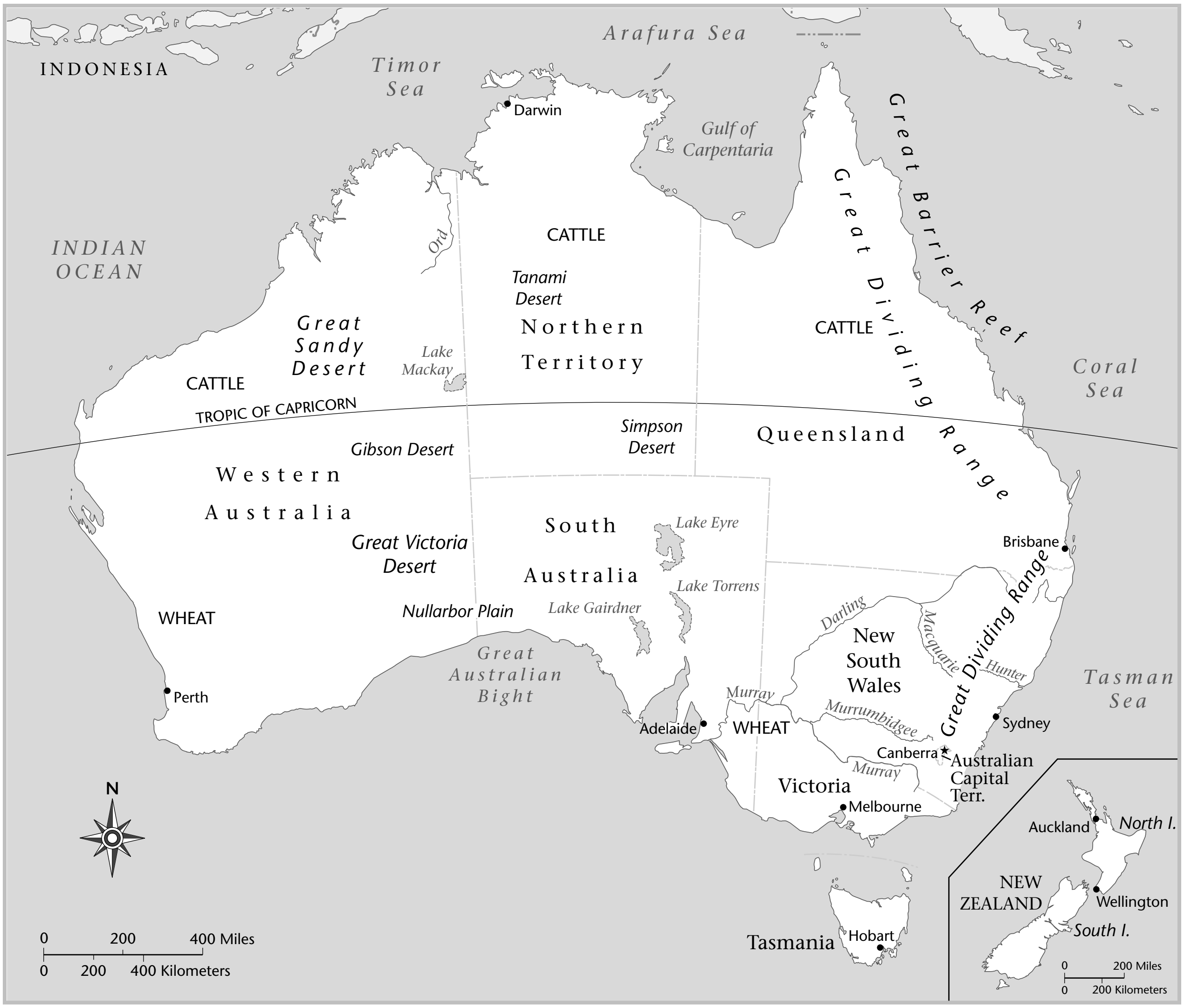
The success and profitability of sheep grazing, which saw sheep numbers in New South Wales increase almost fivefold between 1803 and 1813, meant that meat was abundant and very cheap in the colonies, and a pattern of "meat three times a day" was firmly established by the 1840s. The standard weekly ration for Australian farm laborers in the 1830s was ten pounds of meat, ten pounds of flour, two pounds of sugar, and four ounces of tea.

Mutton, tea, and damper formed the basis of a sustaining, if monotonous, diet for many rural workers. Damper was a yeastless substitute for bread, made of flour, salt, and water and cooked in the embers. In *A Summer at Port Phillip* (1843), Robert Dundas Murray wrote: "You have mutton and damper today,—mutton and damper will appear tomorrow, and from that day till the end of the year, your dinner is mutton, boiled, roasted or stewed." Even in landowners' homesteads, mutton was ubiquitous. It was generally cooked as Robert Dundas Murray described, but in both Australia and New Zealand at least one new dish became popular—Colonial Goose, a roasted boned leg or shoulder of mutton with a sage-and-onion stuffing.

In both Australia and New Zealand, the early white settlers made only limited use of the indigenous food resources, preferring to choose those foods that resembled familiar fare. Seafood, including the oysters of Sydney harbor, and shellfish such as *toheroa* and *paua* (abalone) in New Zealand, were readily accepted and eaten, as were freshwater fish and crustaceans. In Australia kangaroo was rated equal to hare and venison, and kangaroo tail soup was often featured on menus; game birds such as quail, pigeon, duck, and wild turkey were also hunted and eaten. Of the vast range of plant foods consumed by the indigenous inhabitants, only a few, such as native fruits made into preserves or desserts, appeared on colonial tables.

Urban Lifestyles

The gold rushes of the mid-nineteenth century brought great prosperity, especially to the cities, which, by the 1870s, could boast sophisticated restaurants and a wide range of imported luxury foods, from caviar to Gorgonzola cheese. In domestic kitchens, however, plain, homely, English-style cooking prevailed, though with local adaptations. The roast (or baked) dinner serves as an example of how Australia and New Zealand developed their own variations of English traditions; the joint, beef or lamb, was baked in the oven with drippings, sur-


Arafura Sea
INDONESIA
Timor Sea
Darwin
Gulf of Carpentaria
Great Barrier Reef
Great Dividing Range
INDIAN OCEAN
Ord
CATTLE
Tanami Desert
Northern Territory
CATTLE
Great Sandy Desert
Lake Mackay
CATTLE
Coral Sea
TROPIC OF CAPRICORN
Simpson Desert
Queensland
Gibson Desert
Western Australia
South Australia
Lake Eyre
Great Victoria Desert
Brisbane
Lake Torrens
Nullarbor Plain
Lake Gairdner
WHEAT
Darling
Macquarie
Great Dividing Range
New South Wales
Hunter
Great Australian Bight
Tasman Sea
Perth
Murray
Murrumbidgee
Adelaide
WHEAT
Sydney
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rounded by a variety of vegetables—the obligatory potatoes and pumpkin, plus onions, parsnips, orange-fleshed kumara in New Zealand, sometimes carrots, and white-fleshed sweet potato—and served with gravy and a green vegetable, usually peas or beans.

By the turn of the century food was no longer cooked in the hearth but on wood-burning ranges or, in the cities and large towns, gas stoves, which were introduced in the 1870s. Ice chests were also becoming common at this time, favoring the growing popularity of cold puddings such as jellies, flummeries, and molded custards which also took advantage of commercially manufactured gelatin.

Large quantities of meat were still being eaten, despite success with the first shipment of frozen meat from Australia to England in 1880 and subsequent development of a profitable export trade, and despite increasingly loud denunciations of overconsumption of meat by the medical profession. The Sydney physician Dr. Philip Muskett, in particular, railed against the eating habits of a nation of meat worshipers and tried to persuade Australians to adopt a diet more appropriate to the climate by eating more vegetables, particularly salads. At this time, according to the evidence of recipe books, vegetables were typically overcooked and salads rare; tomatoes did not become popular until the 1880s and even then tended to be cooked rather than eaten raw.

Most Australian and New Zealand households at the end of the nineteenth century began the day with a substantial breakfast: porridge, bacon and eggs, sausages or chops (particularly on farms that raised their own meat), toast or bread, tea or coffee. Dinner, the principal meal, was often served in the middle of the day and was centered on the main course of meat and vegetables, sometimes preceded by soup, and followed by dessert of some sort—a hot or cold pudding, custard, tart, or pie. (See the menus sidebar.) The evening meal generally featured meat again, but was less substantial. In cities and towns dinner was often eaten in the evening, after the return from work of the (male) head of the household, and the midday meal, lunch, was reduced to sandwiches and fruit

An Economical Dinner, 1891

Shoulder of mutton, onion sauce
Baked potatoes
Boiled cabbage
Oxfordshire pudding
Stewed fruit, cheese, biscuits

SOURCE: Wicken, Harriet. *The Australian Home, a Handbook of Domestic Economy*. Sydney: Edwards Dunlop, 1891, p. 260

* * *

Family Dinner Menu, 1940

Vermicelli & Parsnip Soup
Triangles of Toast
Baked Stuffed Shoulder of Mutton
Brown Gravy, Red Currant Jelly
Baked Potatoes, Boiled Celery
Stewed Peaches, Baked Custard

SOURCE: Osborne, W. A., and E. Howell. *What Shall We Have for Dinner*? Melbourne: Albright & Wilson, n.d., p. 11

* * *

Four Economy Menus, 1965

Beef curry; Lemon-drop pancakes
Hamburgers; Lemon cream rice
Potato meatloaf; Caramel meringue pie
Brawn, potato salad; Apple snow

SOURCE: *Australian Women's Weekly*, 2 February 1965

* * *

Budget Stretchers— Inexpensive Family Dishes, 1991

Tomato and spinach lasagne
Chickpea casserole with potato dumplings
Spicy baked eggplant
Glazed chicken wings
Beef and vegetable curry
Tuna and corn frittata
Ham and vegetable fried rice

SOURCE: *Australian Women's Weekly*, August 1991

or to the quasi-national dish of both countries, the meat pie (accompanied by tomato sauce).

Scones, Sponges, and Afternoon Teas

In addition to the three daily meals was afternoon tea, which could be particularly lavish on Sundays. Until about the mid-twentieth century, afternoon tea was the accepted way of entertaining guests; it was a particularly feminine form of entertaining, and gave women the opportunity to display their flair and imagination.

Many of the dishes that Australians and New Zealanders claim as their own belong to the world of the afternoon tea. Adapting a British tradition, Australians developed pumpkin scones (with the addition of mashed pumpkin) and fried scones. Lamingtons, cubes of butter cake coated with a thin chocolate icing and rolled in desiccated coconut, were invented in the early 1900s. Anzac biscuits, made with rolled oats, flour, coconut, butter, sugar, and golden syrup, and named after the forces that served in World War I, are common to both countries, as are afghan biscuits, melting moments, and hokey pokey biscuits. Cooks in both Australia and New Zealand specialize in light, airy sponge cakes, often served as a four-inch-high sponge sandwich filled with jam and cream.

Another antipodean invention is the Pavlova, a crisp-shelled, soft meringue cake spread lavishly with whipped cream and decorated with fresh fruit, such as strawberries or passion fruit pulp. Its origins are still disputed, but it seems likely that the cake originated in New Zealand, even if today's standard recipe reflects a later Australian version.

Multicultural Influences

In both Australia and New Zealand, postwar food and eating reflects multicultural influences. Since the 1960s, increasing numbers of Australians and New Zealanders have traveled in Europe and Asia and experienced different cuisines, while at the same time an influx of immigration, particularly from Mediterranean countries—Greece, Italy, the former Yugoslavia, Turkey, and the Middle East—has resulted in the availability of a vast diversity of foods and restaurants. Many Vietnamese settled in Australia at the end of the conflict in that country, further diversifying the range of Asian foods and ingredients available. The tropical city of Darwin, in particular, has a large population of Asian and Pacific Island peoples whose foods and cuisines can be sampled at the weekly (in the dry season) Mindil Beach Market. Among successful "new" foods are Cervena (farmed deer) in New Zealand and kangaroo in Australia, harvested in the wild under license. New Zealand has also effectively commercialized the kiwifruit, a fruit of Chinese origin (and formerly known as the Chinese gooseberry) imported into New Zealand in the early 1900s.

The changes in eating habits since around 1950 demonstrate a convergence of different trends. Supermarkets have replaced individual specialists and convenience foods—prepared soups and sauces, instant cakes and puddings, frozen pastries and ice creams—have largely replaced the raw ingredients from which such dishes used to be made. Relaxation of licensing laws, together with greater appreciation of wine, led to a blossoming of restaurants, often run by immigrants; today's opportunities for dining out range from silver-service

Shepherd Peter Coble at the Narra Allen sheep station north of Boorowa, Australia, prepares to dose Merino sheep in the paddock. Sheep raising is one of Australia's major agricultural industries. © PAUL A. SOUDERS/CORBIS.

restaurants to casual cafés to fast-food franchises. Thanks to both the food manufacturing industry and restaurants, people are familiar with a wide range of cuisines, both European and Asian. Emphasis on the links between health and eating has made people increasingly aware of dietary advice. Finally, a greater recognition of vegetarianism is obvious, with most cafés and restaurants including vegetarian options in their menus.

Domestic menus, while becoming more simplified, also show the influences of many different cuisines and a willingness to accept nonmeat meals. (See the menus sidebar.) Meat consumption declined dramatically in the 1970s when the cholesterol–heart disease connection was announced, though the cooked breakfast had already begun to wane in the presence of a proliferation of ready-to-eat breakfast cereals. In Australia the consumption of meat is less than two-thirds what it had been one hundred years earlier, and consumption of lamb and mutton has halved. In fact, there is more chicken, and almost as much pork, eaten as lamb and mutton (both chicken and pork are the products of intensive factory farming).

The last years of the twentieth century also saw greater awareness of indigenous food resources, such as the Australian flavorings of lemon myrtle and native pepper leaf, which are increasingly used in restaurants and by the food industry.

See also **British Isles**; **Pacific Ocean Societies**.

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AUSTRALIAN ABORIGINES. Australian Aborigines are believed to have first arrived in northern Australia forty to sixty thousand years ago. They gradually spread throughout the continent, adapting to a vast range of environments from coastal tropics to inland desert, from temperate grasslands to mountainous highlands and riverine plains. In view of the diversity of plant and animal resources available in such a variety of settings, it is difficult to generalize about Aboriginal food, diet, and cooking practices. Nevertheless, some fundamental features were common to virtually all of the five hundred "tribes" or language groups believed to have been living in Australia at the time of European settlement at the end of the eighteenth century.

Hunter-Gatherers

Aborigines practiced a highly mobile hunter-gatherer lifestyle, moving frequently from place to place in accordance with seasonal availabilities of food resources. At the same time, they manipulated the environment in such a way as to favor certain species of flora and fauna. Their management of the land and its resources included setting light to dry grass and undergrowth in specific areas at certain times of the year in order to drive out small animals that they could easily capture. This practice has since been termed "firestick farming." It had a secondary benefit in that the new green growth which followed rain attracted small marsupials and other animals to the area, thus ensuring food supplies.

Typically, men hunted large game such as kangaroos and emus, and speared, snared, or otherwise procured smaller animals (opossums, bandicoots), birds (wild ducks, swans, pigeons, geese), and fish. Men tended to operate individually, while groups of women and older children collected plant foods (fruits, nuts, tubers, seeds), small game such as lizards and frogs, and shellfish. There were variations to this pattern; around coastal Sydney, the principal food-gathering task of women was fishing, and men also collected vegetables. The relative contributions of men and women to the communal meal varied according to season and location, but women's gathering activities could provide from 50 to 80 percent of a group's food. The time taken to collect a day's food varied similarly, but rarely would it have occupied the whole day.

The Aboriginal diet was far from monotonous, with a very wide range of food resources exploited. In northern Australia, thirty different species of shellfish were

An Australian Aborigine prepares to throw a boomerang while hunting in the Outback. Photo dated 1930. © BETTMANN/CORBIS.

collected throughout the year from seashore and mudflats; in Victoria, about nine hundred different plant species were used for food. Whatever the available resources, Aborigines did not always and necessarily eat everything that was edible; in some coastal regions fish and sea animals were preferred as sources of protein, and land animals were relatively neglected. On the other hand, Tasmanian Aborigines ate lobsters, oysters, and other shellfish but did not eat scaly fish; they avoided carnivorous animals and the monotremes platypus and echidna, though in other regions echidnas were eaten.

Tools were basic: a digging stick for women, spear and spear thrower for men. Fish, birds, and small game could be caught in woven nets or in conical basket traps. Many Aboriginal groups used lines, with crude shell or wooden hooks, to catch fish; alternatively, fish traps were sometimes constructed in rivers and along the coast to entrap fish, or temporary poisons were placed in waterholes to stun fish or bring them to the surface.

Food Distribution and Taboos

Complex rules determined food sharing arrangements. Men were usually treated preferentially in the distribution of game, with the hunter distributing the various portions among his male relatives who might then pass some to the women; if the hunter himself had a share it was an inferior cut. Offal—heart, liver, kidneys, brains—tended to be particularly prized, and often went to senior men. Women's gathering was for themselves and their immediate family rather than for the whole group, and there were certain plant foods that men apparently ignored.

Because of Aboriginal spiritual beliefs that people, plants, animals, and, indeed, the land are all part of a system created by ancestral spirits, all united and having equal rights to the resources of the country, totemic relationships existed between human and nonhuman species. The rules governing these relationships varied; for some groups killing and eating the totem was always taboo, while for others it might have been prohibited only at specific times or in special ceremonies. Thus some language groups of Aborigines may not have eaten emu while neighboring groups did.

Particular taboos, usually involving animal foods, applied to women during pregnancy or lactation, to young girls at their first menstruation, and to young boys at the time of their initiation. Wallaby and two species of bandicoot were sometimes forbidden to girls, because they would cause premature puberty, and to young boys, because they would favor brownish rather than black beards. Some foods, such as bitter tubers, were prohibited to children but sweet foods, such as plant galls and the edible gums that exude from kurrajong and other trees, were regarded as special treats and preferentially left to the young.

Food Preparation and Cooking

Many fruits and nuts and a few plant foods could be eaten raw and did not require cooking, but generally roots, bulbs, and tubers were roasted in hot ashes or hot sand. Some required more or less lengthy preparations to improve their digestibility or, in some cases, to remove bitterness or leach out quasi-poisonous components. In the central Australian desert, Aborigines relish the honey sucked from the distended bellies of underground worker ants; in effect, these "honey ants" serve as live food stores for other worker ants.

The principal means of removing toxins were pounding, soaking, and roasting, or a combination of any of these. One particular variety of yam, *Dioscorea bulbifera*, was subjected to a series of treatments to remove bitterness. First it was scorched to shrivel the skin, which was removed; then it was sliced and the slices coated with wet ashes and baked in a ground oven for twelve hours or more, and the ashes were then washed off before eating.

The kernels of the cycad palm (*Cycas armstrongii*), highly toxic in their unprocessed state, were treated by pounding, soaking in still or running water until fermented, and pounding again between stones to produce a thick paste that was cooked in hot ashes, sometimes wrapped in paperbark, yielding a kind of damper or bread.

Aborigines did not have sophisticated cooking equipment; basic culinary techniques included baking in hot ashes, steaming in an earth oven, or roasting on hot coals, this last method typically used for fish, crabs, small turtles, and reptiles. Oysters, too, were often cooked on hot coals until they opened, but in northern Australia large bivalves were "cooked" by lighting a quick fire on top of the closely packed shells arranged on clean sand, hinge side uppermost.

Cooking in hot ashes was the most common method of preparing tubers, roots, and similar plant products including yams (*Dioscorea* spp.) and the onion-shaped tubers of spike rush (*Eleocharis* spp.), both of which were important foods for Aborigines in northern Australia. Witchetty grubs (*Xyleutes* spp.) and similar grubs from other trees were also cooked in hot ashes, if not eaten raw, as were the flat cakes, commonly called dampers, made from the seeds of wild grasses such as native millet (*Panicum* sp.). The relatively complicated preparation involved threshing, winnowing, grinding (using smooth stones), the addition of water to make a paste, then baking in the ashes. Seeds of other plants, such as wattles (*Acacia* spp.), pigweed (*Portulaca* spp.), and saltbush (*Atriplex* spp.), as well as the spores of nardoo (*Marsilea drummondii*), were treated similarly.

Earth ovens were essentially pits, sometimes lined with paperbark or gum leaves, heated with coals or large stones previously heated in a fire. Foods to be cooked were placed in the oven, covered with more paperbark, grass, or leaves and sometimes more hot stones, then enclosed with earth or sand. Roots and tubers were sometimes placed in rush baskets for cooking in an earth oven, and when clay was available, such as near the edge of a river, fish were enclosed in clay before baking.

Large game such as kangaroo and emu was gutted immediately after killing and carried back to camp where the carcass was thrown onto a fire for singeing. After the flesh had been scraped clean, the animal was placed in a pit in which a fire had previously been lit to supply hot coals, covered with more hot coals plus earth or ash or sand, and baked. The cooking time depended on how long hungry people were willing to wait.

Ceremonial Foods

When special occasions such as initiation brought large numbers of Aborigines together, it was essential that food resources in the vicinity of the meeting place were both adequate and reliable. Ceremonial foods, therefore, were less associated with particular qualities than with seasonal abundance. In the mountainous regions of southern New South Wales and Victoria, bogong moths (*Agrotis infusa*) were profuse and easy to collect in late spring and summer, and at this time Aboriginal groups converged in the mountains where ceremonies took place. The prevalence of shell middens suggests that shellfish provided ceremonial sustenance in coastal areas. In Arnhem Land (Northern Territory) cycad nuts were plentiful at the end of the dry season, when travel was still possible, and the kernels, once heated to remove toxins, were ground to yield a thick paste, and subsequently baked in the ashes to serve as a special ceremonial food for men participating in sacred ceremonies and forbidden to women and children unless authorized by older men.

Many Aborigines today have lost touch with their foods and foodways, preferring instead the convenience of Western-style foods. Nevertheless, recognition of the health benefits to Aborigines of their traditional diet has resulted in active encouragement of hunter-gatherer practices, even if only to supplement store foods. In many areas, Aborigines have special hunting and fishing rights for species that are otherwise protected or subject to limits—though today their hunting typically involves firearms rather than clubs and spears.

See also **Hunting and Gathering**; **Pacific Ocean Societies**.

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AUSTRIA. *See* **Germany, Austria, Switzerland.**

AVERSION TO FOOD.

Food aversions are far more common, far more diverse both within and across cultures, and far stronger than is often realized. Examination of the characteristics and origins of food aversions can help to illustrate the many contributions of genes and environment to behavior. Further, an understanding of food aversions can be useful in understanding, as well as treating, many eating and drinking disorders.

Classification of Food Aversions

Food aversions have been classified into four types: foods that are rejected because they are dangerous, inappropriate, disgusting, or distasteful. We consider foods to be dangerous, and therefore do not eat these foods, if eating them has previously resulted in physical harm, or if eating these foods is reputed to cause physical harm. However, a dangerous food, such as poisonous mushrooms, would be eaten by someone if there were some medication to prevent any illness from occurring.

Inappropriate foods are items that we consider not to be food. An example of an inappropriate food would be Kentucky bluegrass. Although deer and other herbivores might eat this grass, we would consider it inappropriate for humans to do so. Similarly, there may be an item, such as a particular kind of berry, that is considered to be a food by one culture but not by another.

There are several reasons why someone might treat an item as an inappropriate food. One involves the taste of the item. From birth, humans find certain tastes, notably the taste of bitter, to be aversive, and therefore may not consider items with those tastes to be appropriate foods. For example, many wild plants taste extremely bitter. Given that poisonous plants are often bitter, scientists believe that humans who avoided bitter tastes were more likely to survive and therefore humans evolved to have an innate aversion to bitter tastes. Direct experience with an item may also contribute to its classification as an inappropriate food; attempts to chew some wild plants can be fruitless. Finally, someone may consider an item to be an inappropriate food because of information passed on by someone else. For example, caregivers may tell children that grass is not food.

Disgusting foods are those that most of us would not want in our meals or stomachs no matter how the foods were disguised and no matter how small the amount. Some examples of items classified as disgusting foods are urine and feces. Foods can become disgusting because of someone's having observed others' reactions to these foods, because of contact of a previously nondisgusting food with something considered disgusting, or because a food looks similar to something disgusting. Thus, because most American children learn from others that insects are disgusting foods, we consider a glass of milk that used to have a cockroach in it to be disgusting, and we find fudge that looks similar to feces to be disgusting. Similarly, cultural beliefs can result in certain foods being considered disgusting. For example, many vegetarians consider meat to be disgusting, and Jews who keep kosher may find meal combinations of meat and dairy products to be disgusting.

Probably the most studied is the fourth and final category: distasteful foods. These are foods that most of us would not mind eating if the taste of the food were covered up by another taste, or if we only found out that we had eaten it after we had finished eating. An example is warm milk. Once again, an innate dislike of certain tastes can contribute to food aversions of this sort. However, many members of the distasteful food category are illness-induced food aversions (also known as taste aversions). Humans and many other species exhibit illness-induced food aversions when they eat something, become ill, and then do not want to eat that food again. This is an extremely powerful type of learning. Study of the acquisition of illness-induced food aversions has proved extremely important to the development of general learning theory, and has resulted in a number of different applications outside of the laboratory. Therefore, the following sections discuss illness-induced food aversion learning in some detail.

Taste Aversion Learning: Basic Observations

Prior to scientists' conducting any investigations of taste aversion learning, farmers were aware of this phenomenon, which they called bait shyness. The farmers found that it was difficult to kill rats by putting out poisoned bait. The rats would take only small samples of any new food, in this case the bait, and if they then became ill, they would subsequently avoid the bait.

Laboratory experiments on taste aversion learning began in the 1950s. Researchers noticed that rats eat less after being irradiated. Apparently irradiation makes rats gastrointestinally ill and they associate the illness with food, resulting in a taste aversion to the food.

In 1966 John Garcia and Robert A. Koelling used a taste aversion paradigm to show learning theorists that it is easier to learn some associations than others. In their experiment, rats more easily learned to avoid licking flavored water when that licking was followed by illness than by shock, and they more easily learned to avoid licking water accompanied by clicks and light flashes when that licking was followed by shock than by illness. Garcia and Koelling concluded that it is easier for rats to associate tastes with illness and audiovisual events with shock than vice versa. It was due to results such as these that this type of learning was labeled taste aversion learning.

Odors may also play an important role in food aversions linked to illness, yet the term "taste aversion learning" has persisted. The fact that tastes and odors are more easily associated with illness than with other sorts of events helps us to survive. The presence of a poison is more likely to be indicated by a particular odor or taste than by a particular appearance or sound.

Subsequent experiments found that taste aversion learning has some other special properties that may help animals to survive. For example, taste aversions can be acquired with up to twenty-four hours between consumption of the food and illness. This is advantageous because it may take hours before a poison will result in illness. In addition, in taste aversion learning, the taste actually seems to come to taste bad. This also helps animals to survive because a poison should be avoided no matter under what circumstances it is encountered. Finally, taste aversions are more likely to form to novel foods, and often form after just one pairing of a taste with illness. These characteristics help to ensure that, as much as possible, animals learn quickly to avoid new poisonous foods. Animals appear to have evolved so that they easily acquire long-lasting aversions to cues associated with poisonous foods.

Taste aversion learning has been studied in a great many species, including humans. Surveys have found that most college students report having acquired at least one taste aversion. In general these aversions are strong and have persisted a long time. Laboratory experiments have shown that taste aversions are acquired similarly across species.

Applications of Taste Aversion Learning

Research on taste aversion learning can help us to understand, and possibly modify, many food aversions and preferences. For example, taste aversion learning may cause what are termed specific hungers. These are preferences for specific foods containing a nutrient, such as thiamine or sodium, in which an animal's diet has been deficient. Animals may feel ill when deficient in these nutrients, and thus form taste aversions to their usual foods. New foods, or foods associated with recovery from the illness, are therefore preferred.

In a very different application, taste aversion learning has been used for wildlife management—to prevent coyotes from attacking sheep on ranches in the western part of the United States. Many ranchers choose simply to kill the coyotes. However, coyotes are a valuable part of the ecosystem (for example, by decreasing the rabbit population). Researchers reasoned that, if they could train the coyotes to avoid sheep but not rabbits, this would preserve the ecosystem. They therefore placed lamb bait laced with an illness-inducing drug on the range in areas frequented by coyotes. The coyotes appeared to acquire an aversion to eating or even approaching sheep. In fact, after aversion training, coyotes behave submissively toward sheep, running the other way when a sheep approaches.

Taste aversion learning has also been helpful in understanding the life-threatening anorexia that can accompany cancer. Some cancer treatments, such as radiation and chemotherapy, can cause gastrointestinal illness. When this illness is paired with food consumption, taste aversions can result. Ilene L. Bernstein and Mary M. Webster gave child and adult patients a novel-tasting ice cream prior to their chemotherapy and the patients acquired an aversion to that ice cream. These findings and others have resulted in the development of the "scapegoat technique." This technique involves giving cancer patients a novel food along with some familiar food just prior to their chemotherapy. The patient forms an aversion to the novel food and not to the familiar, usual food.

Although it might seem that taste aversion learning could be useful in decreasing overeating, it is not employed for this purpose. Taste aversions form to specific foods, and it is too easy for a patient to switch to overeating a different food once an aversion has been acquired to a previously overconsumed food.

In contrast, taste aversion learning has been successfully employed in treating alcohol abuse, although the pairing of alcohol and illness must be done carefully in order for strong taste aversions to develop. In addition, it is necessary for illness to be paired with a variety of alcoholic beverages in order to ensure that an alcoholic does not switch to new alcoholic beverages following aversion training.

Conclusion

There are a great many different types of food aversions in humans and other animals. Some of these aversions help animals to survive, and others can be extremely debilitating. Continuing research will help to maximize the positive effects of these aversions, and minimize their negative effects.

Martin E. P. Seligman (president of the American Psychological Association in 1998) has described how, in 1972, he ate sauce béarnaise on steak and then became ill with what was definitely stomach flu (his colleague at work who had not eaten the steak came down with the same affliction, and his wife who had eaten the steak did not). Yet, even though he was absolutely convinced that the sauce béarnaise did not cause his illness, Seligman acquired an aversion to it.

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Some children and pregnant women repeatedly consume nonnutritive substances such as paint, plaster, and dirt. Because such food cravings are most likely to appear in people who need a lot of nutrients, it has been proposed that these cravings are the result of specific hungers for minerals such as iron.

See also **Additives**; **Anorexia, Bulimia**; **Bioactive Food Components**; **Disgust**; **Food Safety**; **Sensation and the Senses**; **Taboos**; **Toxins, Unnatural, and Food Safety**.

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AZTECS. *See* **Mexico and Central America, Pre-Columbian.**

B

BABY FOOD. The consumption of food is an extraordinarily social activity laden with complex and shifting layers of meaning. Not only what we eat but how and why we eat tell us much about society, history, cultural change, and humans' views of themselves. What, when, and how we choose to feed infants and toddlers, the notion of "baby food" as opposed to "adult food," and whether or not these foods are nourishing and satisfying reveals how mass production, consumption, and advertising have shaped attitudes about infancy and corresponding parenting philosophies and practices. From the late 1920s to the postwar baby boom of the 1950s, mass-produced solid infant food, especially fruits and vegetables, shifted items of rarity into a rite of passage, a normal, naturalized part of an infant's diet in the United States. In the early twenty-first century commercially produced infant food not only remained a mainstay of an infant's diet in the United States but manufacturers also sought new markets, including developing countries.

Preindustrial First Foods

Historically, semisolid mixtures of grains and water, animal milk, or broth, variously known as "pap," "panada," or "gruel," have been the first semisolid food (also known as "beikost") an infant receives. (Cone, 1984, p. 12; Quandt, 1984). In many cultures mothers chew food, making it similar in consistency to gruel, then feed it to their infants. The earliest known infant feeding devices date back to the second or third centuries, though few specifics regarding their use are understood (Fildes, 1995, p. 116). Commonly infants have been introduced to pap mixtures as a supplement to breast milk. The pap then becomes an increasingly prominent part of infants' diets until they are completely weaned, which varies from several months old to three to four years of age.

Mass-Produced Baby Food

The industrialization of the food supply laid important groundwork for dramatic changes in infant feeding. By the 1920s in the United States canned goods were mass-produced in sufficient quantity to be affordable for most, allowing Americans to consume, among other things, more fruits and vegetables year round. Also at this time the discovery and promotion of vitamins helped change Americans' wary attitude toward fruits and vegetables. These foods previously were not fed to children before two or three years of age as they were thought to cause cholera and dysentery.

Thus the market was ripe for the introduction of commercially canned food for babies, especially produce. In 1928 the Michigan-based Fremont Canning Company, owned by the Gerber family, began producing strained vegetables for infants, which proved so successful that the company changed its name to the Gerber Products Company and became the exclusive maker of baby foods. By 1935 Gerber's biggest competitors, Beech-Nut, Heinz, and Libby's, entered the baby food market. Despite these competitors' quick development of their own mass-produced strained baby foods, Gerber managed to maintain its dominance of the market (Nisbet, 1954). Mothers, both those at home full-time and those with paid employment, embraced and benefited from commercially prepared solid infant food, and within a matter of decades the product became a common part of an infant's diet. The easy availability of, prominent advertising for, and increasing use of commercially prepared infant formulas acclimated mothers and doctors alike to infants' ingestion of substances other than breast milk.

Increasingly Earlier Introduction of Solids

In the late 1920s, just as Gerber began its national advertising and distribution of canned baby foods, the prevailing wisdom advocated introducing strained fruits and vegetables around seven months. The market for baby food increased with the idea that babies could eat solids, especially fruits and vegetables, at an earlier age. During the 1930s the recommended age was four to six months, and by the 1950s it was four to six weeks, with some doctors advocating feeding infants strained cereals and vegetables within days of birth. As this early introduction of solids became standard advice and practice, solid baby food, like infant formula, functioned not only as a supplement to but as a substitute for breast milk.

Commercial Baby Food: Modifications over Time

While mass-produced baby food increased infants' year-round consumption of fruits and vegetables and provided a welcome efficiency in preparation, it also had its deficiencies. Throughout most of the twentieth century commercially canned baby food was overcooked and contained added salt, sugar, starches, fillers, artificial preservatives, and even, though infrequently, dangerous contaminants, such as lead, glass shards, or pesticides. Moreover until the 1990s baby food manufacturers did not have to list the precise percentage of each ingredient on the label (Stallone and Jacobson, 1995).

Mass-produced baby food was created and became successful in response to an emerging industrialized society, meeting the needs of changing work patterns and an increasingly fast-paced lifestyle. It remained a rite of passage for most American babies at the advent of the twenty-first century, though with modifications. During the 1970s the return to breast-feeding and the renewed popularity of homemade baby foods were products of the public's more skeptical attitude toward corporate capitalism and institutions in general. In the 1980s and 1990s, mostly in response to consumer demand, baby food manufacturers eliminated sugar, salt, and modified starch from most products, introduced organic lines, and eschewed the use of any foods containing genetically modified organisms. Because of an overall declining birthrate in the United States at the beginning of the twenty-first century, baby food manufacturers, to maintain and even increase market share, began to forge new markets, targeting Latino and African American populations in the United States and trying to expand market share in developing countries around the globe.

See also **Lactation; Milk, Human; WIC (Women, Infants, and Children's) Program.**

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BABYLONIA. *See* **Mesopotamia, Ancient.**

BACTERIA, LACTIC ACID. *See* **Microorganisms.**

BACTRIA, ANCIENT. *See* **Indus Valley.**

BAGEL.

A specialty of East European Jews, the classic bagel is a small ring of dough made of white flour, yeast, and water. The dough is first boiled and then baked.

The Bagel in Europe

According to Mordecai Kosover in *Yidishe maykholim*, the earliest mention of the bagel is in the 1610 statutes of the Jewish community of Cracow, which state that it is permissible to make a gift of bagels to the woman who has given birth, the midwife, and the girls and women who were present (Kosover, p. 129). Even earlier sources indicate that the father would send *pretsn*, or pretzels, which are historically related to the bagel, to everyone on the occasion of a circumcision. Legends that trace the first bagel to the Ottoman siege of Vienna in 1683 are apocryphal. The very same story is told about the origin of the croissant, the pretzel, and the coffeehouse.

A relatively affordable treat, the East European bagel was portable and small. According to a Yiddish proverb, only by the third bagel would one feel full. Bagels made with milk or eggs were known from at least the nineteenth century, and almond bagels were among the prepared foods exchanged on the holiday of Purim. Bagels and other round foods were eaten before Tisha B'av, a fast day commemorating the destruction of the Temple, and in the twenty-first century bagels are served after a funeral and during the seven days of mourning that follow. The round shape symbolizes the round of life. The *beuglich* described in Israel Zangwill's *Children of the Ghetto* (1892) as "circular twisted rolls" suggest the *obwarzanek*, a twisted, fresh ring pretzel dating from the Middle Ages and still sold by street vendors in Poland and the large twister bagels sold in Toronto in the twenty-first century.

The Bagel in the United States

The bagel arrived in the United States with Jewish immigrants from eastern Europe at the end of the nineteenth century. From the 1890s until the 1950s bagel bakers struggled to form their own union, a process that began in 1907 with the establishment of a benevolent society for bagel bakers. With the influx of younger and more radical immigrants after World War I, the process of converting the benevolent society into a union intensified. Local 338, the International Beigel Bakers Union of Greater New York and New Jersey, coalesced in 1925 and was finally recognized as an autonomous local in 1937. Thanks to the union, bagel bakers in the New York metropolitan area won the best working conditions in the baking trade.

While radical in their politics, these bakers were conservative in their craft. Bagel bakers resisted technology because mechanization of the rolling process would eliminate jobs. As a result the bagel industry in the New York metropolitan area was one of the last of the baking industries to become fully automated. As late as the 1960s bagels were still made by hand in small bakeries by Jews for Jews, and Local 338 controlled the industry. Water bagels plain or salted were the basic varieties.

From 1955 to 1984 bagel bakeries outside New York and outside the jurisdiction of the bagel bakers' union found ways to distribute this highly perishable product far beyond the freshness radius of the bakery. They modified the dough, introduced flavors, packaged bagels in plastic bags, froze them, and shipped them to groceries and supermarkets across the country. Frozen bagels were marketed primarily to non-Jews. Once the bagel was packaged, it could be branded. The bagel began its shift from a generic product to a branded commodity.

With distribution channels in place and demand growing, the bagel industry was ready to increase production. Thompson Bagel Machine, which had been in development since World War I, was patented in 1960 by the Thompsons, an East European Jewish family in Los Angeles. In 1963 the first automated bagel-forming machines were introduced in New Haven, Connecticut; Buffalo, New York; and St. Louis, Missouri. As the growing bagel industry outside New York started penetrating the New York market, the union weakened and automation entered, thereby transforming the bagel baking business and fueling its exponential growth. By 1984 Lender's Bagels, which started as a family bakery in New Haven in 1927 and was the first to use a bagel-forming machine, had become so successful that it was acquired by Kraft and then Kellogg, who saw the bagel outpacing and even supplanting croissants, doughnuts, cereals, and other breakfast foods.

The Bagel Boom

The bagel has become one of the fastest-growing sectors of the food industry. The bagel industry, with relatively low barriers to entry, has attracted a wide range of people. H&H Bagels, the icon of the New York bagel, has been owned by Herman Toro, who was born in Puerto Rico, since the 1970s. Hand-rolling is largely a specialty of Egyptian and Thai immigrants. During the 1980s, with growing national awareness of the bagel and the introduction of bagel-steaming equipment, the developing bagel category became dominated by rapidly expanding chains, franchises, and privately held as well as publicly traded bagel companies. By the mid-1990s the bagel boom peaked, and a shakeout followed. Some of the companies that grew fastest showed the most serious losses. Meanwhile the bagel had spread to such places as Germany, Turkey, Japan, Taiwan, Australia, and Bali.

The bagel as Americans know it today evolved in the Jewish community in the United States. It has also become an icon of New York food, especially the onion bagel shown here. PHOTO BY ANDRÉ BARANOWSKI.

The Bagel as Icon Food

After the Holocaust American Jews came to identify the bagel with the Old World and with immigrant Jewish culture. The bagel became a lightening rod for their ambivalent feelings. While Irving Pfefferblit declared in "The Bagel" that "the Jewish bagel stands out like a golden vision of the bygone days when life was better," upscale Miami hotels during the 1950s served lox on English muffins or tartines rather than on lowly bagels (Pfefferblit, p. 475).

With the suburbanization of Jews and secondary migration of Jews to California and Florida during the postwar years, the bagels and lox brunch became a Sunday morning ritual with its own equipage, including bagel slicers and decorative bagel platters with compartments for smoked salmon, cream cheese, butter, olives, radishes, and slices of onion and tomato. So important did this meal become that "bagel and lox Judaism" became a metaphor for the gastropiety of suburban Jews.

The close identification of the bagel with New York City arises in no small measure from its labor history, though some claim the secret to the New York bagel is the water. Paradoxically the further the bagel traveled from New York, the more it became identified with New York and with all that is metropolitan and cosmopolitan. However, other cities with large Jewish communities also have long bagel histories and distinctive bagels. The Montreal bagel has a narrow coil and a big hole. It is rolled by hand, boiled in water sweetened with honey, sprinkled with sesame seeds, and baked in a wood-fired oven, which gives it a slight smokiness.

Bagel Innovations

New bagel eaters with no prior loyalties are a prime market for bagel innovations. With but a few concepts (size, shape, flavor, topping, stuffing, and carrier or platform), it is possible to produce combinations, permutations, and improbable hybrids. The early Lender's frozen bagels weighed two ounces. Bagels in the twenty-first century range from three to more than five ounces. There are cocktail minibagels and overstuffed party bagels the size of a tire. Cosi recently introduced the squagel, a square bagel. Where there were once only a few varieties (poppy seed, pumpernickel, and eventually cinnamon raisin), by the twenty-first century there were unlimited flavors (from cranberry granola to piña colada), toppings (everything from poppy seeds, sesame seeds, caraway seeds, and garlic to streusel), and fillings (from cream cheese to bacon and eggs).

At bagel shops offering twenty types of bagels, which is not uncommon, and even more varieties of spreads and fillings, customers can create hundreds of combinations. Bagel eaters from birth tend to be disdainful of what might be called the random bagel effect. "Turkey, tomato, sprouts, avocado, and cream cheese on a peanut butter and chocolate chip bagel" at Goldstein's Bagel Bakery in California is an ungrammatical culinary sentence for those fluent in the language.

The bagel replaces bread, pizza, croissant, and tortillas as the preferred carrier or platform for their fillings and toppings. New hybrid bagel products include the *bagelwich* (bagel plus sandwich), *bragel* (bagel plus roll), *bretzel* (bagel plus pretzel), *fragel* (fried bagel), and *flagel* (flat bagel) as well as the Bageldog, pizza bagel, UnHoley Bagel (ball injected with cream cheese), bagel chips, bagels for birds and dogs, and bagel bones for people. The bagel is distilled into a flavor of its own for bagel-flavored rice cakes and matzoh.

The bagel has become not only a platform for other foods but also a carrier for meanings and values as diverse as those who eat them. For many it is an icon of East European Jewish culture, for others it is quintessentially New York, and for many around the world, including in Israel, it is American.

See also **Bread**; **Breakfast**; **Judaism**; **United States: Ethnic Cuisines**.

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BAHÁ'Í. Originating in Persia in the mid-nineteenth century, the Bahá'í Faith is the youngest of the independent world religions. It is also one of the fastest growing and most widespread of religions with about 7 million adherents in over 220 countries. Founded by the prophet Bahá'u'lláh, the faith is built on the fundamental principles of unity and justice and the necessary convergence of spiritual and social development. The faith embraces a concept of progressive revelation that assigns equal status to previous prophets, who are known as "manifestations of God." There is only one God. As perfect reflections of God the manifestations occupy a status between the human and the divine. Each prophet brings the same core message as well as new teachings suited to the time and place of his particular revelation and the stage of development of humanity. Bahá'u'lláh's purpose, as the latest of these manifestations of god, is to usher in a new world order of peace and prosperity for the human race.

Dietary codes and prohibitions are absent in the Bahá'í sacred writings. Rather than rules there is an emphasis on guidance and on the responsibility of individual believers to live a virtuous life. Food rules and practices are often used as boundary markers in religions and as a way for believers to assert their faith identities. The absence of such prescriptive dietary codes in Bahá'í teachings exemplifies the Bahá'í concept of the unity of humankind by removing one boundary between races, cultures, and religions. There is no symbolic value attached to particular foods, nor are there foods that are associated with specific rituals or celebrations. Generally speaking Bahá'ís follow local dietary custom. Nevertheless, there are three aspects of food that are explicitly addressed in Bahá'í sacred writings: the relationship of diet to health, fasting, and commensality as exemplified in the Nineteen Day Feast.

Role of Religion in Shaping Daily Diet

There is a special concern for the strength and well-being of the body as the temple of the human spirit. The body should be a willing, obedient, and efficient servant, kept in good health so that the Bahá'í can devote all his or her energy to serving Bahá'u'lláh's purpose. To this end, Bahá'ís are expected to take responsibility for looking after their own health, in which diet plays an essential role. Both asceticism and hedonism are to be avoided; the former because it is an inappropriate withdrawal from the world and a rejection of what God has provided, and the latter because one should not be preoccupied with material possessions. Instead, moderation is advised as a means to achieve a state of "detachment" necessary to attain true understanding of God's will.

The ideal regime is a balanced natural diet that is adapted to local climate and to the type of work in which the body is engaged. Although animal food is not forbidden, meat-eating is considered to be only a temporary necessity of the current age, one that will give way in the future to vegetarianism. Vegetarianism is portrayed as being a compassionate practice, for the killing of animals blunts the spiritual qualities of the human race. A meatless diet is also natural in that it uses simple foods that grow from the ground. Finally, vegetarianism is just; one should not eat lavishly while others starve.

Food is not only seen to be the chief way of maintaining health, but also the preferred means for treatment of disease. Health and disease are conceived of in terms of balance and bodily equilibrium reminiscent of Greek humoral theory and Ayurvedic conceptions of hot and cold. Disease arises from disturbances to the balance of the body, which can be restored through consumption of food containing the necessary elements to bring it back to health. Although a time is foreseen when improved medical knowledge and understanding will enable all illness to be treated by food, Baháʾís are enjoined to take full advantage of the best that current medicine has to offer and to seek the services of competent physicians when they are ill.

Fasting and Feasting

There is only one annual fast prescribed for Baháʾís. The precepts of the fast are laid down in the Kitab-I-Aqdas, or Most Holy Book, of Baháʾuʾlláh and along with obligatory prayer it is the most important of Baháʾí ritual obligations. The fast bears a marked resemblance to Islamic practice, the context in which it emerged. The Baháʾí fasting period lasts nineteen days from the second to the twentieth of March, and requires complete abstention from food and drink between the hours of sunrise and sunset. It is a period of meditation and prayer, a chance to renew one's spiritual self, and a reminder of the need to abstain from selfish desires. The fast is binding on Baháʾís in all countries but it is an individual obligation, not enforceable by Baháʾí administrative institutions. It applies to all believers from the age of maturity (thought of as age fifteen) until seventy, with exemptions for travelers under specified conditions; the sick; women who are menstruating, pregnant, or nursing; and those engaged in heavy labor, who are advised to be discrete and restrained in availing themselves of this exemption. Unlike in the Islamic model, fasters who are unable to meet their commitment do not have to offer any sort of restitution or make up the missed days later. Nor are sexual relations prohibited during fasting periods. Baháʾís are allowed to fast at other times of the year but this is not encouraged, and is rarely done. Fasting itself is only acceptable if it is done purely out of love for God. This is reminiscent of the importance of *niyyah* or intent in the Islamic fast of Ramadan.

SELECTION FROM *SOME ANSWERED QUESTIONS* BY ʿABDUʾL-BAHÁ

The science of medicine is still in a condition of infancy; it has not reached maturity. But when it has reached this point, cures will be performed by things which are not repulsive to the smell and taste of man—that is to say, by aliments, fruits and vegetables which are agreeable to the taste and have an agreeable smell. . . . All the elements that are combined in man exist also in vegetables; therefore, if one of the constituents which compose the body of man diminishes, and he partakes of foods in which there is much of that diminished constituent, then the equilibrium will be established, and a cure will be obtained (Sec. 73).

Feast has a particular meaning in the Baháʾí Faith, referring to the monthly community meeting known as the Nineteen-Day Feast. The original purpose of the Baháʾí feast was a means of creating fellowship, and is rooted in the Persian tradition of hospitality. Baháʾuʾlláh enjoined believers to entertain nineteen people every nineteen days even if only water was provided. Over time the feast shifted from being a display of personal hospitality to becoming an institutional event. The modern Nineteen-Day Feast is held in each Baháʾí community on the first day of each Baháʾí month, and consists of three parts. The first is devotional and consists of readings from the Baháʾí sacred writings; the second is a consultative meeting where administrative and community issues are discussed; the third is a social gathering at which food is served. What is served is at the discretion of the host and is guided by personal preference and local custom. The Nineteen-Day Feast is intended only for the members of the Baháʾi community; however, non-Baháʾí visitors should be received hospitably at the social portion of the feast only.

The sharing of food is an important feature of Baháʾí social events. Food sharing also occurs through charitable activity and social action. However, where local community development projects supported by Baháʾís involve food, these usually take the form of agricultural development rather than food distribution.

See also **Fasting and Abstinence: Islam**; **Iran; Vegetarianism**.

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BAKING. Baking refers to two culinary processes: cooking by dry heat in an enclosed oven and making up flour-based goods (breads, cakes, pastries) that are cooked by baking. By extension a baking day is devoted to making breads and cakes and includes the idea of a batch bake or tray bake made up in quantity for cutting into smaller pieces. Cooking flour-based items using a griddle is also considered a form of baking. "Roasting" meat or vegetables such as potatoes in the oven is also in practice baking. The idea is also implied in the clambake of shellfish, using layers of heated stones and seaweed.

Two trades are directly concerned with baking, the baker using yeast to make breads and the pastry cook producing delicate pastries and cakes. The demarcation is unclear in English, which often applies the word "baker" to someone who makes cakes. French distinguishes more sharply between the *boulanger* and the *pâtissier*, as does German between the *Backer* and the *Konditor*.

The technique has a wide geographical spread. It is used throughout North America and Europe, across the Middle East and North Africa, and into central Asia and northern India. The concept was introduced by Europeans to their former colonies, many of whom have continued the practice. Baking is exceptionally important in cultures that rely on wheat as their primary cereal. Methods and technology have developed principally to exploit and enhance the properties of the gluten it contains. Others (rye, barley, oats) contain less gluten but are used in northern and western European baking, usually as residual traditions from times when wheat was expensive and difficult to obtain. Maize does not lend itself to baking, although North American settlers managed to develop corn breads, and the Atlantic communities of northern Portugal and Spain also use it in breads and cakes.

The history of baking is one of interaction between ingredients, fuels, and oven technology. On a basic level virtually any food can be "baked" by burying it in hot ashes or placing it on a stone beside the fire, something that must have been known from the earliest times. Developing control to the point of producing items as diverse as breakfast rolls, soufflés, and chocolate brownies has taken thousands of years.

Enclosed Ovens

Early advances included the development of enclosed ovens. One type was a pit oven in the ground with a fire in the bottom. These were known by about 3000 B.C.E. in Egypt, where they were hollow cones of clay that contained a layer of coals. The modern tandoor, a large ceramic oven sunk into the ground and fired with wood or charcoal, echoes this idea. Tandoors have limited applications for baking but are essential for breads such as the flat, leavened wheat nan of Persian and northern Indian traditions. The dough is slapped onto the clay sides of the tandoor and cooks fast. Tandoors become very hot, and the fire remains in the base throughout cooking. This along with their shape makes them unsuitable for complex baking.

Another type was the beehive oven, a domed structure situated above ground. An early version is in an Egyptian tomb model of about 1900 B.C.E. Early ones were made of clay and had the advantage of enclosing food in a hot environment but allowing the baker the opportunity to make more than flat shapes. Stone or brick ovens of similar shape evolved later and can be seen at Pompeii. They were used for baking with wheat flour and sour dough leaven. Beehive ovens fired with wood became the primary means of baking in medieval and early modern Europe. They were used for wheat or rye breads and the sweet, enriched festive breads and cakes that developed from these breads.

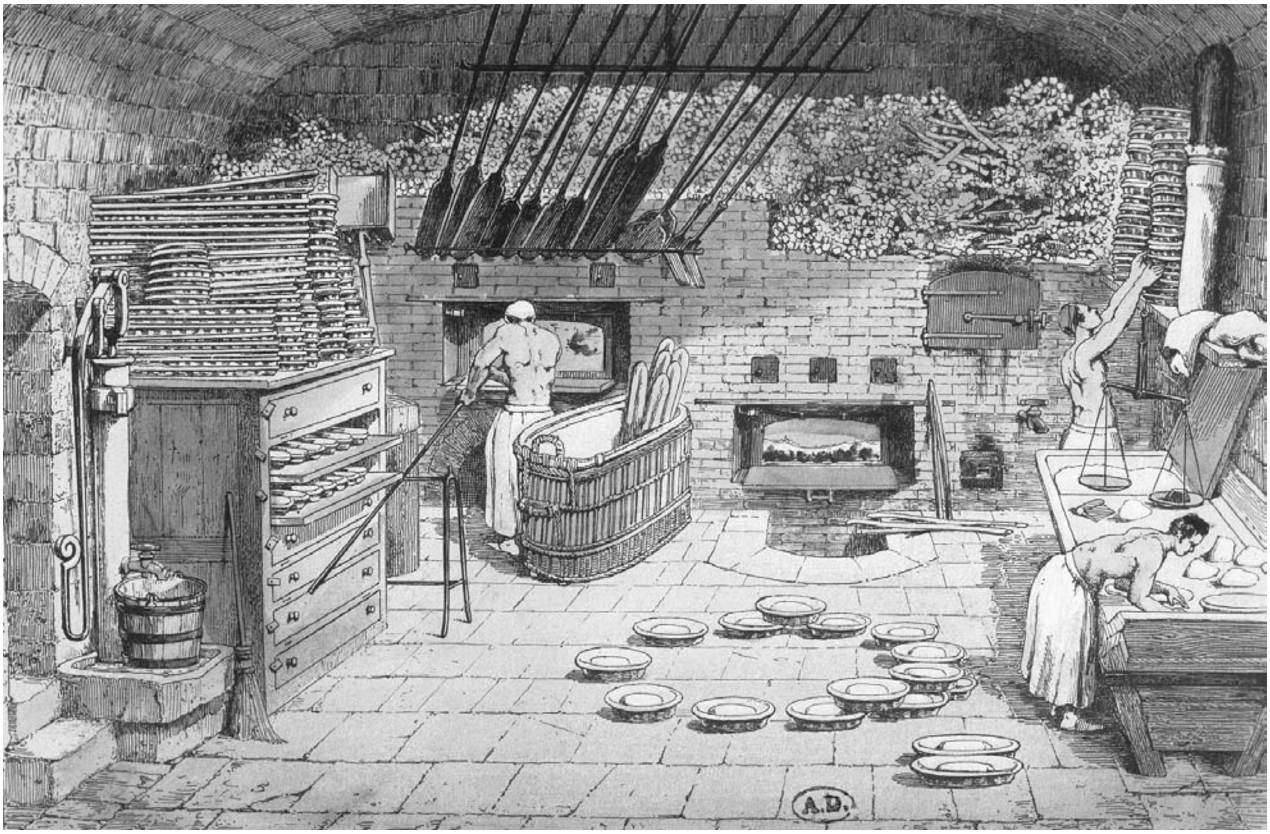
To heat a beehive oven, a fire was lit inside. After a while the oven was cleaned out, leaving heat stored in the walls. This heat diminished slowly over time. It could not be controlled, but by the sixteenth century a sequence had evolved. Coarse breads were baked first, followed by white breads, pastries, and joints of meat (often in pastries or pies), and progressing to cakes that would burn at high temperatures. Residual heat was used for drying fruit or for confectioneries. It was a time-consuming and complex operation. The size of the ovens and scarcity of fuel led to the idea of baking communally. For a small charge customers could bake their own dough or meat in an oven owned by a village baker. Such habits were noted in southern England during the eighteenth century and were still observed in some Mediterranean countries, for instance Greece, in the early twenty-first century. Small clay ovens were also still used in some regions, such as the Iberian Peninsula.

Wood-fired ovens produce unique, much-liked textures and tastes. Italian restaurants sometimes use wood-fired pizza ovens, and French bakers advertise *cuit au feu de bois* (cooked with a wood fire). Baking in these ovens requires a peel, a special implement with a long handle and a flat plate at one end for lifting food into or out of these large and often extremely hot structures.

Griddle Baking

Little is known about the history of griddle baking. An ancient and widespread technique, it was available to anyone with a fire and a flat stone. At some stage specially made griddles—heavy metal plates—developed. Although it does not use enclosed heat, its association with cooking flour-based items links it firmly to the idea of baking.

Griddle baking is associated with Scotland and Ireland, where locally dug peat is used for fuel. Peat gives a slow, gentle heat unsuited to oven baking. The tradition continued in South Wales where cheap coal was burned in open kitchen grates, over which the griddle was balanced. Typical products include Welsh cakes, like small biscuits, and Scottish griddle scones or drop scones, small



French print showing the interior of a nineteenth-century bakery. © GIANNI DAGLI ORTI/CORBIS.

thick pancakes. British crumpets and muffins (made from bread dough) are baked on modern versions of the griddle, gas or electrically heated hotplates.

Another item used for baking with a open fire was the Dutch oven, which could be regarded as a form of covered griddle. It consisted of a heavy iron pot with a lid, both of which were preheated before use. Food was placed inside the pot, the lid was put on, and hot coals were heaped over it. They were used for baking bread, biscuits, and cakes as well as for roasting meat and other cooking. Both griddles and Dutch ovens were easy to carry and were much used by North American pioneers. Baking with these implements was enhanced in the mid-nineteenth century by the development of bicarbonate of soda, leading to the development of Irish griddle-baked soda bread. Bicarbonate of soda and baking powder were promoted through recipe booklets and rapidly became popular for making biscuits, quick breads, and cakes in parts of Europe and North America.

Due to regional poverty and the availability of slow-burning fuel, the East retained a form of griddle baking. Chapatis, the thin flat breads of Pakistan and India, are baked on metal plates over fires of dried cow dung, a fuel that gives slow heat.

Kitchen Ranges

Controllable heat was the key to modern baking. Initially this took the form of the cast-iron coal-fired kitchen range, an idea patented by Thomas Robinson, a London ironmonger, in 1780. Over the next century designs evolved to control the heat, partly through the work of the American statesman Count Rumford. Ranges became fixtures in many European and North American houses. For the first time convenient and controllable ovens existed, although they still needed skill for good results. However, gas was used as a fuel for domestic cooking by the 1880s, and electricity was introduced about a decade later, giving even more accuracy and ease. By this time numerous regional baked specialties had developed, including tortes and gâteaux in central Europe, Christmas *Lebkuchen* in Germany, and teatime cakes in Britain. North America inherited baking traditions from all European countries in the form of festive breads, cakes, and cookies. In turn, by the twenty-first century North Americans grew much of the wheat that sustained the baking traditions in their native countries.

Utensils

Baking requires many utensils. Measuring is important, so most kitchens and all professional bakers possess spoons, cups, and scales. Bowls are needed for mixing, sieves and sifters for flour or sugar, rolling pins for pastry, cutters and molds for cookies, and forcing bags and nozzles for soft mixtures. Paper is used to line trays and molds and to hold cake and muffin mixtures. Flat metal baking sheets are used to support anything from a round loaf without a pan to a batch of cookies.

Many loaves of bread are baked in oblong pans. Common cake pan shapes include square, round, and tube pans. Many cultures have special forms as well, such as the German *Rehrücken* (a ribbed half cylinder for baking a chocolate cake in a "saddle of venison" shape) and the Alpine and Rhine areas' *Gugelhupf* (a tall, fluted tube pan). Novelty shapes run to Santa Claus and Easter lambs. Cake pans affect the rate at which mixtures heat, and ideally they should match the final volume of the cakes baked in them. Professional pastry cooks use many sizes, from the one-bite petit four up to cakes for large parties. Small shapes in special molded trays include patty pans for baking cupcakes or British mince pies and shell shapes for French madeleines. Pies and tarts, too, have special shapes, including plain round plates and tart rings with fluted edges. Cylindrical formers are used in England for raising pork pies.

In contrast, the only essential for baking meats or vegetables is a metal or earthenware container, although various patent "roasting tins," intended to be self-basting for cooking joints of meat, were developed in the twentieth century. The use of a thermometer designed to show the internal temperature of a piece of cooking meat is often recommended by cookery books.

Physanges

Despite the fact that it typically uses temperatures ranging from 300 to 500°F (150 to 260°C), baking is an inefficient method of heat transfer. It relies on a combination of radiant heat from the oven walls and air convection. What it does effectively is dehydrate the surface of food at a high temperature, producing delicious flavors and aromas. These are due to the Maillard reaction, in which amino acids contained in the food react with sugars during heating, producing the typical smells of baking bread and roasting meat.

Physically, three stages can be identified during the baking of bread. They were summarized by Harold McGee (1984) as, first, when the yeast cells have been killed by heat; second, when the maximum temperature has been reached inside the loaf, gelatinizing the starch and coagulating the protein; and third, when the Maillard reaction induces surface browning, producing the characteristic flavor. Cakes follow a similar basic pattern. Yeast is not involved, but the first stage includes the expansion of minute air cells in the mixture and the release of carbon dioxide from any chemical leavening present. In the second, flour, egg, and milk proteins coagulate, and starch gelatinizes as the batter sets into a solid foam. Browning reactions set in during the third.

Nutritionally, baking has little effect on cereal foods, although it reduces the thiamin (vitamin B_1) content. Many baked items are energy-dense because of the quantities of starch, fat, and sugar they contain. Some keep better than others. French baguettes stale quickly, but English fruitcake keeps so well it can almost be regarded as a form of preserved food.

Baking meat has the effect of coagulating the proteins of which it is composed. They shorten and toughen, squeezing out some of the water they contain, leading to weight loss in the cooked item. Most cooks aim at a compromise when oven-baking meat. Muscle proteins coagulate at about 160°F (71°C) and after that become dry and tough. But connective tissue requires long cooking at high temperatures to convert it to tender gelatin. As with cereal foods, the thiamine content is reduced, and the Maillard reaction develops the flavor and aroma. While this has no nutritional effect, it is important in provoking appetite. Baking vegetables, a relatively slow way of cooking them, reduces their vitamin C content significantly.

See also **Bread**; **Hearth Cookery**; **Pastry**; **Roasting**; **Utensils, Cooking**.

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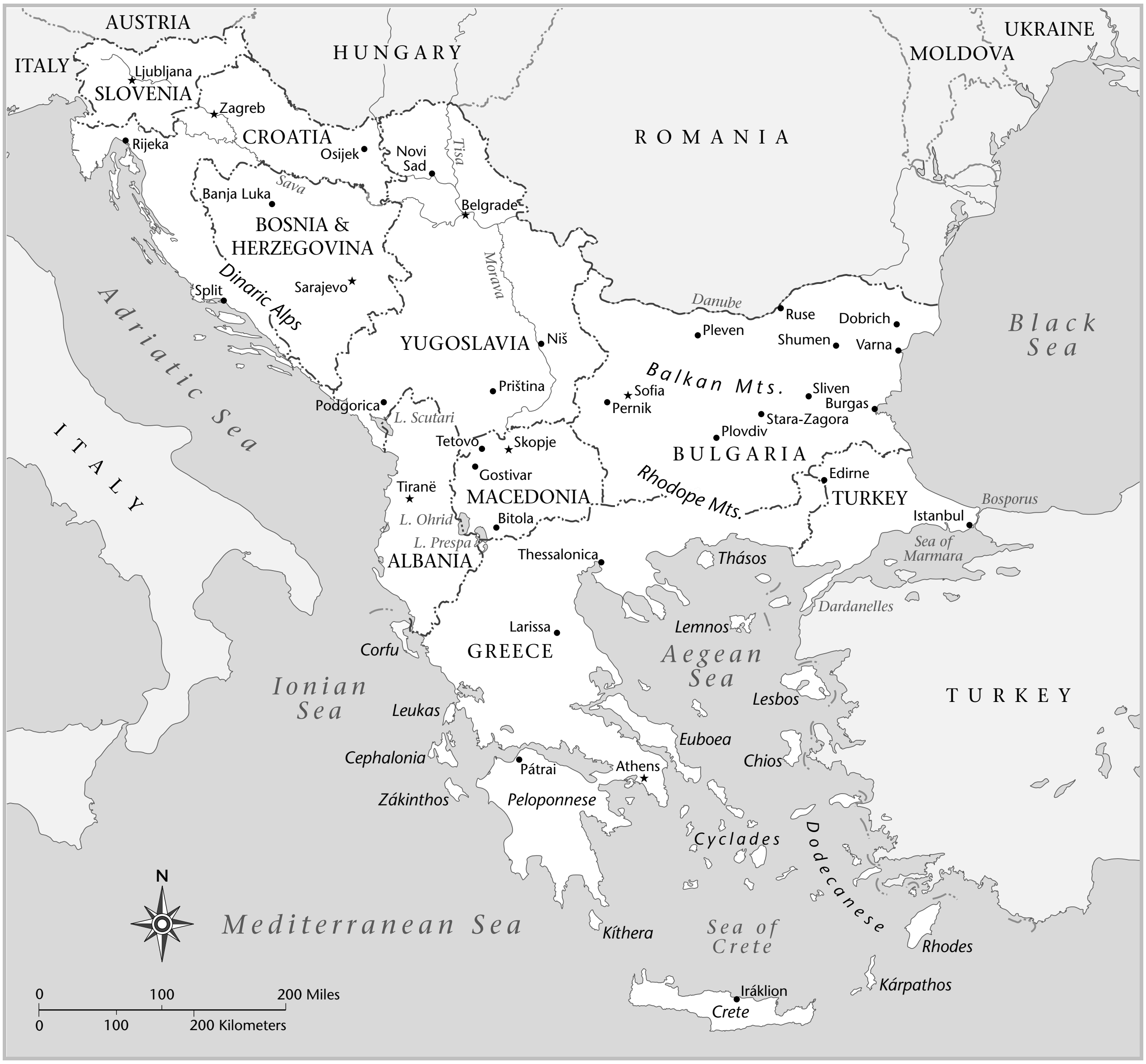
Laura Mason

BALKAN COUNTRIES. Countries on the Balkan Peninsula, a region in southeastern Europe, are bounded by the Adriatic and the Ionian seas in the west, the Mediterranean and the Aegean seas in the south, and the Sea of Marmara and the Black Sea in the east. The penin-


AUSTRIA
ITALY
Ljubljana
SLOVENIA
HUNGARY
UKRAINE
MOLDOVA
Zagreb
CROATIA
Rijeka
Osijek
Novi Sad
Tisa
ROMANIA
Sava
Banja Luka
Belgrade
BOSNIA & HERZEGOVINA
Morava
Dinaric Alps
Sarajevo
Split
Adriatic Sea
Danube
Ruse
Dobrich
Pleven
Shumen
Varna
Black Sea
YUGOSLAVIA
Niš
Balkan Mts.
Priština
Sofia
Sliven
Pernik
Burgas
Podgorica
L. Scutari
Stara-Zagora
ITALY
Plovdiv
Tetovo
Skopje
BULGARIA
Gostivar
Edirne
Tiranë
MACEDONIA
Rhodope Mts.
TURKEY
Bosporus
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Bitola
Istanbul
L. Prespa
Sea of Marmara
ALBANIA
Thessalonica
Thásos
Dardanelles
Larissa
Lemnos
Corfu
GREECE
Aegean Sea
Ionian Sea
Lesbos
TURKEY
Leukas
Euboea
Cephalonia
Chios
Pátrai
Athens
Zákinthos
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sula includes Slovenia, Croatia, Bosnia and Herzegovina, Yugoslavia, Macedonia, Bulgaria, Albania, Greece, and European Turkey.

The region was already settled in the Stone Age. The oldest people living there were the Thracians, the Illyrians, the Greeks, and the Celts. When the Romans invaded Illyria in 168–167 B.C.E., the area was politically and culturally united for the first time in history. The division of the Roman Empire into its Eastern and its Western parts in 375, and the split within the Christian church in 1054 furthered the gap between the peoples of the area (Eastern Orthodox, Catholic), influencing its political and cultural development.

Between the fourteenth and the end of the nineteenth centuries, a great part of the Balkan Peninsula was united in the Ottoman Empire, influenced by its feudal system and civilization, which have strongly marked the culture of the Balkan countries even up to the present.

Principal Characteristics of the Balkan Food Culture

The food culture of the Balkan Peninsula depended upon the historic, geographical, climatic, social, and religious elements. There are three main food culture areas: the Mediterranean, the continental lowland, and the continental mountain areas.

The Mediterranean area is divided into the coastal and the continental parts. People living along the coast tend their vineyards, grow olive trees, different kinds of vegetables, citrus fruits, spices, and they fish. Wine, olive

Housewife preparing vegetables for a meal. Note the traditional raised hearth and the modern stove in the background. © CAROLINE PENN/CORBIS.

oil, cabbage, kale, different kinds of salad greens, cauliflower, figs, grapes, almonds, cherries, marascas, and different fishes are their main staples.

The continental part of the Mediterranean area has a well-developed agriculture. Farmers breed mostly sheep, goats, and poultry, to a lesser extent also cattle and pigs. Fields yield crops of wheat and corn, in some places also rice, cotton, sesame, and poppy. Fertile valleys are sprinkled with vineyards. Meals, therefore, consist mostly of meat dishes, but also of milk, milk products, and vegetables. Lakes provide freshwater fishes.

The continental lowland area, which is distinctly agricultural, starts north of the Balkan Mountains and Šarplanina. Vast fields of corn and wheat give plenty of food. Farmers grow oats, barley, rye, millet, and buckwheat. Since wheat is mostly sold for profit, dishes consist mainly of corn; corn bread is eaten in most places. Because of an abundance of corn, which is very important as fodder, cattle and pig farming are very developed; in the north, sheep and goats are bred as well. The meat of these animals plays a very important role in the food culture of the local population. Farmers also grow fruit, especially apple, pear, plum, and they cultivate walnut trees.

Sheep farming is important in the mountainous part of the Dinaric Alps and in the Rhodope Mountains; less important is cattle breeding. Meals generally consist of milk and different kinds of cheese, corn bread (*proja*), and polenta (*kaèamak*). Many dishes are prepared from cornmeal, eggs, and the *kajmak* cheese; one of these dishes is *èimbur*, boiled eggs covered with *kajmak*. Also popular are vegetable dishes made from cabbage, beans, onions, green peppers, and eggplant. Vegetables pickled in vinegar (*turšija*) are consumed in winter. Meat dishes consist mostly of lamb and sheep meats, usually roasted or prepared in a number of different ways. Beef and pork, which are usually dried in the air and made into prosciutto, or smoked, are eaten during the winter months *(pastrma)*.

Individual Groups of Dishes

The food culture of the Balkan Peninsula displays Asian as well as west European influences. Even though the Oriental influence has been very strong in the last several centuries, ethnic characteristics and traditions have been preserved. Dishes consumed in this region therefore contain many similar elements, but may also greatly differ from each other. One of the characteristics shared by most is the use of numerous spices, onions, garlic, tomatoes, parsley, paprika, and capers.

Soups are prepared from vegetables, meat, herbs, or different kinds of fish. Meat soups usually contain a variety of vegetables, as well. Throughout the Balkans, spring is the time for a thick lamb soup (*mayiritsa*). Other popular vegetable soups are potato, leek, corn, or bean soups, or a soup made of zucchini with milk or eggs. Along the Danube River, fishermen prepare thick soups (*Alaska èorba*), while in coastal areas, they make soup from sea fishes (the Greek *khakhavia*).

In the past, meat did not play a central role in the food culture of the Balkans. It was, nevertheless, a highly esteemed food, which could be prepared in a variety of ways. Grilling and spit roasting are characteristic of the Balkan region, and lambs, kids, or pigs are roasted on spits on prominent occasions, such as weddings and New Year's Day. People grill seasoned minced meat shaped in different forms (*èevapèièi*, *pleskavica*), kabobs (*vešalica*, *šaši kebasi*), lamb and veal cutlets, beefsteaks, or small pieces of meat with vegetables and mushrooms (*muèkalica*, *krzatmas*).

Also very popular are meatballs (*èufte*), be it in or without a sauce, for instance, the *pasha* of Turkey or the Greek *kreftaidakiya*. Minced meat is also used for the preparation of meat pie (*burek*), which can also be filled with cheese or vegetables. Meat can be served in a stew (goulash, paprika). Chicken is roasted with an addition of spices and vegetables, such as olives, peppers, tomatoes, zucchini, and eggplant. Duck or goose is most often served roasted, sometimes with filling.

In Balkan cuisine, vegetables are often prepared as a main or side dish, usually consisting of legumes, cabbage, kale, root crops, zucchini, peppers, tomatoes, and eggplant. These vegetables are made into a ragout, or filled with rice, meat, corn, vegetable, or cheese, or stewed with rice and meat (*ðuveè*). Very popular dishes are those which are made from a mixture of vegetables, meat, and rice (*sarma*), or those prepared with vine leaves (*jalanci dolmasi*), or other leaves (cabbage, kale, chard). There are different casseroles in which meat is prepared together with vegetables, for instance, the Albanian shepherd's pot, or the Bosnian pot. The Turkish moussaka, a baked dish consisting of layers of sautéed vegetables, meat, rice, or potatoes, is prepared throughout the Balkan Peninsula.

Oriental influence is most strongly felt in the great variety of pastries, which have always been an important part of festive meals in all Balkan countries. Among the most popular are different pastries drenched in sugar syrup, and strudels. Most of the sweets contain walnuts and almonds, which are also put into stuffed apples (*tufahije*), or fill walnut pies, cakes, and the famous baklava cakes made from paper-thin dough. Nuts are sprinkled on sweet noodles (*kadaif*). *Žito*, wheat with walnuts, is a festive dish from Serbia. On Christmas and Easter, which are among the most prominent holidays in the region, different kinds of cakes are still served; one of them is the *pinca* from the Croatian coastal area, or Greek *melomacarona*, and another is *kourabiethes*. *Vasiljica* or *badnjaèa* are prepared in Serbia and Bosnia. Tables filled with festive dishes display a great variety of the Balkan cuisine and a strong attachment to the traditional culinary tradition.

See also **Central Europe**; **Greece and Crete**; **Rome and the Roman Empire**.

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Maja Godina-Golija

BANANA AND PLANTAIN. Bananas, including the dessert banana and the cooking types or plantains, are cultivated in more than 120 countries throughout the tropics and subtropics, according to the Food and Agriculture Organization of the United Nations (FAO) current statistics. In terms of total production the banana ranks after oranges, grapes, and apples, but when plantain production is added, it becomes the world's number one fruit crop. While commercial production of bananas is oriented to the fresh export trade destined mainly for temperate-zone markets, plantains and even unripe bananas—consumed boiled, fried, roasted, or even brewed—are a major staple food throughout the tropics.

The origin of the word "banana" probably derives from languages spoken in the coastal regions of Sierra Leone at the beginning of the sixteenth century. It is important to note that none of the major producing regions seem to have incorporated clear linguistic distinctions between dessert and cooking bananas in their languages. The Spanish word *plátano*—from which the English term "plantain" may have derived (Simmonds, p. 57)—does not have a precise origin but is employed throughout the Spanish-speaking world and its meaning changes with location: in most of Central and South America, while the word *banana* is used as in English, *plátano* is reserved for the plantain, whereas in Mexico and Spain—the latter including the Canary Islands, from which the banana is thought to have been carried to the New World (Galán Saúco, p. 9)—it is used for either bananas or plantains. The situation in Southeast Asia is somewhat different, where vernacular names do not differentiate between dessert and cooking bananas (*kluai* in Thailand, *pisang* in Malaysia and Indonesia, *saging* in the Philippines, *chiao* in China, or *choui* in Vietnam) (Valmayor et al., p. 13).

Taxonomy

According to Chesman, who in 1948 pioneered the modern classification of bananas (Simmonds, p. 53), most edible bananas and plantains belong to the *Eumusa* section of the genus *Musa* (family Musaceae) and derive from the species *Musa acuminata* Colla and *M. balbisiana* Colla, which correspond roughly to two species originally described by Linnaeus in his general botanical work *Systema Naturae* (1758) to which he gave the names *M. sapientum* and *M. paradisiaca*, the first referring to a plant producing horn-shaped fruit and similar to the modern "French

In nature all species, plants and animals, are diploids; that is, they have a chromosome number of $2n$, formed by the contribution of n chromosomes (genome) from each progenitor. For diverse reasons and by various natural genetic paths, plants with different levels of ploidy do appear sporadically (e.g., n = haploids; $3n$ = triploids; $4n$ = tetraploids, etc.), and a side effect of this natural process is the loss of fertility. In the case of the banana, the appearance of triploids has proven beneficial to the consumer, as seedless fruits are produced.

Plantain," and the second to a type similar to the most popular dessert banana of the tropics, the "Silk Fig." Both of Linnaeus's designations were soon widely applied, with any plantain being referred to as *M. sapientum* and all dessert types being referred to as *M. paradisiaca.* This outdated nomenclature is still used in some modern reference books and papers.

A completely different group evolved from the *Australimusa* section of the *Musa* genus, the so-called Fe'i bananas, common in the Pacific and composed of a group of cultivars characterized by the red sap of the plant and, chiefly, the fact that its fruit is produced in erect bunches rather than the hanging bunches typical of all *Eumusa* types. It is likely that several species, most particularly *M. maclayi* Muell., are involved in the origin of the Fe'i group.

In purely commercial terms, the most important dessert bananas are those of the Cavendish subgroup—sterile, seedless triploids (AAA) of *M. acuminata*, of which the best known cultivars are "Grande Naine" and "Dwarf Cavendish." Others include AA diploids (such as "Pisang Mas" in Southeast Asia and "Bocadillo" in Latin America, both well known because of their excellent taste, which makes them highly prized by European gourmet fruit retailers), various AB diploids (*acuminata* × *balbisiana*), AAA triploids (the best known is "Gros Michel," at one time the world's leading commercial cultivar but now virtually absent from cultivation because of its high susceptibility to Panama disease, a fungal wilt of serious economic importance), and AAB triploids such as "Silk Fig" (also known as "Pome" and "Manzano"), and the recently obtained AAAB tetraploid "Goldfinger."

Cooking bananas are usually hybrids, mainly AAB or ABB triploids, with the exception of the so-called "Highlands bananas," AAA triploids used in Africa mainly for beer production.

Area of Origin and Main Historical Developmental Facts

Wild bananas were probably used in prehistoric times for, among other non-food purposes, cloth, shelter, and dyes. Interest in them as a food crop appeared early in agricultural history, doubtless linked to the appearance of parthenocarpy (i.e., development of fruit without pollination) and consequent lack of seeds in the primitive types of *M. acuminata* from which the modern edible triploids evolved. Many wild banana diploids and triploids are still abundant throughout southeastern Asia, with a primary area of origin in Malaysia and Papua New Guinea, while most of the plantains originated in India and the Philippines. In any event, both spread quickly to other tropical and subtropical regions of the world. The Fe'i bananas evolved throughout the Pacific islands from Indonesia to the Marquesas and still remain closely confined to the area.

The main recognized milestones of these movements are:

c. 500 C.E. — Introduction to Africa from Indonesia (via Madagascar)
c. 1000 C.E. — Distribution throughout Polynesia and introduction to Mediterranean areas during Muslim expansion
1300s–1400s — Introduction to the Canary Islands from West Africa
1516 — First recorded introduction to the New World (Santo Domingo) from the Canary Islands
1500s–1800s — Distribution of bananas and plantains throughout tropical America
Early 1800s — Introduction to the New World from Southeast Asia of the cultivars Dwarf Cavendish and Gros Michel
Late 1800s — Beginning of the international trade
1900s — Banana becomes a major food item in the temperate-zone markets of the Western world as well as in Asia

Many authors question some of these dates: particularly at issue is the well-documented distribution of the banana in South and Central America shortly after Columbus's first trip, leading some historians to speculate on its presence in the New World prior to 1492. But until proof becomes available, the accepted explanation is that its rapid foothold and spread ran parallel to the slave trade, for which the banana was considered a staple food. The relative durability of banana propagation material and the rapidity with which the plant produces fruit favor this hypothesis, although the archaic uses of the plant's materials still practiced today by some native communities of the Amazon basin, as well as the increasing body of knowledge pointing to the Asiatic ancestry of Native Americans—whose forebears could conceivably have brought banana seeds with them—also support the idea of an early introduction to Latin America (Moreira).

Legends and Myths

The banana plant has been associated with the religions, folklore, traditions, and social customs of many cultures. In most cases these refer to the special botanical characteristics of the plant. A good example is the Indonesian myth "The banana and the rock," which in short recounts how in the beginning, God gave humans a rock as a gift. Not at all pleased, the humans clamored for a different gift, whereupon God gave them a banana plant but with the caveat "You choose the banana and not the rock. Your life will be like this plant, in that soon after it has borne descendants the mother plant will die and the young shoots at its base will come into their own. If you had chosen the rock, your life would be eternal." (Frazer, as cited in *Infomusa*, 1999). The banana is regarded in many cultures as a symbol of fertility and prosperity; thus, it is frequently planted in the corner of subsistence fields of rice, yam, and other basic crops to "protect" them. Throughout Southeast Asia and the Pacific the plant is an important part of the dowry, ensuring food for the newlyweds' future family.

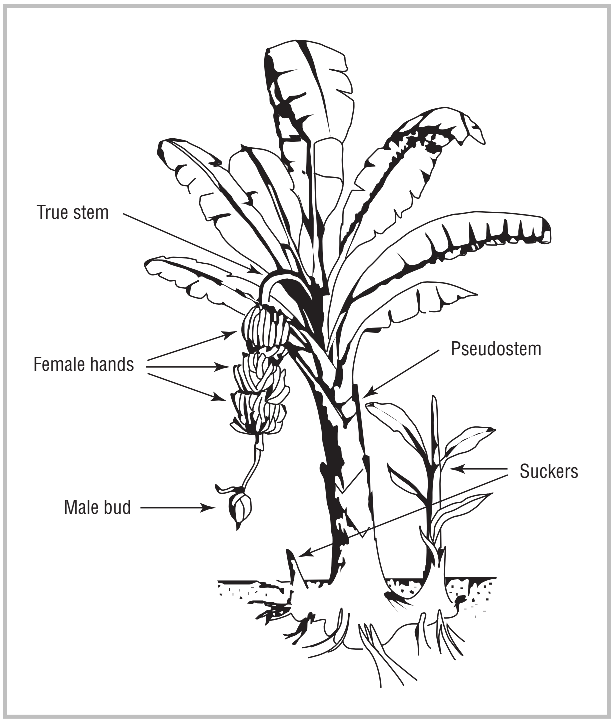
In New Caledonia the Fe'i banana, given its typical blood-red sap, is considered to be the reincarnation of ancestors, with different clones identified with the diverse clans and others considered privileges of the chiefs. The Yanomami tribe of the Brazilian Amazon use the fruit in their funeral rituals, eating a paste of ripe bananas to which the ashes of the deceased are added (http://www.kah-bonn.de/ausstellungen/orinoko/texte.htm).

In the East African highlands, the care and cooking of bananas are tasks reserved for women, with each elderly woman undertaking the responsibility to provide for ten men; beer bananas, on the other hand, are part of the male domain. In Tanzania, however, women prepare the beer and proceeds from sale are their only socially acceptable form of revenue. Hawaiian women, by contrast, were forbidden, under pain of death, from eating most kinds of bananas until the early 1800s (http://hawaii-nation.org/canoe/maia.html).

The Qur'an holds that the banana is the *Tree of Paradise*, and the notorious *forbidden fruit* that tempted Eve in the Garden of Eden could conceivably have been a banana rather than an apple, to say nothing of the leaf—certainly larger than that of the fig tree—with which she later covers her modesty. Simmonds provides some support for this, reminding us that Linnaeus did give the banana its scientific species name of *paradisiaca* (paradise), as well as that the frequent inclusion of "fig" in the common and cultivar names given to certain banana varieties cannot be purely coincidental.

Perhaps one of the best examples of the strong relationship between the banana and humans is the fact that in many languages the banana plant is referred to using terms that indicate people consider it as a family unit: "mother plant" referring to the plant while it is producing a bunch and that will become the "grandmother" once that bunch has been cut; "son" or "daughter" plant referring to the sucker growing at the mother's base, which will produce the next crop; the "parent crop," referring to the plants that will provide the first harvest. In the same anthropomorphic line, the terms "hands" and "fingers" are assigned to the fruit (see Botanical Description).

FIGURE 1



Botanical Description

Bananas and plantains are evergreen herbaceous tropical plants that can be considered giant herbs, as some varieties reach up to ten meters in height, although most commercial types grow to between two and five meters (see Fig. 1). The external "trunk" is in fact a *pseudostem* formed by the concentric assemblement of the leaf sheaths crowned by a rosette of large, oblong-to-elliptic–shaped leaves (ten to twenty under healthy conditions), conferring on the plant the aspect of a herbaceous tree. The *true stem* is a subterranean organ that extends upward at the core of the *pseudostem* until culminating in the inflorescence (the fruiting organ of the plant), which emerges from the top of the plant, and it is responsible for producing all the other parts of the plant: roots, leaves, and shoots or suckers. Leaves are produced successively until the inflorescence is cast, and in variable quantity depending on the specific variety of banana or plantain, climate, and cultural practices.

Although the plant dies after producing fruit, it can be considered perennial in as much as suckers successively replace the senescent aerial parts without need for

Banana ripening facility for Chiquita Brands International in Costa Rica. The bananas are ripened artificially and processed for export. COURTESY AP/WIDE WORLD PHOTOS.

replanting. Several suckers emerge consecutively from buds located at the axil of leaves; under commercial cultivation, they are regularly eliminated, leaving either the most vigorous sucker, or the one capable of producing a bunch when better prices can be obtained, to replace the mother plant.

The large and complex inflorescence is composed of double rows of flowers, called hands, and covered by bracts, usually red or reddish in color, grouped helixoidally along the inflorescence axis, reproducing the pattern of the leaf system. All flowers are hermaphroditic, but only the female or so-called "first" hands (in most cases between four and nine, but sometimes up to fifteen) will give rise to the edible fruit—technically known as fingers; the other hands are of an intermediate or even male character and do not produce edible fruit (these rudimentary fruitlets usually fall before the edible fingers mature). Commercial fruit develops parthenocarpically, although some varieties produce seed in the wild or can be forced to do so in specialized breeding work.

Depending mainly on climate, cultivation conditions, and varieties, the time lapse between emission of the inflorescence and harvesting of the bunch can be anywhere from three to ten months. Bananas are harvested year-round, with normal commercial bunch weights of 15–30 kg, although bunches of more than 45 kg are not unusual when properly cultivated (exceptional cases of bunches of more than 125 kg have been recorded). A medium-sized dessert banana finger weighs around 160 g.

Nutritional Value and Uses

Banana fruit is composed mainly of water (around 65 percent for banana and 75 percent for plantain) and carbohydrates (from 22 percent for banana and 32 percent for plantain). It contains several vitamins, including A, B, and C, and is very low in protein and fat but rich in minerals, particularly potassium (around 400 mg/100 g). It is cholesterol free, high in fiber, and low in sodium. Chemical composition varies not only among cultivars but also according to climatic and other conditions (values are widely available in most of the texts cited in the Bibliography).

Ripe fruit is usually consumed fresh—simply peeled and eaten as a snack or dessert, in salads mixed with other fruit, and with breakfast cereals, but it also lends itself to more elaborate dishes ranging from ice cream to pie fillings.

Plantains, being starchier than bananas, can be eaten ripe or unripe, but many countries have developed commercial processes to provide a wide variety of products from both fruits (in several cases, green bananas can also be used): puree, flour, jam, jelly, chips, crisps, flakes, dried, catsup, relishes or spreads, preserves, vinegar, and even wine. Banana flour, both from green and ripe fruit, has a great industrial potential and, enriched with sugar, powdered milk, minerals and vitamins, and artificial flavoring, is much used in baby foods. In several areas of Southeast Asia, young fruits are pickled. Puree is used in the manufacture of dairy products, such as yogurt and ice cream, in breads and cakes, banana-flavored drinks, baby food, and diverse sauces.

In Uganda—the country with the highest per-capita consumption of bananas and plantains in the world in 1996: 243 kg while people in most European countries only averaged between 7 and 15 kg—an important part of the diet comes from unripe plantains that are first peeled, then steamed wrapped in their own leaves, and finally pounded to a starchy paste called *matoke* that constitutes the main dish. Both Uganda and Tanzania produce and consume large quantities of beer brewed from local Highlands bananas. A plantain and soybean mixture, SOYAMUSA, combining carbohydrates and proteins, has been recently developed in Nigeria to be used as a weaning food for toddlers. All told, bananas and plantains represent more than 25 percent of the food energy requirements of Africa (Frison and Sharrock, p. 30).

Tostones is a very popular dish in the Caribbean: slices of green plantain are double-fried (flattening slices with a wooden press between fryings), producing a tasty side dish used in lieu of the ubiquitous french-fried potato. *Mofongo* is a typical Puerto Rican dish made from fried green plantain, pork, and garlic. Finely ground and roasted dried green plantain has been utilized as a coffee substitute in some countries (Morton, 1987, p 43).

Although the fruit is the main economic product, many parts of the banana plant can be used as food, fodder, or for industrial purposes. Throughout the tropics, male buds, young flowers, and even the pseudostem of some cultivars are eaten cooked as vegetables. Flowers and ashes from burned green leaves and pseudostems are used in curries in Southeast Asia. The possibility of using the raquis to prepare a flour for human consumption and of making a marmalade from plantain peel is being studied in Colombia. Leaves are used for wrapping other food during steaming or other cooking, such as in preparing the Venezuelan *hallaca* and many pit-steamed or pit-roasted meats and vegetables typical among the Pacific Islanders. Banana leaves are also used as environmentally friendly "disposable plates" in southern India, where in fact several cultivars (mainly AAB or ABB plantain types) are grown exclusively for leaf production (Singh, p. 27).

Green and commercially rejected ripe bananas are currently used as animal feed. Leaves, pseudostems, bunch raquis, and peels are also commonly used in fodder. In the Canary Islands (Spain), fresh, chopped banana leaves make up about 80 percent of the diet of Pelibüey sheep.

Medicinal and Therapeutical Value

The easy digestibility and nutritional content make ripe banana an excellent food, particularly suitable for young children and elderly people. In the green stage (and after liquefying) it is used in Brazil to treat dehydration in infants, as the tannins in the fruit tend to protect the lining of the intestinal tract against further loss of liquids. In general, the banana is appropriate for consumption when a low-fat, low-sodium, and/or cholesterol-free diet is required, making it particularly recommendable for people with cardiovascular and kidney problems, arthritis, gout, or gastrointestinal ulcers (Robinson, p. 216).

As the fruit is easy to carry and peel, it is of great value to athletes as a quick and healthy method of replenishing energy because of its high energy value: 75–115 kCal/100 mg of pulp (the lower range for banana and the higher for plantain). Both bananas and plantains contain complex carbohydrates capable of replacing glycogen and important vitamins, particularly B_6 and C, and minerals (potassium, calcium, magnesium, and iron). Ripe fruit has been used to treat asthma and bronchitis, and, as mentioned, in the control of diarrhea. Boiled and mashed ripe fruit, especially when mixed with other appropriate plants, is also cited as a good remedy against constipation.

The juice extracted from the male bud is thought to be good for stomach problems. The peel of ripe bananas has antiseptic properties and can be used to prepare a poultice for wounds or even applied directly to a wound in an emergency. The banana pseudostem is also cooked in India as a dish called "Khich Khach," to be taken monthly to prevent constipation. Fresh leaves have reportedly been used medicinally for a whole range of disorders from headaches to urinary tract infections—at one time, stem juice was considered a remedy for gonorrhea. Many of these purported remedies are not well documented and require further investigation.

Modern History, Commercialization, and Trade

The greatest development of the international banana trade occurred in Latin America during the second half of the nineteenth century, with exports from the West Indies and Central America to markets in North America. It was linked inexorably to railway and port expansion and to land concession policies. The founding in 1899 of the United Fruit Company—of Chiquita brand renown—is generally considered to be the fundamental milestone in this process. According to several sources, over the course of many decades this company wielded considerable power over the governments of several Central American countries, to which it allegedly "contributed" around 30 percent of its net operating profit. Thus the term "banana republic" came into use to define a country whose government was manipulated, and presumably corrupted, by the economic clout of a private enterprise.

From harvesting to consumption, bananas require careful handling as the fruit is very susceptible to physical damage and needs proper (cool) storage to avoid quick ripening and decay. After the bunch arrives at the packing house, it is dehanded and broken into clusters of 4–6 fingers each. Both hands and clusters are washed, usually by passing through tanks containing disinfectant solutions, and packed in cardboard boxes holding 12–18 kg on average. Modern refrigerated ships, equipped with holds that feature controlled temperature and humidity, transport the boxed fruit from the producing countries to distant markets. Temperature during transport is extremely critical: between 13 and 14°C guarantees that fruit will reach its destination in optimum conditions, whereas a short exposure to 12°C or colder temperatures will damage the fruit beyond repair by deteriorating its taste.

According to export trade figures, the major supplying countries can be divided into three groups: 1) the Dollar area, including most Latin American countries (where the trade is largely in the hands of multinationals like Chiquita, Dole, or Del Monte); 2) the ACP area, named for the African-Caribbean-Pacific countries that were signatories of the 1975 Lomé Convention and later treaties with the European Union (EU) designed to protect their economy, largely based on agricultural products; and 3) European producers, particularly the Canary Islands (Spain), the French West Indies, and the Portuguese islands of Madeira.

The main importers are Japan (mostly served by the Philippines), the United States, and Canada (supplied almost exclusively by the Dollar area countries), and the European Union (shared among all the major supplying groups by virtue of the Common Market Organization's banana regulations, which broadly follow the World Trade Organization precepts regarding free trade while safeguarding the traditional economies of ACP countries and EU ultraperipheral regions). Organic production is of increasing importance to import markets and, as is happening with other products, its impact on world trade should be felt in the near future.

About 95 percent of the world export trade is based on Cavendish bananas, but plantains are also the subject of recent interest, especially in Europe because of the burgeoning immigrant population of chiefly African and Latin American origin. Other specialty or exotic bananas, particularly those with red peels and/or flesh, but also *apple* ("Manzano"), *baby banana* ("Bocadillo" or "Pisang Mas"), and *ice cream* ("Lady Finger") types are commercialized on a small scale to satisfy niche markets.

See also **Africa**; **Caribbean**; **Fruit**.

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BARBECUE. While meat grilled over a charcoal or wood fire is common to many cultures around the world, American barbecue is distinguished from these other dishes because of the cuts of meat it traditionally involves, the cooking techniques it employs, and the definitive sauces and side dishes that accompany it. Barbecue is cooked slowly at temperatures ranging from about 175 to 300°F with more smoke than fire. The meat involved varies from region to region. Traditional barbecue most often is pork, beef, lamb, or goat. However, chicken is also a popular barbecue meat.

The word "barbecue" is generally thought to have evolved from the word "barbacoa," which first appeared in Gonzalo Fernández de Oviedo's 1526 book *De La Historia General y Natural de Las Indias*. He describes the technique of skewering meat on sticks and then roasting it over a pit dug in the ground. The writing of Bernardino de Sahaún, who accompanied Hernán Cortés in his conquests of Mexico, uses the word "barbacoa" in references to meats roasted under the ground. References to barbecue cooking technique are also found in the 1698 memoirs of Père Labat, a French priest who wrote about his travels in the West Indies.

Several countries have culinary traditions that, to greater or lesser extents, could be called barbecue. For example, in India, meats are often roasted over charcoal in tandoor, a clay oven. In Jamaica, pork and chicken are barbequed "jerk" style over a slow fire of wood from the all-spice tree. In Mexico, whole goats are often butterflied, skewered, and cooked over a slow fire. In South Africa, the word *braai* is used to refer to the metal or brick pit over which meat is grilled, or to the event at which such meat is served. In Cuba, pit-roasted pigs are the traditional Christmas Eve dinner. In Brazil, *churrasco* refers to the technique of cooking meat on skewers over open pits. That country's *churrascaria* restaurants are famous for their all-you-can eat style of service. American barbecue enthusiasts generally refer to the technique involved in cooking steaks, hamburgers, or fish over an open fire as "grilling" rather than "barbecueing."

The word "barbecue" can be employed as a verb when it refers to the cooking technique. It is also an adjective, as in the phrase "barbecued ribs." And it is a noun when it refers to the gathering at which barbecue is served, as in the sentence, "We are going to a barbecue." Barbecue is important in the American culinary lexicon for two main reasons. First, it takes place outdoors, the cooking is often a public if not a communal event, and it is closely associated with family gatherings and such holidays as Independence Day and Labor Day. Second, barbecue is closely associated with particular regions of the country. The cultural identity of those regions and the people who live in them are inextricable from the style of barbecue served there.

Several theories have been advanced about how roasted meat evolved into American barbecue. The writings of Thomas Jefferson and George Washington include references to barbecue. The event is clearly related to the pig roasts common in Great Britain. While pig roasts may have been common in New England, barbecue did not take root there. Rather, in the eastern United States barbecue is most closely associated with states in which enslaved Africans did much of the cooking. Many of these people were transported from Africa via the Caribbean islands, where they may have learned some of the barbecue techniques of Native Americans. Mexican-Americans continue to use the barbacoa technique described in the writings of Bernardino de Sahagún today.

Barbecue is primarily associated with the American South and is cooked and eaten by most of the region's ethnic groups. But the food was taken to other regions by African-Americans as they fled the South for factory work in the Midwest and other regions in the middle decades of the twentieth century. Barbecue ultimately became common in the area from Virginia over to Kansas, down to Texas, and across to Florida and in African-American enclaves in California.

Barbecue geography can be tricky in that often barbecue styles do not conform to the lines on maps. In the Carolinas, Georgia, and other parts of the Southeast, barbecue means pork, either whole hogs or pork shoulders, generally cooked over hickory or oak wood. It is then chopped, sliced, or pulled and served on buns. Sauces vary widely within the region. Parts of South Carolina are unique in that they use mustard as the basis of their sauce. Parts of North Carolina and Kentucky are similarly unique in that they use a thin sauce that tastes like Worcestershire sauce. The most popular sauce throughout the Southeast is a thin vinegar-based recipe flecked with flakes of dried red pepper and sometimes sweetened with sugar. The most popular barbecue sauce in the country, a thicker, sweeter, tomato-based sauce, is also popular in parts of the Southeast.

Though coleslaw and hush puppies are common side dishes throughout the Southeast, the definitive side dishes are regional stews. In South Carolina and parts of eastern Georgia barbecue is often accompanied by rice and hash, a stew made with some combination of pork and pork organ meats. In Virginia, North Carolina, and Georgia, Brunswick stew is served. The ingredients in this dish vary considerably and can include wild game, corn, lima beans, potatoes, and tomatoes, depending on the locale. In Kentucky, where mutton is the preferred meat for barbecuing, burgoo, a stew similar to Brunswick stew, is the popular accompaniment.

In Tennessee the basic barbecue dish is pork served on a bun with mayonnaise coleslaw. There as in many parts of the barbecue belt significant differences exist between urban and rural barbecue. In urban areas the sauces tend to be thicker and sweeter, and barbecued ribs are a standard part of the menu.

The distinctions in Texas barbecue are based largely on proximity to Mexico. Barbacoa, cow's head cooked in underground pits with mesquite wood and served with salsa on tortillas, is a common Sunday morning meal. While beef brisket is the standard barbecue meat in most of Texas, people along the border often refer to this as "American barbecue" to distinguish it from barbacoa. In southern Texas pinto beans generally accompany barbecue, and the meat is usually seasoned with cumin and chili powder. Eastern Texas barbecue is primarily beef brisket, but baked beans are more common than pinto beans there. Potato salad often replaces coleslaw as a side dish in eastern Texas, and spicing of the meat is influenced less by Mexican flavors.

In Arkansas, Oklahoma, Kansas, and Missouri, where the southeastern and southwestern traditions merge, beef and pork are equally popular. The sauces in those places tend to be sweet, thick, ketchup-based recipes. In Chicago and other cities where African Americans settled, pork ribs are the staple rather than whole hogs or pork shoulders.

Unlike most home cooking, barbecue is generally cooked by men. Sociologists have several theories for this. Men may be attracted to the fact that barbecue is cooked outdoors and in public rather than in a closed kitchen. Also at the root of barbecue is a primitive technique, often involving chopping wood, taming a fire, and butchering large cuts of meat. These tasks are traditionally viewed as masculine, and the technique is passed down from father to son.

With an increasing emphasis on faster, simpler cooking, some commercial establishments have replaced wood and charcoal pits with electric or gas ovens. Additionally the popularity of barbecue sauce as a condiment has meant that sometimes any meat slathered in a sweet, ketchup-based sauce is improperly called barbecue.

See also **United States,** *subentries on* **African American Foodways** *and* **The South.**

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Lolis Eric Elie

BARLEY. Barley is recognized as one of the very first crops to be domesticated for human consumption. It remains one of the major cereal crops grown in the world: barley is grown on every continent on which crops are grown. It is well adapted to diverse environmental conditions and thus it is produced across a broader geographic distribution than most other cereals. Relative to other cereal crops, barley ranks fourth in total grain production. The grain of barley enters the human food chain via distinctly different routes. First, barley is used as an animal feed and therefore makes an essential contribution to the human diet indirectly through meat production. Second, barley serves as a substrate for the production of alcoholic beverages, in particular beer. Third, a minor amount of barley is used to produce a diverse range of foodstuffs eaten by humans.

The Biology of the Barley Plant

The scientific name of barley is *Hordeum vulgare L.* Barley is a flowering plant belonging to the family Poaceae (the grasses). In addition to barley, the grass family includes the crops most important to human existence, including rice, wheat, and maize, and other species such as sorghum, oats, rye, millet, and sugarcane. In European contexts, barley grain is often referred to as "corn." The genus *Hordeum* includes approximately thirty species that are indigenous to at least four continents. Barley is the only domesticated species to have emerged from the genus *Hordeum*, in contrast to other crop genera such as *Triticum* (the wheats) and *Phaseolus* (the dry beans), which each contain several domesticated species. The other members of the genus *Hordeum* exist as wild plants.

Growth and development. The life cycle of the barley plant first begins with seed germination underground. The first visible sign of germination is root emergence, followed by the emergence of the cylindrically shaped coleoptile, which is the first structure to appear above ground. Interestingly, most above-ground tissues of the barley plant initially develop from the crown, a structure located below ground. The first leaf grows upward within the cylinder of the coleoptile, and emerges above the soil. This and other leaves do not expand along their entire length; rather the outer section (the blade) does so, while the base (the sheath) remains formed in a hollow cylinder. New leaves emerge in succession up through the sheaths of the older leaves.

The barley plant is not restricted to the development of one main stem, as observed in maize. Rather, like most other small-grain cereals such as wheat and rice, barley produces several additional secondary stems termed tillers that emerge up from the crown beginning a few weeks after the emergence of the main stem. The number of tillers produced varies depending upon the barley genotype and the environment. For instance, under highly fertile conditions, plants will produce more tillers than if nutrient starved.

Reproduction. Barley varieties are classified as spring or winter types, depending on whether they need a cold treatment, ranging from two to several weeks before making the transition to the reproductive phase of growth. When barley switches to its reproductive phase, the true stems of some of the tillers, called culms, elongate upward. The flowering structure, known variously as the spike, ear, or head, is borne upward, ultimately emerging from the "boot," which is the sheath of the uppermost leaf on the culm (the flag leaf). The height of a barley plant when the spike has emerged varies greatly, but averages approximately eighty centimeters. The spike consists of a large number of individual flowers called florets, which are present in individual spikelets that are attached to a central stemlike structure called the rachis. Spikelets are attached in groups of three on opposite sides of the rachis. The total number of spikelets on a spike varies, but averages approximately sixty. The awns are a notable feature of the spike. They are hairlike extensions that emerge upward from the lemma, one of two thin sheets of cells that surround the floret (the other is the palea). Awn length varies considerably among barley varieties.

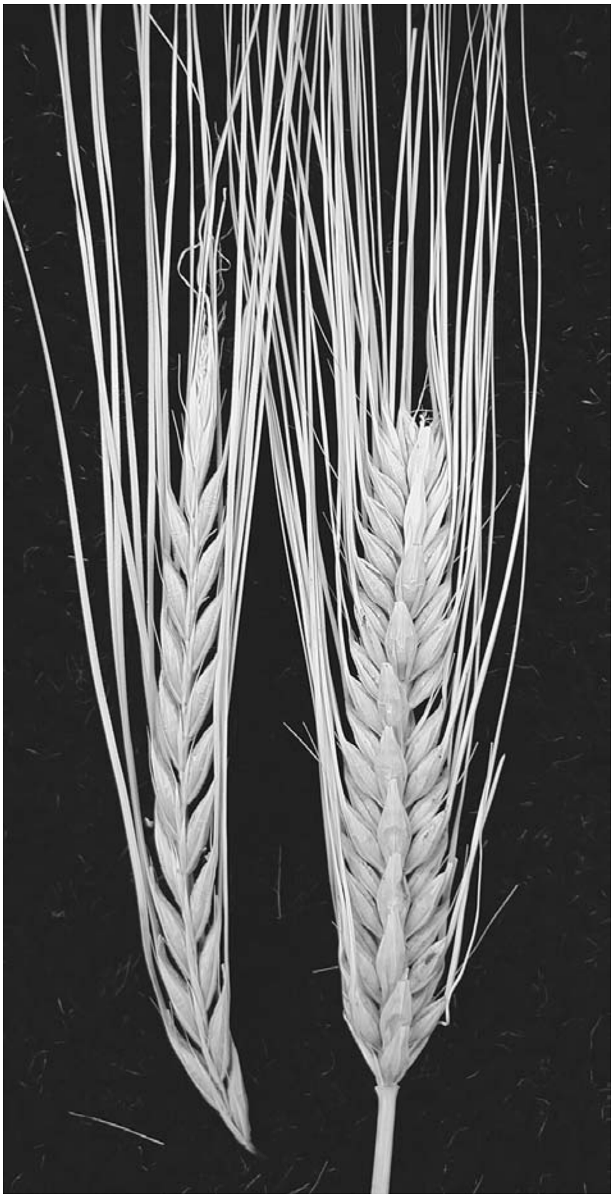
Barley is also classified based upon the fertility of the florets on the spike. In six-rowed barleys, all of the florets are fertile, leading to six vertical rows of seeds on the spike. In contrast, in two-rowed types only the central floret of the three at each node is fertile, and thus just two rows of seeds develop on opposite sides of the rachis. The fertile florets consist of both male and female reproductive structures, and fertilization occurs as the spikes are emerging from the boot. Barley is thus predominantly self-pollinated. Between twenty-five and sixty seeds per spike are produced, and for spring barley the seed matures three to five months after planting.

Characteristics of the barley grain. Barley seeds are approximately eight millimeters in length and weigh approximately fifty milligrams when mature, though there is a considerable range in these values between varieties. In most cases, the harvested barley grain includes the seed, a small structure called the rachilla, and both the palea and lemma, all of which adhere firmly to the seed. Barley grain in which these structures remain attached is referred to as covered barley, with the palea and lemma, collectively termed the hull. However, barleys in which the palea and lemma do not adhere to the seed are also well known. These hulless barleys share harvesting features similar to wheat, because when harvested the seed is cleanly separated from all other components of the spike.

The barley seed consists of the embryo, a series of outer layers of cells called the pericarp, and the endosperm. The endosperm contains different nutrients that the embryo draws upon as it grows into a plant. The principal compound found in the endosperm is starch, which represents about two-thirds of the mass of the seed. This starch serves as an energy source for the seedling. Another significant carbohydrate, the β-glucans, are components of the endosperm cell walls. The second largest component of the barley endosperm is protein. The amount of protein present is generally inversely proportional to the amount of starch. This protein provides a source of amino acids that can be used for protein synthesis by the seedling. The amount of protein present in a seed is positively correlated with the amount of nitrogen fertilizer applied when the parent plant is being grown. Additionally, the barley grain contains a large variety of other compounds present in minor amounts, including mineral nutrients and different organic compounds, including various vitamins.

The History of Barley Use

The progenitor of cultivated barley is *Hordeum vulgare* subspecies *spontaneum*, or wild barley. Wild barley is still widely distributed in a large geographic region ranging west from Israel, Turkey, Syria, and Egypt, eastward to Pakistan, India, and into western China. It is particularly prevalent in the Fertile Crescent region of the Near and Middle East. Biological evidence for wild barley as a progenitor of cultivated barley is suggested by the fact that they both have the same base chromosome number (seven), and can be easily crossed to produce fertile offspring. Wild barley is two-rowed, and thus the first domesticated barley was two-rowed. Six-rowed types and hulless barley emerged not long afterward from the domesticated two-rowed types, due to a few chance mutations. Several traits have been selected in barley compared



Barley spikes from two-rowed and six-rowed types. PHOTO COURTESY OF DAVID GARVIN, USDA–ARS.

to wild barley, which facilitate harvest, storage, and utilization. The most important of these are nonshattering spikes where the seeds adhere to the rachis and allow easy harvesting, increased straw strength, larger seeds, and reduced grain dormancy.

Along with wheat, barley was one of the first crops to be domesticated by humans and thus it played an important role in the emergence of agriculture in the Old World. There is rich evidence of barley in the archaeological record from numerous sites throughout the Near and Middle East, supporting the notion that it was a common and important crop in ancient times. It is likely that barley was already domesticated and being cultivated as early as ten thousand years ago, though wild barley was likely being harvested as a food long before this. Further, early written records from various cultures bear frequent mention of barley, as does the Bible, reinforcing the fact that barley was an important crop. Indeed, barley remained an important human food crop for many millennia, but it was gradually supplanted by wheat. The rapid spread of agriculture from the Near East into Europe and Asia led to the broad dissemination of barley and its cultivation. In more recent history, barley was brought to the New World as far back as the explorations of Columbus. Barley was introduced to the eastern United States early in the seventeenth century, and the west coast of the Americas in the eighteenth century.

Barley Production

Barley is grown on nearly sixty million hectares of land worldwide, resulting in the production of approximately 140 million metric tons of grain. The top ten barley producing countries include Russia, Germany, Canada, Ukraine, France, Australia, the United Kingdom, Turkey, United States, and Denmark. Barley producers select the appropriate varieties to be grown and crop management schemes to produce grain well suited to a particular end use. Specific producer considerations vary widely, but include the choice of variety to plant, the timing of planting and grain harvesting, and agricultural inputs such as fertilizers, herbicides, fungicides, and insecticides. In the Northern Hemisphere, in regions where winters are too severe to allow winter barleys to survive overwintering, spring barleys are planted, usually in April or May. In warmer regions where winter barleys can overwinter, planting is done in September or November.

Given that the producer obtains only a small profit margin for barley produced, additional agricultural inputs are minimized. For instance, nitrogen fertilization is managed to maximize yield without compromising end-use quality. Barley is also subject to damage by a range of diseases, including powdery mildew, stem and leaf rust, smuts, leaf blotches, viral diseases, and head blights. Thus these diseases are managed by a combination of strategies including the use of disease-resistant varieties, application of fungicides, tillage practices, timing of crop planting, and crop rotation.

When the barley crop is mature, harvesting is accomplished either by direct combining or by first swathing, which entails cutting the culms and allowing the grain to dry in the field, and then harvesting. Technology for harvesting ranges from a simple sickle in developing countries to sophisticated mechanical combines that cut the culms above the soil, move the harvested plants between rollers to dislodge seeds, and pass this over mesh screens, allowing the grain to fall into a collection bin and the chaff to blow back out to the ground. Once the grain is harvested, it may either be stored in bins on the farm, or delivered to a local grain elevator where it is purchased from the producer. The price paid for barley grain depends on its intended end use. After purchasing the grain, the elevator cleans, dries, and stores it, and ultimately resells the grain to the various businesses that use barley (feed, food, and malt industries).

Barley Consumption

Animal feed. The principal use of barley grain is as feed for poultry, swine, sheep, and cattle. Worldwide, 60 percent or more of the barley that is produced is used for animal feed. The particular barley varieties used as animal feed are sometimes specially developed "feed barleys" with attributes such as high protein that are geared specifically toward this end use. Sheep can be fed whole barley; however, before barley is fed to other animals it is ground using a hammer mill or rolling mill, or may be flaked with steam-heated rollers. Thus, the final feed product may be whole, ground, flaked, or pelleted barley. Since the phosphorus in barley is generally more readily absorbed by animals than it is from other feed grains, the use of barley as animal feed tends to result in less potential environmental phosphorus contamination from the animal waste runoff. While barley grain is the principal part of the plant used as animal feed, in some instances barley plants themselves may be used as a forage hay for animals.

Human consumption of barley. Less than one-half of the barley produced throughout the world is used for the preparation and production of products directly consumed by humans. Only a minor amount of barley is actually used in the production of foods for human consumption, though the range of uses for barley within this context are diverse. In some regions of the world, barley is grown for human consumption where other grains do not grow well. When consumed as grain, hulless barley is generally used because the absence of the hull makes the product more palatable and easier to process. Barley can be pearled, which removes the outer layers of the seed and the embryo, followed by processing to produce small rounded pieces of the endosperm. Covered barley can also be dehulled, milled, and polished to remove the bran layers, to produce a ricelike product. Pearled and polished barley are used in porridges and soups and as rice substitutes. Other food uses include barley flakes, flour for baking purposes (either alone or in mixtures with wheat flour) to produce breads and crackers, grits, breakfast cereals, pilaf, noodles, and baby foods. Lastly, some barley is used for the production of distilled spirits such as whiskey, vodka, and gin, and for making vinegar and malted beverages.

Beer: the main use of barley for human consumption. The truly unique feature of barley that sets it apart from other small-grain cereals such as wheat is that the vast majority of barley that humans consume is not in the form of solid food derivatives, but rather in the form of a single product, the alcoholic beverage beer. The production of beerlike alcoholic beverages dates back several thousand years, and beer may be the oldest fermented beverage consumed by humans. Many barley varieties are developed specifically to possess the chemical and biochemical properties desirable for this purpose; such barleys are called malting barleys. In contrast to feed barley, malting barley has a high starch content. Because of the greater value of the end product of malting barley compared to feed barley, malting barley brings the producer more money. However, barley must meet stringent specifications of the malting and brewing industries before it will be used for this purpose. Both two-rowed and six-rowed barley are used to make beer, with six-rowed types preferred in the United States and two-rowed varieties preferred elsewhere. Beer production is divided into two processes, barley malting and brewing, which are undertaken by independent industries.

The beer-making process. Beer production requires just four ingredients: barley, water, hops, and yeast. Barley provides sugars and amino acids for yeast growth, and the yeast converts the sugars to ethyl alcohol in a process called fermentation. Before barley is used to make beer, it is converted to "malt" to render it a better substrate for brewing. Malting is essentially a process of truncated seed germination. When grain enters a malt house, it is first steeped in water for two to three days. After steeping, the barley is transferred to germination beds for three to four days. Here the grain begins to produce enzymes capable of degrading the starch, protein, and the cell walls of the endosperm, and degradation of protein and cell walls proceeds. The barley grains are then subjected to heat that kills the growing seedling and dries the remnant grain, but leaves intact the components of the endosperm as well as the enzymes capable of degrading them. The product that emerges is malt. Major malt producing countries include the United States, Germany, and France, while major importers of malt include Japan, Germany, and Brazil.

Malt is used by breweries for beer production. The malt is first milled and mixed with water in a process called mashing. This mash is allowed to rest at temperatures that encourage degradation of starch from the endosperm into sugars, by the enzymes present in the malt. The mash is then transferred to a container with a sieve on the bottom, called a lauter tun. Here the liquid fraction of the mash, called wort, is separated from the residual solids by filtration. Traditionally, covered barley is used for beer production because the hulls of the barley malt settle in the lauter tun and participate in filtering out residual solids. The resultant wort contains the soluble components derived from the malt, such as sugars and amino acids liberated by enzyme action. Hop plant flowers (or a derivative of them) are added to the wort and boiled. The hop oils add certain bitter flavors to the beer and protect it from bacterial contamination. The wort is then cooled, transferred to a fermentation vessel, and inoculated with yeast. The yeast use the sugars and amino acids from the malt to grow, and as it grows the metabolism of the sugar maltose leads to the production of ethyl alcohol and carbon dioxide as by-products of the fermentation process. After fermentation, the yeast and other solids are allowed to settle out. This is followed by an aging period, carbonation, and final packaging to produce the finished beer. Thus, the role of barley grain in beer production is similar to its role in the barley life cycle: to provide nutrients for growth. However, in beer production the benefactor of the nutrients is the yeast and not the growing seedling.

Worldwide, well over one billion hectoliters of beer are produced annually, from approximately sixty million metric tons of barley. It takes approximately fifty grams of malt to produce a 375-milliliter bottle of beer, though this amount can be less depending on the type of beer and whether adjuncts (nonbarley sources of sugars, often rice or corn) are used. The largest beer producing countries include the United States, China, Germany, Brazil, Japan, the United Kingdom, and Mexico.

Traditions. The principal barley product consumed by humans, beer is produced and drunk in large quantities worldwide. Beer is probably recognized as the beverage most strongly associated with celebration, relaxation, and social interaction, and has become a ubiquitous component of recreational activities. Beer is commonly consumed in a diverse range of settings, including the home, restaurants, and bars, and for a broad range of occasions, particularly social gatherings. For instance, beer is a fixture at professional sporting events of all kinds held around the world. The increasing demand for beer is reflected in the rapid expansion in the number of microbreweries, and in the growth in popularity of home brewing. Beer consumption continues to grow in popularity, with production doubling over the last thirty years to keep up with demand. In addition, barley plays a ceremonial role in some societies. For instance, in India barley is often used in marriage and other ceremonies.

See also: **Beer**; **Cereal Grains and Pseudo-Cereals; Grain Reserves; Livestock Production; Maize; Rice; Wheat.**

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BEANS. *See* **Legumes.**

BEARD, JAMES. Born in Portland, Oregon, Beard (1903–1985) spent most of his life in New York, spanning the continent as the father of American cooking and as the larger-than-life champion of American foods, reveling in their glorious abundance and variety. His father was a "Mississippi gambler type" who skipped town while his English mother, Mary Elizabeth Jones, an émigré to Portland, firmly ruled her son, her Gladstone Hotel, and the Chinese chefs in its kitchen. In his culinary memoir *Delights and Prejudices* (1969), Beard gives a fine account of growing up amid the backstairs comedy of the Gladstone, a drama which no doubt influenced his lifelong passion for the theater.

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James Beard in his New York kitchen. PHOTO DAN WYNN/© RITA WYNN

At nineteen he went to London to become an opera singer and then to New York to become an actor. To keep from starving, he opened a catering shop called Hors d'Oeuvre with friends in 1937 and three years later published his first cookbook, *Hors d'Oeuvres & Canapes*, followed by *Cook It Outdoors* in 1941. By combining food with showmanship, he channeled his theatrical energy into writing and single-handedly created the drama of American food. Over the next four decades—after a stint in the army and the United Seamen's Service, opening navy canteens—he would publish more than twenty books in addition to making extensive contributions to *House & Garden*'s single-subject cookbook series and writing numerous articles for newspapers and magazines. With the publication of *The James Beard Cookbook* in 1959, he became America's leading food guru, preaching the gospel of honest American food to those who had earlier looked exclusively to Europe for guidance in all things culinary.

At six feet four inches, weighing 310 pounds at his heaviest, he was as large as his subject, and his persona matched his message. He was among the first to promote both on television, when he appeared with Elsie the Cow for the Borden Company on NBC in 1946. He also initiated a new style of domestic cooking school to urge ordinary home cooks to take pleasure in their food. In 1955, he began the James Beard Cooking School in New York and soon added one in Seaside, Oregon. By teaching in all sorts of venues across the country, he created a network of devoted followers who continued to spread the word after his death.

That word was "fun." During the postwar decades of affluence, he taught Americans, who had survived the Depression, World War II austerity, and native Puritanism, to have fun with cooking, eating, and living in the American way. His 1972 *American Cookery* defined and celebrated the tradition of American cooking he had inherited from a body of cookbooks that began before the Civil War with Mary Randolph and Eliza Leslie and stretched to his contemporaries Irma Rombauer and Helen Evans Brown. While his appetite for traveling was as large as his girth, and while he spent much time in France, he sieved the flavors of other countries through his own American palate to create a menu that was always exciting because of the new combinations it offered. While his meals and menus were eclectic, he would say that it was the cook, not a country or a culture, that unified a meal. His culinary library in the 12th Street townhouse he owned in Greenwich Village was vast, and he was instrumental in directing his cooking students toward the literature of cooking.

In 1986, his house became a living theater honoring his name and his mission as the headquarters for the James Beard Foundation, where chefs from around the world showcase their skills. Through events such as the annual celebration of Beard's Birthday and Beard Awards for members of the food industry, the Foundation has established a generous scholarship fund and a national network of chefs, writers, and restaurateurs.

ONION SANDWICHES

Brioche loaf or good white bread, sliced very thin
White onions, peeled and sliced very thin
Mayonnaise, preferably homemade
Chopped parsley

Cut the brioche or bread into rounds with a biscuit cutter. Spread the rounds lightly with mayonnaise. Divide into two batches. Arrange a layer of onion slices on one batch and top with the other. Press together gently. Roll the edges in mayonnaise and then in the chopped parsley. Pile on a serving dish and refrigerate for several hours before serving.

—*Love and Kisses*, p. 364

"It has always been my contention that the people of the Western European countries ate pretty dull food until the discovery of America."

"Like the theater, offering food and hospitality to people is a matter of showmanship, and no matter how simple the performance, unless you do it well, with love and originality, you have a flop on your hands."

"The kitchen, reasonably enough, was the scene of my first gastronomic adventure. I was on all fours. I crawled into the vegetable bin, settled on a giant onion and ate it, skin and all. It must have marked me for life, for I have never ceased to love the hearty flavor of raw onions."

—*Delights and Prejudices*

See also **Child, Julia; Cookbooks.**

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Betty Fussell

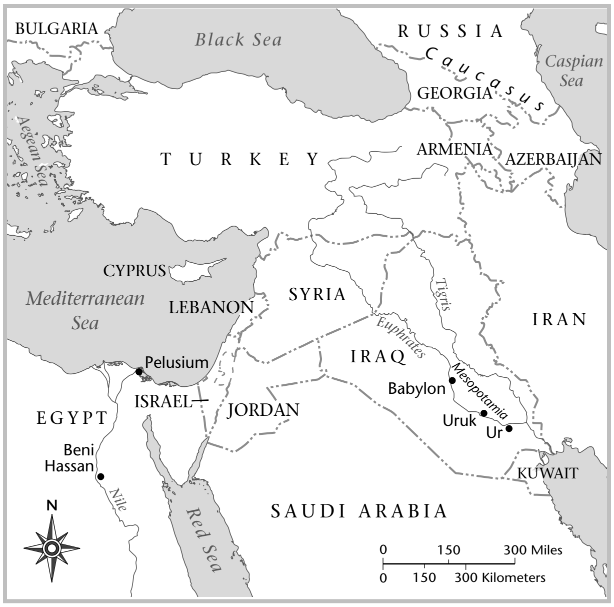
BEEF. *See* **Cattle; Meat.**

BEER.

This entry includes four subentries:
Origins and Ancient History
From Late Egyptian Times to the Nineteenth Century
The Twentieth Century
Production and Social Use

ORIGINS AND ANCIENT HISTORY

The Origin of the "Cereal Wine"—Beer
The origin of beer lies far back in prehistory; there is evidence that it was being made at least eight thousand years ago in Mesopotamia, but it had probably been produced



for many thousands of years before, and perhaps in many different places. Its great success must be closely related to the development of cereal agriculture, which occurred about ten thousand years ago. The sequence of events might well have been:

1. Making a dough of grain (whether crushed or uncrushed), which then underwent spontaneous fermentation.
2. Baking dough into bread, soaking the bread in water, heating the result, and allowing it to cool and then to undergo spontaneous fermentation. (A similar process would have occurred if the grain had been mixed with water and boiled into porridge: after cooling, it would have undergone spontaneous fermentation.)
3. Steeping the grain induces sprouting and the synthesis of amylase enzymes that decompose the starch of the grain into sugar, a process that is aided by heated water and/or baking. After cooling in water, the spontaneous fermentation will start. Barley has the advantage of having a rather large excess of amylases in comparison with other cereals such as millets and sorghum.

When people learned to steep grain in water and then heat it slowly, the overall product was greatly improved. Another improvement to the process that was invented was to bake bread from crushed or malted grain and then immerse it in water and heat the result. If bread was the intended product, more crushed or malted grain could be added to the dough; if beer was desired, all that was needed was the addition of more water instead. It is unknown when the use of a starter (a small amount saved from a previous fermentation for use in the next fermentation) began.

All these primitive beers were, technically, ales (that is, top-fermented)—spontaneously fermented both by yeasts and by *Lactobacillus*, which gave the beverage a sour taste.

Domestication of Barley, Wheat, and Rye

Domestication of the most important beer cereals—barley, wheat, and rye—started at least ten thousand years ago at the transition from the Pleistocene to the Holocene period in the Fertile Crescent, the region from the eastern Mediterranean Sea to the eastern part of the Tigris and Euphrates area. When the glacial ice finally started to withdraw in the Northern Hemisphere, the climate of the Fertile Crescent was mild, wet, and ideal for early man, and numerous species of wild cereal grasses (grains) available for gathering flourished. Subsequently, the climate got warmer and drier and agriculture, a more prolific and dependable source for grains and other foods, was developed through the domestication of wild plants. The exact course of this domestication is complex, and is based in part on climatic changes, plant availability, preadaptive technology, population pressure, and resource stress.

All three cereals, barley (*Hordeum*), wheat (*Triticum*), and rye (*Secale*) are grasses in the tribe *Triticeae*, and they have all in different varieties played a great role in the development of beer in the Eurasian region. In other parts of the world, other cereals have had the corresponding importance, for example, sorghum (*Sorghum bicolour*) in Africa, rice (*Oryx sativa*) in Asia, corn or maize (*Zea mays*) in America, and millets. Cereals not belonging to the wheat, barley, oats, maize, or rice genera are commonly referred to as millets and are found in America, Africa, India, and Eurasia.

All domesticated varieties of barley belong to the same species, *Hordeum vulgare*, and its wild form *H. vulgare spontaneum* crosses easily with all domesticated forms. The major morphological difference between the wild and the domesticated forms is a tough rachis (the main stem holding the seed clusters) in the latter. In principle, there are three forms of barley, the two-rowed, the six-rowed, and the naked-grain form.

In connection to beer, the most important domesticated wheat varieties have been einkorn (*Triticum monococcum*), emmer, and the bread wheat, *Triticum aestivum.* Einkorn is a diploid form close to its wild ancestor, emmer is tetraploid, and the bread wheat is hexaploid.

Domesticated rye, *Secale cereale*, is very closely related to wild rye, *Secale montanum*, which still grows in the mountains of Turkey, northwestern Iran, and the Caucasus. Wild rye is more cold- and drought-resistant than are wild wheat and barley. Cultivated rye is predominantly a winter crop and it can succeed under less favorable climatic and soil conditions than can wheat.

There was probably a close connection between the production of beer and bread, the domestication of barley, and the social and ceremonial importance of the alcohol in beer. Beer was produced from bread, and barley is a very suitable cereal for both bread and beer production. Additionally, alcohol has been emphasized to have an important role in social relationship, in matters of reciprocity and obligation. The archaeologists Solomon Katz and Mary Voight have proposed that the development of settled agriculture was dependent on the desire to brew beer.

Mesopotamia

The oldest documentary evidence of beer brewing comes from Uruk in Mesopotamia and dates to about 3500 B.C.E.; it is found on clay tablets that tell the story of Gilgamesh in Sumerian, written in cuneiform with accompanying pictures. The tablets describe in great detail how beer was prepared, the different varieties of beer, how its brewing and selling was arranged, and how it was consumed. Röllig (1970) gives an excellent review of most of the details from the historic periods in Mesopotamia from the old Sumerian period (about 3000 B.C.E., which is the most interesting period for our present purposes) until about 1000 B.C.E.

At this time in Mesopotamia, barley was the most important cereal for both humans and animals. The grain was steeped into water and then either air- or oven-dried. After removal of the sprouts, the malt was milled. For brewing, various kinds of beer-breads or *bappir* were baked from unmalted barley or other cereals and added, along with sweeteners and spices; it has been proposed by some investigators that hops were sometimes used also. (The amount of emmer used was taken as indicative of the quality of the beer.) Then the malt and the beer-breads were probably mixed with water and heated, after which the vessel was removed from the oven to cool. It has been pointed out by Katz and Maytag (1991) that the "cooked mash" was spread out on mats to remove the spent grains and to allow the liquid to drain. By the time of the hymn to Ninkasi, from about 1800 B.C.E., a "filter" had become the symbol of the brewers. Consequently, long straws were not necessary any longer, and the beer could be consumed directly from cups. Before fermentation, spices, herbs, and sweet plant extractives with effects that were believed to be medicinal were added; the augmented sugars and microorganisms from the herbs helped to induce fermentation. (It is known that the brewers saved some of the wort from one fermentation to use it as a starter for the next brew, as has often been done in sour-bread fermentation.) Katz and Maytag (1991) also found in the hymn of Ninkasi that date juice and grapes or raisins were added to the wort to induce fermentation. The entire concoction was then transferred, with more water, into a fermentation vessel, which was long and narrow-necked to minimize the mixture of inside and outside air and decrease infection from outside. We do not know how long fermentation lasted, but probably most of the beer was quickly top-fermented into weak ale, which was tapped from the bottom of the vessel through a filter after a few days.

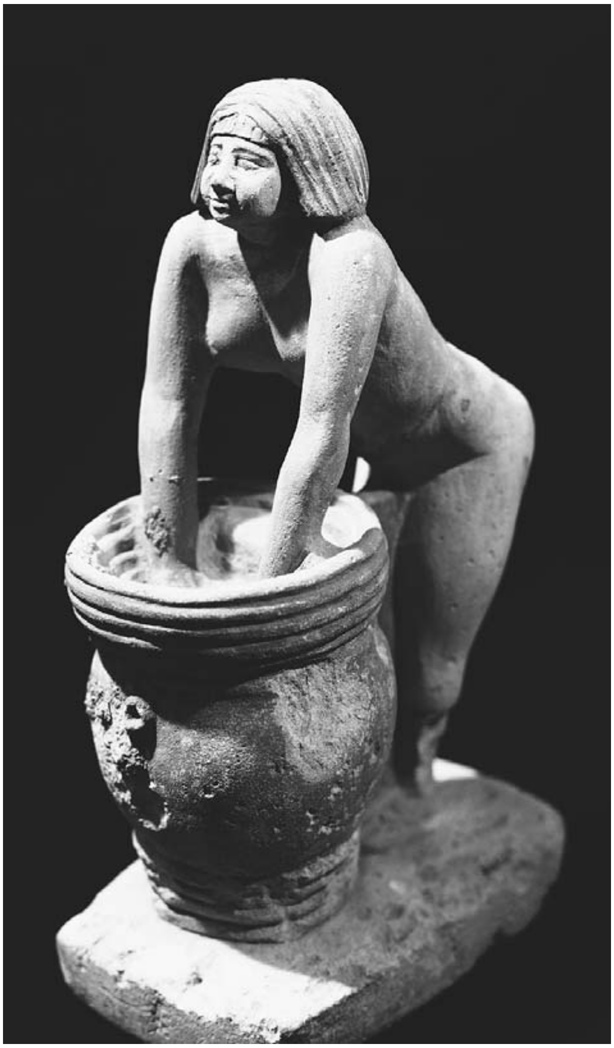
In early Sumerian times, beer was drunk through long straws, with the remnants of all the ingredients still present in the beer; such a straw, made of gold, has been found in a tomb at Ur. In later times, the beer was filtered as described above and then drunk from small vessels.

Many different recipes and descriptions are preserved from the Mesopotamian period: "strong beer," "red-brown beer," "pressed beer," "dark beer," and "good dark beer," for example. These beers were very heavy and thick—almost like syrup—and very nutritious. Although they were very strong and heavy, they could not stand long storage in the warm climate, and so the people had good reason to complain about sour beer. The goddess of beer of the Sumerians was Ninkasi, who was in charge of everything concerning beer, one of the most important ingredients of life in Mesopotamia, both as a food and socially. A Sumerian proverb says: "Who does not know beer, does not know what is good. Beer makes the home pleasant." It is interesting to note that the first very important king of Babylonia, Hammurabi, who reigned between 1792 and 1750 B.C.E., issued a set of laws (known as the Code of Hammurabi) that governed civil and criminal matters, included in which are rules for making and serving beer. (One copy of the code can be viewed on a column made of green diorite that is housed at the Louvre Museum in Paris.)

Egypt

For the ancient Egyptians also, beer was the preeminent beverage and was more popular than water, which often was contaminated; and although beer had a lower social status than wine, beer was a necessity for the household and the kitchen. Brewing was the woman's task, as it was in Mesopotamia. The divinities presiding over it were goddesses and some kind of chief brewer (the official Kha-bau-Seker, who bore the title of "Controller of the Brewing Women"). According to Egyptian religious tradition, Osiris, the god of agriculture, taught the people to prepare beer. The Greeks connected Osiris with Dionysus, the wine god, who in turn was associated with the earlier Thracian god Sabazius. The connection between the Egyptian people, beer, and their gods—for instance, Hathor-Sekhmet—was very close. The intimate relation between baking and brewing in Egypt and in Mesopotamia is supported both by the use of the Sumero-Akkadian word *lahamu*, originally meaning "loaves" (compare Hebrew *laham*, "bread"), to indicate brewing and by the constant association of baking and brewing in Egyptian art. "Bread and beer" was the symbol of food and a greeting formula.

Artifacts dating from about five thousand years ago found in the ancient tombs of Beni Hassan in Egypt show an established practice of brewing, serving beer to the public, and exportation of beer through the city of Pelusium to many Mediterranean ports. *The Book of the Dead,*



Wooden figurine of a female brewer, ca. 2465–2323 B.C.E. This carving is located in the Egyptian Museum, Cairo. © GIANNI DAGLI ORTI/CORBIS.

which dates from the same era, depicts beer being made from barley and offerings of cakes and beer to various deities.

The process of malting and dehusking the malted grain is probably thousands of years old, and the methods of today are very similar. In general, the preparation of beer, as described in late Egyptian documents and in tomb art of all periods, did not materially differ from the methods of preparing present-day *bouza* or its African analogues; however, Egyptian beer was often flavored by such plants as skirret (*Sium sisarum*—a member of the water-parsnip genus).

The Egyptians used either malts of various grains (principally emmer), which were formed into dough, or dried bread, and yeast (*Saccaromyces winlocki*), which was fermented in a rather warm place. In principle, there were two methods:

1. Steeping the grain in water, and then aerating it, remoistening it, grinding it, working it into a dough, and adding yeast. Finally, after fermentation, the whole mass was strained though a cloth or a sieve, and the filtrate recovered.
2. Drying bread, soaking it in water, and leaving it to ferment in a warm place, which is identical to the traditional method for making *kvas* ("kvass," in English—a beer made in Russia, typically from rye).

The preparation of *bouza* in modern southern Egypt and the Sudan consists of the following steps:

1. Ground wheat, barley, or other cereal is kneaded with water and yeast.
2. After a short leavening, the dough is lightly baked into thick loaves.
3. Another fraction of wheat is moistened, exposed to air for some time, crushed, and then added to the previously prepared loaves after they have been crumbled.
4. The fermentation is initiated by adding some old *bouza*.

Flavorings are not added. The result is a thick beverage with a strong yeasty odor.

Beer was consumed primarily for pleasure and nutrition, but it was also used for cooking and for medicinal purposes, often as a constituent of mixtures. The beer given to the slaves was unfiltered and crude, but was very nutritious because it contained residual grain proteins and vitamins.

See also **Barley; Cereal Grains and Pseudo-Cereals; Wine.**

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Sven-Olle R. Olsson

FROM LATE EGYPTIAN TIMES TO THE NINETEENTH CENTURY

Late Egyptian to Roman Times

The Egyptians exported beer to the Greeks, who traded it to Gaul, to Spain, and to the east coast of the Adriatic; it then spread to Germania (what is now Germany and some portions of central Europe), where it became very popular. Beer may also have been established in non–wine-producing areas at an earlier date. It is rather probable that beer production originated close to the geographic expansion of agriculture, which implies that beer could have been present in Europe at least around 3000 B.C.E., when use of the plow spread in Europe. In a female grave in Egtved in Denmark from about the year 1357 B.C.E. rests from an alcoholic beverage were found in a vessel made of birch bark. It contained rests of wheat, cranberry, honey, and bog myrtle (sweet gale). (Corresponding remains have been found in the Hallstatt beer amphora found at Kulmbach dated 800 B.C.E.).

In China, alcoholic beverages seem to have been present since 4000 B.C.E. in Dawenkou in Shandong; the oldest written documents come from the Shang dynasty, 1324–1066 B.C.E., written by Du Kang and describing the production of *jiu. Jiu* meant all alcoholic beverages, usually of 10–15 percent alcohol, obtained by fermentation of cereals, millet, and wheat. The process was first to make a ferment cake, which provided molds and yeasts that then started the fermentation process in a mash of cooked cereals. During the T'ang dynasty, 618–907 C.E., the cereals for this process were either glutinous millet or glutinous rice. These processes later spread to Japan, Korea, and all of Southeast Asia. Prior to the introduction of this process in Japan, brewers saccharified the rice by chewing boiled and raw rice.

Beer was a considered a barbaric drink by the Greeks and Romans, though, according to Pliny, beer was known in the Mediterranean countries before viticulture (the cultivation of grapes) became popular. There are frequent references—in Tacitus, for example—early in the common era to malt beverages being consumed by the tribes of Germania (as well as by the Saxons, Celts, Thracians, and Scythians), and even to the establishment of *tabernae*, or taverns. Originally, beer was produced from a variety of malted and unmalted grains such as millet, barley, wheat, oat, and rye, with different supplements such as honey, juniper, mushrooms, and bark—but without hops. In the Greek and Roman world, wine was the beverage of the upper classes and beer was the drink of the common people, as was the situation in pre-Ptolemaic Egypt. (For more details see Arnold [1911] and Hoffman [1956].)

Medieval Times to the End of the Nineteenth Century

Home brewing. From the year 719, when the Lex Alemannorum (a code of laws formulated by the Franks) was promulgated, all people in the Germanic area were entitled to brew their own beer. Home brewing began in Great Britain in about the twelfth century. With the growth of towns, commercial operations started brewing and selling in the same establishment. Later, the point of sale was centrally located in a town or city. Growth of brewing was slow until the industrial revolution made large breweries possible.

The types of beer and brewing techniques of the Middle Ages survived until recent years in the Nordic countries, as has the old method of spontaneous lactic and alcoholic fermentation of *kvas* ("kvass," in English—a beer made typically from rye) in eastern Europe.

Monasteries. Monasteries have had an active role in the brewing and sale of beer, and in the improvement of brewing processes. Two of the first beer-brewing monasteries—with brewing activities dating back to the seventh to eighth centuries—were St. Gallen (in Switzerland) and Weihenstephan (in Bavaria), both of the Benedictine order. Beer was a substitute for wine, a good nutrient during Lent, and an excellent base for spices used medicinally. In the year 1000, forty of the houses of the monastery of St. Gallen were devoted to brewing; they produced strong beer, oat beer, and light beer for themselves, guests, and pilgrims, and for sale. In the early Middle Ages, there were four to five hundred monasteries brewing beer in Germany; the practice was international and a large source of income for the monasteries. The famous Trappist beer is still made in Belgium by Trappist monks, whose order has developed from the Benedictine and Cistercian orders.

Cities. In southern Germany, Bavaria was a wine-drinking area until the Thirty Years' War (1618–1648), and the monasteries were the main producers of beer. During the twelfth and thirteenth centuries, cities were burgeoning and they created licenses to produce beer, which could be heavily taxed by the authorities. In the northern part of Germany, many competing breweries were developed and great volumes of beer were exported by members of the Hanseatic League to other parts of Europe. In the northern city of Hamburg, there were six hundred brewers in the sixteenth century, as contrasted with only thirty in the southern city of Munich in the fifteenth century. Some of the most famous breweries in the sixteenth century were in Erfurt, Einbeck, Zerbst, Naumburg, and Braunschweig.

After the Thirty Years' War, which destroyed the northern cities and Bavarian viticulture, most of the brewing shifted from the north to Bavaria, where by 1420 the monasteries had developed the method of bottom fermentation that produces lager beer. Before this development, all beers were top-fermented—that is, ales. In 1516 the *Reinheitsgebot* (Purity Law) was approved for Bavaria, which decreed that only barley malt, hops, and water were allowed for beer brewing. In 1551 another law was approved in Munich saying that bottom-fermenting yeast should be used. Northern Germany was opposed to the new law, and Baden and Württemberg did not accept it until 1896 and 1900, respectively. In 1906 it was accepted for lager throughout the German Empire. The only exception made was to allow wheat malt in the specialty ales *Alt*, *Kölsch*, and *Berliner Weisse* and in wheat beer.

Grut and hops. Ancient beer was flavored by many different spices, even medically active ones, during the centuries, and Hildegard von Bingen mentions in her *Physica*, which dates from about 1156, both hops and *grut* as additives to beer, which is the first documentation of the use of hops in beer. *Grut* was a mixture of several spices, chief among them being the leaves of bog myrtle or sweet gale (*Myrica gale*). It was used mainly during the thirteenth to fifteenth centuries and it survived in the northwestern part of Germany and in the Netherlands until the eighteenth century. In many areas, the authorities sold the right to use *grut* (*Grutrecht*). During these times, hops and *grut* were used for beer simultaneously.

Hops had been introduced for beer brewing sometime between the years 764 and 1156, when the first hop agriculture was found in Geisenfeld in the Allertau area in Bavaria, and when Hildegard wrote her *Physica*, respectively. The introduction of hops probably came via contacts of the Germans with Slavic peoples in central Europe. The acceptance of hops in beer was very slow and even forbidden in certain areas. By the year 1400, the Dutch had already introduced hops, but it was not until the sixteenth century that the use of hops in beer was gradually accepted in England. One reason for this slow acceptance could have been the difference in taste of the beer, from a rather strong and sweet beer without hops to a less strong and somewhat bitter beer. The great advantage of hopped beer was the better storage capabilities it afforded.

Ale and lager. Ales were the only beer type in Europe before the advent of lager, beginning in the fifteenth century in Bavaria. In 1603 lager was forbidden by the city of Cologne. However, it slowly spread through Germany together with the Purity Law, and during the nineteenth century, production volume increased dramatically. The most important types of lager were the dark from Munich, the pale from Dortmund, and the pale and heavily hopped from Pilsen (pilsner). Dortmund Export became world-famous in the nineteenth century, and pilsner became the great winner in the world of the twentieth century. In the northern and western parts of Germany, ales dominated until the start of the twentieth century.

In England, Professor Charles Graham became interested in lager in 1888 and started a discussion about the two types of beer. It was not until the end of World War II that lager was accepted by the British people. One significant impediment to the success and spread of lagers was their great need for cooling.

In Britain, ales have been the popular beers and have influenced tastes in both British colonies and other countries through export. At the end of the seventeenth century, most of the export of ale from Britain went to America and the West Indies, but the trade of strong, sweet ale, "Russian Imperial Stout," and porter (a heavy, dark-brown ale) to Russia and the countries around the Baltic had begun. In the beginning of the nineteenth century, half of the ale exported by Britain went to Asia and Australia. That type was called Indian Pale Ale (IPA); it was strong, sweet, and highly hopped.

Development in America. Brewing in America started with the early British and Dutch settlers. As early as 1587, Sir Walter Raleigh malted maize (corn) for brewing, and hops were grown by 1637 in Charlestown, Massachusetts. Malt and ale were imported from Britain, and New York and Philadelphia became the main brewing centers in the eighteenth century. In Canada, brewing was initiated in 1620 by the monastery of Notre Dame des Anges. The first steam engine was installed in Philadelphia in 1819. At the beginning of the nineteenth century, there were 150 breweries in the United States, producing 160 thousand Imperial barrels (7.2 million U.S. gallons).

From 1840 onward, German immigrants began brewing lager, and the number of breweries increased to 4,131 in 1873; this number decreased to 1,092 in 1918 and 230 in 1961. In 1850, ale brewing was dominant, and in 1860, lager production was less than twenty-five percent of the total production of 3.8 million barrels. Hop culture spread to California in 1851, Wisconsin in 1860, Washington State in 1866, and Oregon in 1880. After 1850, lager began to prevail, but brewing it required ice, and machines to make that ice. This requirement was met by the introduction of the refrigerator. The first one was installed in New Orleans in 1867.

Brewing companies and the science of brewing. By the beginning of the eighteenth century, three items had been invented that later had very great importance for the brewing industry: the hydrometer, the thermometer, and the steam engine. Both the hydrometer (along with its offshoot, the saccharometer) and the thermometer gave the brewer instruments to measure and monitor processes more exactly, and the steam engine—which replaced horses—opened possibilities of working with greater volumes in the brewery. All the vessels of the brewery were still of wood except the brew kettle, which was made of copper. The technical revolution during the eighteenth and nineteenth centuries, as well as the beginning of free trade among both cities and states, had a great impact on the development of the brewing industries in Europe and the United States, and it was during this time that most of the big brewing companies were started and formed.

However, the most important inventions for the breweries were made in the biological and biochemical fields. In 1833 Anselme Payen and Jean-François Persoz discovered an enzyme, diastase, that can split starch. In the late 1830s, Franz Schulze discovered the yeast cells, *Saccaromyces;* his discovery was confirmed by Louis Pasteur in 1857. The final synthesis explicating the fermentation process was performed by Eduard Buchner in 1897; he demonstrated that fermentation could proceed with just the juices of the yeast cells—without the living cells—showing that a complex of enzymes (zymase) is responsible for the conversion of carbohydrates to alcohol and carbon dioxide.

Before these discoveries, people did not know why and how fermentation occurred. Often they ascribed it to supernatural forces, and many used the same equipment from fermentation to fermentation; sometimes sourdough from bread baking was used to initiate the fermentation. In any case, most of these beers and ales were also lactic-fermented and thus sour. In 1883, E. C. Hansen from the Carlsberg Laboratories of Carlsberg Brewery in Copenhagen isolated the active yeast culture from bottom-fermentation yeast, which J. C. Jacobsen, the founder of the brewery, had brought there from Munich. This species was called *Saccaromyces carlsbergensis* (it was later renamed *Saccaromyces ovum*) and today is considered a variety of *Saccaromyces cerevisiae*, the common yeast organism. Jacobsen's method of isolation and pure-culture propagation of yeasts from single cells was rapidly adopted. By 1896 it was in wide use in lager breweries in many countries and has become the standard method.

Germany became unified during the nineteenth century, and it was then possible for breweries to sell their products over a wider area than before. The first limited brewing company was formed in Dresden in 1838. Between 1831 and 1865, because of the great success of lager, there was a dramatic fall in the numbers of breweries producing ales in Prussia, from 16,000 to 7,400. The first scientific brewing research institutions were formed in Bavaria (Munich and Weihenstephan) in 1880, and in Berlin in 1883.

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Sven-Olle R. Olsson

THE TWENTIETH CENTURY

Beer in 1900

The central area for modern beer development and beer culture is the portion of Europe from Austria in the southeast to the British Isles in the northwest. The Nordic nations are also beer countries, but, with the exception of Denmark, they have not played a significant role. At the beginning of the twentieth century, ales dominated the market in the United Kingdom, the northern and western part of Germany, and Belgium. Lager had started its spread from Bavaria to the big cities in Germany and to the neighboring countries. It had also become rather well established in the United States, but the populace of the United Kingdom had not yet accepted it.

Beer Around the World

Around the world, Australia got Foster's beer, a lager, from the United States in 1888. East Africa received beer from the United Kingdom in 1922, and today, lager, ale, and sorghum beer are all brewed by African breweries. One of the best-known beers from that region is Tusker lager from Kenya. Guinness and Heineken also have large breweries in the area. In South Africa, lager is dominant. In 1904, China got its first lager, Tsingtao, and in 1916 the company was acquired by the Dai Nippon Beer Company in Japan. The Japanese then spread the beer-brewing culture to other parts of East Asia.

Beer in the United States

The United States—where the brewing industry was well established before 1900, with a very wide production of different kinds of beers such as ales, stouts, and lagers—experienced a golden age of brewing between about 1870 and 1919. This, however, came to a halt on January 16, 1919, when the Eighteenth Amendment to the United States Constitution, which prohibited all alcoholic beverages, was ratified. Prohibition lasted from January 16, 1920, to December 5, 1933, when its repeal by the Twenty-first Amendment took effect. During this period, breweries had to survive on nonalcoholic products such as near beers, malted milk, ice cream, and so forth. Two of the surviving companies, Anheuser-Busch and Miller, ended up being two of the top three breweries of the world. The top ten breweries produced about one-third of the world production of 1.25 billion hectoliters (hL, equivalent to 33 billion gallons) in 1995.

World Production

During the twentieth century, world beer production increased from about 250 million hL (6.6 billion gallons) in 1900 to about 1.306 billion hL (34.5 billion gallons) in 1998, an increase of 522 percent. In 1900, production volumes in Germany and the United States were about equal and together constituted about half of the world production. In 1998, the United States produced 238 million hL (6.29 billion gallons) and Germany 112 million hL (2.96 billion gallons), which together represents only 27 percent of the world production. World production of beer was distributed by region in 1997 as follows: the Americas, 37%; Europe, 34%; the Far East, 23%; Africa, 4.5%; the South Pacific, 1.8%; and the Near East, 0.1%. The greatest increase in beer production is found in areas far away from the traditional beer countries—such as China, countries in Latin America, South Africa, and Turkey (an Islamic country). It is evident that they have evolved a new way of life. Two of the traditional beer countries, Germany and the United Kingdom, are still in the top ten in production, but they will probably soon be overtaken by some of the countries mentioned above.

World Per Capita Consumption

Per capita consumption of beer in different countries shows which people have beer as their natural and central beverage. The top ten countries in 1999, each with a per annum consumption of at least 88.1 liters (23.3 gallons) per person, are still from the old beer center of Europe, which stretches from the British Isles to Austria and up to Denmark (Table 1)—except for Australia, which got its beer traditions from the British colonization of the continent. The newcomers are Turkey, some Latin

TABLE 1

The top ten countries in per-capita beer consumption in liters, 1999

	Consumption 1999, e = estimated	% change 1970–1999	No in top-ranking list of % change 1970–1999
1 Czech Rep.	159.4 e	13.9	27
2 Rep Ireland	154.7	53.8	20
3 Germany	127.5	-9.6	37
4 Luxenbourg	109.0	-14.2	38
5 Austria	108.9	10.3	28
6 Denmark	101.9	-6.1	32
7 U.K.	99.0	-3.9	31
8 Belgium	97.5 e	-26.4	43
9 Australia	91.2 e	-24.6	41
10 Slovakia	88.1 e	-16.0	39

SOURCE: *World Drink Trends 2000*, p. 15

American countries, South Africa, and several European countries (including some that have traditionally been considered "wine countries"). Except for the Czech Republic, the Republic of Ireland, and Austria, the traditional beer countries show a decrease in per capita consumption (Table 1).

Lager and Ale

During the twentieth century, a variant of pale lager, pilsner, became the big winner all over the world—in Australia, the United States, and even the old ale area of the British Isles. Only northwestern Europe is bucking the trend: In Belgium, Trappist-Abbey and brown ales are increasing in production, as are *Altbier*, *Kölsch*, and wheat beer in Germany. In the British Isles, bitter ale, pale ale, mild ale, Scotch ale, sweet stout, and barley wine are decreasing in consumption; only bitter stout is increasing. Consumption of draft beer in Great Britain for 1999 is as follows: lager, 44.8 percent; ale, 42.2 percent; stout, 6.3 percent. The remaining 6.7 percent of the total consumption concerns packaged beer of all types. It was not until after World War II that lager truly began to succeed in Great Britain, and it took about fifty years for it to achieve approximately 50 percent of the British market.

Beer Developments in the Twentieth Century

Characteristic of the development of beers and breweries during the twentieth century is the worldwide success of the American variant of the Bohemian lager, pilsner—crystal-clear pale-dry beer, often of the light type, with a low taste of malt and a low bitterness, frequently served very cold. Another trend is that the number of breweries has decreased, individual breweries have become bigger and bigger, and different companies have merged into great brewing conglomerates. In the United States, there were 750 brewing companies and plants in 1936; this number had decreased to 26 companies and 215 plants in 1989, despite a 440 percent increase in volume. Still another trend is the increase of popularity and consumption of beer in nontraditional beer-drinking areas such as Latin America, South Africa, and various parts of Asia. The exportation of beer is a huge worldwide business; Table 2 lists volumes for countries with large exports and imports.

The establishment of microbreweries, which started in 1981 and had increased to 500 breweries by 1992 in the United States, and has spread to other countries as well, is an interesting development that demonstrates the desire for high quality and diversity of beer. Other important developments are ice beer (made by freezing off some of the water); dry beer, with a very low content of residual sugar; light beer, with a low content of dextrins in the beer; low-alcohol beer (less than 1.5 percent alcohol by volume); and nonalcoholic beer (less than 0.5 percent alcohol by volume). Most important are the advances in biochemistry, which have allowed brewing to become an industry based on science and technology. The industry has progressed to the use of stainless steel vessels and containers, and all processes are fully automated and all by-products are taken care of. The expenses for beer production are dominated by costs for packaging, sales, production, and taxes; only a very small proportion of the costs is needed for raw materials.

Beer and Health

Calories, vitamins, and minerals. The effects on health of beer drinking depend to a large degree on which beer is consumed, how much, and by whom. Contents of alcohol, carbohydrates, and proteins differ greatly between low- and high-alcoholic beer. The nutritional value of heavy beer is significant, especially if the beer is unfiltered and contains yeast cells. The caloric value of beers varies from 276 kcal/L in alcohol-free beer, to 428 kcal/L in pilsner, to 660 kcal/L in a *Doppelbock* (double-strength bock beer—a heavy dark beer). For example, 360 ml (just over 12 fluid ounces) of ordinary beer with 419 kcal/L, 4.5% alcohol and 38 g/L carbohydrates will give about 5–12% of the Recommended Dietary Allowance (RDA) of folate, niacin, vitamin B_6 (pyridoxine), riboflavin, and pantothenic acid; 10.3% RDA of magnesium; and 13.5% RDA of phosphorus. Thiamine and pantothenic acid amounts are rather low in beer in relation to the caloric content. This implies that other dietary sources of B-complex vitamins are needed. Beer also contains some chromium, which is needed for glucose and lipid metabolism. The amount of chromium present can be significant for chromium-deficient people. Further, the low content of sodium tends to counteract the water retention seen in heavy drinkers, which, in fact, may typically result from their additional salty food intake. Aside from the caloric content of modern filtered beer, it cannot be

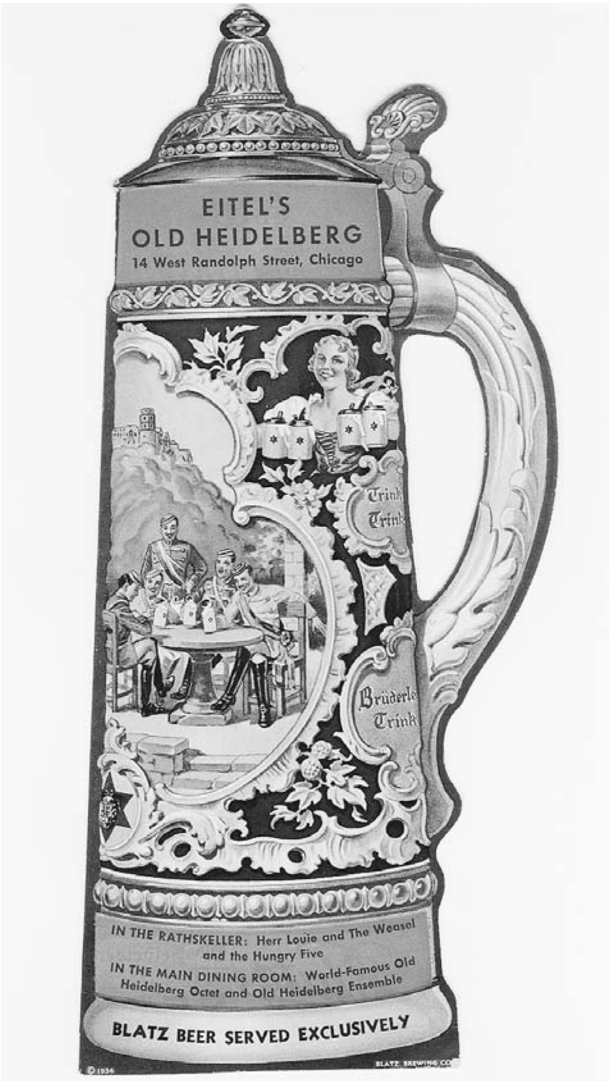
TABLE 2

The top ten countries in beer importation and exportation in 1995

Worldwide in million hectoliters

Importation			Exportation	
Country		Million hL	Country	Million hL
1	U.S.	13.2	Netherlands	10.4
2	U.K.	5.2	U.S.	9.8
3	France	3.5	Germany	7.6
4	Italy	3.0	Belgium + Luxembourg	4.5
5	Japan	2.7	Canada	3.6
6	Germany	2.6	Ireland	3.3
7	Russia	2.0	Denmark	3.1
8	South Africa	2.0	U.K.	3.1
9	China	0.9	France	1.4
10	Canada	0.66	Czech Rep.	1.12

SOURCE: Bamforth, 1998, pp. 10–11.


EITEL'S
OLD HEIDELBERG
14 West Randolph Street, Chicago
Trink
Trink
Brüderle
Trink
IN THE RATHSKELLER: Herr Louie and The Weasel and the Hungry Five
IN THE MAIN DINING ROOM: World-Famous Old Heidelberg Octet and Old Heidelberg Ensemble
BLATZ BEER SERVED EXCLUSIVELY
© 1934
BLATZ BREWING CO

Menu in the shape of a Bierstein for Eitel's Old Heidelberg restaurant in Chicago, 1934. The restaurant served beer only from the Blatz brewery in Milwaukee, much like the pub and brewery arrangements in England. ROUGHWOOD COLLECTION.

regarded as an important nutrient, since the vitamin and mineral contents are relatively low, but it does make a contribution. To make a complete meal with beer, a source of protein and fiber-rich vegetables should accompany the beer.

Medical effects of beer. Although beer is a low-alcoholic beverage of less than 10% alcohol by volume (typically about 5 to 7 percent) in comparison with wine and spirits (about 10 to 50 percent), all the effects of alcohol must be considered. For reviews on this subject, see Cox and Huang (1991, 165–176) and Owades (2000, 19–26). Generally, beer has not been found to differ specifically in its physiological effects on a short- or long-term basis from other alcoholic beverages, if the effects are related to the amount of alcohol consumed. Beer also has the advantage of filling the stomach more quickly than wine and spirits and will give a slower increase of blood alcohol level. Heavy drinking may provoke diarrhea or vomiting and cause excessive urination, all of which flush vitamins and minerals out of the body. Heavy drinkers of alcohol may get dilated cardiomyopathy with specific intracellular changes, which is a kind of congestive heart failure. In 1884, it was described as *Münchener Bierherz* (Munich beer-heart) by Bollinger. This type of disease also occurred during the period of addition of cobalt to beer to stabilize its head.

In the past, alcohol has, in the medical literature, usually been connected to negative and hazardous effects on the body; however, in recent decades, a large number of clinical studies have shown that moderate drinking (about two to three drinks or twenty-five to eighty grams [about 0.88 to 2.8 ounces] of alcohol per day) decreases the risk for cardiovascular morbidity and mortality in comparison with both a higher and a lower alcoholic consumption, and most studies indicate that there are no beneficial differences among alcoholic beverages (but see below). Subjective health has also been shown to be highest in persons with a moderate alcoholic consumption (100 to 199 grams [about 3.5 to 7.0 ounces] per week). The beneficial effects of alcohol might be explained by an increase of HDL-C (high-density lipoprotein-C), decreased levels of prothrombotic factors such as fibrinogen, and reduced platelet aggregability, vessel contractility, and pulmonary artery pressure in heart failure patients. Antioxidative compounds—which may decrease the oxidation of LDL (low-density lipoprotein) and the risk for atherosclerosis—such as polyphenols, gallic acid, rutin, epicatechin, and quercetin in red wine and in full-bodied and darker beers may have additional beneficial effects. The question of whether some alcoholic beverages have more prominent effects in these respects remains to be elucidated in further clinical studies. However, red wine has been proposed to be more efficient than other alcoholic beverages in a number of studies.

Hops and medical effects. Other effects of beer, such as the central nervous arousal and the sedative effects, can be explained by the general effects of alcohol. It has often been discussed whether compounds from hops might influence the physiological effects of beer. It is interesting to note that hops—dried, liquid extract, and tincture—are recommended by health-food specialists for various conditions: "Hops are stated to possess sedative, hypnotic, and topical bactericidal properties. Traditionally, they have been used for neuralgia, insomnia, excitability, priapism, mucous colitis, topically for crural ulcers, and specifically for restlessness associated with nervous tension headache and/or indigestion." (Newall, Anderson, and Phillipson 1996, 162–163). Antibacterial activity toward gram-positive bacteria is documented, but the sedative effect needs to be documented, as most of the studies are made with hops in combination with other herbs. Recurring suggestion has been made that hops and beer have estrogenic activity and that the infection of molds producing estrogenic mycotoxins is a significant problem. Recently, a potent phytoestrogen, 8-prenylnarigenin, has been identified in hops and shown to have a concentration in beer of about 100m/L, which is equivalent to a few mg/L estradiol or less. This concentration in beer is not considered to be detrimental, but handling and ingestion of hops might have estrogenic effects in humans. It is also possible that 8-prenylnaringin might contribute to the health-beneficial effects of moderate beer consumption.

See also **Alcohol; Barley; Vitamins; Wine.**

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Sven-Olle R. Olsson

PRODUCTION AND SOCIAL USE

Beer may be defined as a cereal wine: an alcohol-fermented (and sometimes concomitantly lactic-acid-fermented) beverage, produced from one or more malted cereals, such as barley, wheat, rye, oats, corn, or rice, or from mixtures of these and unmalted cereals. In the following, the product is called "beer" if barley is at least one of the main constituents of the malt; otherwise, it is called "wheat beer," "rye beer," "oat beer," etc., as appropriate.

The Basic Beer-Production Process

To ferment the starch inside the grains of the cereals, it is malted (softened by soaking in water and allowed to germinate) and mashed with warm water; this allows the diastases of the grains, which are activated by the malting and mashing processes, to break the starches into shorter carbohydrates, upon which yeasts can act. After separation, a clarified liquid, known as wort, is produced, which is then boiled with hops; this adds a note of bitterness to the beer's flavor while killing microorganisms. After chilling, yeast is added (either naturally from the environment or as an intentional addition), and fermentation takes place. After clarifying and storage, the beer is ready for consumption.

Classification of Beers

Beers can be categorized according to the type of cereal used, but it is more common to use the type of fermentation for this purpose: spontaneous fermentation, top fermentation, or bottom fermentation.

Spontaneous fermentation. Spontaneously fermented beers are produced without the active addition of any microorganisms to the wort. The microorganisms come from the surrounding air and the equipment used in the brewing process and are a mixture of yeast species and lactic-acid bacteria, a mixture that produces alcohols and lactic and other organic acids, and gives the product a sour taste. Examples are the Russian beverage kvass, which is typically made of rye, and Belgian Lambic beer and the old *Berliner Weisse*, which are both produced partly from wheat. All beers made before the introduction and knowledge of pure yeast cultures were in a sense made via spontaneous fermentation. However, most such beers (as well as wines) were made inside containers that were repeatedly used for this purpose. Such containers rapidly become infected with spores that continue to maintain the original species of yeast—that is, the ones that produced fermentation in the first place. The use of the same vessel and associated equipment from one batch to the next causes the cereal grains employed to continue to be cross-infected between brewings. Recent scientific studies indicate that these spores remain alive for decades, or even longer. Moreover, many beer-making traditions include the step of adding fruit, such as raisins, to the mixture; this practice assures that the yeasts that naturally reside on the surface of the fruit will become a significant part of the microorganisms that infect the mixture.

These types of beer are technically ales—that is, they are all top-fermented.

Top fermentation: ales. Top-fermented beers, ales, are fermented at a rather high temperature, about 64–72°F (18–22°C), letting the yeast float on the surface of the wort.

Typical ales are British and Irish pale ales, bitters, stouts, and porters; Belgian ales, such as Trappist and abbey beers; and western German ales, such as *Alt Bier* and *Kölsch*. The Bavarian wheat beers—*Weissbier* (*Weizenbier*)—are also top-fermented and are produced in different varieties: pale and dark, with and without yeasts remaining, and as bock and *Doppelbock*. Some of the British and Belgian ales can be very strong, up to about 12–17 percent alcohol by volume, while common ales have a concentration of 3.5–6.0 percent alcohol by volume. Ales were predominant before the great expansion in popularity of bottom-fermented beers, the lagers, in the nineteenth century.

It should be noted that the term "ale" has also been used to signify unhopped beer, as contrasted with hopped beer (Cantrell, p. 619).

Bottom fermentation: lagers. Bottom-fermented beers, lagers, originated in Bavaria, where a cold-adapted yeast strain had been developed over a period of many years in the cold caves used for fermentation and storage. A temperature of about 45–59°F (7–15°C) is typical for bottom fermentation. The cold fermentation and the location of the yeast cells at the bottom of the container yield better storage capabilities and a cleaner, more purely malty taste in lagers, in comparison with ales, which are usually more fruity and bloomy in flavor. The name "lager" implies it is stored in cold conditions. Lagers are the dominating beers of the world today: pilsner; Bavarian; Vienna; *Münchener*, pale and dark; *Dortmunder*; bock; and *Doppelbock* beers. The difference between them depends principally on the brewing liquid, the type of hops, and the type of malt used. Bock and *Doppelbock* beers have a higher alcoholic content, 6.0–7.0 percent by volume and 6.0–8.0 percent by volume, respectively, in comparison with the other lagers, 3.8–6.0 percent by volume. Bocks and *Doppelbocks* are spring beers; their high levels of alcohol were originally produced to compensate for Lenten fasting.

Raw Materials

Barley. Barley is a grass of the genus *Hordeum* and of the family Gramineae; it is one of the most important cereals of the world, after wheat, maize (corn), and rice. Barley is mainly used for livestock feed and for beer malting. The world production for 1999 was 130 million tons, with the greatest producers being Germany (13.3 million tons) and Canada (13.2 million tons) (FAO, *Production Yearbook*, 1999). Barley is produced all over the world up to 70°N latitude; it prefers reliable rainfall, a long growing season, and deep rich soils, but it can stand much more difficult conditions. It is not as cold-resistant as wheat, and in some regions it is sown in the autumn (Kendall, pp. 109–111).

For malt production, the two-rowed form of barley is often preferred over the six-rowed, although both give excellent malts. The advantages of barley for malting are principally the following:

- The husk gives each individual grain of barley microbiological protection during malting, thereby helping to prevent the growth of mold.
- The husk provides a useful filter during traditional wort separation. The filtered material, spent grains (trub), is composed of husks, proteins, a little starch, and minerals. The trub is used for animal food (Narziss, 1995, p. 176).
- The gelatinization temperature of malt starch is lower than the inactivation temperature for α-amylase, which is one of the main enzymes breaking down the starch into shorter carbohydrates. (Gelatinization accelerates the transformation to sugars and makes it more thoroughgoing.) (MacLeod, pp. 50–51)

For more detailed reviews see Hough, Briggs, and Stevens (1971) and Adamic (1977).

Water. The different composition of natural brewing water, or production water, from Pilsen, the Czech Republic; Burton upon Trent, England; Munich; Dortmund, Germany; and Vienna characterizes five types of different beers. Pilsen water has low concentrations of ions and is suitable for highly hopped lager beers with pale malt. Burton upon Trent water has high concentrations of calcium, bicarbonate, and particularly sulfate, and this combination has been shown to be perfect for highly hopped ales with dark malt. The waters from Munich, Dortmund, and Vienna have rather high concentrations of alkaline ions, and Dortmund water in particular has rather high concentrations of calcium and sulfate. Vienna water is more highly mineralized than Munich water, with a rather low sulfate but a higher bicarbonate concentration. The waters from Munich and Vienna give a lager that is not heavily hopped and is used with both light and dark malts. The *Dortmunder* lager is more highly hopped and has a slightly higher alcohol content and a pale malt.

Brewing water must be of potable-water quality. The ion composition and pH can be adjusted by ion exchanges, for example. The pH before wort boiling should be 5.4, so as to obtain a pH after boiling of 5.2 (Moll, pp. 138–139). The different ions of the brewing water have profound effects on the malting and brewing processes, the fermentation, the flavor, and, as a result, the type and quality of the beer. The previously mentioned famous beers are distinguished by the effects of geological conditions of their wells on the brewing water. The important cations are calcium, magnesium, sodium, potassium, iron, manganese, and trace metals. The anions are carbonate, sulfate, chloride, nitrate and nitrite, phosphate, silicate, and fluoride. Their concentrations in the brewing water should comply with those found in water suitable for drinking (for standards, see Moll, pp. 134–135).

Some of the many effects of the ions are pH adjustments made by calcium, magnesium, carbonates, and sulfate from the brewing water and phosphate and organic acids from the malting. If calcium chloride is added, insoluble calcium carbonate, phosphate, and free hydrogen ions will form, which will decrease the pH. In contrast, pH can be increased when the brew is boiled, forming carbon dioxide from carbonate and hydrogen carbonate, which binds hydrogen ions. Many of the different anions such as carbonates, phosphates, and all the organic acids in the brew have buffering capacities (they minimize changes in the pH).

Besides these pH effects, many of the cations, including trace metals, work as coenzymes for many different enzyme systems. For example, magnesium is a cofactor in the metabolic enzymes necessary to produce alcohol and protect yeast cells by preventing increases in cell membrane permeability elicited by ethanol and temperature-induced stress. Other critical trace element cofactors are cobalt and chromium, which enhance the kinetics of alcohol fermentation.

Calcium, along with phosphates, provides thermal protection for mash enzymes and is the principal factor for pH adjustments during wort boiling. It also tends to inhibit color formation during the boil, and facilitates protein coagulation, oxalate sedimentation, yeast flocculation, and beer clarification. Magnesium works similarly to calcium and causes harsh bitterness (Fix, p. 5). Sodium, together with chloride, causes a salty taste in higher concentrations (>400 mg/l), but in lower concentrations it can be used to increase the "mouthfullness." Sodium is also very important for sodium/potassium transport across cell membranes. The amount of potassium should not be excessive as it inhibits many enzymes in the wort preparation. Iron should be avoided as it inhibits the malting, gives color to the wort, decreases the "mouthfullness," and causes a bitter taste. Iron is essential for the oxidative processes of the yeasts, especially terminal oxidation. Manganese works as a coenzyme in many enzyme systems and stimulates cell division and protein generation.

Sulfate, with calcium and magnesium, decreases the pH and stimulates the carboxyl and amino peptidases. The sulfate concentration in the brewing water determines the concentration of sulfate in the final beer (malt and hops also contribute to the amount of sulfate) but does not increase the amount of sulfur dioxide. Sulfate also increases the flower flavor of hops and gives beer a dry, bitter taste. Chloride stimulates α-amylases and gives a soft and full beer taste as calcium chloride. Often, the chloride/sulfate concentration ratio is used to describe the ratio of body and fullness in relation to dryness.

Nitrates and nitrites are the last stage in the oxidation of organic material and give beer a bad taste. Nitrites are toxic for the yeast cells. Phosphate ions in the brewing water are not acceptable because they indicate organic contamination. Silicates of calcium and magnesium have negative effects on the proteins and cause protein-unstable beers. Fluorides have no negative effects on the fermentation but cause the beer to become a little darker and have a broader taste (Narziss, 1992, pp. 17–52). For more details about the effects of the ions in brewing water, see Narziss, 1992; MacLeod; and Moll.

Hops. The cultivated hop plant, *Humulus lupulus*, with its relatives *H. japonicus* and *H. yunnanensis*, belongs, along with species of the genus *Cannabis* (e.g., *C. sativa*, hemp), to the family Cannabinaceae. Together with the nettle family, Urticaceae, they form the order Urticales. Hops are dioecious (i.e., there are individual male and female plants) and perennial and are indigenous throughout much of the Northern Hemisphere between 35° and 70° N, though mostly cultivated today between 43° and 54° N, and 37° and 43° S. The most important regions for hop cultivation are in South Africa, Australia, Argentina, the United States, Germany, the Czech Republic, and England, having an amount of daylight during the growing season of 15:27–18:42 hours, a mean temperature of about 50–66°F (10–19°C), and average rainfall of between 2.5 and 22.4 inches during the period of April to September in the Northern Hemisphere and October to March in the Southern Hemisphere (Barth, Klinke, and Schmidt, p. 49). The world production in 1999 was about 98,000 tons, with Germany contributing about 28,000 tons, the United States about 29,000 tons, and China about 15,000 tons (FAO, *Production Yearbook*, 1999). Many different varieties of hops with different contents of humulone (an antibiotic) and hop oils have been developed, particularly in Germany, England, and the Czech Republic. (For more details about the varieties, the history, and the trade, see Barth, Klinke, and Schmidt, pp. 1–383.)

Both pollinated and unpollinated cones (strobili) from the female plants are used, with the unpollinated ones used in Germany thought by some to yield a better taste than the seed (MacLeod, p. 80). Inside the infolded bases of the bracteoles (the small leaves from which the flowers grow) and on the seed are the resin-producing lupulin glands, which contain the essential compounds for use in beer: the resins humulone (the α-acids) and lupulone (the β-acids), and the aromatic hop oils. The α-acids yield, after boiling and isomerization, iso-α-acids, which contribute bitterness to the beer, and hop oils, which contribute to the aroma. In addition, hops also benefit beer by improving clarity and foam stability, and, most important, flavor stability because of bacteriostatic activity of the iso-α-acids (flavonoids) (Grant, pp. 157–167). Hops are the major preservative of beer.

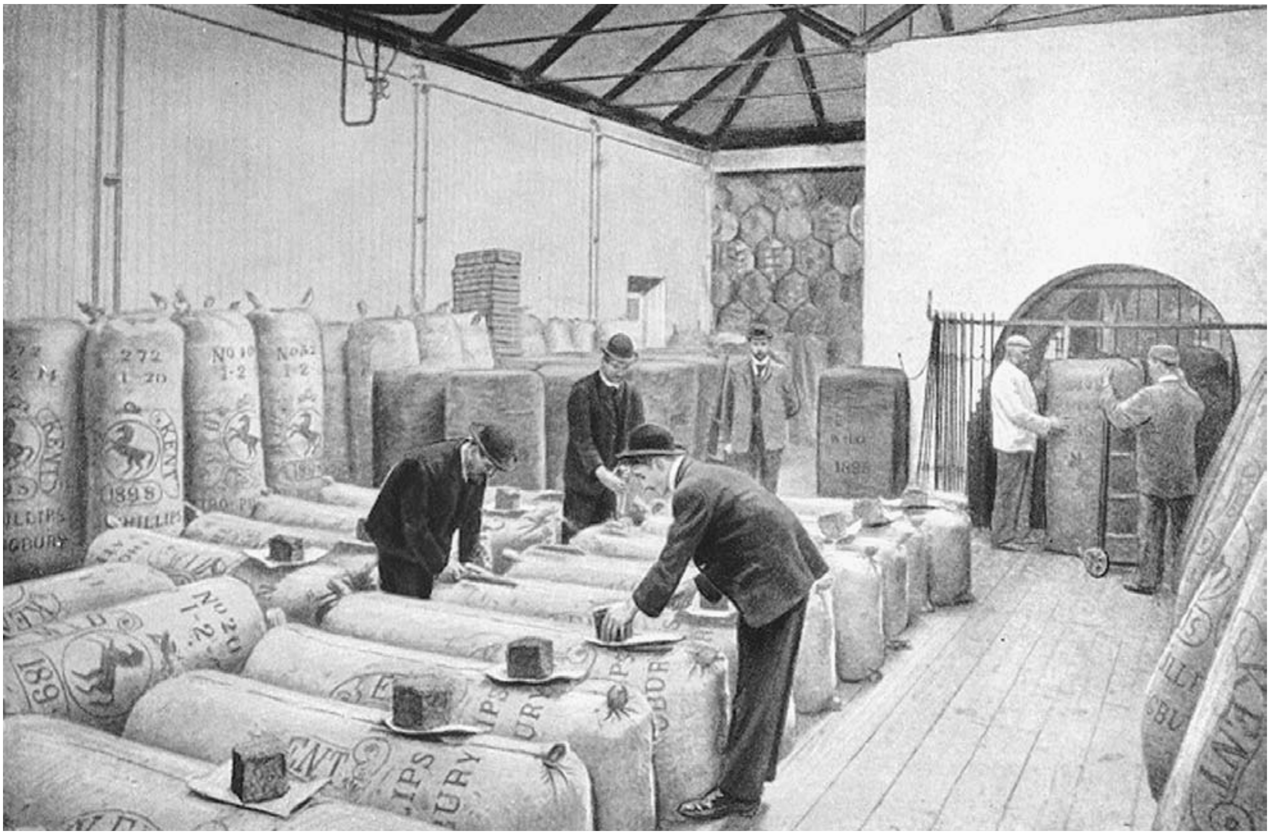
Other herbs and spices. Down through history many types of herbs and spices have been added to beer (von Hofsten, pp. 208–221; Rätsch, pp. 28–40), and many of them have been considered to be remedies. Besides hops, sweet gale (*Myrica gale*) and marsh tea (*Ledum palustre*), two of the constituents of the old European mixture of beer additives, *grut*, are believed to have been in widespread use. Placotomus mentions in his book from 1543 the use of more than twenty plants as additives for beer (von Hofsten, p. 212).

Since 1516, when the *Reinheitgebot* (Purity Law) was approved in Bavaria, the use of additives other than hops in beer has been prohibited there; this inhibited the use of new herbs and spices, and new combinations of old ones, in beer in Bavaria. However, in Belgium and its surrounding areas, and in Great Britain, other types of beers using wheat and herbs and spices were developed. Many of the recipes are secret, but we know of the use of coriander leaves and seeds, cardamom, camomile, clover, grains of paradise (the seeds of the West African plant *Aframomum melegueta)*, cinnamon, plums, peaches, cherries, coffee, chilies, and chocolate (Jackson, 1998, pp. 16–17).

Yeast. The living microorganism producing beer from wort by anaerobic degradation of sugars to alcohol is a yeast species, *Saccaromyces cerevisiae*, which is also used for baking and wine fermentation. The species has at least a thousand different strains (Barnett, Payne, and Yarrow, pp. 595–597). Two of them are *S. cerevisiae cerevisiae* used for top-fermentation of ales and *S. cerevisiae uvarum* (*carlsbergensis*) used for bottom-fermentation of lagers. They differ from each other by the temperature used: as noted above, 64–72°F (18–22°C) for the ales and about 45–59°F (7–15°C) for the lagers. Further, *S. c. uvarum* (*carlsbergensis*) has the ability to ferment the disaccharide melibiose, which *S. c. cerevisiae* is unable to do, due to lack of the enzyme melibiase (α-galacoidase) (Russel, pp. 169–170). Different breweries have developed their own strains or mixtures of strains of yeast to maintain the distinctive qualities of their beers. Important requirements for a good brewing yeast are flocculating power (i.e., the capability of forming loose, fluffy clumps), ability to ferment maltotriose (a complex sugar found in the wort), head-forming potential, fermentation efficacy, interaction with isohumulones (forms of the antibiotic α-acids produced by hops), response to fining (clarifying and purifying), and propensity for producing important individual flavor components (MacLeod, p. 84). In the San Francisco beer Anchor Steam, lager yeast is used for fermentation at a high ale-fermentation temperature, which gives a very interesting beer with the roundness and cleanness of a lager and the fruitiness and some of the complexity of an ale.

Outline of Modern Brewing Procedures

Detailed descriptions of this highly technological and scientifically based process can be found in de Clerck (1957–1958); MacLeod (1977); Hardwick (*Handbook of Brewing*,



Hop-sampling warehouse at the Guinness brewery, Dublin, Ireland, circa 1915. To maintain the quality of hops used in brewing, samples were taken from various lots of newly purchased hops and tested. Roughwood Collection.

1995); Hough, Briggs, Stevens, and Young (1982); Narziss (1992–1999); and Narziss (1995).

An outline of the different procedures is given by Hardwick ("An Overview of Beer Making," 1995, p. 88).

Beer Chemistry

Malting. The process of malting grain starts with steeping it in water. After several hours, the embryo begins to take up water and to grow. To produce energy, the growth hormone giberellinic acid is formed and transported to the aleurone cells around the starch-rich endosperm to start the formation of hydrolytic enzymes such as α-amylase, endo-β-glucanase, and peptidase. The cell walls of the endosperm contain β-linked glucan and pentosan, which are degraded by the endo-β-glucanase and pentosanases. The net action is to solubilize and break down the cell walls and the small starch granules in the endosperm. The peptidases break down the peptides into amino acids, which are essential for yeast nutrition; the large polypeptides, which have not been used by the yeast cells during fermentation, are important for foam stability in the final beer, but in conjunction with polyphenols have the potential to form undesirable haze in the beer.

When the malting is completed, the malt has to be kiln-dried to stop the enzymatic activities and to reduce the water content so as to allow storage of the finished malt. The kilning is divided into two steps: the drying, at temperatures up to 176°F (80°C), giving a moisture content of 4 percent; and the curing process, at higher temperatures, yielding flavor components through the Maillard reaction. This reaction browns the malt, producing amino acid–carbonyl compounds, which undergo further transformations to yield the colored, aromatic compounds known as melanoidins. The higher the temperature, the darker the malt will be and the more the enzymes will be inhibited (Kendall, pp. 117–118; Fix, pp. 41–45). These compounds contribute both to dark color and to different varieties of burnt-sugar or caramel taste. The malt type and the mixture of malts forms the body or the "mouthfullness" of the beer and produces the basis of classification into pale, medium, and dark beers. If the malt is kilned over an open fire, it will acquire a definite smoky taste like the Bavarian *Rauchbier*, "smoke beer." The feeling of "mouthfullness" can be decreased by splitting the residual sugar of the beer, the α-glucans, dextrins, by exogenous enzymes during the malting process. The resulting carbohydrates will finally be fermented by the yeast. The process is used to produce diet, lite, light, and dry beers.

Mashing. The type of brewing liquid used for beer production plays a very great role. However, with modern technology, any type of liquid with the optimal concentrations of the different ions can be created from any water. Calcium ions contribute to a more acid mash by precipitating as calcium phosphate and thus setting hydrogen ions free from phosphate ions. The pH obtained in this way, 5.4, is favorable for the activities of amylases. Bicarbonate ions act in the opposite way and give a more alkaline mash, which is unfavorable, and thus they should typically be removed. Calcium sulfate is often added to the mash to decrease the pH and to give bitterness to ale. Nitrates and iron ions have deleterious effects on yeasts. For detailed discussions on brewing liquids and salts, see Moll (pp. 133–156).

Germany complies with the *Reinheitsgebot*, the Purity Law, which, except for *Weissbier*, permits only barley malt, hops, and water for beer brewing. In most other countries, however, adjuncts up to 50 percent by volume are added to the mash to decrease the cost and to balance the taste of the beer. The adjuncts can be sugar solutions, other malts, or other unmalted cereals, such as rice, maize, wheat, or barley (though both rice and maize must be precooked before their incorporation into the mash, as their starches have high gelatinization points) (Stewart, pp. 121–132).

The mashing can be performed by either infusion or decoction. Infusion mashing is performed in a single vessel at a uniform temperature of about 150°F (65°C), and after the mashing, filtration is performed in the same vessel. The decoction system starts with a low temperature, which is then raised by the removal, boiling, and return of a part of the mash. The whole mash finally is transferred to a separate vessel, the lauter tun, for filtration. In Britain, the infusion is used with well-modified and coarsely ground malt, whereas in continental Europe the larger decoction method is used with a finer grind and less well-modified malt. Decoction mashing is a more versatile procedure for different malts and also has the advantage of low temperature, which helps to maintain the stability of such heat-labile enzymes as proteinases, β-glucanases, and β-amylase (MacLeod, pp. 59–73; Narziss, 1999; Rehberger and Luther, pp. 247–322).

The objective of the mashing is to produce fermentable sugars from the degradation of solubilized starch, amylose, and amylopectin. The sugars obtained are glucose, maltose, maltotriose, maltotetraose, and higher dextrins to a total of about 70 to 75 percent, with the higher values coming from decoction malting. Unfermentable dextrins persist to the finished beer and are an important part of the mouth-filling experience of the beer. Proteins, peptides, and amino acids, as well as vitamins, inorganic ions, fatty acids, organic acids, tannins, and lipids, are extracted during the mashing and all are important for yeast fermentation.

The amount of malt used is directly proportional to the alcoholic concentration of the finished beer. About one-fourth to one-third of the weight of the malt is metabolized to alcohol.

Wort boiling. The filtered sweet wort from the mashing is transferred to the wort vessel for boiling, which inactivates the enzymes, sterilizes the wort, lowers the pH via precipitation of calcium phosphate and removal of carbon dioxide from bicarbonate, concentrates the wort, denatures and precipitates proteins, dissolves any additional sugars used, isomerizes hop α-acids, and removes unwanted flavor components. A long boiling process increases the shelf life of beer. Elimination of high-molecular-weight material (i.e., flocculation of the proteins) is increased by stirring and adding carrageen, a colloid typically extracted from the red alga *Chondrus crispus*. It has also been shown that the malty full-bodied flavor of beer declines and sharper notes are enhanced with rising temperature of heat treatment. The color of the wort is also increased with higher temperatures, aeration, and higher contents of soluble nitrogen. The process is the same as the one that occurs during kilning, the Maillard reaction (MacLeod, pp. 73–81).

During the wort boiling, hops, whole or powdered, are added to give their characteristic bitterness and aroma to the beer and, because of their antimicrobial action, to increase its shelf life. Principally, there are two types of acids contributed by the hops: α-acids such as humulone, cohumulone, and adhumulone; and β-acids such as lupulone, colupulone, and adlupulone. The bitter taste of fresh hops derives almost entirely from the α-acids, but they have only limited solubility in the wort. However, during the boiling, the α-acids are transformed into soluble, bitter iso-α-acids, which contribute to the hoppy bitterness of the beer. There are at least six cis- and trans-iso-α-acids and their overall level in beer is about 0.0002 to 0.0005 oz/gal (Neve, pp. 33–38). The β-acids are largely unchanged during boiling.

The aroma of the hops comes from a very complex mixture of compounds and most of the volatile hop oils are lost in boiling, but a late addition of aroma hops increases the flavor. A discussion and list of the hop compounds in beer is found in Hardwick ("The Properties of Beer," pp. 573–577).

Fermentation. The principal pathway for carbohydrate metabolism is the Embden–Meyerhof–Parnas pathway, which is the anaerobic metabolism of glucose to pyruvates and alcohol by the yeast cells:

1 mole of glucose gives 2 moles of pyruvates, which will give 2 moles of alcohol and 2 moles of carbon dioxide (CO_2).

A more comprehensive equation that describes a brewery fermentation is given by Bamforth (p. 143):

Maltose (100 g) + amino acid (0.5 g) → yeast (5 g) + ethanol (48.8 g) + CO_2 (46.6 g) + energy (50 kcal)

Glucose and fructose are the first carbohydrates to be absorbed by the yeast cells from the wort. For the uptake of maltose, the principal sugar of the wort, maltose permease must be synthesized, and before maltotriose can be used, the maltose of the wort has to be almost completely depleted. The formation of maltose permease is the time-limiting effect on the speed of fermentation of the wort. This enzyme is also inhibited by glucose, thus yielding a longer lag period in glucose-supplemented wort (MacLeod, pp. 81–103).

Amino acids can be divided into four groups according to their uptake into the yeast cells: A, B, C, and D in that sequence for both *S. c. cervisiae* and *S. c. carlsbergensis.* The A and C amino acids appear to compete with the same permease. Proline, which is the only member of the D group, disappears very slowly, implying that a substantial amount of this amino acid will remain in the final beer: about 0.003 to 0.004 oz/gal.

Unwanted products from the fermentation process, which are closely related to amino-acid metabolism, are certain higher alcohols: 3-methylbutanol, fusel alcohol, and vicinal diketones (diacetyl). Presence of diacetyl seems to depend on a deficiency of the amino acid valine. A deficiency of methionine or an excess of threonine gives unacceptable levels of hydrogen sulfide (MacLeod, p. 91). Consequently, careful control of the amino-acid composition of the wort is essential. Esters (e.g., ethyl acetate) are also important as taste- and aroma-producing compounds. Their formation is favored by high-gravidity brewing followed by dilution, ample supplies of assimilable nitrogen, and relatively high concentrations of alcohol (MacLeod, pp. 81–103). For further discussion on fermentation, see Munroe (1995, pp. 323–353).

The wort is rather rich in B vitamins, but this content, particularly the content of thiamine, is decreased during fermentation by the yeasts (Hardwick, pp. 576–577).

Aging and finishing. Newly fermented beer, often referred to as green beer, has to mature in flavor through storage at low temperatures and should be removed from the yeast. It may also require being clarified, stabilized, carbonated, blended, or standardized. The processes involved include filtrations, CO_2 additions, pasteurization, and additions of tannic acid and proteolytic enzymes for clarification of the product. For a more detailed discussion, see Munroe (pp. 355–379). Storage of green beer together with its yeast cells decreases the amount of diacetyl and 2,3–pentanedione, which have a buttery taste that is undesirable in lighter beers. Sulfur-containing compounds, such as hydrogen sulfide, sulfur dioxide, and dimethyl sulfide, may also show up in the beer, producing unattractive flavors and aromas.

During storage, a secondary fermentation can be performed to accelerate aging and the maturation of taste. A secondary fermentation can also be performed in the bottle, as is done in many Belgian ales and Trappist beers, for example. Another method used is to add up to about 20 percent of highly fermenting primary beer (high*kräusen)* to the green beer in storage. Also during storage, aroma hops may be added to increase the aroma of the beer, and iso-α-acids from hops can be added to help control bitterness in the beer.

Modern industrial processes of aging and finishing beer, with ultrafiltrations, pasteurization, and total separation of yeast cells, give the modern-style clear, “dead” beer, which has a long shelf life. This contrasts with “real” beer or ale, which retains living yeast cells and thus exhibits richer taste and aroma, but has a shorter shelf life and often greater variation in taste and aroma. Most lagers do not contain yeast cells, but many bottom-fermented beers such as *Weissbier mit Hefe* (literally, “wheat beer with yeast”), Belgian beers, and British ales and stouts do. A comprehensive summary of the chemical constituents and the physical properties of beer can be found in Hardwick, “The Properties of Beer” (pp. 551–585).

Beer aging and oxidation. Beer is a fresh food product, which undergoes chemical changes during storage. Some of these are expressed as sensory changes shown in the schematic graph given by Bamforth (p. 68). The progression of these changes has been described by Dalgliesch (1977, cited in Fix):

Stage A is the period of stable, “brewery-fresh” flavor.
Stage B is a transition period in which a multitude of new flavor sensations can be detected.
Stage C products exhibit the classic flavor tones of beer staling.
Stage D, not included in Dalgliesch, “is the development of ‘kaleidoscopic flavors,’” as exemplified in Rodenbach’s Grand Cru and in Trappist beers, “recalling the subtlety and complexity of great wines” (Fix, pp. 127–128).

Most of these changes are due to a range of oxidative reactions in the beer. Hence, it is extremely important for the quality and shelf life of beer that the beer be oxygen-free. The alcohols in beer can be oxidized to aldehydes and acids, and the iso-α-acids can also be oxidized, with the formation of free fatty acids. All these compounds have prominent effects on aroma and taste. Free fatty acids can also form esters with the alcohols and the unsaturated fatty acids as well as the melanoidins produced via browning of the malt can undergo autooxidation. The fatty acids will give fatty and soapy flavor notes. Melanoidins may oxidize alcohols to aldehydes or acids. However, melanoidins can also be reduced by the oxidation of iso-α-acids and work as antioxidants, thereby protecting the beer from oxidation, as is the case in dark beer. The same effects are seen from malt- and hop-based phenols. Together with fatty acids, they interact in a complex electron exchange system.

The different kinds of phenols, from cathecin to polyphenols (also called tannins and flavonoids), which originate from the malt, the hops, and also from the fermentation process itself play a large role in these chemical reactions. They can act as useful antioxidants in the beer and add to the sensory impression of freshness. However, if they themselves become oxidized, they contribute astringency and harshness. Another very important result of the chemical reactions is the reduction of unsaturated fatty acids. This inhibits the development of long-chained unsaturated aldehydes, such as trans-2-nonenal, which is a prominent factor for the development of staling and cardboard and/or papery notes. Because of these reactions, highly hopped beer is less prone to develop the staling effect (Fix, pp. 127–139).

Beer and Social Use

Throughout history, beer-drinking peoples have considered beer an essential part of both their food supply and their enjoyment of life. Bread and beer—food and beverage—were two parts of nutrition united via having almost the same process of fabrication. In earlier times, beer was thought of as liquid bread. As a beverage, it was also preferred over water, partly because water was often contaminated by bacteria, whereas beer became almost sterilized through the boiling of the wort and the antiseptic qualities of hops.

Beer and other alcoholic beverages have played a very important religious and social role: maintaining ties within groups and between people and their deities. It is not surprising that man has considered intoxicated humans to be in close contact with the deities and acquiring spiritual and supernatural forces from them. In Old Norse mythology, mead (an alcoholic beverage fermented from honey) gave humans immortality, wisdom, and poetic abilities. Mead and beer were considered to contain the spirit of the gods, and hence people ingested the gods by drinking the beverages in the same way as Christians drink the blood and eat the flesh of Christ at communion, in the form of bread and wine (Thunaeus, vol. 1, pp. 17–24; Wiegelmann, pp. 533–537).

At the ceremonial feasts of the Nordic people in the tenth century, the beer and food were first blessed and then highly ornamented horns of beer went to everybody to make toasts to the gods: to Odin for victory and power for the king, and then to Njord and Frej for a good harvest and peace. Then they drank *minne*, memory, for their ancestors and relatives. The ceremony formed and strengthened bonds both between the gods and men, and among men (Thunaeus, vol. 1, pp. 17–24; Wiegelmann, pp. 533–537). In medieval times and persisting until the nineteenth century, important ceremonies such as baptisms, weddings, funerals, and harvest celebrations had *öl*, beer, in their names; there were, for instance, *dopöl*, the celebration of baptism, and *gravöl*, the funeral feast. For the various celebrations, a strong beer was produced. On other days, a much weaker beer was consumed, which was sometimes even mixed with milk. People showed their hospitality by having a tankard with beer standing on the table, and everyone was welcome to take a sip.

These examples from the Nordic countries exemplify the general pattern of mankind using alcoholic beverages as ceremonial links to the gods and a method of creating and increasing social contacts among people. Many of these ceremonies and social implications of drinking together are still active today.

Mixtures of Beer and Other Beverages

In *Berliner Weisse*, juices of red raspberry, green sweet woodruff, or, more recently, pineapple may be added. To Belgian Lambic, different fruits can be added to the second fermentation to create, for example, *Kriek* (using cherries) and *Framboise* (using raspberries) (Jackson, 1991, pp. 95–100).

The English shandy (beer mixed with lemonade or ginger beer) and the German *Radler* and *Alsterwasser* (beer mixed with a clear soft drink, typically lemon or lemon–lime soda) are quite popular today. Shandy has a tradition that dates back to the tenth century (Zotter, pp. 222–223). *Alsterwasser* has also become popular with cola and tequila (Pini, pp. 88 and 788). *Radler* was earlier a common mixture for children and young people in Germany. In southern Sweden, the mixture of beer (*svagdricka*) and milk called *drickablandning* (mixture of drinks) was very popular until about the middle of the twentieth century.

Food and Beer

Beer is used as an ingredient in food preparation in soups and stews, for marination of meat, as a liquid for boiling, and in sauces. Many German examples are given by Lohberg (pp. 269–331). Traditional soups with beer in northern Europe are *Biersuppe*, *Öllebröd*, and *Ölsupa*, which are boiled mixtures of beer and meal and/or milk and egg, with ginger, cinnamon, and fruits. *Carbonade*, beef stewed in beer, is a favorite dish in northern France, Belgium, and the Netherlands.

The specific types of beer used traditionally in an area almost always fit very well with traditional local food. The most popular type of beer in the world today, pilsner or light lager, which is served cold and has low levels of bitterness and maltiness, is a good partner with almost any kind of food, which may well be an important reason for its popularity.

Other types of beers, which have a more complex taste, should be paired with different foods using some care, as the combination should not overpower the individual flavors of either the beer or the food, but enhance the positive features of both. A nice introduction with illustrative food and beer combinations has been presented by Jackson (1998). In general, beer can be paired with different kinds of food as well as wine can be, and sometimes better.

Service Traditions

Drinking vessels and beer containers. In Latin America, the Incas and the Mayas developed very elaborate containers both for the production of *chica* and for storage and ritual drinking. The malting and fermentation took place in hollow tree trunks that were often decorated and covered with carpets or palm leaves. The bottles were ceramic stirrup vessels with a long neck, sometimes two joined into one, with a round bellow that could be formed as a human head. Ordinary ceramic cups were also used. The ceramics were painted with many different scenes, often with a strong erotic touch. Bottles filled with *chicha* were buried with the dead (Rätsch, p. 103).

The serving of beer in Mesopotamia and in ancient Egypt was from ceramic containers, both large ones from which people drank with straws (primarily to penetrate the top-fermenting yeast and floating husks) and smaller ones like our cups. For ceremonial drinking, elaborate bull's horns were used in northern Europe. After the ceramic period and persisting into the twentieth century, the wooden barrel and the wooden tankard were the principal storage and drinking containers. In Scandinavia, it was common to have elaborate drinking bowls, often in the form of a goose, for ceremonial feasts, and during the sixteenth century, the upper class used ornamental wooden drinking vessels (Hirsjärvi, pp. 57–68; Cleve, pp. 15–42; Gjærder). Drinking vessels were also later made of lead, tin, copper, silver, stoneware, ivory, china, or glass. Tankards usually had the same general design whether or not they were lidded. Lids were usually metallic, and the rest of the tankard was made of glass, ceramic, or wood. There were very elaborate, expensive tankards and also simple and practical ones (Jung; Lohberg).

Although its history is very long, perhaps as long as the history of beer itself, before the nineteenth century the beer glass was seen only among the upper classes. It was the technique of glass pressing in great industrial scale in the nineteenth century that made the glass available to everyone. The design of the beer glass has developed in some distinctive ways, with special sizes and shapes for specific types of beers and special glasses displaying the names and logos of the brewers for almost every brand of beer (Lohberg; Jackson, 1998). Jackson includes color images of both the glass and the bottle for each type of beer presented in the book.

The original wooden barrel was generally replaced in the twentieth century by the steel barrel. At the end of the nineteenth century, glass bottles were introduced, and beginning in 1935, they were joined by metallic containers—beer cans.

Serving temperature. There is a correct serving temperature for every beer. The richer the flavor and aroma of a beer is, the higher its serving temperature should be. A very low temperature is suitable if taste is secondary. The only beers that are appropriate to serve cold, about 39°F (4°C), are light, pale lagers. More tasty lagers should be served between 43 and 50°F (6 and 10°C), and ales between 54 and 64°F (12 and 18°C). Jackson (1998) is a good source for recommendations of serving temperatures for specific beers.

DRINKING ESTABLISHMENTS IN EUROPE

The establishments for serving beer in Europe have developed into three different lines or beer-serving cultures:

- The Central European in the area of South Germany, the Czech Republic, and Austria: The *Bierkeller* or *Biergarten* has no bar but rather big wooden tables, chairs, or benches; the beer (only a few brands) is served from barrels. The glasses are specific for the type of beer served. In Munich the beer could be served in a tankard of glass or ceramics, *ein Mass* (which means one tankard) of either one or two liters.
- The British: The pubs have a bar around which most of the people gather. Some real ales, a stout, and a light lager from kegs are served in pint glasses.
- The Belgian: The typical cafés have some resemblance to the French or the Austrian cafés serving wines and coffee. The number of brands of beer offered is great—up to the hundreds in some cafés in Belgium.

In all three types of establishments the food served is simple but in most cases nourishing.

Beer and Traditional Medicine

Hans Zotter's book (pp. 222–223) contains medical recommendations and rules from Ibn Butlan from the tenth century. It illustrates how beer was looked upon medically in the old tradition of Hippocratic medicine, a tradition that prevailed until about the seventeenth century. Its view was that

> Beer is "hot and humid"; or "cold and humid."
> The best beer is sharp and spicy.
> Beer drinking relieves the sharpness of heat and drunkenness.
> It dilates the vessels and creates discomfort.
> In contrast, the mixture of beer and lemon juice or citric acid helps.
> Beer drinking creates "malicious body fluids," which are good for people with hot "complection" and for young people, especially during hot weather and in hot countries.

In 1614, the philosopher and alchemist Paracelsus wrote: "Cerevisia malorum divina medicina" (Beer is a divine medicine against harms) (Rätsch, pp. 12–14). Beer was also used as a carrier or solvent for many different folk remedies (Rätsch, pp. 28–40). The use of herbs and spices, such as hops and sweet gale, in beer may well have its origin in folk medicine.

Interestingly, beer is still prescribed today in the United Kingdom as a medication for the elderly.

See also **Alcohol**; **Fermentation**; **Fermented Beverages Other than Wine or Beer**; **Wine**.

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BEETON, ISABELLA. Isabella Beeton (1836–1865), author of *Beeton's Book of Household Management*, was born at 24 Milk Street, Cheapside, London, as Isabella Mary Mayson, one of four children of Benjamin and Elizabeth Mayson. Isabella was educated at Heidelberg, Germany, and became an accomplished pianist.

When she returned from Germany, and while visiting family and friends in London, she met the wealthy publisher Samuel Orchart Beeton. Samuel Beeton, a publishing genius, possessed a talent for capitalizing on Victorian market trends. Part of the new and prosperous middle class, he published popular literature and *Beeton's Book of Garden Management* and *Beeton's Book of Universal Information*. Isabella and Samuel were married on 10 July 1856 and settled in the London borough of Harrow.

Their marriage was a fruitful professional collaboration: He was enthusiastic and creative, while she was a meticulous, level-headed researcher with an eye for detail. Beeton encouraged Isabella to compile her recipes and household management tips into articles written for *The Englishwoman's Domestic Magazine: An Illustrated Journal Combining Practical Information, Instruction, and Amusement* (*EDM*). She eventually assumed editorial responsibilities for *EDM*, and also for the Beetons' new journal, the *Queen*. She was soon working regularly at Samuel's office at the Strand, in an era when very few women worked in an office. While writing and editing for Samuel's magazines, and despite the loss of her first child, Isabella was already researching and gathering data for her magisterial work, *The Book of Household Management*. She also found time to open a soup kitchen at her house in the winter of 1858 to feed the poor children of Hatch End and Pinner.

According to Nicola Humble, the editor of the 2000 edition of *Mrs. Beeton's Book of Household Management*, the book remains one of the great unread classics of our time, though a highly collectible one. Published in October 1861, *Mrs. Beeton's Book of Household Management* (*BHM*) sold 60,000 copies and nearly 2 million by 1868. Originally published as monthly supplements in *EDM*, the first installment appeared in September 1859 when Isabella was twenty-three.

The *BHM*, as Humble notes, is much more than a cookery book. Its comprehensive range of recipes and household management techniques (2,751 entries) speaks to a culture that was caught up in the social changes of mid-nineteenth-century urban England. The *BHM* is also a sort of window into the Victorian social life of kitchens and household, giving all manner of instructions on etiquette, on the handling of servants, the economic spaces of kitchens, child rearing, medical advice, and animal husbandry. The book is also noted for some famous maxims, including, "A place for everything and everything in its place." Isabella Beeton herself never claimed that the recipes were original, and her preface acknowledges correspondents from Great Britain and Europe for their ideas. She adapted recipes from Alexis Soyer's *Modern Housewife* and Eliza Acton's *Modern Cookery for Private Families*, and, though she cites Soyer, she does not give credit to Acton. What Isabella Beeton did do was test the recipes herself, and any recipe she found uneconomical, impractical, and difficult, she discarded. If she was not an original cook, she was supreme in her organizational skills, arranging the recipes in alphabetical order, listing estimated costs, and producing clear, concise instructions for all food preparation and cooking as modern cookbooks do. It is worth noting that the *BHM* is not the first of its kind, and that Hannah Glasse's *The Art of Cookery Made Plain and Easy* (1747) also included household improvement tips and simplified cooking techniques.

Isabella Beeton became ill after the birth of a child, and died of puerperal fever at age twenty-eight—but not before completing the editorial work on *Mrs. Beeton's Dictionary of Cookery*. Samuel Beeton died of tuberculosis twelve years later, in June 1877. The Beetons are remembered by a road, Beeton Close, near their old home at Hatch End, which was bombed out during a German air raid in September 1940. The *BHM* has since been reprinted numerous times, and Isabella Beeton's life has been turned into the one-woman show *Bella* by Alison Neil and adapted for BBC radio in 2002 by Tony Coult.

See also **Cookbooks**.

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BELGIUM. *See* **Low Countries.**

BERIBERI. Beriberi is a disease that usually begins with a loss of feeling in the feet and then weakness and pain in walking. In many, but not all, cases the body then becomes swollen and in the most serious cases the heart begins to fail, and the patient becomes breathless and soon dies. The problem stems from an insufficient intake of the vitamin thiamin (or "thiamine") even though we require each day only about 1 milligram, which is equivalent to one 32,000th of an ounce. The word "beriberi" comes from Indonesia and may mean "weak" or "swelling," but there have been many other suggested meanings.

The disease used to be a serious problem in Far Eastern countries where white rice was the staple food and people ate only small quantities of supplementary foods. Husked rice grains provide a reasonable amount of this vitamin, but further processing, or "polishing" to rub off the bran and germ, removes most of the remaining thiamin. Washing the grains and boiling them leaves even less thiamin in the final cooked food. Unfortunately, brown (unpolished) rice goes rancid more quickly under tropical conditions and so has only a short storage life. In traditional peasant communities, where enough paddy (unhusked grain) would be pounded and winnowed each morning for the day ahead, this was not a problem. When inexpensive power machinery for milling and polishing rice was developed, this made the provisioning of the armed forces in particular much more convenient, but in Japan and other Asian countries it was followed by serious outbreaks of beriberi in the army and navy.

Infantile beriberi also has been a major cause of death among breast-fed infants in the Philippines and other communities where mothers are in a state of borderline, subclinical thiamin deficiency. Affected infants typically cease to pass urine and experience difficulty in breathing. Even those near death, however, respond dramatically to a dose of thiamin.

It is technically possible now to mix in with white rice a few vitamin-rich pellets manufactured to resemble rice grains. However, where rice-growing communities each have their own small village mill, it has been found impracticable to control such additions, which slightly increase the millers' costs. As an alternative, communities at risk can be supplied with inexpensive vitamin pills.

In developed countries thiamin deficiency is still a problem among alcoholics, partly because such addicts have highly abnormal diet patterns and partly because they seem to absorb the vitamin less efficiently. They also may show acute heart problems without any early symptoms of traditional beriberi. A small proportion progress to a syndrome with irreversible brain damage that requires indefinite hospitalization.

In many Western countries, millers are required to fortify white wheaten flour with thiamin (along with other micronutrients). Thus, even the population groups, such as alcoholics, who are eating an unbalanced diet are less likely to become deficient. It also has been suggested that alcoholic drinks should be fortified with thiamin. This would not be prohibitively expensive, but authorities have felt that, on balance, it would be undesirable because it would allow them to be marketed as "health drinks" despite the injurious effects associated with or caused by alcohol consumption, that is, automobile accidents, disruption of families, and a wide range of health problems.

See also **Dietary Assessment**; **Dietary Guidelines**; **Disease: Metabolic Diseases**; **Rice: Rice as a Food**; **Rice: The Natural History of Rice**; **Vitamins: Overview**; **Wheat**.

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BERRIES. Wherever humans have lived, berries have been a part of their diet. Most of these have never developed beyond local markets but some have become globally important crops. Historically, berries were eaten fresh or processed into dried or fermented products. Many descriptions of indigenous American culture describe smoking and/or drying berries that are mixed with some sort of meat product to form Pemmican. As sugar became commonly available as a preservative, jams, preserves, and jellies became popular. With the development of the canning industry in the late 1800s, the freezing industry in the mid-1900s, and the global transportation system in the late 1900s, long-distance distribution and long-term storage began to spread a handful of berry crops throughout the world. Today, in any large grocery, fresh berries are available year round. Whereas berries used to be found only in the fresh produce and dessert sections, they are now found in every section as well as in the adjacent health food store as a nutritional supplement and in the liquor store as wine and distilled spirits. Historically, berries were welcomed as a pleasing and nutritious addition to a drab table. While this has not changed, the increased value placed on nutraceutical foods is likely to expand berry consumption even further. (Nutraceutical foods, also called functional foods, are foods that provide a medical or health benefit beyond the traditional nutrients they contain.)

Market globalization has led to the development of a group of major crops, often at the expense of still popular regional crops. This discussion is largely limited to the most economically important and well-known temperate "berry" crops that are produced on a shrub or a perennial herbaceous plant, including: strawberry (*Fragaria* X *ananassa*), blueberry (*Vaccinium corymbosum* and *V. angustifolium*), cranberry (*V. macrocarpon*), black currant (*Ribes nigrum*); red raspberry (*Rubus idaeus*), black raspberry (*Rubus occidentalis*), and blackberry (*Rubus* sp.).

Strawberry (*Fragaria*)

Plant biology. The cultivated strawberry (*Fragaria* X *ananassa*) is a low-growing, herbaceous perennial in the rose family (Rosaceae). Trifoliate leaves are produced from a crown as are the flowering trusses and runners. The hermaphroditic (both sexes present) flowers have white petals with many stamens surrounding a pistil-covered receptacle. The showy flowers are insect pollinated. Following successful pollination and fertilization, the achenes (seeds) set, and the receptacle tissue below the achenes swells and ripens. The crown also produces runners, which are elongated stolons that can root and form new "daughter" plants.

History. Strawberries are believed to have been cultivated in Greek and Latin gardens and they were mentioned by Pliny the Elder (23–79 C.E.) in his *Natural History*. Darrow reprints many examples of the use of strawberry in Christian religious art of the 1400s. The "*X*" in the Latin name for the cultivated strawberry, which indicates that it is a hybrid between two species, points to its interesting background. The Mapuche and Huilliche people of Chile were cultivating the native *F. chiloensis* at the time of the Spanish conquest in the mid-1500s and the plant was counted by the Spaniards as a spoil of war that they carried north into Peru and Ecuador. In 1711, Amédée François Frézier was commissioned by King Louis XIV of France to sail to Chile on an intelligence mission. In addition to mapping and observing Spanish activities, he explored the botany of the region. Five plants from Concepción survived the six-month voyage back to France in 1714. Frézier did not realize that the wild species are largely dioecious (separate male and female plants) and he had only collected female plants. As a result, these Chilean treasures were very uneven in their performance, producing little if any fruit in France. After many years of observation, gardeners realized that the plants were productive when grown with *F. virginiana*, the meadow strawberry, which the Europeans brought back from their colonies in eastern North America. Regardless of whether the hybridization of these two American species in France was intentional or happenstance, the result was the cultivated strawberry.

Fragaria chiloensis, the beach strawberry, ranges from Alaska to the central California coast in North America and Chile, primarily on dunes within the fog zone adjacent to the Pacific Ocean. *Fragaria virginiana* ranges throughout much of temperate North America except for the drier regions. New germ plasm (wild representatives of a species) from these two species have been used over time to introduce new traits into the cultivated strawberry and, in one case, this led to a revolution in the industry. While most strawberries produce flower buds in response to the shortening days of late summer and go on to fruit the following spring, one population of *F. virginiana* from the Wasatch Mountains in Utah was found in the 1960s that, when grown in California, flowered and fruited regardless of day length. This "day-neutral" trait was incorporated into commercial cultivars and allows for nearly year-round production of fruit throughout the world.

The *Witte Hollander* or White Dutch Currant, one of the oldest strains of white currants surviving from the late 1600s. It was developed in Holland and introduced into English and American gardens in the 1720s. ROUGHWOOD SEED COLLECTION, PHOTO WILLIAM WOYS WEAVER.

Production, processing, and distribution. California is the most important production area in the world, and cultivars and production techniques developed there are commonly used throughout the world. Strawberries for the wholesale fresh market are grown on fumigated soils with plastic mulch and drip irrigation. The plants are primarily grown as an annual crop. Fruiting begins about two months after planting and continues for seven to nine months, after which the plants are removed. Fresh market strawberries are harvested directly into plastic clamshell packages that are then shipped under refrigeration. Strawberries for the processed market are either a by-product of the fresh market, that is, those that are too small or malformed, or they are harvested from cultivars specifically designed for the processed market. Processing cultivars have intense color and flavor, and maintain their integrity after processing. Strawberries are canned and dried but the primary raw processed products are as frozen IQF (individually quick frozen) berries, sugar and sliced packs, purees, or as juice. A tremendous diversity of consumer products are made from these primary raw products.

Strawberries, as with most berries, once had to be consumed locally due to perishability; however, with improved cultivars, production practices, packaging, and transportation, fresh fruit can be shipped long distances from the growers' fields.

Strawberries are a valuable source of vitamin C, fiber, folic acid, and anthocyanins (red pigment). Anthocyanins have been recently recognized for their nutraceutical benefit as antioxidants in human nutrition.

Red Raspberry, Black Raspberry, Blackberry, Caneberry, Bramble (*Rubus*)

Red (*Rubus idaeus*) and black raspberry (*R. occidentalis*), and blackberry (many diverse *Rubus* species), are the most important crops in the genus *Rubus*. In addition, some of the hybrids between red raspberry and blackberry such as "Boysen" and "Logan" and other species such as the cloudberry (*R. chamaemorus*) in Scandinavia, the wineberry (*R. phoenicolasius*) in Japan, the mora (*R. glaucus*) in Andean South America, and the trailing raspberry (*R. parvifolius*) in Asia have become regionally important crops. As a group, these species are often referred to as "caneberries" or "brambles."

Plant biology. Members of the Rosaceae discussed above have perennial root systems and biennial canes. With one exception, these biennial canes are vegetative the first year (primocanes) and produce fruit the second year (floricanes) before dying. The primocane/fall fruiting raspberries and, in the near future, blackberries are the exception, as they flower and produce fruit late in the season on first-year canes. Floricanes break bud in the spring and produce flowering branches with many insect-pollinated flowers. Flowers have white or light pink petals with a ring of many stamens that surround a pistil-covered receptacle (also called torus). After pollination and fertilization, each of the individual ovaries develops into a drupelet, which collectively form the aggregate fruit. Raspberries are differentiated from blackberries based on whether the torus remains on the plant when the fruit is picked (raspberries) or whether it is picked with the fruit (blackberries).

Raspberry history. Red raspberry is native throughout the colder temperate regions of the Northern Hemisphere and black raspberry throughout the midwestern and mid-Atlantic regions of the United States. The first red raspberries were introduced into cultivation in Europe about 450 years ago, according to Hedrick, and European cultivars were brought to North America prior to 1800. Black raspberries were commonly picked from the wild in North America and the first named cultivars began appearing in the 1850s.

Red raspberry. While raspberries today are grown throughout the world in temperate regions, their production is concentrated in eastern Europe and the Pacific Northwest of North America. Berries from these two regions are primarily processed as IQF, purees, or juice, and these basic raw products serve as the basis for innumerable consumer products. Trellised, irrigated, long-term, perennial plantings that are mechanically harvested are standard for the processing industry. Production for the fresh market is evolving rapidly, with California and Mexico as the production centers for the Americas and Germany in Europe. Chile, New Zealand, and Australia are the major suppliers of fresh fruit during winter in the Northern Hemisphere. For the fresh market, plants are grown either in a perennial system or, as in California, for one and a half years, during which two crops are produced, and then the plants are removed. Fruit for the fresh market are hand-picked and generally produced under protective plastic hoop structures.

Black raspberry. While there are many scattered small plantings of black raspberries throughout North America to serve local fresh market needs, the bulk of the industry is concentrated in Oregon's Willamette Valley. Black raspberries are grown in hedges about one by one meter in short-term (three- to four-year) perennial plantings that are machine harvested. While some black raspberry jam is produced, the berries are primarily processed as juice and often used as a natural colorant.

Blackberry. Blackberries are native throughout Eurasia and the Americas, although the primary commercial cultivars were developed from species native to North America. Erect and semierect cultivars were derived from eastern North American species and these can be characterized by being upright-growing, firm-fruited, large-seeded, and more suitable for the fresh market than for processing. These types are generally grown in small, long-term, perennial plantings throughout the United States, with a higher concentration of acreage on the western coast of the United States. For the processing market, the trailing blackberry cultivars, particularly "Marion" (often called Marion berry), are grown in long-term, trellised plantings that are harvested by machine for the processing market. This industry is concentrated in Oregon's Willamette Valley, although Mexico is expanding production. Fruit is processed as IQF, purees, and juice, and these are used to produce many consumer products.

Variations in regional demand. Demand for the various types of caneberries shows marked geographical trends. Since the caneberries have always been picked from the wild near where people have lived, there are many small but regionally significant industries that have developed around these crops. While red and black raspberry and blackberry dominate the worldwide market, travelers in Andean South America or Scandinavia will find an abundance of products made from the regionally grown mora or cloudberry, respectively. In North America, the region where one grew up often influenced what kind of caneberry one preferred, with southerners preferring blackberry and northerners preferring red raspberry.

Uses and nutrition. Until the late part of the 1900s, raspberries and blackberries were primarily used to make jams and jellies or desserts. Now these crops have been incorporated into myriad products that require juices. Blackberries and raspberries are an excellent source of vitamin C, calcium, fiber, iron, and folic acid. The increased interest in nutraceutical products focuses special interest on these crops. While blueberries and cranberries have been touted for their proven health benefits, the anthocyanins (pigments that give the fruits their red and purple colors), which are powerful antioxidants, are even more concentrated in blackberries and raspberries, especially in black raspberries.

Blueberry, Cranberry, Lingonberry (Vaccinium)

Plant biology. Blueberry, cranberry, and lingonberry are all long-lived perennial crops in the Ericaceous family. These crops were originally native to acidic and moist soils with high organic matter levels in cool temperate regions of the Northern Hemisphere. Blueberries are upright-growing plants with long-lived perennial canes. Highbush blueberry (*Vaccinium corymbosum*), native to the eastern United States, is a shrubby, crown-forming bush (1–2.5 m) and is the basis for most of the cultivated blueberry industry. Lowbush blueberry (*V. angustifolium*), native to the northern United States and southern Canada, is a small bush (0.5 m) that spreads by underground stems. Managed wild stands of the lowbush in eastern Canada and eastern Maine are the basis for the "wild" blueberry industry. Cranberry (*V. macrocarpon*) is a creeping plant that produces fruiting uprights and is native to boggy areas of the northern United States and southern Canada. Lingonberry (*V. vitis-idaea*) is a short-statured (0.3 m) plant that spreads by underground stems, and while it is found circumboreally, it has been primarily developed into a crop in Scandinavia and northern Europe.

Blueberry. Blueberries produce clusters of hanging bell-shaped white or light pink flowers in the spring. The insect-pollinated flowers swell to form a true berry that contains many very small seeds. When ripe, the fruit have a bluish black skin covered by a waxy bloom that gives them their bright blue appearance.

Blueberries are truly an "all-American" crop, as they were native to this continent, developed as a crop on this continent, and, until the late 1900s, were not well known outside of this continent. In the early 1900s, a grower in New Jersey began to work with the U.S. Department of Agriculture (USDA) to develop improved blueberries. From these modest beginnings, the USDA went on to release all of the cultivars, which led to highbush blueberries' rise from a little-known "swamp plant" to one of the most important berry crops worldwide. While lowbush blueberries have not been changed by breeding, the production practices have become highly developed since the first Europeans harvested the expanses of mixed lowbush blueberry and forest lands in Maine and eastern Canada that Native Americans had harvested for generations.

Highbush blueberry production is concentrated in North Carolina, New Jersey, Michigan, and the Pacific Northwest, and the much smaller European industry is primarily in Germany and France. Chile, New Zealand, and Australia are major suppliers in the winter months in the Northern Hemisphere. Today plants are grown on ridged plantings, with irrigation and pest control, and they are harvested by machine for processing markets. The berries for the fresh market are harvested, cooled, packed in plastic clamshells, and shipped around the world. Fresh blueberries are often stored for up to two months in a controlled atmosphere.

Early growers and commercial canners recognized that if they burned their "wild" lowbush fields every other year, they could more easily harvest the abundant fruit in the intermediate year. Field burning not only managed growth, but it eliminated many of the competing plants, insects, and diseases. While lowbush blueberries were never planted by man, they are really no longer "wild" since the larger commercial operations are intensively managed, as are the highbush blueberries. Lowbush blueberries are harvested by hand with rakes and, where the ground surface area permits, by machines for processing.

Lowbush and highbush blueberries are processed as IQF, purees, juice, and dried products. One of the reasons that blueberry consumption and production rose so dramatically at the end of the twentieth century was their suitability for many processed products (for example, they have no noticeable seeds or pits, they blend well with other products, and their flavor is not intense so they can be used very widely).

Blueberries are an excellent source of vitamin C and fiber. Anecdotal stories from World War II attributed the supposedly better night vision of British pilots to their consumption of bilberry (V. *myrtillus*) jam. Decades later, in the 1990s, the benefits of bilberry to the health of microcapillaries and as a powerful antioxidant were documented by medical research. Subsequently, blueberry, which is more readily available for mass consumption than bilberry, was studied and was found to have a similar chemical constituency, although sometimes at a lower concentration than in bilberry.

Cranberry. Cranberry, originally called "craneberry" by early immigrants to North America due to the shape of the flower, was used by Native Americans as a food, a medicine, and a dye long before Europeans arrived. Native to northern temperate areas from Minnesota to the Atlantic Ocean, cranberries were first cultivated in Massachusetts in the early 1800s. While many cultural changes have improved production, most of the cultivars grown today are selections from the wild or superior plants found in growers' bogs. Bog establishment is a very expensive process that involves land leveling, water system management, soil amendments, and diking. Since the development of wetlands is tightly regulated in North America, establishing new bogs there is becoming increasingly difficult. The vining plants produce uprights that produce flowers. With insect pollination, the flowers are fertilized and the fruit develop. In early fall, the fields are flooded and specialized machines beat the fruit off the plant where they can float to the surface and be skimmed off into trucks. While many have the image of cranberries growing in water, they are actually not tolerant of flooding for extended periods, so fields are drained immediately after harvest. For commercial bogs in very cold climates, water is layered into the fields in early winter, and after each layer freezes, another is added, eventually covering the plants and protecting them from the harsh climate. Fruit is primarily processed into juice. A small portion of the crop is sold fresh for the Thanksgiving and Christmas holiday season, and there is a growing market for dried, sweetened cranberries ("craisins"). Cranberries have a long association with holidays, particularly American Thanksgiving. In 1959, just before the holiday season, a pesticide scare swept the United States, closing all outlets for fresh cranberries, and much of the crop was dumped. This disaster further spurred the development of a wider variety of products. The Ocean Spray growers cooperative, formed in the 1930s, did a remarkable job of expanding cranberry demand in the late 1900s, particularly through their well-known fruit juices.

Cranberry juice has been a well-known home remedy for women seeking relief from yeast infections in their urinary tract. In the 1990s, medical research documented that consumption of cranberry juice could cure yeast infections. In addition, cranberries are a rich source of vitamin C, fiber, and anthocyanins, which are powerful antioxidants.

Lingonberry. Lingonberries have always been closely tied with the people of Scandinavia and northern Europe, where much of the commercial crop is still harvested from wild stands. When cultivated, the plants are established in rows that fill in quickly with growing underground stems. Two crops are produced in long season areas; the summer crop is usually not harvested, but the fall crop is harvested for holiday sales. While machines are being developed to harvest lingonberries, hand raking is still the predominant method of harvest. Lingonberries most often remind people of a "mild" cranberry. As such, they can usually be used in similar applications to fresh cranberries and are popular as preserves and relishes.

Black Currant, Gooseberry, Red Currant (Ribes)

Gooseberries and currants are members of the Saxifrage family that have been prized in Europe and Russia for centuries but have not developed a strong market elsewhere. Gooseberries and red currants have very interesting histories, but their production is tiny compared to black currant and they will not be discussed in detail. Part of the reason that currants and gooseberries have not developed a following in the United States is that growing them has been banned in many states, as they are an alternate host for white pine blister rust, which can be devastating to the white pine timber trade.

Plant biology, history, and production. These crown-forming, long-lived perennial shrubs produce their fruit on woody, one-year-old, smooth canes (gooseberries have thorns). Buds along the cane produce strigs that have from eight to thirty flowers in the spring. The flowers are not showy, typically light green or yellow colored, but are attractive to insects for pollination. Black currants (*Ribes nigrum*) are native to the cooler regions of Eurasia and can tolerate extremely cold winter temperatures. Despite being found in close association with humans for a long time, they were largely used as a medicinal plant until fairly recently. Hedrick quotes an herbal from 1633 that says black currants are "of a stinking and somewhat loathing savour."

Uses and nutrition. Beginning in the 1900s, juice products from currants were developed, the most famous being Ribena, as it was recognized that the high vitamin C content of black currants could be maintained when juiced. In a sense, black currant juice has been to Europeans what orange juice was to Americans. In addition to vitamin C, black currants are a rich source of antioxidants, vitamin A, and calcium. Black currants are grown almost exclusively for processing as juice. Plants, primarily cultivars developed in the United Kingdom or Russia, are cultivated in hedgerows that are mechanically harvested. Fruit is bulk frozen and then juiced.

Lesser-Known Crops

As was first mentioned, wherever humans have lived they have made berries a part of their diet, and as such there are innumerable berries not mentioned here that are part of the human diet. Some examples of other berries that have generated renewed or new interest, in addition to red currant and gooseberry, include aronia (*Aronia melanocarpa*), elderberry (*Sambucus nigra/S. canadensis*), sea buckthorn (*Hippophae rahmnoides*), juneberry/serviceberry/saskatoon (*Amelanchier* sp.) and edible honeysuckle (*Lonicera caerulea*) (Finn). However, unless they have unique characteristics, such as high nutraceutical value, they are unlikely to significantly impact the production and consumption of the major crops.

See also **Fruit; Nutraceuticals; Pesticides; Wine.**

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Chad Elliott Finn

BETTY CROCKER.

Betty Crocker, an American cultural icon, was created in 1921 by the advertising department of the Washburn Crosby milling company just before it merged with General Mills. The consummate homemaker who could answer any cooking question with ease, Betty Crocker was based upon several real women, the two most notable being home economists Janette Kelley and Marjorie Child Husted.

Neither her name nor her face, which has been updated numerous times, was real. Both, however, became synonymous with good cooking and competent homemaking through newspaper columns, radio programs, television spots, and the publication of over 150 cookbooks. Betty Crocker's most significant contribution came in 1951 with the publication of *Betty Crocker's Picture Cookbook*, which remains a top-selling cookbook today. Unlike the extremely thorough *The Joy of Cooking* by Irma Rombauer, *Betty Crocker's Picture Cookbook* helped women cook by including both large illustrations and recipes on one page.

Betty Crocker's image and what it represents has created an automatic acceptance by consumers of numerous General Mills products from breads to cake mixes. Perhaps more important, her icon status has given her an active role in American life. Betty Crocker has helped generations of American women over the years deal with challenges including food scarcity during the Depression and World War II, a renewed emphasis on homemaking in the postwar years, and the increasing sophistication of American taste. From cutting food costs to increasing women's satisfaction through cooking to adding new ingredients to update old recipes, Betty Crocker continues to keep her finger on the pulse of American life and to respond accordingly.

See also **Advertising of Food; Baking; Cake and Pancake; Cookbooks; Cooking; Marketing of Food**.

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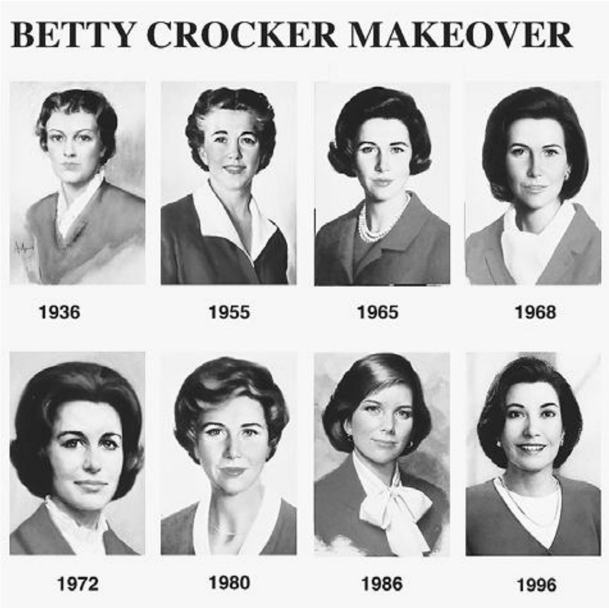
Erika A. Endrijonas



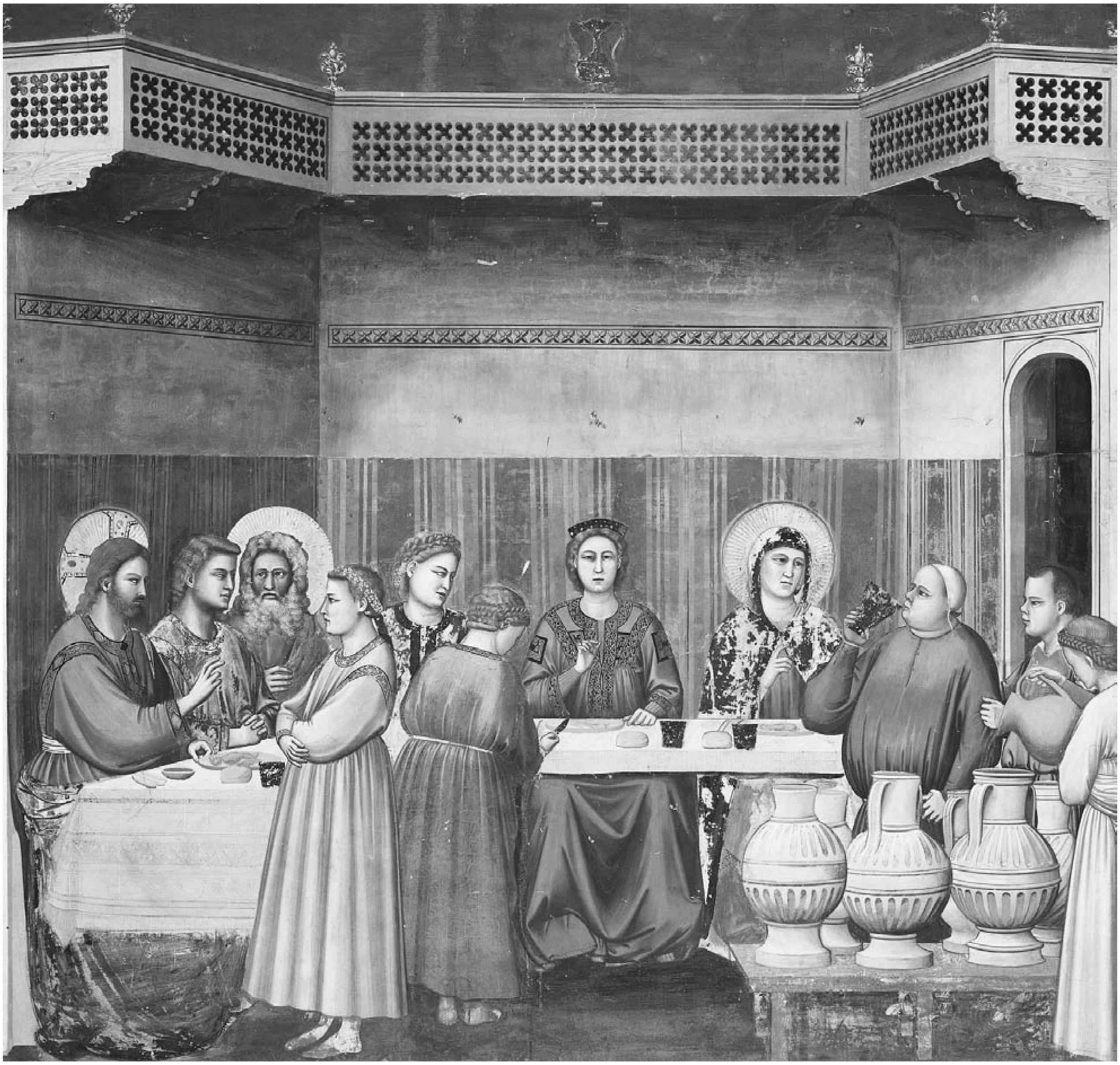
General Mills created Betty Crocker in 1921 as a kind of mother figure to promote the company's food products. Over the years, Betty has undergone a number of makeovers to keep her in tune with changing perceptions about homemakers and cooking. These eight pictures show how she has changed since 1936. One thing has remained consistent: she is always dressed in red. © AP/WIDE WORLD PHOTOS.

BIBLE, FOOD IN THE.

Food and drink are everywhere in the Bible. Among the best-known scenes are the Last Supper (Mark 14:17–25; Matthew 26:20–29; Luke 22:14–23; John 13:1–14, 13:31), the feeding of the five thousand (Mark 6:30–44, 8:1–10), the feast for the lost son (Luke 15:11–32), and the wine miracle in Cana (John 2:1–12) from the New Testament and the first Pesach meal in Egypt (Exodus 12:1–13, 12:16); Abraham's sacrifice of Isaac, for whom a wild goat was substituted (Genesis 22:1–19); the manna in the desert (Exodus 16:31–35); and the recurring mention of the land flowing with milk and honey from the Old Testament. The function of food in the Bible is twofold. First, it offers information on what was produced and consumed in the area in biblical times, including how food was prepared and its meaning; second, it conveys messages to the reader.

Attitudes toward Food in the Bible

Scientific interest in food in the Bible always has focused on, among other things, sacrifice and abominations (Bolle; Bourdillion and Fortes; Douglas; James; and Smith). The biblical sacrificial animal is rarely burnt entirely, as indicated in the descriptions of some specific sacrifices in Numbers 28 and 29 or Abraham's sacrifice. The majority of a sacrifice is consumed either by those who offer the sacrifice or by the priests (1 Samuel 1–2). Each food offering (the meat) is accompanied by a grain offering (flour and olive oil) and a drink offering (preferably wine,



One of the most popular food scenes in the Bible is the Marriage of Cana, which has allowed Christian artists down through the centuries to employ their creative talents on imagery drawn from their own life experience. Italian Renaissance painter Giotto di Bondone (d. 1337) created this dinner scene as it would have appeared in a nobleman's house around the early 1300s. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

but in some cases beer is acceptable) (Numbers 28–29). Sacrifices, usually offered at feasts, distribute precious animal protein evenly among the population and over time. A feast occurs on each new moon, and others follow in the middle of at least every second month.

The nature of the sacrifice follows the rules of purity described in Leviticus. No restrictions apply to the consumption of plants, but elaborate rules govern animal food. Animals are divided into three groups: animals on land, creatures in the water, and birds. Of these only a small sample are considered clean: "You may eat any animal which has a parted foot or a cloven hoof and also chews the cud; . . . all those that have fins and scales," and birds with two legs who fly and do not eat carcasses (Leviticus 11). The purity rules conform with the animals well adapted to the local climate and easily domesticated. Furthermore the food taboos keep the Israelites distinct from other peoples of the region, supporting their group identity. When Christianity starts to convert other peoples, the strict food rules become an obstacle and therefore are removed. According to Acts 10 it was revealed to Peter that nothing is unclean.

Meat is always in the foreground of biblical narratives on food, and it is the highly esteemed center of any festive meal, religious or secular. During their wanderings in the wilderness, the Israelites yearn for the fleshpots of Egypt (Exodus 16:2); in 1 Samuel 2:12–17 the priests demand a piece of good roast from the sacrifice instead of being content with whatever their forks catch from the cauldron; it is a sign of honor to be fed a piece of meat by the host (1 Samuel 9:23); and meat is essential to a covenant. Nevertheless, the staples are cereals (barley, wheat, emmer, spelt, millet, and sorghum). Barley, the most important, is mainly consumed as grits (porridge); wheat is valued higher and is baked into bread. The highly valued fruits include olives for oil, which is easy to store, and dates, which provide energy. Vegetables (leek, orache, onion), pulses (fava bean, pea, lentil, chickpea), fruits (apple, fig, pomegranate, melon, mulberry, grape), and herbs and spices (cassia, cinnamon, coriander, cumin, dill, garlic, ginger, laurel, mint, mustard, saffron, turmeric) are abundant.

Situations of Consumption

Among the most prominent situations for consuming specific foods are feasts, covenant meals, carouses, and fasts. The majority of religious feasts consist of the sacrifice of animals—usually birds, sheep, goats, or cattle, depending on the means of the family—and the communal meal of the family. The important religious feasts are Pesach (Passover), Massot (Feast of Unleavened Bread), Shavuot (Pentecost), Rosh Hashanah (New Year), Yom Kippur (Day of Atonement), Succoth (Feast of Tabernacles), Hanukah (Festival of Lights), and Purim (Feast of Lots). Life-cycle festivals mentioned in the Bible include weddings, birthdays, and burials. For the wedding of Jacob and Leah, "Laban gathered all the men of the place together and gave a feast" (Genesis 29:22); when Samson marries, the party lasts seven days (Judges 14:12); Raguel tells his wife Edna "to bake a great batch of bread" and has two oxen and four rams slaughtered for the two weeks of celebrating the marriage of Tobias and Sarah (Tobit 8:20); Jesus compares heaven to the wedding feast of a king's son (Matthew 22:1); the wedding party at Cana-in-Galilee runs short of wine, and Jesus turns water to wine (John 2:1–12). The only birthday party mentioned in the Bible is the Egyptian pharaoh's, which turns out to be the day of destiny for the chief baker and the chief butler when one is hanged the other restored to his service (Genesis 40:20). The bread to console and the cup of consolation are the frugal nutrients for mourners, who often refuse to eat and drink for a short time after the death of a beloved or fast for a longer period to display their mourning.

The covenant meal as a pact between people or between God and his followers is a recurrent theme. This meal makes the oath binding forever by threatening the partners' bodies with a curse. In case of perjury, the curse "may seep into his body like water and into his bones like oil" (Psalms 109:18). God's covenants with Abraham and Moses are sealed by the ritual slaughtering of several animals (Genesis 15; Exodus 24). When Jacob leaves Laban's home, they swear an oath regarding the respective territories and have a feast with their kinspeople (Genesis 31:43–54). Joseph is sold to the passing tradesmen while his brothers "sat down to eat some food" (Genesis 37:25). Sharing provisions with the inhabitants of Gibeon, Joshua settles a pact with the Gibeonites (Joshua 9:14–15). Those who share a meal are obligees, but they frequently betray each other (Psalms 41:9; Proverbs 23:7; Mark 14:18). The New Covenant is made at the Last Supper (Matthew 26:17–30; Mark 14:12–26; Luke 22:7–39; John 13:1–30).

Biblical authors highly value wine and beer but oppose any abuse. Nevertheless, carousals are frequently mentioned and are often connected with licentiousness. Lot's two daughters intoxicate their father with wine "and then lie with him" (Genesis 19:32). The author of the book of Ecclesiasticus (also known as Sirach) dissuades a man from sitting with a woman and drinking wine (Ecclesiasticus 9:13). Holofernes wants to dine with Judith and intends to seduce her. When he drinks too much, he falls asleep, and Judith decapitates him (Judith 12–13).

Important figures like Moses, Jesus, and Paul fast at times of particular spiritual, psychological intensity.

THE STORY OF JUDITH

The story of Judith in the book of Judith exemplifies the meaning the Israelite society accorded to food. The behavior of the two protagonists presupposes their respective fates. Judith, the shining heroine who finally saves the Israelites from the Assyrian siege, always does the right things. She fasts except on religious feasts, she only eats pure food, and she is never drunk. On the other hand Holofernes, the commander in chief of the Assyrian army, is a glutton and drunkard who gives dinner parties every day. This is the starting point for Judith's project to rescue her people. She goes to Holofernes's tent dressed in her best clothes and prettily adorned, but she sits at her own table and consumes her own pure food, only pretending to be his guest. Holofernes is blinded by the beauty of the Israelite lady and does not realize she is not truly participating in his party. He eats and drinks until he is so drunk he is incapable of seducing her. When he falls asleep, Judith cuts his head off. Deprived of their leader, the Assyrians withdraw, and Judith is celebrated as the savior of the Israelites.

Moses abstains from eating and drinking for forty days before he climbs up Mount Sinai to bring down the Ten Commandments (Exodus 34:28; Deuteronomy 9:9). These forty days recur in the New Testament when Jesus goes to the desert before he starts to preach (Matthew 4:2–11; Mark 1:12–13; Luke 4:1–13). The Christian interpretation is that everything Jesus says afterward is comparable to Moses' commandments. Paul fasts as a sign of a new beginning after his conversion (Acts 9:9). Whenever the Israelites are at war, they proclaim a general fasting (Judges 20:26; 1 Samuel 14:24–32; 2 Chronicles 20:3; Ezra 8:21–23; Esther 4:15–16; 1 Maccabees 3:46–60). The mourner refuses to eat (Genesis 49:10; Numbers 20:29; 2 Samuel 1:12, 3:35). The preparatory fasting before a religious feast is meant to purify the individual and the community (Leviticus 16:29, 23:26; Numbers 29:7; 2 Kings 25:4–8; Zechariah 7:5, 8:19).

Preparation of Food

On most biblical occasions it is the women's domain to prepare food. They pound the grains in mortars or use hand mills (Numbers 11:8). From barley they prepare the grits (Leviticus 2:14), sometimes after roasting the barley (Ruth 2:14). They grind the wheat and then bake bread, cake, or biscuits (Genesis 18:6; Leviticus 2:2; 1 Kings 5:2). Bread is leavened or unleavened (Exodus 12:15; Numbers 9:11; Deuteronomy 16:2; Joshua 5:11). Butter and cheese are made from the milk of cows and sheep (Genesis 18:8; 2 Samuel 17:29; Isaiah 7:22). Meat is boiled in a cauldron (1 Samuel 2:13) or roasted on a fire and seasoned with herbs and spices (Exodus 12).

Meanings of Food in the Biblical Text

Food is integral to communicating the biblical message. Food characterizes situations and persons, and it structures and marks the dramatic development of the text. Metaphors frequently consist of gastronomic terms, and many of Jesus' parables are connected with food. Two important culinary fantasies active in modern texts or imaginations are Cockaigne and cannibalism.

Naming is a simple way to convey something about a person. Biblical figures often have figurative names, many derived from food. Adam, the ancestor of all humankind, is made "from red clay," a soil good for growing certain crops. Adam is described in a close relationship to agriculture, and the moment he leaves paradise he starts farming: "So the Lord God drove him out of the garden of Eden to till the ground from which he had been taken" (Genesis 3:23). Names like Leah, Rachel, Rebecca, Egla, and Tamar express the qualities of the women bearing them. Leah, which means "cow," and Rachel, which means "mother sheep," become the mothers of the twelve tribes (Genesis 29). Rebecca, "cow," is Isaac's wife and Jacob's mother (Genesis 24, 25, 26). Tamar, "date palm," is the name of a number of influential women from Genesis to Matthew. The women important to Israel are named after animals and plants fundamental to subsistence in the Near East, part of everyday experience, and available, tame, and reliable. They guarantee survival, and they provide milk, meat, and fruit. In contrast, women and men named after wild animals, often favorite game animals, do not play any important role in the history of Israel. Associated with sexual situations, their names indicate they are beautiful, elegant, charming, and erotic. Examples include Dishon, Epher, Tabitha, and Zibiaha, which mean "gazelle"; Hoglah, which means "partridge"; and Zipporah, which means "bird" (Genesis 36:21; Exodus 2:16–22; Numbers 12:1; Judges 11:25; 1 Chronicles 1:38; 2 Kings 12:2; Joshua 17:3; Acts 9:36–41).

A person's character is revealed in his or her good behavior at table. A negative figure is usually depicted as lacking good table manners, such as eating and drinking too much, consuming impure food, choosing a wrong seat according to the hierarchy, and general immoderateness. Frequently such people are killed, and their bodies become food for the dogs (1 Kings 14:11, 21:23; Psalms 68:24; Jeremiah 15:3). Good and ideal people eat and drink moderately. They are modest and hospitable, and they carefully choose their food and their company at table.

Feasts and fasts not only structure the year of the community and the life cycles of individuals, they also mark climaxes and happy events, for instance, when people meet after a long separation (Genesis 43:25–34; Luke 15:11–32), on the occasion of a wedding (Genesis 29:22; Judges 14; Matthew 22:1; John 2:1–12), before people part for some time (Genesis 31:54; John 13; Acts 20:7), and when a war is won (Genesis 14:17; 1 Samuel 14:32; Esther 9:17; 1 Maccabees 4:23). Plenty of food and drink is typical of every feast, often indicating that the story is over and everything went well (Judith 16:18–20; Nehemiah 8:10; 2 Maccabees 10:6). Hunger moves people from one place to another, as when Abraham moves to Egypt (Genesis 12:10), when Jacob's family does the same (Genesis 46), and when hunger brings David's pious ancestor Ruth to the family (Ruth). Fasting marks turning points, as when the sterile Hannah prays, fasts, and finally conceives Samuel (1 Samuel 1:7) when the warriors fast before the decisive battle, they will win (Judges 20:26; 2 Chronicles 20:3; Ezra 8:21–23).

The recurrent combination of "milk and honey" can be called a biblical leitmotif and is one of the best-known biblical gastronomic metaphors. Milk and honey are highly valued products, symbols of the wealth of a country. The land God promised to Abraham and his children, usually identified with Canaan, "is a land flowing with milk and honey" (Exodus 3:8, 3:17, 13:5, 33:3; Leviticus 20:24; Numbers 13:27, 14:8; 16:13–14; Deuteronomy 6:3, 11:9, 26:9, 26:15, 27:3, 31:20; Joshua 5:6; Ecclesiasticus [Sirach] 46:8; Jeremiah 11:5, 32:22; Ezekiel 20:6, 20:15). The cup is a metaphor for life or death (Isaiah 51:17–23; Jeremiah 25:15–29, 49:12, 51:7; Ezekiel 23:31–34; Obadiah 16; Habakkuk 2:15–16; Zechariah 12:2; Psalms 16:5, 23:5; Mark 10:38; Matthew 23:25; Revelation 17:4; 1 Corinthians 10:21), and the cup of the

Eucharist is the culminating point in the New Testament (Matthew 26:26–29; Mark 14:22–25; Luke 22:19–20). Psalms 23 is the poetically outstanding citation of the metaphor for the relation between Israel and God, the shepherd and his herd.

Pictures of the other world are deeply rooted in worldly experiences, of which food and eating and drinking are most important. Good and evil, heaven and hell are described with an abundance of excellent food and drink or with hunger, starvation, and cannibalism respectively. The promised land Canaan is expected to produce plenty of food, and paradise is the place without hunger. The Garden of Eden is described in contrast to the place where Adam must work hard to eat his bread (Genesis 2–3). The garden is lost forever, but after death the good will be rewarded. Job states that for the wicked the other world will not "swill down rivers of cream or torrents of honey and curds" (20:17), implying that it will for the good. The New Testament promises all those who believe in Jesus will be invited to the never-ending heavenly feast with Abraham, Isaac, and Jacob or to "the wedding-supper of the Lamb" (Matthew 8:11, 22:2–14, 26:29; Luke 12:37, 13:29, 14:15, 22:16, 22:30; Revelation 3:20, 19:9, 19:17).

If Israel conforms to the commandments, the reward will be fertility and abundance (Leviticus 26:3–13; Deuteronomy 28:1–4). But if the people do not hold the commandments, God will curse them with infertility of the land and the people (Leviticus 26:20–39; Deuteronomy 28), thistles and thorns will grow instead of corn [wheat, not maize] and fruit in the fields (Genesis 3:18; Job 31:40; Wisdom 24:31; Isaiah 5:6, 32:13; Jeremiah 12:13; Hebrews 6:8). People will be driven to eat unclean food (2 Kings 6:25; 2 Maccabees 6:18–20, 7:1; Isaiah 65:4, 66:3, 66:17; Ezekiel 4:9; Daniel 1:8), they will suffer from hunger and will starve to death (Deuteronomy 28:48, 32:24; 2 Samuel 24:13; 1 Chronicles 21:12; Psalms 34:11, 105:16; Isaiah 32:6; Jeremiah 11:22, 42:16; Luke 6:25; Revelation 18:8), and worst of all they will eat their own children (Leviticus 26:27–29; Deuteronomy 28:53–57; Lamentations 4:10; Zechariah 11:9). Eating one's own children on the one hand is the worst of sins and on the other hand is the strongest punishment for sinning. Eating the children is the reversal of giving birth. Instead of propagating humankind and the family, society is endangered. If people do this willingly, they violate God's wish to have a great number of followers, but if they violate his commandments, he will end their existence. To be without children means to be without a future, the name of the family extinguished forever. Living on in Israel means living on in future generations, as the many genealogies show (Genesis 4:20, 10:21, 17:4–16, 19:30–38, 25:12–18, 36:9; Exodus 1:5; Ruth 4:18–22; 1 Chronicles 2–8; Matthew 1:1–17).

See also **Christianity; Fasting and Abstinence; Feasts, Festivals, and Fasts; Judaism; Religion and Food; Sacrifice; Sin and Food.**

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Eleonore Schmitt

BIOACTIVE FOOD COMPONENTS. The term "bioactive food component" refers to nonessential biomolecules that are present in foods and exhibit the capacity to modulate one or more metabolic processes, which results in the promotion of better health. Bioactive food components are usually found in multiple forms such as glycosylated, esterified, thiolyated, or hydroxylated. Bioactive food components also have multiple metabolic activities allowing for beneficial effects in several diseases and target tissues. In general, it is thought that bioactive food components are predominantly found in plant foods such as whole grains, fruit, and vegetables. However, probiotics, conjugated linolenic acid, long-chain omega-3 polyunsaturated fatty acid, and bioactive peptides are most commonly found in animal products such as milk, fermented milk products and cold-water fish.

Table 1 summarizes the biological function and food sources for both plant- and animal-based bioactive food components. However, a review of both plant- and animal-based bioactive food components is beyond the scope of this article. Therefore, this article will focus on plant-based bioactive food components.

Common Forms Found in Foods

There are myriad bioactive food components in plant-based foods. A partial list includes the polyphenols, phytosterols, carotenoids, tocopherols, tocotrienols, organosulfur compounds including isothiocyanates and diallyl- (di, tri)sulfide compounds, soluble and insoluble fiber, and fruto-ogliosaccharide. It is most common to find mixtures of these compounds within a plant food rarely is one class of bioactive food component found singly.

Polyphenols are the most numerous and widely distributed group of bioactive molecules. Polyphenols are a diverse group of plant substances that contain one or more benzene rings and varying number of hydroxyl (OH), carbonyl (C=O), and carboxylic acid (COOH) groups. These commonly exist with one or more attached sugar residues (that is, conjugated). The most common class of polyphenols is the flavonoids. Other types of polyphenols include catechins, thearubingens, theaflavins, isoflavones, and over eight thousand others. Food sources of polyphenols and flavonoids include vegetables, fruits, cereals, legumes, nuts, tea, wine and other beverages made with fruit, vegetables, and grains. The polyphenol content can vary tremendously between food sources and within foods of the same type. For example, Bravo (1998) reported the following ranges for total polyphenols in barley and millet as 590 to 1,500 mg/100 g dry matter, 8.7 to 30.9 mg/100 g dry matter for oats and corn, 20 to 2,025 mg/g fresh onions and leeks, and 6 to 15 mg/100 g fresh brussels sprouts. For blueberries, strawberries, cranberries, and raspberries the total polyphenol content is 37 to 429 mg/100 g berries.

The organosulfur compounds are commonly found in cruciferous vegetables such as broccoli, cauliflower, and brussels sprouts or allium vegetables such as garlic, leeks, and onions. Organosulfur compounds contain sulfur atoms that are bound to a cyanate group or a carbon atom in a cyclic or noncyclic configuration. The bioactive components of foods containing organosulfur compounds are obtained only after cutting, chewing, or crushing has damaged the vegetable. In cruciferous vegetables various isothiocyanates such as sulforaphane, phenethyl-isothiocyanate, and benzyl isothiocyanate are formed from glucosinolyates by the action of myrosinase. In alliums, allicin is formed from alliin and then rapidly converted to diallyl sulfide, diallyl disulfide or diallyl trisulfide by the action of allinase. In both cruciferous and allium vegetables, these hydrolytic breakdown products are the health-promoting bioactive food components.

Phytosterols are the plant counterparts of cholesterol in animals. The structures are similar, however; the side-chain in plant sterols contains additional double bonds and methyl and/or ethyl groups. The most common bioactive phytosterols are beta-sitosterol, campesterol, and stigmasterol. The nonvegetarian diet contains approximately 250 mg/day of unsaturated phytosterols while a vegetarian diet contains over 500 mg/day. The best food sources include nuts, seeds, unrefined plant oils, and legumes. The saturated derivatives of plant sterols are plant stanols, the most common being sitostanol. Plant stanols occur naturally in wood pulp, tall oil, and soybean oil, but are most commonly obtained in the diet by chemical hydrogenation of plant sterols. Western diets contain approximately 20 to 50 milligrams of plant stanols.

The carotenoids are lipid-soluble plant pigments that are either oxygenated or non-oxygenated hydrocarbon containing at least forty carbons and an extensive conjugated double bond system. Beta-carotene, alpha-carotene, and lycopene are the predominant nonpolar bioactive carotenoids and lutein is the primary polar bioactive carotenoid. Carotenoids can be found esterifed to fatty acids or unesterifed in plant tissue. Carrots, squash, sweet potato, and spinach are abundant in both beta- and alpha-carotene and the dark green leafy vegetables such as kale, spinach, mustard greens, and green beans are good sources of lutein. Lycopene is found predominately in tomatoes. The total carotenoid content of fruits and vegetables varies with age and storage (Parker).

The tocopherols and tocotrienols are lipid-soluble bioactive compounds that contain a phenolic-chromanol ring linked to an isoprenoid side chain that is either saturated (tocopherols) or unsaturated (tocotrienols). There are also four primary forms of tocopherols and tocotrienols—alpha, beta, gamma, and delta—that differ in the number and position of methyl groups on the phenolic-chromanol ring. In addition, the tocopherols have three asymmetrical carbons at position 2, 4′, and 8′ of the isoprenoid side chain. Consequently, there are eight isomeric forms of tocopherols, of which RRR-a-tocopherol has the greatest bioactivity and is also the most abundant in human blood and tissues. Typical dietary sources of both tocopherol and tocotrienols include vegetable oils; nuts and the germ portion of grains are rich sources of both these compounds.

Biological Actions

There is a significant lack of understanding of the precise biological mechanism(s) of how plant-based bioactive food components impart health-promoting benefits. It is clear that bioactive food components act simultaneously at different or identical target sites. Bioactive food components have been shown to have the potential to reduce the risk of cancer, cardiovascular disease, osteoporosis, inflammation, type 2 diabetes, and other chronic degenerative diseases.

Bioactive food components have health-promoting roles at various stages of diseases that are associated with multiple progressive steps, from initiation to development. For example, in cardiovascular disease, isoflavones may reduce circulating oxidized low-density lipoproteins in the plasma, bind cholesterol in the intestinal tract thereby reducing absorption of dietary cholesterol, enhance bile excretion thereby reducing endogenous cholesterol levels, and modulate arterial elasticity thereby improving blood vessel dilation and constriction response.

As antioxidants, polyphenols, carotenoids, tocopherols, and allyl sulfides quench free radicals and reactive oxygen species. A free radical is a carbon or oxygen atom that has an unpaired electron and is highly unstable. Free radicals can form in lipids, proteins, and carbohydrates. The primary actions of antioxidants include the regulation of the redox potential within a cell and the reduction of potential initiators of carcinogenesis. The redox potential refers to the balance of the reducing and oxidizing reactions that occur within the cell. Redox changes within a cell are able to trigger various molecular responses such as induction of apoptosis (cell death) and activation of signal transduction (the transfer of messages between cells and within a cell). Therefore, redox and antioxidant regulation of physiological and pathological processes is important in optimizing health and disease prevention.

Other bioactive compounds are able to bind to toxins or carcinogens in the intestinal tract thereby preventing transformation or even absorption such as the binding of *N*-nitroso compounds in the intestinal tract by polyphenols in tea. The lipid-lowering mechanism of dietary fiber and phytosterol/stanols occurs by sequestering cholesterol in the intestinal tract and reducing cholesterol absorption. Dietary fiber is the indigestible parts of plant foods; it provides structure to the plant cell walls and is composed of long straight chains of carbohydrate molecules held together by bonds that cannot be broken by human digestive enzymes. This long fibrous structure allows dietary fibers to entrap harmful toxins and carcinogens in the digestive tract. There are two types of dietary fiber: soluble and insoluble. Soluble dietary fiber can dissolve in or absorb water and is effective in binding toxins and cholesterol in the intestinal tract. Insoluble dietary fiber, on the other hand, cannot dissolve in water and is effective in adding bulk and increasing the rate of passage of food through the intestinal tract. Insoluble dietary fiber, therefore, acts by diluting out potential carcinogens and decreasing contact of toxins and carcinogens with the intestinal tract by speeding their passage out of the body. Foods rich in soluble dietary fiber include apples, cranberries, mango, oranges, asparagus, broccoli, carrots, peanuts, walnuts, most legumes, oats, and psyllium. Rich food sources of insoluble dietary fiber include apples, bananas, berries, broccoli, green peppers, spinach, almonds, sesame seeds, most legumes, brown rice, whole-wheat breads, and cereals.

The structural similarity between several isoflavone metabolites and the metabolite of estrogen, estradiol, suggests the possibility of estrogen-like biological activities. Isoflavones or phytoestrogens, however, exhibit antagonist estrogen activity resulting in lower overall exposure to estrogen in premenopausal women and reducing breast cancer risk (Cassidy et al. 1994, 1995; Shimizu et al.). In postmenopausal women phytoestrogen-rich diets reduce the hormone-sensitive increases in plasma cholesterol levels and bone loss (Potter et al.; Setchell and Cassidy).

The induction of enzyme systems that detoxify toxic chemicals such as the phase I and phase II detoxifying enzymes is thought to reduce one's susceptibility to mutagenic effects. Bioactive food components with antioxidant functions are able to activate phase II detoxifying enzymes via an antioxidant-responsive element (Mukhtar and Ahmad). Isothiocyanates, in particular sulforaphane, are potent mono-inducers of phase II detoxifying enzymes (Zhang et al.). Diallyl sulfides from garlic preparations, on the other hand, are inducers of both phase I and phase II detoxifying enzymes (Yang et al.).

A primary mechanism for immune-modulation is the multiple antioxidant capability of polyphenols, tocopherols, carotenoids, isothiocyanates, and allyl sulfides. Together these compounds are able to reduce the deleterious effects of reactive oxygen species and free radicals, which cause premature death of immune cells (Brennan et al.). Bioactive food components have also been shown to stimulate the phagocytic action of macrophages and synthesis of several immune cell types, which increases the protection against infection. Among the foods that have been shown to have benefical immuno-modulatory effects are broccoli, garlic, onions, vegetable oils, almonds, walnuts, and others that are listed in Table 1.

Effects of Food Processing

In general, processing of fresh fruits and vegetables results in changes in composition of the bioactive food components. These changes can be beneficial or detrimental to the total content of health-promoting phytochemicals. It has been shown that coarseness of cutting, length of storage post-harvest, steam blanching, and thermal processing all influence the retention of bioactive compounds in cruciferae and allium vegetables (Howard et al.; Song and Milner). Reported losses of 30 percent to 80 percent of bioactive isothiocyanates have been reported (Howard et al.). Temperatures of 212°F (100°C) and higher result in the inactivation of key enzymes, myrosinase in cruciferae and allinase in allium vegetables, thereby reducing the amount of bioactive components. However, temperatures associated with normal cooking have shown little evidence of substantial loss of isothiocyanates. Leaching of glucosinolates and hydrolysis products also results in a reduction in total phytochemical content following cooking. Research has shown that heating garlic to a temperature of 140 to 212°F (60 to 100°C) or microwave heating for 30 to 60 seconds results in significant losses of the anti-inflammatory, anticancer, antimicrobial, and antioxidative activities of garlic (Song and Milner). However, the protective effect of garlic was nearly restored if the garlic preparation was allowed to sit for 10 minutes at room temperature prior to any heat treatment.

The bioavailability of carotenoids and other lipid-soluble bioactive food components has been shown to be improved with processing that increases surface area, such as cutting and chopping, and heat treatments that break down the protein and carbohydrate matrix that bind carotenoids (Stahl and Sies; Parker). The brewing

TABLE 1

Summary listing of various bioactive food components, common food sources, and biological functions

Bioactive component	Food source	Function
Glucosinolates, diallyl sulfides, isothiocyanates	Broccoli, cauliflower, brussels sprouts, garlic, onions	Induction of detoxifying enzyme systems, antimicrobial, immunomodulator, anticancer
Tocopherols and tocotrienols	Vegetable oil, nuts, seeds	Antioxidant, immunomodulator
Isoflavonoids and polyphenols	Grapes, red wine, tea, fresh fruit, and vegetables	Antioxidant, lipid-lowering, immunomodulator, antiosteoporotic, anticancer
Phytoestrogens (genistein, daidzein)	Soybean and other soy-based products, flaxseed, cabbage, legumes, tea	Antiestrogen, anti-osteoporotic, antiproliferative
Phytosterols	Vegetable oils, nuts	Lipid-lowering
Dietary fiber	Whole grains, oats, fresh fruit with skin	Lipid-lowering
γ-linolenic acid, α-linolenic acid, and omega-3 fatty acids	Evening primrose or borage oil, walnuts, rapeseed, flaxseed, fish, microalgae	Anti-inflammatory, lipid-lowering
Lutein	Green leafy vegetables	Reduction in age-related macular degeneration
Carotenoids	Carrots, corn, squash, green leafy vegetables, oranges, papaya, red palm oil	Antioxidant immunomodulators
Lycopene	Tomatoes	Antiproliferative, anticancer
Bioactive peptides: lactoferrin, glycomacropeptide	Milk and fermented milk products	Immune system enhancing, antiproliferative, antimicrobial
Probiotics	Fermented milk products	Immunomodulators, anticancer , gastrointestinal health modulators

of tea leaves, whether black or green, releases 69 to 85 percent of bioactive flavonoids within 3 to 5 minutes in hot water (Trevisanato and Kim).

Dietary Recommendations

Clearly, bioactive food components will play an important role in health maintenance in the future. However, information is needed in regards to the bioavailability of bioactive food components and the effective dosage required in humans to optimize health benefits. Current information suggests that to obtain and maintain blood levels of beneficial polyphenols, especially phytoestrogens and isoflavonoids, and carotenoids one needs to consume on a daily basis 25 to 60 grams of soy protein, five to nine servings of fruits and vegetables, one fresh clove of garlic, and four to six cups of green or black tea (Klotzbach-Shimomura). To achieve optimal phytosterol/stanol and fiber levels a daily intake of 25 to 35 grams of fiber is recommended by consuming seven to eleven servings of whole grains, legumes, pastas or nuts, and five to nine servings of fruits and vegetables.

The average American diet consists of two to four servings of fruits and vegetables and only five to seven servings of whole grains. Consequently, there is still a need to provide information and food choices to consumers to aid in the selection of a diet that contains optimal levels of health-promoting bioactive food components.

See also **Antioxidants**; **Assessment of Nutritional Status**; **Dairy Products**; **Dietary Assessment**; **Dietary Guidelines**; **Fiber, Dietary**; **Fish**; **Fruit**; **Lipids**; **Nutrient Bioavailability**; **Vegetables**.

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Joy Emilie Swanson

BIODIVERSITY AND THE CORNUCOPIA OF FOODS. Whenever you take up a bowl of paella, or a salad plate of mixed greens, nuts, and fruits, you are enjoying the benefits of biodiversity. There is something intrinsically pleasurable about a heterogeneity of vegetable varieties, shellfish species, or the ecological mosaic of marine and terrestrial landscapes sampled to prepare such dishes. Biodiversity can be simply defined as the "variety of life on Earth," and it includes both the richness of habitats found within different regions as well as the richness of species, varieties, and genes.

In a world where agricultural and aquacultural practices correspond to the growth rates and population densities of edible plants and animals, biodiversity can be sustained, without depleting harvests or degrading ecological habitats. But where traditional practices of food production and harvesting have been displaced, or species-rich landscapes have been degraded or converted to urban or industrial uses, this diversity is imperiled. In other words, the continued availability of this cornucopia of foods can no longer be taken for granted, and the term "biodiversity" is increasingly used in the context of loss of biodiversity or the extinction crisis. The number of species doomed to extinction each year of this coming

Biodiversity is evident in the large range of grass and flower species occupying this prairie at the National Bison Refuge in Montana. © PHOTO RESEARCHERS, INC.

Biodiversity includes not just the mix of different species but also the unique variations within species, as in the case of these heirloom turnips. The flat-rooted variety is Purple Top Milan, the white one in the center Goose Egg, and the ones beneath it Orange Jelly. Each variety also exhibits a very different flavor and storage qualities. Photo by L. Wilbur Zimmerman. Courtesy of the Roughwood Seed Collection.

century is projected by Harvard professor E. O. Wilson to be on the order of 27,000 unique and irreplaceable life forms. This extinction rate is the highest rate since humankind began manipulating life on earth.

Although the term "biodiversity" first came into vogue around 1988, during a conference on this theme sponsored by the National Academy of Sciences of the United States, synonyms such as "biological diversity" and "biotic diversity" had already been in currency among scientists and conservationists for some four decades. However, most people erroneously equated the term with species diversity or species richness, as if the number of plant and animal species in a given area served as the only indicator of biodiversity. "Biodiversity" is now considered to include the variety of life considered at all levels, from genetic variants belonging to the same species, through arrays of species and lifeforms, to the variety of habitats and ecosystems found within an ecological landscape including both wildlands and farmlands.

Let us first consider how our cornucopia of foods is filled with the genetic variation found within a single species. Consider, for example, the astonishing variety of vegetables and fruits grown and stored on just one patch of land, such as that of the Heritage Farm of the Seed Savers Exchange in Decorah, Iowa. The dozen or so members of the Seed Savers Exchange staff grow and maintain the genetic diversity represented by some 4,100 named varieties of tomatoes (one species), 3,600 varieties of beans (six species), 1,000 varieties of peas (one species), 1,200 chili peppers (four species), 1,200 squash and pumpkin varieties (four species), 400 melons (two species), 650 varieties of maize (two species), and 200 varieties of garlic (one species). Each of these varieties, whether it is a land race developed exclusively by traditional farmers and gardeners, or a cultivar developed by scientifically trained plant breeders, has been selected for its unique flavor, texture, color, size, shape, keeping time, as well as for its maturation rates, productivity, and resistance to pests, diseases, droughts, and freezes.

Unfortunately, many varieties such as these have already been lost from future use by gardeners, chefs, brewers, and the public at large. For example, it is estimated that 60 percent of the crop land races grown by indigenous tribes in North America at the time of first European colonization have been lost over the following five centuries. Several threats have led to losses of genetic replacement by modern commercial cultivars, and genetic contamination through accidental hybridization with modern cultivars, including genetically modified organisms (GMOs). Further consequences include genetic erosion due to the decline in traditional farming, along with reductions in planting areas and crop population sizes, and genetic extirpation resulting from the genocide or displacement of traditional farming communities, and termination of their agricultural practices.

In addition to genetic variation below the species level, biodiversity is influenced by the number of crop species grown in a given area and how they are intercropped. For example, some fifty botanical species of fruits, vegetables, and nuts can be found in some indigenous dooryard gardens, intermixed in what agroecologists term "polycultures." These crop mixtures often outyield the harvests that a single crop would produce on the same area of land, and harbor a variety of beneficial insects, such as predators on pests and pollinators.

At the landscape level, an ecological mosaic of fields, gardens, orchards, hedgerows, and managed wildlands provides what is now termed "agrobiodiversity," which includes habitat for both wild and domesticated organisms. It is at this level that land conservation organizations interested in protecting the diversity of foods desired by the public must succeed, for this diversity can be easily lost without the cultural landscapes that sustain species, their interactions with one another, and traditional ecological knowledge about how to manage them.

Gary Paul Nabhan

BIODYNAMIC GARDENING. *See* **Organic Agriculture; Organic Farming and Gardening.**

BIOTECHNOLOGY. Biotechnology, in its broadest sense, is the use of biological systems to carry out technical processes. Food biotechnology uses genetic methods to enhance food properties and to improve production, and in particular uses direct (rather than random) strategies to modify genes that are responsible for traits such as a vegetable's nutritional content. Using modern biotechnology, scientists can move genes for valuable traits from one plant into another plant. This way, they can make a plant taste or look better, be more nutritious, protect itself from insects, produce more food, or survive and prosper in inhospitable environments, for example, by incorporating tolerance to increased soil salinity. Simply put, food biotechnology is the practice of directing genetic changes in organisms that produce food in order to make a better product.

In nature, plants produce their own chemical defenses to ward off disease and insects thereby reducing the need for insecticide sprays. Biotechnology is often used to enhance these defenses. Some improvements are crop specific. For example, potatoes with a higher starch content will absorb less oil when frying, and tomatoes with delayed ripening qualities will have improved taste and freshness.

Paving the Way to Modern Biotechnology

Advances in science over many years account for what we know and are able to accomplish with modern biotechnology and food production. A brief review of genetics and biochemistry is useful in evaluating the role of biotechnology in our food supply.

REGULATORY OVERSIGHT

Three government agencies monitor the development and testing of biotechnology crops: the Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), and the Environmental Protection Agency (EPA). These agencies work together to ensure that biotechnology foods are safe to eat, safe to grow, and safe for the environment.

U.S. Food and Drug Administration (FDA): Lead agency in assessing safety for human consumption of plants or foods that have been altered using biotechnology, including foods that have improved nutritional profiles, food quality, or food processing advantages.

U.S. Department of Agriculture: Provides regulatory oversight to ensure that new plant varieties pose no harm to production agriculture or to the environment. USDA's Animal and Plant Health Inspection Service (APHIS) governs the field testing of biotechnology crops to determine how transgenic varieties perform relative to conventional varieties, and the balance between risk and reward.

Environmental Protection Agency (EPA): EPA provides regulatory and safety oversight for new plant varieties, such as insect-protected biotechnology crops. EPA regulates any pesticide that may be present in food to provide a high margin of safety for consumers.

Proteins are composed of various combinations of amino acids. They are essential for life—both for an organism's structure, and for the metabolic reactions necessary for the organism to function. The number, kind, and order of amino acids in a specific protein determine its properties. Deoxyribonucleic acid (DNA), which is present in all the cells of all organisms, contains the information needed for cells to put amino acids in the correct order. In other words, DNA contains the genetic blueprint determining how cells in all living organisms store, duplicate, and pass information about protein structure from generation to generation.

In 1953 James Watson and Francis Crick published their discovery that the molecular structure of DNA is a double helix, for which they, along with Maurice H. F. Wilkins, won a Nobel Prize in 1962. Two strands of DNA are composed of pairs of chemicals—adenine (A) and thymine (T); and guanine (G) and cytosine (C). A segment of DNA that encodes enough information to

Genetically Modified Organisms: Health and Environmental Concerns

There is really little doubt that, at least in principle, the development of genetically modified organisms (GMOs) can offer many advantages. Genetically modified organisms have included crops that are largely of benefit to farmers and not clearly of broad public value. Plans for development of GMOs include foods that have far greater nutritional and even pharmaceutical benefit; crops that can grow in regions that currently cannot provide enough food for subsistence; and foods that are more desirable in terms of traits that the public wants. The market forces that largely determine which products are developed are complicated, and there are important trade-offs: the traits that may be needed to feed a starving world are different from the traits farmers in the United States want, and both may differ from the characteristics the paying public supports.

Most criticisms of genetic engineering focus on food safety and environmental impacts. What impact will GMOs have on the health of those who eat them? Will some individuals develop allergic reactions? The new technology makes it possible to cross species barriers with impunity. A scare over StarLink corn is instructive of this kind of problem. "*Bt* corn," a common GMO, includes a gene from *Bacillus thuringienis,* which produces a pesticide that kills the European corn borer. StarLink is a variety of *Bt* corn that includes a protein (Cry9C) that does not break down as easily in the body, which increases the risk of allergic reactions in some people (though there are no verified cases of this). StarLink corn was approved for animal feed but not for human consumption. Unfortunately it is difficult if not impossible to keep the food supply for animals and humans separate. The result has been the discovery of small amounts of StarLink corn throughout the food supply. (Of course, there is also the question whether a small trace of Cry9C in a fast-food taco is the greatest health problem involved in such a meal.)

A second set of concerns arises over the environmental impact of GMOs. There are several different concerns. First, there are worries about gene flow. The same genes that may one day make it possible for plants to grow in poor, salty soil or in relatively arid regions could create an ecological nightmare by allowing these crops to spread beyond their normal range as a result of the gene(s) that have been transferred into the crop itself, or if those same genes should be introduced to other plants. This can happen through outcrossing between the GMOs and closely related plants. For example, GM wheat could cross with native grasses in South America to alter the makeup of the ecosystem and potentially create "super weeds," a possibility that has raised concerns in the "Wheat Belt" of the United States and elsewhere. Even in the absence of gene flow, the GMOs themselves could become super weeds (or the animal equivalent) as a result of the traits that make them better suited to new habitats. The environmental trade-off for technology that

make one protein is called a gene. It is the order of DNA's base pairs that determines specific genes that code for specific proteins, which determines individual traits.

By 1973 scientists had found ways to isolate individual genes, and by the 1980s, scientists could transfer single genes from one organism to another. This process, much like traditional crossbreeding, allows transferred traits to pass to future generations of the recipient organism.

One Goal, Two Approaches

The objective of plant biotechnology and traditional crop breeding is the same: to improve the characteristics of seed so that the resulting plants have new, desirable traits. The primary difference between the two techniques is how the objective is achieved. Plant breeders have used traditional tools such as hybridization and crossbreeding to improve the quality and yield of their crops with a resulting wide variability in our foods. These traditional techniques resulted in several benefits, such as greatly increased crop production and improved quality of food and feed crops, which has proven beneficial to growers and producers as well as consumers through a reduction of the cost of food for consumers. However, traditional plant breeding techniques do have some limits; only plants from the same or similar species can be interbred. Because of this, the sources for potential desirable traits are finite. In addition, the process of crossbreeding is very time-consuming, at times taking ten to twelve years to achieve the desired goal—and complications can arise because all genes of the two "parent" plants are combined together. This means that both the desirable *and* undesirable traits may be expressed in the new plant. It takes a significant amount of time to remove the unwanted traits by "back crossing" the new plant over many generations to achieve the desired traits. These biotech methods can preserve the unique genetic composition of some crops while allowing the addition or incorporation of specific genetic traits, such as resistance to disease. However, development of transgenic crop varieties still requires a significant investment of time and resources.

makes it possible to produce sustainable agriculture or aquaculture in regions where it cannot "naturally" flourish is the significant risk of loss of biodiversity and the unchecked spread of plants or animals into unintended regions. (The argument is made, however, that biotechnology can be used to increase yields on the land that is currently used for agricultural production, allowing nonfarm land to be retained as forests and reserves and thereby conserve biodiversity.)

In addition to these concerns over the ecosystem and the creation of superweeds, there is a worry over the potential impact of some GMOs on nontarget organisms. Cornell University researchers found that pollen from *Bt* corn could kill the larvae of monarch butterflies that ingested it. This raised the fear that these engineered crops could kill butterflies and other nontarget organisms in addition to the corn borer. The consensus from subsequent field research is that *Bt* corn does not pose a major threat to monarch butterfly populations—loss of habitat in Mexico, where the butterflies overwinter, is a more serious threat. Nevertheless, the *Bt* corn–butterfly issue showed that it is not always possible to predict the consequences that may arise from the introduction of these crops.

Genetically engineered microorganisms present even greater environmental and health concerns. It will soon be possible to engineer bacteria and viruses to produce deadly pathogens. This could well open a new era in biological weapons in addition to the environmental problems that could result from the release of organisms into the environment. The environmental assessment of the widespread introduction of engineered microorganisms has only barely begun to receive attention (Cho et al., 1999).

These concerns are exacerbated by some inadequacies in the regulatory framework for GMOs. There is a growing sense that the Food and Drug Administration, the U.S. Department of Agriculture, and the Environmental Protection Agency are not sufficiently rigorous or consistent in how they regulate GMOs and that there should be a single set of standards, including a mandatory environmental assessment. The opposition to GMOs in Europe is much more widespread than in the United States, and the single most important factor for the differences between European and American attitudes is the level of confidence in the regulatory institutions that protect the food supply. After "mad cow disease," Europeans do not trust their governments to provide safe food. A similar loss in confidence among U.S. consumers could have a similar effect. In spite of these concerns, however, there have so far been no documented food safety problems resulting from the introduction of GM crops in the mid-1990s and their large-scale consumption by the American public. There have also been no ecological disasters, although the time since their introduction has been too brief for the absence of disaster to be very meaningful. In some crops, notably in *Bt* cotton, there have been significant reductions in the use of pesticides.

David Magnus
with contributions by Peter Goldsbrough

The Many Applications of Biotechnology

Since the earliest times, people have been using simple forms of biotechnology to improve their food supply, long before the discovery of the structure of DNA by Watson and Crick. For example, grapes and grains were modified through fermentation with microorganisms and used to make wine, beer, and leavened bread. Modern biotechnology, which uses the latest molecular biology technology, allows us to more directly modify our foods. Whereas traditional plant breeding mixes tens of thousands of genes, biotechnology allows for the transfer of a single gene, or a few select genes or traits. The most common uses thus far have been the introduction of traits that help farmers simplify crop production, reduce pesticide use in some crops, and increase profitability by reduction of crop losses to weeds, insect damage, or disease.

In general, the early applications of crop biotechnology have been at points in our food supply chain where economic benefit can be gained. The following are examples of modern biotechnology where success has been achieved or is in progress.

Insect resistance. Crop losses from insect pests can cause devastating financial loss for growers and starvation in developing countries. In the United States and Europe, thousands of tons of pesticides are used to control insects. Using modern biotechnology, scientists and farmers have removed the need for the use of some of these chemicals. Insect-protected plants are developed by introducing a gene into a plant that produces a specific protein from a naturally occurring soil organism. *Bacillus thuringiensis (Bt)* is one of many bacteria naturally present in soil. This bacterium is known to be lethal to certain classes of insects, and only those organisms. The *Bt* protein produced by the bacterium is the natural insecticide. Growing foods, such as *Bt* corn, can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market. The introduction of insect-protected crops such as *Bt* cotton has allowed reduced use of chemical pesticides. This suggests that genetically engineered food crops can also be grown with reduced use of pesticides, a development that would be welcomed by the general public.

Herbicide tolerance. Every year, farmers must battle weeds that compete with their crops for water, nutrients, sunlight, and space. Weeds can also harbor insects and disease. Farmers routinely use two or more different chemicals on a crop to remove both grass and broadleaf weeds. In recent years new "broad-spectrum" chemicals have been discovered that control all these weeds and therefore require only one application of one chemical to the crop. To provide crops with a defense against these nonselective herbicides, genes have been added to plants that render the chemicals inactive—but only in the new, herbicide-resistant crop. Many benefits come from these crops, including better and more flexible weed control for farmers, increased use of conservation tillage (involving less working of the soil and thereby decreasing erosion), and promoting the use of herbicides that have a better environmental profile (that is, that are less toxic to nontarget organisms).

Disease resistance. Many viruses, fungi, and bacteria can cause plant diseases, resulting in crop damage and loss. Researchers have had great success in developing crops that are protected from certain types of plant viruses by introducing DNA from the virus into the plant. In essence, the plants are "vaccinated" against specific diseases. Because most plant viruses are spread by insects, farmers can use fewer insecticides and still have healthy crops and high yields.

Drought tolerance and salinity tolerance. As the world population grows and industrial demand for water supplies increases, the amount of water used to irrigate crops will become more expensive or unavailable. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help overcome these limitations. Although genetically engineered crops with enhanced drought tolerance are not yet commercially available, significant research advances are pointing the way to creating these in the future.

Food applications. Research into applications of biotechnology to food production covers a broad range of possibilities. Examples of food applications also include increasing the nutrient content of foods where deficiencies are widespread in the population. For example, researchers have successfully increased the amount of iron and beta-carotene (the precursor to vitamin A in humans) in carrots and "golden rice"—a biotech rice developed by the Rockefeller Foundation that may help provide children in developing nations with the vitamin A they need to reduce the risk of vision problems or blindness.

Another example of food biotechnology is crops modified for higher monounsaturated fatty acid levels in the vegetable to make them more "heart-healthy." Efforts are also under way to slow the ripening of some crops, such as bananas, tomatoes, peppers, and tropical fruits, to allow time to ship them from farms to large cities while preserving taste and freshness.

Other possible food applications for which pioneering research is under way include grains and nuts where naturally occurring allergens have been reduced or eliminated. Potatoes with higher starch content also promise to have the added potential to reduce the fat content in fried potato products, such as french fries and potato chips. This is because the starch replaces water in the potatoes, causing less fat to be absorbed into the potato when it is fried.

Edible vaccines. Vaccines that are commonly used today are often costly to produce and require cold storage conditions when shipped from their point of manufacture in the developed world to points of use in the developing world. Research has shown that protein-based vaccines can be designed into edible plants so that simple eating of the material leads to oral immunization. This technology will allow local production of vaccines in developing countries, reduction of vaccine costs, and promotion of global immunization programs to prevent infectious diseases.

Global food needs. The world population has topped six billion people and is predicted to double by 2050. Ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. Biotechnology can play a critical role in helping to meet the growing need for high-quality food produced in more sustainable ways.

What Are Consumers Saying?

Crops modified by biotechnology (also known as genetically modified or GM crops) have been the subjects of public discussion in recent years. Considerable public discussion may be attributed to the public's interest in the safety and usefulness of new products. Although biotechnology has a strongly supported safety record, some groups and organizations abroad and in the United States have expressed a desire for stronger regulation of biotechnology-derived products than of similar foods derived from older technology. The assessment of the need for new regulation is related to an understanding of the science itself, as was detailed in the sections above; this is a continual process of development.

Consumer acceptance is critical to the success of biotechnology around the world. Attitudes toward biotechnology vary from country to country because of cultural and political differences, in addition to many other influences.

In the United States, the majority of consumers are supportive about the potential benefits biotechnology can bring. Generally, U.S. consumers feel they would like to learn more about the topic, and respond favorably when they are given accurate, science-based information on the subject of food biotechnology.

See also **Agriculture since the Industrial Revolution; Agronomy; Crop Improvement; Ecology and Food; Environment; Food Politics: United States; Food Safety; Gene Expression, Nutrient Regulation of; Genetic Engineering; Genetics; Government Agencies; Green Revolution; High-Technology Farming; Inspection; Marketing of Food; Toxins, Unnatural, and Food Safety.**

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BIRDS. *See* **Poultry; Seabirds and Their Eggs.**

Photograph of Clarence Birdseye, shown using a Dictaphone in his office. PHOTO COURTESY OF THE LIBRARY OF CONGRESS.

BIRDSEYE, CLARENCE. Clarence "Bob" Birdseye (1886–1956), American businessman and inventor, was originally an Amherst biology major, but dropped out and became a U.S. field naturalist in Labrador in 1920. There he became impressed with the well-preserved cellular structure of cooked fish that was frozen naturally in the Arctic outdoors. He noted that this quick freezing process caused less crystallization within the fish tissue. Once he returned to the United States, Birdseye developed his crude Multiplate Quick Freeze Machine: tightly sealed cartons, encased in metal, that were filled with food and then lowered into a low-temperature brine solution that froze the foods. Later, he froze foods with calcium chloride brine chilled to −40°F. In 1924 he organized the General Seafood Corporation and turned his attention to developing refrigerated railroad boxcars to transport frozen foods nationwide. In 1929 Birdseye sold his company to Postum, Inc., which became General Foods Corporation. His line of frozen foods was renamed Birds Eye.™ Ultimately, in 1949, using the anhydrous freezing process, Birdseye managed to cut freezing time from 18 hours to 90 minutes.

Though his process was not the first to freeze foods, distinction came to him for the quickness of his method for producing tasty, well-preserved fresh fish, fruits, and vegetables in retail-sized containers. The restaurant business profited greatly from his work. Birdseye held three hundred patents, in addition to a patent for a process of converting crushed sugarcane residue into paper pulp.

FROZEN PEAS

Birdseye's process indirectly improved the diet of the industrialized world by making possible the freshest frozen foods, frozen at or near farm sites, year round. This later led to the packaging of ethnic foods and meal combinations such as TV dinners. One of his most popular frozen products is green peas, the second largest vegetable crop in the United States. In the early twenty-first century more than 90 percent of all peas are sold as frozen peas. Frozen peas retain their brightest color and original shapes when placed in boiling water and removed from the heat.

See also **Fish; Frozen Food; Peas; Preserving; Storage of Food; Vegetables.**

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Marty Martindale

BIRTHDAY FOODS. Food is almost always a significant part of the observance or celebration of a birthday in the Western world. It may play several roles: as refreshments for those attending a celebration; as a gift, such as a box of candy for the honoree; as sweets or cupcakes taken to school by the birthday child; or the candy in a piñata at a party. Families often have their own favorite festive food that is served on birthdays of family members, or a favorite food of the birthday celebrant will be served in his or her honor.

In some cultures, a birthday food is an important cultural symbol recognized by the entire community. Wheat noodles, a symbol of longevity, are stretched to great lengths and served in soup to birthday celebrants in Northern China. Another symbol of longevity there, the peach, appears for birthdays as a bun, shaped and colored like a peach, with a sweet paste filling.

Food may be offered to the gods as a part of the religious celebration of a birthday. In Thai communities it is taken to the temple on the birthday morning, to receive a birthday blessing from a monk. In Sri Lanka, children go to the temple on their birthdays to receive a special blessing and to give money to the priest for a special offering of a traditional food, such as rice porridge, to the gods. This is also shared with the family.

Other traditional festive foods include the French *croquembouche*, a cone-shaped tower of small cream puffs fastened together with caramel, or the Norwegian *kransekaka*, a pyramid of as many as twenty-six pastry rings, gradually decreasing in size from bottom to top, and iced and decorated. These may be part of a birthday celebration but are more likely to be the centerpiece for a wedding or, perhaps, a christening. In Korea, steamed rice cakes of various kinds, usually made of layers of ground rice alternating with a bean paste, are served on birthdays but also on other special days.

However, in many parts of the world and especially in the West and countries influenced by Western traditions, by far the most popular food for celebrating a birthday is the birthday cake, complete with decorative icing and glowing candles. In the United States, birthday cakes, especially for children, are essential to the celebration. The custom cuts across all economic, racial, and religious lines. Although elaborately decorated cakes also are used to mark events like weddings, farewell parties, and other major events, the birthday cake is distinctive because of its candles. Any depiction of a circle topped by a one or more candles is recognized at once as a birthday cake.

Birthday Celebrations

Birthdays of powerful and wealthy individuals have been celebrated for millennia. The Bible's book of Genesis (ch. 40:20) indicates that Egyptian pharaohs organized festive events around their birthdays and, according to Dalby and Grainger in *The Classical Cookbook* (p. 32), so did Romans in far-flung parts of the Empire. After the Middle Ages, birthdays began to be celebrated by others of wealth and position. Eventually, a growing middle class in the United States in the post–Civil War period began to emulate the customs and manners of their more affluent fellow citizens.

Although there are a number of cultures in which birthdays are not observed, particularly in Africa and the Middle East, usually a birthday is regarded as a rite of passage marking an individual's progress through the life cycle. Certain points along the way may be regarded as more important than others: for example, a first birthday or a sixtieth for a Korean; a fifteenth for a girl in the Latino community or a sixteenth in some other cultures in the United States, a twenty-first, fiftieth, or seventy-fifth for an American, or any birthday year which ends in a zero for a Dane. For such occasions a cake with candles usually is considered essential and extraordinary efforts may be made to provide it. A birthday cake requires a social gathering and ordinarily would not be eaten without others being present.

Cakes and celebrations. The birthday cake tradition in the United States is little more than a century old, but the relationship of cakes and celebration has a much longer history. It was traditional in Roman times, especially for those reaching fifty years of age, to be feted with special cakes, according to Toussaint-Samat in *History of Food* (p. 32), but the cakes of Roman times, and for many centuries after, consisted mainly of cereal grain meal moistened with water or wine, and perhaps leavened with some form of yeast. Like small pancakes, they were baked on a griddle and picked up and eaten like cookies.

The Development of Modern Cakes

During the Middle Ages in Northern Europe there was little distinction made between bread and cake. Both were leavened with yeast and sweetness was not an important characteristic. Alan Davidson has written in *The Oxford Companion to Food* (p. 123) that it was not until the late fourteenth century in Europe that professional cooks were able to create immense yeast-leavened cakes filled with dried fruits for special occasions. In the sixteenth century, Italian and French pastry cooks began to develop lighter baked goods using batters based on egg-and-sugar foam instead of yeast. As their methods spread to other parts of Europe, cakes began to change rapidly, although still requiring a professional baker.

Chemical leavens. Leavening baked goods with chemical substances, particularly pearlash, a refined form of potash, was in use by professional bakers in Europe by the mid-seventeenth century, according to Witteveen in *Petits Propos Culinaires #21* (pp. 66–68). But pearlash, saleratus, ammonium carbonate, and other substances known as "yeast powders," also used by home cooks in the United States by the end of the eighteenth century, imparted an unpleasant taste, particularly to delicately flavored baked goods. In 1863 two pharmacists in Indiana finally succeeded in developing the right blend of baking soda and cream of tartar to produce baking powder. Much earlier in the nineteenth century, the cast iron stove had come into use, and as home bakers learned to employ it in concert with chemical leavens, the modern-day layer cake became possible.

At that time, preparing cake ingredients still involved a lot of tedious work, but later in the century, many labor-saving devices for cooks—egg beaters, standardized baking pans, measuring cups and spoons, and ice boxes—appeared. What once was accessible only to a person wealthy enough to hire and outfit a professional cook had become possible for home cooks everywhere to produce successfully.

Twentieth-century cakes. By early in the twentieth century, women's magazines and their advertisers were spreading the word not only about modern kitchen equipment and products that made baking a cake quick and easy, but were introducing their readers to recipes for layer cakes with glorious frostings and luscious fillings as popular desserts, especially in the American South. Since then, except for the introduction of the chiffon cake in 1948, and cake mixes at about the same time, the contemporary cake has not changed substantially. It is a baked, sweetened creation leavened with eggs or chemical leavens perhaps with the addition of eggs so that it is tender, light, and porous in texture. Usually, but not always, it contains wheat flour or a substitute like finely ground nuts. It may contain a substantial amount of fat or none at all.

Birthday Cakes

The great cake, a large, lavish creation, was the centerpiece for any Early American party at which it appeared. Making it was difficult, time-consuming, and costly. As Louise Conway Belden points out in *The Festive Tradition: Table Decoration and Desserts in America, 1650–1900* (pp. 184–190), its appearance made the event special and festive.

HAPPY BIRTHDAY

First birthdays are a rite of passage for most American children, and part of the fun is to get down into the food. © Ariel Skelly/CORBIS.

Lavishly decorated cakes continue to be symbolic of life's festive and dramatic moments, and birthday cakes are expected, above all, to be dramatic in appearance. Only wedding cakes are more elaborate. Besides highlighting an individual's birthday as an important event, today they often are used as spectacular centerpieces for public occasions in order to provide a photo opportunity or other publicity. Size and appearance are the first consideration; the cake's flavor and texture may be of less concern.

A contemporary American birthday cake is usually tall, composed of two or more layers or baked in an angel food, bundt, or other tube pan. It often is a unique creation, shaped and decorated to please the birthday celebrant (a clown cake for a child, or a hobby-related cake for an adult). Icing with elaborate decorations of gum paste (which has been made in the Middle East since before the end of the twelfth century) and the generous use of color, borrowed by medieval Europeans from Arab cuisine, add to the dramatic effect, but are not essential. The cake's primary distinguishing characteristic is that it is topped with candles.

Candles. Light from the sun or from fire had very early religious and mystical significance, and rituals using light in the form of candles became part of religious ceremonies surrounding weddings, funerals, and other important human events, according to O'Dea's *Social History of Lighting* (pp. 34, 139–143). Candles also are associated with the measurement of time, and were used in the late ninth century by England's King Alfred to measure the hours of the day. In the Judeo-Christian tradition they have been used to symbolize the passage of time (at Advent or Hanukkah). The candles, rather than the cake itself, connote a long span of time.

Using very small tapers to light a special cake, with the number of tapers equal to a birthday child's age, seems to have begun in Germany in the late eighteenth century or earlier, judging by a letter written in 1799 by the German poet and dramatist Johann Wolfgang von Goethe, in which he referred to the tradition of *Kinderfest* (Goethe, pp. 114–115).

Birthday cake rituals. During the twentieth century, birthday celebrations spawned a host of traditions, rituals, and objects related to the festive cake. Although these vary among families and groups, when the cake appears, it is almost always accompanied by the singing of the "Happy Birthday" song, usually in English, even in non–English-speaking countries in Europe and Asia. In Spanish-speaking countries of the Western Hemisphere, it often is sung in both Spanish and English. Spain and Denmark have their own birthday cake songs, with other words and tunes.

The honoree is encouraged to make a secret wish and attempt to blow out all the candles with one breath to ensure that the wish will be realized. Despite various theories that have been advanced, the true origins of this custom are unknown. After the candles are extinguished, the cake is cut and distributed to guests. For young children, whose celebrations are more focused on their ages and growth, there may be attempts by child guests, particularly in Spain and Northern Italy, to pull the birthday child's earlobes, once for each year of age, just as in the United States, spanks may be administered, finished off with "and one to grow on."

Development of an Industry

A global industry has grown up around the birthday cake tradition. Hundreds of kinds of cake decorating supplies are sold, in small shops and from huge warehouses: retail, wholesale, by mail and on the Internet. The techniques, supplies, and equipment are available to residents of even the most isolated rural areas. The industry also has published hundreds of profusely illustrated instruction books describing how to use the tools and supplies to create fanciful cakes. Women in many parts of the world have learned by using books or taking classes to decorate cakes for family and friends and many have gone on to establish a career in cake decorating.

Bakeries, pastry shops, and supermarkets in the United States do a thriving business in birthday cakes that can be decorated with frosting, gum paste flowers, or little plastic figures and carry a standard piped-on icing message like "Happy Birthday," or they can be customized for special orders in as elaborate a form as any purchaser's imagination and purse will permit, including having color photos reproduced on the iced cake's top surface.

Birthday candles reflect the global nature of birthday cakes. Some candle boxes carry safety directions in as many as five languages, and list manufacturing sites in Asia, Europe, and the United States. They are available in many sizes and lengths, all colors, metallic finishes, stripes, polka dots, and fanciful shapes such as cowboy boots, toy trains, or clowns. There are candles shaped like numbers for use when one taper for each year would be impractical, musical candles, and trick candles that relight magically after being blown out.

See also **Cake and Pancake; Candy and Confections; Christmas; Epiphany; Wedding Cake; Weddings**.

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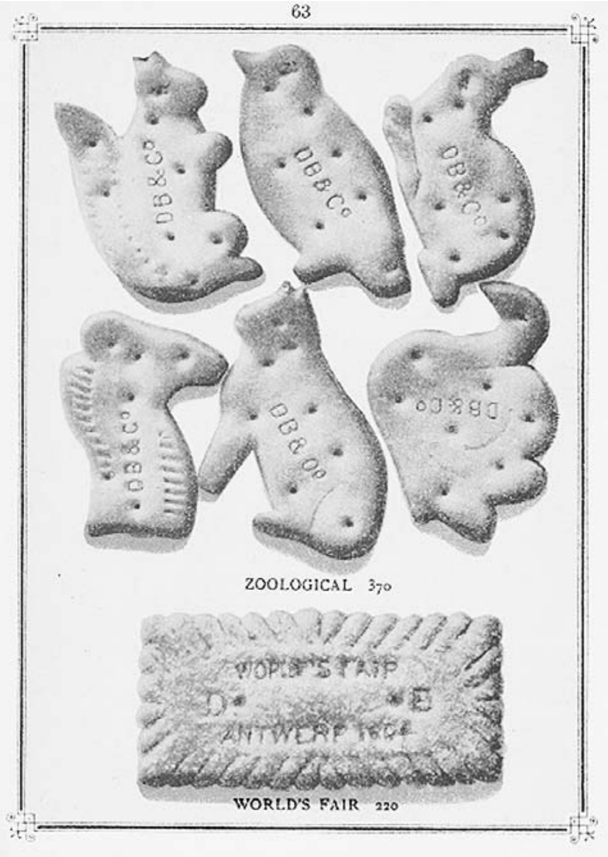
BISCUITS. The word "biscuit" is derived from the Latin *panis biscoctus*, "twice-baked bread." From the sixteenth to the eighteenth century, forms of the word included *besquite* and *bisket*. Similar forms are noted in many European languages. "Biscuit" covers a wide range of flour baked products, though it is generally an unleavened cake or bread, crisp and dry in nature, and in a small, thin, and flat shape. It has a number of cultural meanings. In the United States, a biscuit is a soft, thick scone product or a small roll similar to a muffin. The British biscuit is equivalent to the American cookie and cracker. These latter terms are relatively modern. "Cookie" comes from the eighteenth-century Dutch word *koekje*, a diminutive of *koek* (cake). "Cracker" is a North American term that also came into use in the eighteenth century, connoting the sound of the wafer as it was chewed or broken (at this time, "cracker" was also used to mean a firecracker or a noisy person or object).

Biscuits have evolved from different aspects of baking practices such as tarts, pastries, short cakes, and sugar confectionery. They have given rise to the wafer, macaroon, cracker, sandwich, snap, gingerbread, honey cake, rusk, and water biscuit. Some, like the wafer, were baked in the Middle Ages; others are of more recent origin, such as the "fancy biscuit," an early-nineteenth-century invention of British bakers that led to the development of a biscuit industry, which was later exported throughout the world. Biscuits are divided into two main groups. The first are plain or have a savory flavoring. The second type are sweet or semi-sweet in character.

Biscuits are made from a number of ingredients. Flour is the most basic and important. Different types give a range of textures and crispness. Wholemeal wheat flour is used in the "digestive," "sweetmeal," or "wheatmeal" type of biscuits. Oatmeal forms the basis of oatmeal biscuits. Rice flour and corn flour add flavor. Fats give the biscuits their "shortness." Butter and lard are the main fats, though these are augmented by vegetable and other refined fats. For fancy biscuits, sugar is an important ingredient, and introduces a range of tastes. It is added in several forms: processed as caster and Demerara sugars, syrups, honey, and malt extract. These have a range of consistencies and may help to bind together other ingredients. Aerating and raising ingredients, such as baking powder (bicarbonate of soda and tartaric acid), make the biscuit light. Flavorings are also added. These include dried fruit, nuts, chocolate (powder or chips), spices, herbs, and flavoring essences such as vanilla. The dry ingredients are bound together with eggs and milk (fresh, condensed, or dried) or water. Biscuits have a high energy content, ranging from 420 to 510 kcal per 100 g.

The mechanized process of biscuit-making is rapid and continuous. The ingredients are mixed into a dough that is then kneaded and rolled to a uniform thickness. Biscuit shapes are cut from it, and placed in a traveling oven. Some biscuits require special preparation and cooking techniques. Biscuit-making has become increasingly and highly mechanized since the early nineteenth century, when technological aids were limited and it was highly labor-intensive. They can be baked commercially or in the home.



A circa 1896 chromolithograph showing "Zoological Biscuits," the original name for animal crackers, which were introduced in England in the late 1870s. ROUGHWOOD COLLECTION.

Most biscuits are distinguished by their appearance: round, square, oblong, finger-shaped, or fancifully impressed with designs. Plain biscuits are normally punched with a cutter or docker, to increase crispness during baking. Fancy biscuits can be covered with sugar, icing, or coated (fully or partially) with chocolate. Each type of biscuit also has its own commercial name, which refers to ingredients, a designation (sandwich, wafer, macaroon, or cracker), texture, eating qualities, and the time when it was to be eaten. The range of biscuits has increased over the past 150 years. Huntley & Palmers, of Reading, England, a world leader in biscuit production, sold around 130 varieties in 1870; by 1898, this increased to over four hundred. Some became well established and have a long history. For example, the "Abernethy biscuit," a proprietary biscuit based on the captain biscuit, was devised by Dr. John Abernethy (1764–1831), chief surgeon at St. Bartholomew's Hospital, London. Some biscuits have been eaten in large

THE AMERICAN BISCUIT—A DIVERGENT TRADITION

In Britain and most of Europe, the biscuit follows a direct lineal descent from the Latin *panis biscoctus* (literally twice-baked bread), but in North America broad inconsistencies have emerged in the way this term is used in advertising and in common speech. For light baked goods with a crisp, brittle texture, two terms are in common use: "cracker" and "cookie." Historically Americans also used the word "biscuit" like their British cousins, as in the case of the ship biscuits or water biscuits of the early 1800s. Both of these foods are called crackers in the United States.

The old water biscuit of the nineteenth century has become the oyster cracker of seafood restaurants and oyster houses. The ship biscuit, with its light sprinkling of salt, has become the boxed cracker of the supermarket. Nabisco Saltines were one of the first of this type marketed commercially on a national scale.

However, Americans call the soft crackers of Maryland's Chesapeake Bay area "beaten biscuits." This is a cracker made with high-gluten flour and water that is beaten (the technical term is "broken") until the dough becomes soft and spongy. When baked, the biscuits are tender and fluffy as though made with yeast. Out of this species of cracker evolved the fluffy raised biscuits made with baking powder that are popular in the South. These soda biscuits, as they were once called, represent a type of bread substitute served with gravies and various fricasseed foods. In the American South they are almost universally eaten at breakfast.

Two common denominators unite all types of American crackers. The first is that they are not sweet, and therefore they are not considered dessert foods. The second is that they are "docked," the baking term for punching tiny holes into the dough so they become light and brittle once they are baked. Docking prevents the dough from shrinking and becoming tough. The old baker's tool used for making the holes was called a biscuit dock, normally a wooden handle attached to a stamp featuring numerous spikes arranged in whatever pattern the baker wanted for his or her crackers. Many docks featured the baker's initials or a simple pattern, such as a ship's anchor for a ship's biscuit.

When sugar is added to these simple recipes, American terminology changes. The crackers become wafers, and if fat of any kind enters into the recipe, the wafers graduate to cookies. The term "cookie" was borrowed from the Dutch, who settled in New York in the early 1600s. The word simply means a little cake, and "little cake" is what most cookies were called in early American cookbooks, just as they were in England. By the 1790s, however, the New York term began to show up in many places outside of that state.

The popularity of the term increased because of its connection with the fashionable New York New Year's cookies, highly ornamented stamped cookies served during New Year's Day entertainments. The word moved into American cookbook literature and eventually came to encompass any crisp, sweet finger food. But one further distinction has developed. "Cookie" is applied to foods of this kind that are either homemade or intrinsically American. How is this known? Chinese fortune cookies were invented in the United States in the 1840s under the name of motto cookies. They are not foreign. By this same rule, imported French champagne biscuits are not called cookies. Likewise the Italian *biscotti* served at nearly every coffee bar would never be characterized as cookies. Cookies are comfort food. Cookies are what children are allowed to eat. The word separates what is recognizable and American from all the rest.

William Woys Weaver

quantities. The Digestive (or Wholemeal) and Rich Tea became market leaders in Britain from 1949 onward. Other sorts fell out of favor, but new varieties are being continually developed as a result of consumer demand, changing tastes, and innovations in production techniques. Chocolate-coated biscuits started to become popular in the first decade of the twentieth century.

Some biscuits have become cultural markers. The snickerdoodle, flavored with nutmeg, nuts, and raisins, is a speciality of the Pennsylvania Dutch. The gingersnap, a thin ginger biscuit, is popular in Sweden. Povorone is a Spanish and Mexican biscuit of pastry dough flavored with nuts or cinnamon, rolled in icing sugar after baking. Shortbread, a rich, short biscuit that is a speciality of Scotland, is exported throughout the world. Traditionally, it was a festive food eaten at Hogmanay (the eve of New Year's Day), though it is now eaten on everyday occasions.

Biscuits are sold in several distinctive ways. They are marketed either as a single variety or as an assortment. Some of these, such as Victoria Assortment, are well-known in England and Canada. Originally, fancy biscuits were sold as novelties. They were kept in highly decorated tins, which are still sold, but have been largely replaced by other forms of packaging. The earliest tins held 228 g; later ones extended to 4.5 kg. They were sold in tens of thousands, especially at Christmastime. Biscuit tins have become something of a cultural phenomenon quite separate from the biscuits themselves, since the empty tins are commonly reused as household furniture, for storage, or as decoration.

The role of the biscuit in the diet has also changed. In the early nineteenth century, the fancy biscuit was an expensive novelty, eaten only by the upper classes, and played a relatively minor role in popular diet. Only when the time of meals altered did the role of biscuits increase, being eaten at luncheon and afternoon tea. However, it was not until the 1960s that quality biscuits were within the range of most family incomes, especially in Britain. Biscuits have adapted to a range of uses. They have become health foods (sold in pharmacies), as well as slimming or digestive aids. They are now accompaniments to hot drinks, alcoholic beverages, courses of a meal (usually with cheese), snacks, or substitutes for bread, like the old ship's biscuit, eaten by men on long sea journeys. Biscuits have also assumed a place in popular folklore, for they surface in such expressions as "take the biscuit," which in Britain means the most surprising thing that could have occurred.

See also **Baking; Bread; Cake and Pancake; Digestion; Pastry; Wedding Cake.**

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BISON. *See* **Cattle; Mammals; Meat.**

BODY. The intricate relationship between food and the human body finds expression in virtually all dimensions of human existence: from physiology to psychology, from the domestic sphere to that of political economy, from the societal to the symbolic. In exploring the ways in which food and its consumption are articulated in the forms and images of corporeality, it bears note that the human body, per se, is an abstraction. As gender studies scholars have maintained, there is no such thing as a neutral "human body": every human body is individually unique in a multiplicity of ways (most basically, at the genetic level). In addition, all human bodies are sexed—be they female, male, or born hermaphrodite. For heuristic purposes only, then, it is convenient to generalize about "the human body."

Human Growth and Development

The size and shape of an individual human body (what biologists call "phenotype") is the product of the interactions over time of the genetic makeup ("genotype") and environmental influences, including behavior. Morphology, or physical form, derives from hereditary, endocrinological, metabolic, maturational, environmental, and lifestyle factors, yet the relative weight of these effects may vary depending on the somatic trait in question. For example, adult height is under rather high genetic control, whereas adult weight has a relatively low degree of heritability. There is strong evidence, however, that both energy expenditure and the basal metabolic rate enjoy a significant genetic component; likewise, gene regulation is pronounced in the distribution, or patterning, of body fat at all stages of the life span.

Growth, in terms of the progressive development of adult proportions, is measured linearly (by height or length of limb bone); in the expansion of girth, or surface area (by quadratic measures); and in terms of volume, or mass (by cubic measures). Aberrations in any of these dimensions can arise from genetic abnormalities or environmental stress, in the form of malnutrition, disease, toxins, accidents, psychosocial stress, and/or other insults to the developing organism. Human growth is so highly sensitive to environmental forces that it provides a reliable indicator of the quality of the environment, although even under stress the body maintains proportionality, in what has been called the "harmony of growth." Moreover, short-term or seasonal sources of stress need not permanently compromise the developing body, since humans possess the capacity for "catch-up" growth—a rapid increase in growth velocity that restores a child to predicted size—in weight and to a lesser degree in height. Despite its sensitivity, human growth thus appears to be a "target-seeking process" that seeks to move back to its individual trajectory when driven off course (Johnston, p. 318). The ability to recover is a function of the timing, duration, and intensity of insult, plus the quality of the post-insult environment. Data suggest that weight recovery from severe caloric and/or protein shortages can be achieved (in both children and adults), with lean muscle tissue synthesized first, followed by the laying down of adipose tissue. However, weight gain in itself does not necessarily guarantee a return to normal health, as the body's chemical composition and anatomy may be in danger of disequilibrium without attention to key micronutrients during the recovery process. With respect to stature, chronic stress in childhood can lead to permanent stunting in adult height. It is estimated that approximately one-third of the world's children are stunted in height in comparison with averages compiled for children in North America alone.

Under normal circumstances, human growth and development from conception to maturity follow a patterned trajectory. This trajectory is characterized by a rapid velocity of post-natal growth (with growth rate at its fastest in the first year of life); a steady growth rate with a lower, decelerating velocity during childhood; a juvenile growth spurt around the age of seven or eight (in about two-thirds of healthy children); and the onset of adolescence, with a markedly accelerated growth spurt, beginning for girls at age ten, on average, and for boys at age twelve years (in Western societies, yet later in stressed ecosystems). With the onset of adolescence, the relatively similar childhood body shapes and compositions of the two sexes undergo maturational processes that lead to marked differentiation. Maturation involves skeletal changes, such as the female's wider pelvic girth relative to shoulder width; muscular changes, with males exhibiting a more dramatic increase in accretion of muscle than do females; changes in adipose tissue and fat patterning, with females adding both central body and limb fat, and males losing fat from the subcutaneous layers (superficial under-the-skin fat, as opposed to deep body fat); and changes in secondary sexual characteristics, such as pubic hair and breast development. Growth ceases on completion of puberty after the period of peak growth velocity, whereupon the human body attains adult stature and achieves full reproductive maturity.

The most striking features of the adult stage of life are its stability (homeostasis) and its resistance to pathological influences. With advances in nutrition, medicine, and hygiene and a resulting increased life expectancy at all ages, more humans today live sufficiently past the reproductive years to experience chronic disease and failing physiology. Senescence—defined as cumulative, universal, progressive, irreversible, and degenerative aging—does not appear to be under tight genetic control. Rather, aging is a multi-causal process, and most pathologies relating to age (for example, cancers, heart disease, and late-onset diabetes) are probably culturally and environmentally specific. However, there is a general tendency for both sexes to experience age-related losses in stature and in muscular (lean body) mass, coincident with a decline in total energy requirements. Biological aging in non-Western populations tends to be associated with declining fatness as a percentage of total body composition; in contrast, industrialized populations tend to experience age-related increases in fat.

Human Morphological Variation

As a result of the dynamic gene-environment interactions taking place from birth to maturity, body size and morphology exhibit a wide range of variation within and between populations. Variation in body shape at a population level may, in part, mark a phenotypic manifestation of the evolutionary forces of natural selection, wherein statistically normal adult morphology is regulated by genetic adaptations to specific ecosystemic and other environmental constraints. For example, there exists a clear geographical pattern that, in colder habitats, mean body weight is greater, which might assist in the maintenance of core body temperature. Likewise, low weight may confer a thermoregulatory advantage in tropical climates, where, too, greater skin surface area (with pores) as a proportion of weight can assist with the dissipation of heat through perspiration.

In addition to genetic differences, there are many environmental and behavioral factors that influence body shape. Nutrition and overall dietary intake play central roles, as do energy-expenditure activities, disease, lifestyle, and socioeconomic status. Variance in basic caloric intake (measured as an excess or deficit in energy balance) is a major determinant of visible differences in body morphology, mainly in the ways that caloric excess shapes subcutaneous fat deposition. Simply put, eating plays an increasingly prominent role in determining what we look like, and the kinds of cross-population and intra-individual variations we see. Fat is one of the most labile tissues of the body and alters according to both genetic and environmental factors. Ethnic differences in subcutaneous fat thickness suggest genetic variation in fat patterning among populations, with peoples of European ancestry exhibiting a more peripheral than central pattern of fat distribution (limb fat over visceral fat) than those of African and Asian ancestry. Across all ethnic groups, there is marked sexual dimorphism with regard to total body fat and fat patterning, with post-adolescent females averaging approximately 20 percent in body fat composition, whereas males average 12 percent. Fat patterning is related to health status in direct and indirect ways; for example, there is strong evidence that body fat at greater than normative values (relative to gender), especially in the form of central body depositions of adipose tissue, correlates with increased risk for cardiovascular diseases and for the metabolic malady of late-onset diabetes (non-insulin-dependent diabetes mellitus).

Processes of societal "modernization," including increased population mobility, provision of social services, and industrialization (the transition from a predominantly agricultural mode of subsistence to a cash-based economy) have all influenced body shape and size, in both positive and negative ways. Positive effects have come through improved health care and education; negative effects through the growing preponderance of Western lifestyles and consumption of highly processed, energy-dense foods (such as candy and "fast food"). Widespread increases in levels of obesity (often coupled with malnutrition) have been common in low-income as well as middle- and upper-income communities, and throughout urban, peri-urban, and rural areas. Medical obesity (generally defined as an individual who weighs 25 percent more than the expected weight for a given height and body frame) has become particularly acute among recently modernizing populations of the so-called New World regions, that is, the Amerindians of the Americas, the Aborigines of Australia, and the Polynesians of the Pacific islands. It is unclear whether these populations may be genetically susceptible to late-onset diabetes triggered by rapid social and economic change, or whether undernutrition during fetal and infancy years may be an underlying factor. While in the developed (some might say overdeveloped) countries excess energy (caloric) intake relative to expenditure presents the greatest food-related health problem, in much of the world undernutrition is still a major cause of morbidity and mortality.

Culture and Excess Food Consumption

Ideologies about the body and beliefs concerning ideal body size and shape are highly culture specific and, as such, transform over time, as cultures themselves undergo changes in subsistence, politics, religion, aesthetic tastes, and cross-cultural contact.

Contrary to the medical diagnosis of obesity, social definitions of obesity vary cross-culturally and across different historical eras. In traditional societies, excess body weight has generally been regarded in positive terms. Its value may even be culturally elaborated to such an extent that certain members of the group are deliberately fattened, especially in communities living in environments experiencing extreme seasons or marginal subsistence. For example, in past times when food supplies were irregular among the Nauru peoples of the Pacific, young women were fattened to improve their reproductive performance. Herein, the reproductively viable woman "was supported in her role as the creator of new life, in a community which perceived itself to be under demographic threat" (Ulijaszek et al. 1998, p. 410). Even when Nauru puberty ceremonies involving fattening practices diminished in importance as a result of the introduction of a cash economy, food as a marker of prestige persisted. Likewise, ritual fattening of Annang women in Nigeria is believed to enhance fertility, whereas, among the Azande of Central Africa, fatness is still associated with higher social status as well as greater fertility.

In some cultures, fatness has not only been desirable, it has been evocative of desire, particularly sexual desire. During the Chinese Tang Dynasty (618–907) and for long thereafter, plumpness was the standard of beauty for women; wealthy women were over-fed to levels of excessive obesity. Today, Chinese phrases still equate plumpness with health and good fortune; conversely, phrases associated with thinness indicate poor physical and social position.

Turning to prehistory in this context, it is worth noting the numerous Paleolithic statuettes of obese, voluptuous female figures that have been found over a broad geographical region of present-day Europe. The remarkable uniformity of female figurines, which are almost invariably obese and far outnumber male figurines (none of which are corpulent), suggests that a shared perception of a particular female form existed during Paleolithic times. The most famous of such figurines—the Venus of Willendorf—dates from 26,000 to 22,000 years ago. While we may never know whether the Venus of Willendorf was an actual woman, a fertility-cult idol, or a "mother" goddess, she likely represented a widespread ideal of femaleness, one that emphasized obesity. Based on the life-like depiction of the fat patterns and other features of the statue, it has been suggested that she must have been modeled on a real human subject. If so, she would most likely have been exempt from food-gathering and other high-energy exertion activities, implying that collective food resources were devoted to her care.

The positive value accorded to fatness in some cultures has generally been interpreted as a response to the vagaries of uncertain food supply, wherein individuals with larger body size represented better reproductive potential, higher social status, economic success, and/or better survivability during times of shortage. Body fatness does in fact confer considerable advantages in buffering adversity and promoting female reproductive success: the energy store of body fat in adequately nourished women is usually equivalent to the energy cost of a pregnancy. There is thus a direct, biological equation between body size and individual health, and by extension between the body size of group members and group welfare. Since physical strength derives from food (that is, adequate nutrition and caloric intake), controlling a secure food supply is a source of power, and a marker of such, resulting in a symbolic connection: food not only converts into, but comes to symbolize, fat, flesh, mass. Excess body size might reflect food security, signaling the endurance of the collective and its demographic (hence, politico-military) strength. The obese, voluptuous female may literally embody the practical and ideological values of food. Likewise, the pregnant or lactating female figure is a corporeal sign of the body as life-giving food, itself a source of survival for future generations.

With the rise of industrialization, the majority of the population has become emancipated from direct engagement in the food quest and food production, while at the same time food has become more readily available to all.

The positive value and the aesthetic desirability of obesity common in traditional societies tend eventually to subside with modernization. In late-twentieth-century Western societies, fatness became associated with sloth and laziness, and the cultural ideal emphasized a slender body form and even implied a moral virtue related to thinness. In spite of these new ideals and well-documented negative health effects of being overweight, obesity has nonetheless emerged as an epidemic health problem worldwide (reaching levels as high as 60 percent of adults in the contemporary United States). Tragically, moreover, the excessive ideals of thinness allowed to perpetuate in the fashion and cosmetics industries have contributed to the rise of another major public health crisis in Western societies, in the form of eating disorders, such as self-starvation, or anorexia nervosa.

Ideologies of the Anorexic Body

Food's central role in mediating the cultural construction of the body is as true in the case of such wasting diseases as anorexia nervosa as it is for obesity. An extremely complex psychological and somatic illness, anorexia nervosa is a life-threatening eating disorder defined as a refusal to eat that results in a body weight of less than 85 percent of the individual's expected weight for height and age. Features of anorexia that shed light on the relationship between the body, the self, and culture include an intense fear of gaining weight, a distorted body image of being fat (even when the anorexic may be emaciated in actuality), absence of regular menstrual periods, and in some cases, binge eating followed by self-induced vomiting or laxative abuse. Anorexia predominantly strikes females, especially in their teenage years; only 10 percent of sufferers are males. Conservative estimates suggest that 1 percent of females in the contemporary United States develop anorexia, and approximately 4 percent of college-age women in the United States suffer from the binge-eating disorder of bulimia.

Anorexia in its contemporary form is generally regarded as a negative symptom of the current popular culture ideal of female slenderness that valorizes an emaciated and androgynous supermodel-type of figure, characterized by an unrealistically thin waist, willowy limbs, and small breasts. The disease is thus shaped by the cultural concept of the female body in the West, a concept in which food and food symbolism play a central role alongside gender roles and expectations. According to feminist theories, patriarchal ideologies juxtapose the masculine body as an active working thing (energized by caloric intake and a very carnal, consuming relationship to the external world at large) against the feminine body as a passive vehicle intended to provide gratification, which exists in order to be used, to be itself consumed. In short, the masculine subject depends for its existence on the construction of the feminine object as an arena for action and penetration.

In this context, anorexia has been interpreted as both a symptom of a woman's imprisonment to patriarchal society and as an attempt to resist its pressures. On the one hand, an anorexic woman enslaves herself to the impossible ideals of thinness, and by practicing self-starvation literally internalizes and embodies dominant culture's tacit attempts to minimize and control her. On the other hand, by not eating, the anorexic attempts to assert autonomy over her body and body boundaries, and thereby free herself of external incursions. In both events, food acts as a metaphor for all foreign (contaminating) substances, and food abstinence becomes a measure of self-discipline, self-reliance, and purity: the anorexic shuts out the world, with an autonomy on display and visibly performed in the figure of her thin, model-like body. Yet food consumption is also an expression of desire. If women threaten to become active subjects through the expression of desire in the form of a voracious appetite, then the patriarchal definition of womanhood is undermined. In the logic of this equation, "flesh is appetite made concrete" (MacSween) and appetite is a form of voice (Brumberg, p. 19). Female fat thus becomes an external sign of female desire that intrudes into masculine space. While power might commonly be equated with size, it has been noted that, as women become more powerful and visible in society, they also paradoxically become less massive. In other words, the successful woman is a thin woman. On the surface, the dominant theme reads that a successful woman has the willpower to not eat; at the same time, however, there exists a hidden and contradictory subtext: that women should really not be visible or powerful. With a rise in female power, then, there is a corresponding loss of female flesh, and, paradoxically, a symbolic cancellation of female presence.

Hence, by not desiring food, a modern anorexic makes her body desirable according to the norms of dominant society. By making her body a mirror of starvation, she simultaneously makes herself less threatening to patriarchy. These parallels between desire and food, modesty, and morality also underpin a type of "holy anorexia" that pious medieval women were known to practice. In Europe in the early Christian Middle Ages, asceticism—including abstinence from food consumption—was considered a form of religious piety, and anorexia in particular was a chosen path for women wishing to express their religious fervor. Like its modern counterpart, medieval anorexia may have served to order women's behavior according to dominant values, but also to exercise a kind of resistance. In a historical epoch with few or no birth control options, medieval women anorexics (whose symptoms generally included irregular menstruation) could free themselves of the burden of fertility, while manipulating the powerful imagery of female fertility. For both the medieval and the modern anorexic, then, self-starvation has been part of a larger struggle for liberation from a patriarchal family and society, in the former case, to achieve greater spiritual purity and in the latter, to succeed in the secular public sphere.

Food and Body Connections

For a variety of reasons, males are less associated with food and food symbolism than are females, a situation that largely holds across cultures. Ideologies about the ideal male body in contemporary Western societies tend to focus on muscular body build achieved through energy expenditure and exercise regimes, rather than through food intake or abstinence. Men who suffer from anorexia athletica (compulsive exercise) may abuse food in the form of undereating or binge eating, along with steroids or laxatives, in attempts to achieve a model physique.

Perhaps because of the ideological links between musculature and virility, red meat (primarily beef) has popularly been regarded as "man's food" in contemporary society. The common cliche "real men don't eat quiche" captures such gender assignment of food in a Western "you are what you eat" cultural paradigm. Salads are seen, by contrast, as the preserve of women, though not simply based on caloric levels, since while meat has higher calories than lettuce, salad dressings are likely to be calorie-rich. Chinese culture provides another pronounced example of food categorization schemes, wherein most foods possess either a *yin* or *yang* nature, categories that also align with female or male connotations, respectively.

In sum, culture-specific body image plays a prominent role in consumption patterns and types of food consumed, based on gender and dominant ideologies. As food consumption is "worn" by the body through processes of human growth and development, it might be said that beliefs about food are "worn" by the body as a reflection of cultural norms. In various cultural and historical contexts, the body, as an index for food, has come to symbolize individual and collective welfare, fertility, morality, sexuality, power, and/or resistance.

See also **Anorexia, Bulimia**; **Aversion to Food**; **Body Composition**; **Consumption of Food**; **Eating**; **Evolution**; **Gender and Food**; **Obesity**; **Women and Food**.

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Kyra Landzelius

BODY COMPOSITION. The term body composition describes the various components that make up a person's body. The absolute and relative amounts and distribution of these components are relevant to diverse body functions and, thus, influence the state of health and various disease risks. A commonly used body composition model organizes the body to five levels of increasing complexity: from atomic to molecular, cellular, tissue-system, and whole body.

At the atomic level, the body is made up of chemical elements essential for life. Four major elements, oxygen, carbon, hydrogen, and nitrogen, collectively account for more than 96 percent of adult body weight. The remaining are minerals present in the form of salts. Calcium and phosphorus make up the major bulk of remaining minerals, found mostly in bone.

The four elements, oxygen, carbon, hydrogen, and nitrogen, are present at the molecular level in water and as organic compounds. Water serves as a solvent where chemical reactions take place. Protein and phospholipids serve as major structural components of the body. Proteins, glycogen, and lipids that include phospholipids and fats are all organic compounds. Protein, in the form of enzymes and hormones, performs important biochemical and physiological roles in the body. Glycogen reserves are small and used mainly as metabolic fuel. Fat serves as insulation and as an energy store. The two major organic compounds, protein and fat, plus water are usually grouped with the mineral component (osseous and nonosseous) to form the four-compartment model, a model used most often when considering the nutritional status of a person.

Two alternate groupings of these components used to describe body composition at the molecular level are the division of the body into a fluid and a dry component. The latter is comprised of proteins, minerals, and fat. The second alternative, also referred to as the classic two-compartment model, divides the body into fat and fat-free masses. Fat mass is the most variable as it is affected by energy balance. The fat-free mass is composed of water, proteins, and minerals. This term is used synonymously with lean body mass. This compartment also includes essential lipids. It is metabolically important and its chemical composition is assumed to be constant in a healthy adult.

At the cellular level, the chemical compounds are assembled into either the cellular component (the body's main functional components) or the extracellular supporting components; for example, extracellular fluid and solids, of which the skeleton makes up its major bulk. Because living cells consist of metabolically important structures and an inert fat component, the cellular component is further subdivided into a body cell mass and fat. This three-compartment model of body cell mass, fat, and extracellular components presents a physiological view of the body.

The tissue system level is also of structural and functional importance. Tissues contain cells that are mostly similar in appearance and function. Tissues and organs are categorized into adipose tissues, skeletal muscles, skeleton, blood, and a "residual" category that includes the skin and visceral organs. Adipose tissue includes fat cells, blood vessels, and structural elements. White adipose tissue is located mainly in the subcutaneous and visceral compartments. Subcutaneous fat provides insulation, and most visceral fat serves as an energy store. Brown fat is present in small quantities in discrete locations and plays an important role in heat production in neonates during cold exposure.

The whole body level of organization involves physical characteristics, such as body size and shape.

Normal Changes Throughout the Life Cycle

Growth. The growth process involves an increase in body size and compositional changes of tissues and organs, physiological changes during adolescence, and finally, chemical maturation of tissues and organs to reach a "stable" composition in adulthood (Table 1). Growth in height, weight, tissues and organs, and changes in chemical composition are not uniform. Thus, the relative proportions of various tissues and organs vary at different stages of growth (Table 2).

Length and weight increase rapidly during the second half of gestation and continue to change rapidly through the first year of postnatal life. There is a relative slowing in growth rates as gestation approaches term,

TABLE 1

Anthropometry and body composition of fetus, neonate, and adult

		Neonate		20- to 29-year-old adult		60- to 69-year-old adult	
Parameter	28-week fetus	Boy	Girl	Male	Female	Male	Female
Body weight (kg)	1.015	3.530	3.399	78	64	83	71
Length/height (cm)	36	50	49	176	163	174	160
Body mass index (BMI)	–	–	–	25.2	24.2	27.4	27.7
Components of whole body (% body weight)							
Fat	4	14	15	11	29	31	45
Water	84	69	69	65	51	52	43
Protein	9	13	13	18	15	14	11
Bone mineral mass	1.2	2.1	2.1	4.2	3.7	3.5	2.7
Components of fat-free mass (% fat-free mass)							
Water	88	81	81	73	72	75	77
Protein	9	15	15	20	21	20	20
Bone mineral mass	1.3	2.4	2.5	4.7	5.2	5.0	4.9

Data on fetuses were calculated from those of Widdowson and Dickerson, and those of Ziegler and coworkers.
Data on neonates were those of Fomon and coworkers.
Bone mineral mass for fetuses and neonates were calculated using the equation of Koo and coworkers.
BMC (g) = 24.2 ∗ body wt (kg) – 11.1.
Data on body weight and stature in adults were from NCHS for all race/ethnicity groups in the United States.
Data on body fat and fat-free mass in adults were those of Reference Man.
Data on water, protein, and bone mineral mass of adult Caucasian males and Caucasian females in the United States were calculated from their relative proportion in fat-free mass using the data of Ellis.
Data on water, protein, and bone mineral mass in fat-free mass of adult Caucasian males and Caucasian females in the United States were those of Ellis.

TABLE 2

Weight distribution of organs and tissues

		Adult	
	Neonate	Male	Female
Body weight (kg)	3.4 kg	70 kg	58 kg
Organs or tissues (percent body weight)			
Adipose tissue	27%	21%	33%
Skeletal muscle	22%	40%	29%
Skeleton	9 –18%	9 –18%	9 –18%
Visceral*	8%	7%	7%
Skin (excluding hypodermis)	6%	4%	3%

Data were those of Reference Man.
*Visceral organs include heart, lung, stomach, intestines, liver, gall bladder, pancreas, and spleen.

due to the physical constraints imposed on the fetus. Rapid growth in skeletal muscle and adipose tissue causes a concomitant surge in the relative protein and fat contents in the fetus and a decrease in its relative water content. At the same time, a progressive fluid shift occurs from the extracellular into the intracellular compartment. Progressive mineralization of the skeleton also occurs during this period.

After the first year, growth rate slows until the second major growth spurt at adolescence. Hormonal changes during adolescence cause major physiological differences between sexes. The "adolescent growth spurt" lasts about two to three years and begins earlier in females. In females, there is a larger accretion of body fat. In males, the increase in skeletal muscle mass is more intense and of longer duration. This sex difference in skeletal muscle and fat content persists throughout the adult years. "Chemical maturation" of the fat-free mass is completed during adolescence, when there is a relative decrease in water and a relative increase in fat, protein, and bone mineral mass.

Normally, adult height and weight are reached at about eighteen years of age by females, and twenty years of age by males. The height and weight is 170 cm and 70 kg respectively for the reference adult male, and 160 cm and 58 kg for the reference female. Relative weights of skeletal muscles and adipose tissue are higher, and that of viscera lower, in adults compared with infants. Although relative weight of the skeleton is similar between infants and adults, the adult skeleton has a higher mineral content.

Aging. The aging process produces a decline in height, lean weight, muscle mass, and skeletal size. Loss of skeletal muscle and bone mass is related to the age-associated decline in physical activity and to the decline in various hormonal secretions.

BODY MASS INDEX

Body Mass Index (BMI) is a useful guide for assessing adiposity. BMI is weight/height^2 (kg/m^2). It is related positively with body fat content. A high BMI is associated with an increased risk of cardiovascular disease, diabetes, osteoarthritis, and other conditions. However, a high BMI may also reflect a high muscle mass. Thus, other assessments should be performed, and BMI is only one of several risk factors associated with the diseases noted above.

A range of values for BMI has been used to help adults assess their health status. According to the Centers for Disease Control and Prevention (CDC), a healthy BMI for adults is between 18.5 and 24.9 kg/m^2. An individual with a BMI value of less than 18.5 is considered to be underweight. A BMI value of between 25.0 and 29.9 is considered to be overweight, and obesity is designated by values of 30 or higher.

It is more difficult to interpret BMI values for children and adolescents because of changes in body fat content that vary normally with age and sex in these life stages. As with growth references for weight and height, sex-specific preferences for BMI-for-age are available for ages two to twenty years. Limits have been established to identify undesirable weights in children and adolescents. Those under the fifth percentile on the BMI-for-age references are classified as underweight; those equal or over the eighty-fifth percentile are considered to be at risk of becoming overweight; and those equal or over the ninety-fifth percentile are considered to be overweight.

Changes in Body Composition under Different Conditions

Weight loss. Prolonged food deprivation causes growth faltering in children and weight loss in adults. Recurrent infections due to poor hygiene and health care may exacerbate food deprivation. Severe weight loss also occurs in diseases, such as malignant cancers, hepatic and renal diseases, and those involving the gastrointestinal tract. Loss in weight in severe undernutrition is due to loss in both body cell mass and fat mass.

Loss in body cell mass and preservation of the extracellular fluid results in an increase in water content in the fat-free mass and an increase in the ratio of extracellular fluid to intracellular volume.

Weight gain. Most weight gain involves a mixture of fat and lean tissues with their relative contribution depending on the initial body composition, physiological

Methods of Measurement

Because of the implications of changes in body composition to health and disease, there is a need for their measurements. Virtually all the major elements—oxygen, carbon, hydrogen, nitrogen, sodium, chlorine, calcium, and phosphorus—can be measured directly by *in vivo* neutron activation analysis techniques. Total body potassium (K) can be measured by whole-body counting of the naturally occurring radioisotope ^{40}K. These techniques are expensive and are available in only a few centers.

The four-compartment model (fat, water, protein, and mineral) is ideal for assessing growth and nutritional status. Theoretically, fat mass can be assessed from the distribution volume of inert gases; but in practice, it is problematic, and its use remains a challenge. Water can be estimated by measuring the dilution volume of water labeled with stable-isotopes of hydrogen, ^2H_2O, or oxygen, $H_2{}^{18}O$); protein may be estimated indirectly from measurements of total body nitrogen by assuming that 16 percent of protein is nitrogen; and the total body mineral contents calculated from total bone minerals which are estimated by whole-body dual-energy X-ray absorptiometry (DXA).

Although fundamentally important, methodological constraints often limit the use of the four-compartment model. Thus, the classic two-compartment model that compartmentalizes the body into fat mass and fat-free mass is used more widely by physicians and exercise physiologists. Fat-free mass, which includes water, proteins, and minerals, can be determined by various indirect methods if one assumes that the relative composition of this compartment is relatively constant in healthy adults. The established "constant" values for the various components of fat-free mass are population- and ethnic group–specific, and applicable only to healthy young white adults. Successful application of the two-compartment model to the young, sickly, elderly, and different ethnic groups requires determination of group specific "constants."

The earliest method, and one considered to be the "gold standard," for estimating fat-free mass, is densitometry. The body density is obtained by underwater weighing and assuming a density of 1.100 g/cm^3 for fat-free mass and 0.900 g/cm^3 for fat mass. A more modern air-displacement method has been used to measure body density. Its advantage is its applicability to infants, the sickly, and the elderly. Fat-free mass can also be estimated from measurement of either total body water or potassium, and by assuming that the water content of fat-free mass is 73.2 percent, and that its potassium content is 68.1 mmol/kg in adults. Other noninvasive methods for measuring body composition include total body electrical conductivity (TOBEC) and bioelectrical impedance analysis (BIA) techniques. These methods use the principle that the fat-free mass conducts an electrical current better than does the fat mass.

Although information at the cellular level is important, quantifying the compartments may be technically difficult. Attempts have been made to assess the size of cellular compartments in healthy adults by using "constant" values. Body cell mass has been estimated from measurements of potassium multiplied by a factor of 8.33, and extracellular solids from estimates of total body calcium and the assumption that 17.7 percent of extracellular solids is calcium. Dilution volume of bromine or chlorine has been used to estimate the extracellular fluid volume.

Most of our knowledge of the composition of specific tissues and systems comes from studies of cadavers and tissue biopsies. Computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound imaging provide information on subcutaneous and visceral adipose tissues, and DXA provides information specific to the skeleton. Skeletal muscle mass can be estimated indirectly from measurements of total amount of creatinine in the urine over a 24-hour period. Radiology is useful to assess the proportions of bone, fat, and muscles in limbs.

Commonly used techniques at the whole body level are anthropometric measurements of body weight, height, body circumferences, and skinfold thicknesses. These techniques are simple and easy to perform and are well suited for field work or for large-scale studies. Sex-appropriate clinical growth charts available from the National Center for Health Statistics (NCHS) are used routinely for clinical assessments of growth by pediatricians. Two sets of sex-appropriate weight-for-age, length-for-age, and weight-for-length percentile references are available: one for infants from birth to thirty-six months, and another for older children from two to twenty years of age. Two often-used methods that reflect fatness are measurements of skinfold thickness and estimates of the body mass index (BMI). Regional subcutaneous fat distribution can be estimated from skinfold thickness measured with specifically designed calipers. The approximate ratio of upper–body adiposity to lower-body adiposity may be estimated by measuring waist and hip circumferences. Body mass index, calculated from weight/height^2 (kg/m^2), is often used to assess adiposity.

status, and physical activity. For example, an obese person gains a larger proportion of fat than lean tissues than does a lean person.

Overweight and obesity, and their associated health risks, are of increasing prevalence in affluent societies. In the United States, the incidence of obesity has increased from 12 percent in 1991 to 17.9 percent in 1998.

The significant consequences of increase in adiposity are not limited to net changes in body composition. Specific regional fat distributions appear to be associated with diverse levels and types of morbidity. Higher levels of upper-body obesity, especially of the visceral, is associated with abnormalities of fatty acid metabolism and is related to the higher risks of hypertension, premature coronary death, and type 2 diabetes mellitus.

Physical training. In general, physical training increases muscle and bone mass, and decreases fat mass. Gains in muscle mass and losses in fat mass vary with the intensity and duration of usual physical activity. Changes in body composition associated with physical activity are mediated by increases in the secretion of anabolic hormones. These increase lean body mass. Increases in catecholamines facilitate fat loss.

Immobilization. Reduction or loss of mobility increases the nutritional risk of obesity or sarcopenia, an abnormally low lean body mass. Prolonged immobilization causes loss of body nitrogen and calcium, hence a decrease in muscle mass accompanied by decreases in muscle strength and decreases in bone density.

Osteoporosis. The high prevalence of osteoporosis in the elderly, especially in females, is a major public health concern. Loss of bone mass and deterioration of bone tissue is a feature of the normal aging process that is attributable to an intrinsic deterioration of the ossification process. It leads to increased bone fragility and, consequently, increased risk of bone fracture. Although reduction in bone density affects every individual, in some, loss in bone mass is severe. The skeleton is not uniformly involved; the spine and other trabecular bone are more affected commonly and severely than is the cortical bone of the axial skeleton. The greater severity of osteoporosis in females is attributed to a lower peak bone mass achieved at puberty and estrogen withdrawal at menopause. Other factors causing loss of bone mass are a lack of physical activity and decreased calcium intake.

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BODY IMAGE. *See* **Anorexia, Bulimia; Body; Eating: Anatomy and Physiology of Eating; Obesity.**

BOHEMIA. *See* **Central Europe.**

BOILING. The admission of the novice cook that he or she “cannot even boil water” has perpetuated the idea that boiling water is one of the simplest tasks in the kitchen. In reality, it is also a frequently misunderstood and mislabeled culinary technique. Boiling is one of the moist (as opposed to dry) heat processes of cooking, which include pressure cooking, scalding, simmering, poaching, stewing, fricasseeing, braising, casserole-making, double-boiling, and steaming, as well as partial moist-heat processes, like blanching. Through the years, however, these traditional terms for different kinds of moist heat cooking have been variously interpreted and,

Photo showing the physics of boiling water and its change to steam. COURTESY OF PHOTO RESEARCHERS, INC.

of necessity, combined with other culinary methods. For example, a braise, fricassee, and brown stew have their origin in dry heat sautéing but are finished by long moist-heat cooking in stock. Even foods that are specifically labeled "boiled," such as boiled eggs, boiled potatoes, and boiled coffee, are not entirely cooked in boiling water but rather simmered after being brought to a boil. The pores of food are sealed by being dropped into rapidly boiling liquid, but then the temperature is usually reduced to a simmer (185–200°F)—the suitable temperature for cooking soups, stews, and braises.

Boiling, or *bouiller*, is cooking in boiling water. Water boils at 212°F (sea level), and simmers at 190°F. To fully understand the heating process, Julia Child advises the cook to observe water in its various cooking stages, from tepid to real boil, by testing it and using an immersable thermometer and noting the following temperature changes:

Tepid: 85 to 105°F. The water is comparable to the temperature of the human body.
Warm: 115 to 120°F. The water is touchable but not hot.
Hot: 130 to 135°F. The water is too hot to touch without injury.
Poach: 160 to 180°F. The water is beginning to move, to shiver.
Simmer: 185 to 200°F. There is movement, and little bubbles appear in the water.
Slow boil: 205°F. There is more movement and noticeably larger bubbles.
Real boil: 212°F. The water is rolling, vigorously bubbling, and steaming.

Boiling is affected by altitude. At sea level, water boils at 212°F; at 3,000 feet, it boils at 205°F; 5,000 feet, at 203°F; and 7,500 feet, at 198°F. Because certain foods, like soup, pasta, and vegetables, will cook at a lower temperature, they will take longer to cook.

The boiling process serves two purposes: it destroys organic impurities, and it transforms raw ingredients into cooked foods. Boiling water hardens the albumen in eggs; toughens fibrin and dissolves tissues in meat; and bursts starch grains and softens cellulose in cereals and vegetables. One of the great advantages of water as a cooking medium is that it needs only a vessel and heat to reach and maintain its boiling point, no matter how long or how hard it is heated.

The food scientist Harold McGee maintains that during the boiling process, it is the convection currents in hot water that heat food. The "moist" cooking methods, however, cannot brown foods; consequently, meat and vegetables are normally sautéed in a frying pan before they are simmered in broth or water. Despite this limitation of the technique, by which boiling in water is conducted at a substantially lower temperature level than that of broiling, baking, and frying, boiling is a very efficient process. As McGee notes in *On Food and Cooking*, "The entire surface of the food is in contact with the cooking medium, which is dense and turbulent enough that the water molecules continuously and rapidly impart their energy to the food" (p. 615).

The old adage "a stew boiled is a stew spoiled" can be applied to almost every other kind of food because lengthy cooking at high temperatures toughens the proteins in meats, fish, and eggs, and the rapid bubbling breaks up delicate foods. While recipes either call for foods to be immersed in cold water and brought to the boiling point or plunged into boiling water, they almost never indicate boiling for a protracted period of time. Even so-called "boiled" eggs should be simmered after the initial contact with boiling water. Simmering, then, is often used in tandem with boiling because simmering liquid gently cooks fragile foods and tenderizes tough ones.

Only certain foods, such as vegetables, pasta, cereals, and other grains, are truly boiled in water. In these cases, it is necessary to maintain the boil to ensure their proper cooking. Because adding foods to boiling water lowers the boiling point, it is usually stipulated that the quantity of water must be at least three times the volume needed to cover the ingredient to offset the lower temperature caused by their addition. In cooking vegetables, particularly, the amount of salted water will insure rapid boiling, thereby shortening the time of cooking and preserving color.

According to Fannie Merritt Farmer, milk should never be allowed to boil because at boiling temperature the casein is slightly hardened, and the fat is rendered more difficult to digest. She advises the use of a double boiler to "scald (196 degrees)" milk heated over boiling water.

History of Boiling

McGee theorizes that, as a culinary technique, boiling probably followed roasting and preceded baking. Because boiling requires containers that are both water- and fireproof, the development of pottery at least ten thousand years ago had to precede boiling. And the large pots hanging in the fireplaces of the earliest kitchens attest to the fact that many meals were slowly simmered, sometimes over a period of days. In Taillevent's *Viandier* (c. 1364) the cook's activities centered on a fireplace that featured an adjustable pothook from which large cooking pots hung filled with meats, poultry, game, and vegetables. To control temperatures, the pot's position could be stationary over temperate ashes or could be swung over the hottest coals. Hot coals or logs could also be moved beneath it. This method of hearth cooking continued into the eighteenth century and even later in rural areas. Chef and author John Thorne eulogizes the pot as the emblem of the kitchen and quotes the noted French chef Alain Senderens, who suggests in his *Figues sans barbarie* (1991) that unlike "spit cooking" or the kind of roasting associated with the early "gatherers," "the cooking of the pot symbolized the feminine domain of the kitchen, family, economy, and, by extension, the civilizing process itself." By preparing food in boiling water in a pot, the cook took what nature provided and transformed it into thoroughly cooked food. "From this instant," Senderens believes, "cooking came to indicate the cultural, intellectual, and technological level of a society" (Thorne, p. 239).

Whether gender driven, as Senderens implies, or a matter of historical temperament, the cooking process became more complex and varied because of the invention of pottery at least ten thousand years ago. Furthermore, the word "pot," contrary to popular belief, does not seem to reflect the Latin *potare* (to drink) or be related to the Spanish *olla* or Italian *pentolone* or *marmitta*—the words for large cooking vessels. Etymologically, "pot" can be traced to Celtic origins: Irish *pota*; Gaelic *poit*; and Welsh *pot*, and there is reason to believe that the word "pot" may have developed initially in northern lands.

Traditionally, boiled dinners and one-pot cooking seemed to be a congenial way of dining in cold climates. From broth-based fondues in Switzerland to the soup kettle that used to hang over the open hearth in the old farmhouses of Japan's snow country, variations on sustaining one-pot meals can be found in almost every ethnic cuisine, including the Italian *bollito misto*, Spanish *cocido*, and the French *potee lorraine*. The cold regions of China had a communal dish known in the West as the Mongolian hot pot, named for its distinctive cooking utensil, and a popular contemporary Japanese modification is called *shabu-shabu*.

Asian cooking also has a communal one-pot meal, called *nabemono*, literally "things in a pot," which is served at home and in restaurants. Diners do their own cooking, choosing whatever meat, poultry, fish, and vegetables they like from platters overflowing with raw ingredients that they cook over a communal pot of sizzling broth. The broth is continually enriched in flavor as the ingredients are dipped into it. Although the *donabe*, an earthenware casserole with thick pottery walls and distinctive shape, requires a portable and substantial heat source to maintain the temperature of the dipping broth, everything from gas rings to an alcohol or canned-heat burner can be used effectively during the traditional lengthy meal.

Pot-au-feu, or "pot on the fire," consisting of meat, poultry, and vegetables in their cooking liquid, has also been a fixture of French gastronomy since the Middle Ages, and it was dramatized by King Henri IV, who promised his subjects a chicken in their pot every Sunday. In some French cookbooks a distinction is sometimes made between a pot-au-feu, a boiled beef and vegetable dinner; and a *poule-au-pot*, in which a whole stewing hen was used; and a *potée* or mixed pot of ingredients, including pork and veal shoulder and various sausages. Used in every French household, the tall earthenware cylindrical pots known as marmites were the ideal cooking utensils for this meal of meat, poultry, and vegetables, which was brought to a boil in water and then simmered for hours over the fire. A good consommé was thereby produced and a full-course dinner served—clear broth first, the boiled meat and vegetables presented separately. A dish called petite marmite was almost identical with pot-au-feu except that its primary purpose was to be served and eaten all together.

By the time Pierre François de la Varenne's cookbook was published in 1651, the fine broth that hours of simmering had produced in these one-pot meals had an intrinsic value, and separate recipes for bouillon began to appear for the purpose of enhancing soups and entrees. As did medieval cooks before him, La Varenne kept in reserve one meat stock and one fish stock to make a roux, flavor a soup or stew, and combine with other ingredients for a sauce.

On the other side of the Atlantic, boiled dinners have always been popular in New England, Pennsylvania, and other parts of the country. Prepared like a pot-au-feu, the New England boiled dinner is made traditionally with either corned or fresh beef, and boiled beets on the side, while other sections of the country feature an Irish boiled dinner that includes cabbage, onions, and new potatoes simmered with the corned beef. Boiled crab dinner, the signature seafood dish of the Chesapeake Bay region, consists of blue crabs placed into seasoned boiling water, cooked, cracked open, and accompanied by melted butter. And Wisconsin boasts a famous Door County whitefish boil.

Among the nutrition conscious, there is growing concern about whether cooking, especially the lengthened cooking of boiling, robs foods of their vitamins and enzymes. The cult of raw food, for instance, has rapidly gained momentum. For such adherents, 116°F is the point beyond which components of the original human diet become "dead," unhealthy victuals. But nutritionists generally come down on the side of cooked food, both to rid ingredients like mushrooms and meats of toxins and to enhance the pleasures of the table. Boiling and its related moist heat cooking techniques, therefore, are worthy of mastering and a challenge to the cook.

See also **Child, Julia; Cooking; La Varenne, Pierre François de; Nutrients; Packaging and Canning, History of; Poaching; Preparation of Food; Taillevent; Water: Water as a Resource.**

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Joan Reardon

BOTANICALS. Botanicals are fresh or dried plants, plant parts, or plants' isolated or collective chemical components, extracted in water, ethanol, or other organic solvents, plus essential oils, oleoresins, and other extractives used for flavoring, fragrance, functional health benefits, medicine, or other biological and technical activities. Many botanicals, broadly speaking, also can be classified as herbs, plants used for flavor, fragrance, or medicinal qualities, such as caraway, parsley, rosemary, sage, and thyme. Other botanicals fall under the classification of spices, piquant aromatic plant materials, usually of tropical origin, used to season food. Examples include cloves, cinnamon, nutmeg, and pepper. Botanicals commonly are used in foods, drugs, and cosmetics. The cosmetic industry uses over 360 botanical ingredients, classified as "biological additives," to enhance the fragrance, performance, or consumer appeal of products. Botanicals, either in crude form (whole dried plants or plant parts) or in their isolated or modified chemical constituents, also are used in prescription and nonprescription (over-the-counter) drugs. In addition, over 1,600 botanicals and their derivatives are sold in the United States in a special food category called "dietary supplements." In commercial trade, botanicals, though not defined as such, generally refer to dried materials of plant origin sold in bulk form as whole, cut-and-sifted, or powdered ingredients.

Botanicals in Human Experience

Botanists conservatively estimate that 250,000 species of flowering plants exist on Earth. At least 85,000 plant species worldwide have been documented as being used as medicinal botanicals, at least in folk medicine. The World Health Organization estimates that as much as three-quarters of the world's population relies on traditional forms of medicine, chiefly herbal or botanical medicine. Botanicals used in foods, drugs, and cosmetics are an integral part of daily life.

The human experience in the use of botanicals is inextricably interwoven with human history. The first known historical evidence for the use of plants comes from the Middle Paleolithic burial site in Iraq known as Shanidar IV, a Neanderthal grave containing remains of yarrow flowers (*Achillea* spp.), marshmallow (*Althaea* spp.), and ephedra (*Ephedra* spp.), all of which are botanicals still in use in the twenty-first century.

The Ebers papyrus, dating to 1500 B.C.E., was discovered in 1876. This ancient Egyptian manuscript mentions 876 medicines, most of which are of botanical origins. Undoubtedly, ancient Greek scholars learned from their Egyptian predecessors about the use of botanicals in medicine. The writings of Hippocrates (466–377 B.C.E.) refer to many botanical substances. The starting point for Western medicine, and in particular botanical ingredients used in the West in the nineteenth and twentieth centuries, is the first-century work *De Materia Medica of Dioscorides of Anazarba in Cilicia*. For more than fifteen centuries, all Western cultures depended on this source for information on botanicals. It includes over six hundred botanicals, most of which are in use in the twenty-first century.

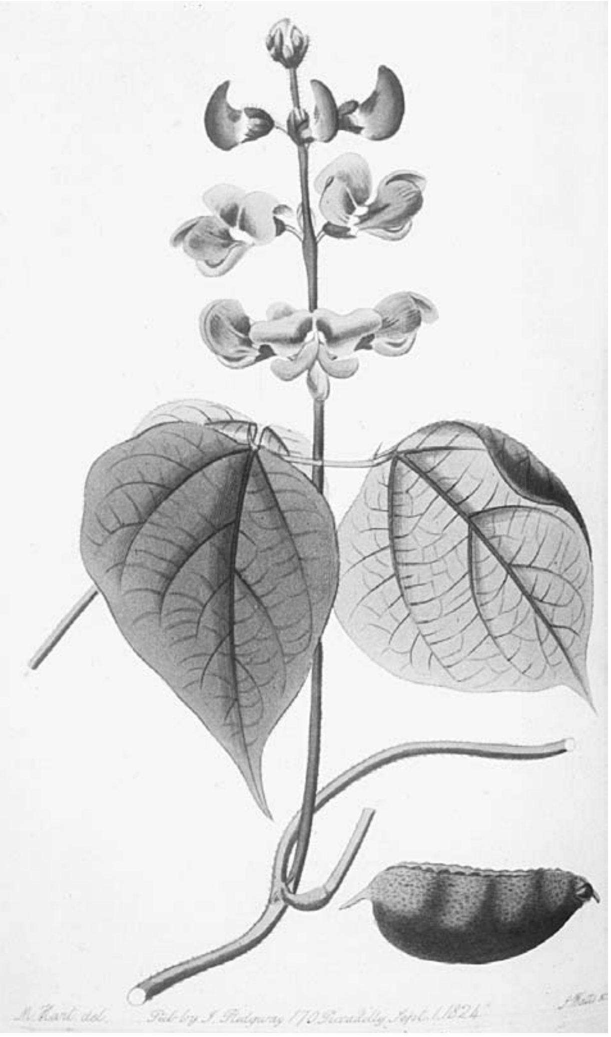
Botanicals as Food Additives

Over 250 botanical substances are added during food product manufacturing for flavor, fragrance, or technical characteristics, such as coloring, thickening, or preservative activity. These botanicals are used commonly and extensively, often in the form of concentrated extracts at parts per million levels, as natural ingredient additives for many categories of food products, including baked goods, canned goods, meat products, dairy products, nonalcoholic beverages, and alcoholic beverages. Many botanical ingredients have a long history of use and generally are recognized as safe. However, for a new ingredient, not previously marketed materially in the United States, to enter the American market, it must receive prior approval by the Food and Drug Administration (FDA). The manufacturer (or industry trade organization) may submit toxicological data to the FDA in support of the ingredient's safety.

Botanicals as Dietary Supplements

In 1994 the U.S. Congress passed the Dietary Supplement Health and Education Act, which created a special food regulatory category for dietary supplements, including vitamins, minerals, herbs or other botanicals, amino acids, or other dietary substances used to supplement the diet by increasing the total dietary intake. Concentrates, metabolites, constituents, extracts, or their combinations also are included in the definition. Dietary supplements are regulated as foods rather than as drugs despite the fact that most such products are intended to provide a health benefit. The vast majority of botanicals available on the American market, from over 1,600 plant species, are sold as dietary supplements.

Many well-known botanicals sold as dietary supplements in the United States also are available in other Western countries, notably Germany, where they are regulated as drugs under a special category called phytomedicines. By definition, phytomedicines include the totality of chemical constituents within a botanical or plant part rather than a single isolated chemical component. Well-known botanicals in this category are garlic *(Allium sativum)*, ginkgo leaf extracts *(Ginkgo biloba)*, echinacea *(Echinacea purpurea*, *E. angustifolia*, and *E. pallida)*, ginseng *(Panax ginseng)*, kava kava *(Piper methysticum)*, saw palmetto *(Serenoa repens)*, St. John's wort *(Hypericum perforatum)*, and valerian *(Valeriana officinalis)*. In the European markets for these botanicals, quality is strictly regulated. In the United States, it is not; therefore dietary supplements are perceived as "unregulated."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Botanical illustrations provide a rich source for information about historical food plants. This picture of the purple hyacinth bean (*Dolichos labab*) appeared in *Edward's Botanical Register* in 1824 and represents one of the most beautiful scientific renderings of this bean. It was grown as an ornamental in the United States, but the white flowering variety provides an important source of food in India. The bean was also known to the ancient Greeks and Egyptians. ROUGHWOOD COLLECTION.

Botanicals in Modern Medicine

Prescription and nonprescription drugs of botanical origin are used widely in modern medicine, primarily as purified derivatives or partially modified secondary chemical compounds. Remarkably it is estimated that approximately 25 percent of drugs in the average American pharmacy are botanical derivatives. Of 121 prescription drugs in use in the early twenty-first century that originate from 90 plant species, 74 percent were discovered in scientific follow-up of historical or folkloric claims of medicinal value. Botanical derivatives used in chemotherapy include paclitaxel (taxol), extracted from yew species (*Taxus* spp.), used for certain forms of breast and ovarian cancer; vincristine and vinblastine, purified alkaloids extracted from the Madagascar periwinkle *(Catharanthus roseus)*, used in the treatment of leukemias and Hodgkin's disease; and semisynthetic compounds from mayapple (*Podophyllum* spp.), used in the treatment of testicular and small-cell lung cancers. Nonprescription botanical ingredients include the laxatives psyllium seed (*Plantago* spp.) and senna leaves (*Senna* spp.). Some botanicals are the source of both drugs and foods. Morphine, codeine, and other chemical analogs from the opium poppy (*Papaver somniferum* L.) are used for the management of pain. The opium poppy is also the source of poppy seeds, used as a decorative and flavoring component in the culinary arts.

Foxglove: From Folk Medicine to Modern Botanical

The cardiac glycosides digoxin and digitoxin, extracted from several species of foxglove (*Digitalis* spp.), are used in the treatment of heart diseases, such as atrial fibrillation and congestive heart failure. This botanical was not well known to the ancients as a medicinal plant. Instead, it was considered a poisonous plant. A British physician, William Withering, introduced the drug to medicine in 1785 in *An Account of the Foxglove and Some of Its Medical Uses: With Practical Remarks on Dropsy and Other Diseases*, published in Birmingham, England, where Withering served as a physician at the general hospital. In 1775 Withering became aware of the secret family recipe of an elderly patient, Mrs. Hutton, in Shropshire, England. She had developed a reputation for curing "dropsy" (congestive heart failure) when physicians had failed. Withering discovered that the active ingredient was foxglove. Crude extracts of the botanical were prescribed widely in the 1800s, although exact dosing requirements sometimes resulted in fatal overdoses. The crude drug and its preparations have a narrow therapeutic ratio. A small increase in dose, only slightly above that necessary for therapeutic results, can produce toxicity. The discovery and isolation in the leaves of the glycosides responsible for the botanical's pharmacological cardiac effects led to more exact controlled dosage forms with lower risks of toxic effects.

"The Dose Makes the Poison"

Foxglove and its isolated chemicals are a good example of a fundamental principle in the response of a cell, organ, or organism to a botanical drug or food ingredient. The response or expected activity is proportional to the dose. Therefore, research on the effects of a substance on an organism requires measurement of a dose-response relationship. Such information is gathered by measuring responses to appropriately variable amounts of the active agent (usually in laboratory animals). Doses are increased incrementally until 80 percent of the maximal response is achieved. Above the level of 80 percent, usually only small changes in activity are observed. Higher doses also may result in toxic effects. Quantitative analyses of the dose-response curve measure the relative potencies of a drug or extract and help determine at what levels a beneficial or a toxic reaction may occur.

Inhibition or potentiation of a response often involves attachment of a molecule to a cellular receptor site. Targeting cell receptor sites helps direct research to specific activities, such as anti-inflammatory or analgesic (pain-relieving) effects, or to diseases, such as diabetes mellitus or cancer. Mechanisms of action of potential interest often relate to cell receptor site competition. Sometimes effects are mechanical. For example, psyllium seed works as a bulk laxative by absorbing moisture in the intestines, thus increasing bulk and stimulating mechanical peristalsis.

A common adage in toxicology is "the dose makes the poison." In pharmacology, the measure of a substance's margin of safety is known as the "therapeutic index." This index is expressed as the ratio of the dose causing harmful effects to the dose causing a therapeutic effect in a specific proportion of individuals. The amount of a substance that causes death in 50 percent of laboratory animals is expressed as LD50 (dose lethal to 50 percent).

Botanicals Withdrawn Due to Safety Concerns

Most botanicals have a long history of apparent safe use. Ingredients may be withdrawn when new information raises safety concerns. Sassafras *(Sassafras albidum)* is an example. Sassafras derives its flavor and fragrances from an essential oil comprised of up to 80 percent safrole. In the late 1950s safrole, then used as a primary root beer flavoring, was banned as a food additive due to concerns over serious liver toxicity and carcinogenicity. The ban was subsequently extended to dried sassafras bark sold for the intended purpose of making an herbal tea. Dried sassafras leaves (used as a base for gumbo filé) must also be free of safrole. Another example of a botanical no longer considered safe is comfrey (*Symphytum* spp.). Popular in the 1970s and 1980s, comfrey leaves and roots were regarded as a virtual cure-all, earning it the name "all-heal." Apparently used safely for centuries, comfrey was found to contain significant amounts of a class of pyrrolizidine alkaloids that cause a condition known as veno-occlusive disease of the liver (resulting in the occluding or clogging of the major veins in the liver). The rare disease can only be diagnosed with a liver biopsy; thus it went unrecognized for decades. Internal use of comfrey products is restricted or prohibited in many countries.

See also **Additives; Flowers; Herbs and Spices; Hippocrates**; **Processing of Food.**

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Steven D. Foster

BOTULISM. Botulism is a paralytic illness caused by a nerve toxin produced by the soil bacterium *Clostridium botulinum* and spread by contaminated food or by infection of a wound. The term comes from the Latin *botulus* (sausage), but the vehicle in food-borne cases today is usually vegetables or other food improperly canned at home. Commercial canning is almost never implicated, although a notable case in 1971 left one person dead and several others seriously injured. The illness is rare, with only twenty-five to thirty food-borne cases reported annually in the United States.

C. botulinum is a spore-forming bacteria that can lie dormant in the soil for months or years. In a warm, moist, low-oxygen environment, however, the spores can produce vegetative cells that multiply rapidly and secrete a deadly toxin, which attacks the nervous system of the person ingesting contaminated food.

Symptoms of botulism include double vision, blurred vision, drooping eyelids, slurred speech, difficulty in swallowing, dry mouth, and muscle weakness. An antitoxin can be used with early diagnosis, but otherwise treatment involves supportive care, sometimes including a ventilator. A severe case can require months of medical and nursing care and may leave the patient with permanent impairments. Botulism is fatal in about 8 percent of cases, usually from respiratory failure.

Thorough washing can remove the spores and proper heating will destroy them. If, however, the food being canned is not washed properly and fails to reach the necessary temperature for the required time, the spores can germinate and produce toxin in the canned goods.

A pH in the acid range will also kill the spores, so acidic foods such as fruit and tomatoes are less likely to be vehicles than low-acid food such as corn, green beans, or asparagus. Canners are often advised to raise the acidity of food by adding an acid source such as lemon juice or citric acid.

To avoid the danger of botulism, home canners of low-acid foods are advised to use a pressure canner instead of the unpressurized, boiling-water-bath systems used previously. A temperature of up to 250°F is needed, which can be reached with pressure canners operated at ten to fifteen pounds per square inch. The time required ranges from twenty to one hundred minutes, depending on the food and the size of the jars. Detailed instructions are available with home canning systems, either from the U.S. Department of Agriculture or from an extension agent.

Industrial quality control makes it highly unlikely that commercially canned food will be contaminated with *botulinum* toxin. However, consumers should reject any commercial canned goods that appear swollen or bulging and any canned food with a bad smell or flavor.

In recent years, scientists have recognized an infant form of botulism in which infants ingest spores that germinate and produce toxins in the intestines. This appears to be linked mainly to the ingestion of raw honey, so authorities urge parents never to feed raw honey to babies. There is little danger of this variant of the disease after the age of one year.

See also **Packaging and Canning, History of**; **Packaging and Canning, Modern**; **Safety, Food**.

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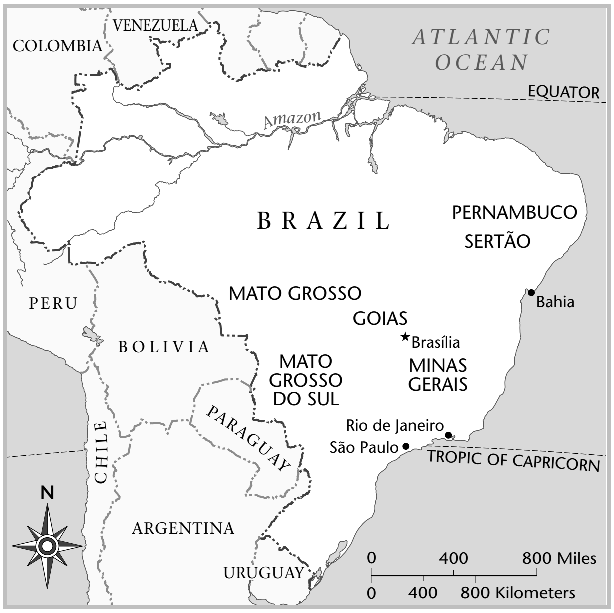
BRAZIL. The only Portuguese-speaking country in South America and the largest Portuguese-speaking country in the world, Brazil has been called "a country without a memory" by one of the leading guidebooks. Lack of memory, though, should not be interpreted as lack of history, as the mix of cultures in the country's gene pool is rich indeed, with a complexity and variety that show nowhere more than in the food.

Portuguese seaman Pedro Alvares Cabral was thousands of miles from his stated destination of the Cape of Good Hope when he arrived on 22 April 1500 and became the first European to walk on the land that would be named Brazil in 1511. The treaty of Tordesillas, signed in 1494, had divided up the globe and given all lands known and unknown east of an imaginary north-south line 370 leagues west of the Cape Verde Islands to



the Portuguese. By 1532, when the first substantial Portuguese settlement was founded, the die had been cast based on Portuguese experiences in Asia and in Africa. Brazilian sociologist Gilberto Freyre notes in *The Masters and the Slaves: A Study in the Development of Brazilian Civilization* that Brazil was "a society agrarian in structure, slave holding in its technique of economic exploitation, and hybrid in composition, with an admixture of Indian and later of the Negro." Almost five hundred years later, these three major groups—Indian, Portuguese, and African—continue to form the matrix threads of Brazil's culinary culture.

Native Influences

French chronicler Jean de Lery's 1770 *Histoire d'un voyage fait en terre du Bresil* offers insights into the daily life of the native peoples and reminds readers that the women were responsible for much of the agriculture, the management of the entire house, and all of the cooking. Many of these culinary creations are still a vital part of the country's menu. Manioc or cassava (*Manhiot esculenta*, *Manhiot aipi*, or *Manhiot dulcis*) remains a major staple. The bitter cassava tuber, which required time-consuming preparation to remove the prussic acid (also known as hydrocyanic acid), was processed into a meal, which formed the basis of the diet. The liquid was also used and became the basis for *tucupi*, a condiment of cassava water, garlic, chili, chicory, and seasonings that is still prized today in the Amazon region. The Portuguese colonists at first confused the manioc with the true yam that they were familiar with from Africa. Soon, though, they were eating such Indian dishes as a form of cassava cake known as *mbeieu* or *beiju*, a cassava porridge or paste known as *mingau*, and *pacoka* or *pacoca*, a pulverized fish and cassava meal that has given its name to a popular contemporary pulverized peanut and sugar candy. Maize (*Zea mays*) was known, but never assumed the importance in Brazil that it had in other parts of Central and South America. Fish was also abundant and played a major role in the diet, with the pirarucu (*Arapaima gigas*) having the place of primacy. Fish was frequently prepared by roasting it in its own fat over a slow fire, then sealing it in earthenware jars. Other varieties of Amazon fish were prepared in this manner as was manatee, which was called *peixe boi* or ox fish.

Green vegetables were scarce, but nuts were consumed, particularly the cashew, as were the sweet potato, peanut, and cacao. Papaya (*Carica papaya*) and guava were eaten, as were pineapples. When the Portuguese brought bananas and citrus fruits, they were immediately adopted by the natives. Ripe fruit was eaten raw and green fruits grilled or roasted. Seasoning was done with chili; in fact the Indians were known for their overuse of the fiery capsicum as well as their abundant use of ginger and of lemon. Freyre cites a Jesuit account that cautions that excessive usage of the three resulted in frequent attacks of dysentery. Another of the lasting contributions of the native Brazilians to the cooking of today's Brazil has been the cooking utensils. The mortar, earthenware water jug, and wicker sieve, along with calabash utensils large and small, all hark back to the first Brazilians.

Portuguese Colonization

Portugal at the time of the colonization of Brazil was a nation recovering from a lengthy period of Moorish occupation. Old Portuguese cookbooks like *Arte de Cozinha*, published in 1692 by "a royal cook," list numerous recipes for "Moorish lamb," "Moorish fish," and the like. The everyday diets of the Portuguese in the years after the Moors fluctuated between feast and famine. The upper classes hovered between the excesses required on religious feast days, when meals had to be provided to royal retainers, rent collectors, and religious persons for show and status, and the far more frequent days when bread and radishes were the norm. For the poor, bread and onions were typical fare, and meals of sardines or other fish were a treat; meat was rarely tasted. Much of the agricultural wealth of the country was maintained in the convents and monasteries.

In the new land, the colonists began to shape their diet with the foods they knew either in their Iberian home or in the Asian and African colonies. They brought figs, citrus fruits, coconuts, rice, watermelon, the pumpkin called Guinea pumpkin (West Indian cooking pumpkin or *Cucurbita maxima Duchtre*), mustard, cabbage, lettuce, coriander, cucumbers, watercress, eggplant, carrots, and more. Gabriel Soares de Sousa, in his *Tratado descriptivo do Brasil em 1587*, offers a seemingly exhaustive listing of the plants brought. He adds that a green belt of one to two leagues encircled Salvador and provided much of the fruits and vegetables for the capital. Olive oil, butter, chickens, and eggs all arrived, as did pigs and the art of preserving pork and other meats.

Although the colonists brought an abundance of ingredients with them, they were so preoccupied with acquiring fortunes in the new land that their diets did not markedly improve. All was sacrificed to King Sugar. Cattle were banished because they destroyed the cane, and domestic agriculture was neglected. By the seventeenth century, travelers were astonished to note that large cities had no slaughterhouses as there were no cattle to send to them. The colonists, though, did have a major influence on the cooking pots of contemporary Brazil, not only by transporting and acclimatizing countless plant species, but also by establishing a countrywide culture—that of Portugal, with its abundant use of cabbage and kale, its hearty soups and rich stews, its traditions of grilling, and the Iberian fondness for sweets. (The Iberian "sweet tooth" combines the North African love for sugar and a tradition of intricate confections developed in Roman Catholic convents.) It is to the mother country that Brazil owes dishes such as the dense, rice-filled chicken soup known as *canja*, the strips of leafy kale greens that accompany the *feijoada* that is the national dish, and a national taste for meat and potatoes.

Brazil's long coastline has blessed it with a rich fish cookery. These fishermen are sorting their catch on the beach at Ceara, Brazil. © STEPHANIE MAZE/CORBIS.

African Influence

The African hand in the Brazilian cooking pot completes the triptych, most noticeably in the northeastern states, where the plantation system held greatest sway. There, from virtually the inception of colonization, Africans were in control of the kitchens of the Big Houses. In Bahia, they were from the Bight of Benin and the Sudanese regions of West Africa. In Rio and Pernambuco, they were mainly Bantu. All brought their own tastes in food. The religious traditions of the African continent crossed the Atlantic as well, and in the hands of the Big House cooks, many ritual dishes were secularized and joined the culinary repertoire. The *akara*, a bean fritter fried in palm oil by the Yoruba people of southwestern Nigeria, was transformed into the Brazilian black-eyed pea fritter, or *acaraje; fon akassa* changed only its spelling to become the *acaca*, and the Angolan cornmeal porridge known as *funji* kept its name and its spelling as the dishes of the African continent were turned into Brazilian standbys.

African cooks embellished dishes with ginger, chilies, and pulverized cashew nuts and maintained the tastes of coastal Africa in the continued use of dried smoked shrimp and palm oil. They adapted recipes and adopted the ingredients of the new land to create a cooking so unique that the food of the state of Bahia is considered by many the linchpin that connects the cooking of Africa with that of the Western Hemisphere.

In the late nineteenth and early twentieth centuries, new immigrants joined the cultural mix that is Brazil: Japanese arrived to work on the coffee plantations, Syrians and Lebanese arrived and became shopkeepers and merchants, German and Swiss farmers settled in the southern states, and Italians established themselves in São Paulo. Each group brought its own dishes, and soon stroganoff and sushi, risotto and sauerbraten could claim pages in any Brazilian cookbook. The result is a country where the regional cuisine is as distinctive as it is varied.

Regional Cuisines

The Amazon region still recalls the country's first inhabitants in dishes like *beijus*, cassava flour crackers that are sometimes flavored with coconut, and *pato no tucupi*, duck cooked with *tucupi*, a condiment prepared from cassava liquid with garlic, chicory, and the leaves of the *jambu* plant, which produce a slight numbing effect on the tongue. The condiment also turns up in *tacaca*, a soup that also contains dried shrimp and tapioca. Fish from the river abound, with the enormous *pirarucu* and the flavorful *tuncare*. Tropical fruits range from the little known, like the *guarana* (the seeds of which make a highly caffeinated beverage), *cupuacu*, a relative of cacao, and the fragrant *jambo*, or rose apple, to the more familiar *maracudja*, or passion fruit, and cashew. There are also Brazil nuts, called *castanha do para*.

Culinary historian Luís da Câmara Cascudo claims that the food of the country's northeast region can be broken down into that of Bahia and the rest of the region. The tastes of the rest of the region are simple ones, featuring dried meats called *charque*, *carne seca*, or *carne do sol.* Stewed with beans and served with rice and abundant sprinklings of cassava meal, the meals are as stripped of pretense as the cowboys and hard-scrabble farmers who inhabit the arid inland region known as the Sertao. The rich tastes of Bahia reflect the area's exuberance. The tastes of sugar, coconut, *cachaca*, chili, and orange-hued

The biodiversity of Brazil's native fruits is one of the largest in the world. These fruits were photographed in the market at Angra, Brazil. © Richard Bickel/CORBIS.

palm oil called *dende* abound in dishes where the African hand is evident. Dishes with the gustatory complexity of *vatapa*, a puree of dried, smoked shrimp, ground peanuts and cashews, bread crumbs, ginger, chilies, coconut milk, and palm oil, are popular. The *acaraje*, or black-eyed pea fritter, is traditional street food, often slathered with *vatapa*, and sweets prepared from coconut, sugar, and tropical fruits are traditional.

The two major cities of São Paulo and Rio de Janeiro revel in international dining that knows few borders, with restaurants owned by three-starred Michelin chefs and local notables. Specialties include Rio's Saturday *feijoada*, the country's national dish of black beans, rice, stewed meats, greens, and sliced oranges. São Paulo offers Japanese fare in the Liberdade district as well as German-style beer halls and *rodizio*-style churrascarias (Brazilian barbecue), where waiters circulate constantly with a never-ending procession of skewers of meat that is sliced at the table.

The heartlands of Minas Gerais and Goiás are marked by their love of beans. They celebrate with dishes like *Tutu a Mineira*, mashed black beans served with pork chops and kale, and a version of *feijoada* prepared with pink beans instead of black ones. Mineros pride themselves on their wood-burning ovens called *fogao de lenha* and their cheeses, which are prized throughout the country.

The southern states are more European in focus, with large settlements of Italians and Germans. They are also the home of Brazil's gauchos and boast a meat culture centered on spit-roasting meat *churrasco*-style. The prairies of Mato Grosso and Mato Grosso do Sul are made up of huge ranches called *estancias* or *fazendas*, where cattle farming is a major industry. Beef, pork, and fish dominate the regional menu, and as settlement increases there, the newcomers are sure to add another chapter to the rich and ongoing history of the food culture of Brazil.

See also **Africa: North Africa**; **Cassava**; **Central America**; **Columbian Exchange**; **Iberian Peninsula**; **Mexico**; **Mexico and Central America, Pre-Columbian**; **South America**; **Sugar and Sweeteners**.

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Jessica B. Harris

BREAD. What is bread? At its simplest it is merely a paste of flour or meal and water cooked over or surrounded by heat. More complex breads are leavened in various ways and contain salt and other ingredients, particularly fat and sugar. Although bread is usually thought of as being made from wheat, it can be made from virtually any grain—rye, corn (tortillas), barley and oats (bannocks), teff (injera), amaranth, millet, and rice. Only wheat, however, has the gluten that is essential to a risen loaf, so unless these other grains are mixed with wheat, the loaves will be flat. Many, such as oat, barley, and pure rye bread, will be heavy and dense as well.

Plant Biology

The kernel of wheat is the grain used in most breads. Wheat is the single grain that contains enough gluten to allow the development of the protein strands that are the foundation of bread. These strands form layers and pockets that trap the steam from the water and the carbon dioxide released by the yeast during the fermentation process and thus give the bread its rise. Since other grains do not have this capability, they are usually combined with wheat flour to increase the gluten level of the mixture.

Wheat is not actually a seed but rather a true fruit. The wheat grain has three parts. Bran is the outer layer of the wheat kernel and is high in fiber and nutrients. The germ is the "embryo" of the kernel, and when sprouted, it reproduces new wheat plants. The endosperm makes up most of the kernel and is the food reserve for the germ. The endosperm is extracted during the milling process to make common white flour.

Plant Nutrition

Wheat is rich in complex carbohydrates, which are an excellent source of energy for the human body. It also contains many essential B vitamins and the key minerals iron and calcium. After the milling process, in which the bran and germ, which contain most of the vitamins and minerals, are separated from the endosperm, enrichments frequently are added to the flour to restore the grain to its nascent nutritional levels. The two most common enrichments are folic acid, which prevents heart disease and neural deformities, and the other B vitamins, including niacin, thiamin, and riboflavin, which prevent beriberi, pellagra, and nutritional anemia.

Types of Wheat

Many different types and strains of wheat are grown conventionally or organically worldwide. In the United States wheat is classified into four categories. Hard wheat is used for breads and similar baked goods; soft wheat is preferred for cakes and pastries; winter wheat, which includes hard wheat varieties, is planted in the late fall to over-winter in harsh climates and is harvested in the spring; and spring wheat is planted in the spring and is harvested in the late summer or early fall. Wheat is further categorized as red wheat, that is, hard, red winter wheat; or white wheat, that is, soft, white spring wheat. The thousands of varieties of wheat grown in the United States break down into six classes: hard, red winter; hard, red spring; soft, red winter; durum, primarily used in pasta making; hard white; and soft white.

In the late 1990s the artisanal baking world developed an interest in wheat's particular profile. This profile is generally indicated by a farinograph, which displays such important factors as protein (gluten) levels, ash content (a measure of extensibility, related to fiber), and falling number. Each of these elements plays an important role in the overall baking process, and each farinograph number tells the baker what type of results to expect. The baker's knowledge of the specific flour's profile dictates how much water to add, how long to knead the dough, and how long the fermentation time should be.

Identity preserved (IP) wheat has also attracted interest. Traditionally, when the wheat is harvested, it is stored in large silos prior to distribution to the mill. The mélange of different strains of wheat, even within a single category, present in the silo makes it virtually impossible to know how the flour will perform once it is milled. Yet these "blends," as they are called, are the most prevalent grains in the marketplace. Using the IP methodology, only one type of wheat is stored in a particular silo, thus giving the discerning baker more control over the outcome of the final product. While this IP methodology will probably never rule the marketplace due to silo space limitations and lack of general interest, it will continue to gain market share as the artisanal side of the baking industry continues to flourish.

The History of Bread

It is widely believed that the domestication and cultivation of wheat and other grains directly influenced human transition from nomadic people to domesticated, stationary people. In most parts of the world this transition was completed as wheat and subsequently bread became significant dietary staples. However, people continued nomadic ways where cultivation of grains was either not feasible or not desirable.

The earliest breads were more like porridges and flat cakes. Grains were mashed with water or milk and were eaten either raw or cooked, providing nutrition and sustenance. The porridge became thicker and more pastelike, and eventually this paste was cooked either on a hot rock or in an early subterranean oven, creating a more mobile product. Twenty-first-century descendants of those earliest breads include Middle Eastern pita bread, Indian naan, and pizza.

The first leavened breads were invented nearly seven thousand years after flatbreads were introduced into the diet. To put the history of bread on a timeline continuum, it is necessary to start nearly ten thousand years ago. About 8000 B.C.E. the first grinding stone, called a

Bread is indeed the staff of life in most wheat-consuming countries. The great variety of North African breads is evident in this Tunisian bread shop. © Michelle Garrett/CORBIS.

quern, was invented in Egypt, and the first grain was crushed. The modern Indian chapatis, made from unleavened whole wheat flour, and Mexican tortillas, made from corn, resemble the breads produced at that time. Between 5000 and 3700 B.C.E. Egypt began organized grain production along the Nile River Valley. At this time bread became a staple food that often was used in trade and barter, and it began to migrate to other cultures.

About 3000 B.C.E., also in Egypt, varieties of wheat that were tougher, that is, more tolerant of weather and environment, were developed. It is widely thought that, owing to the Egyptian skill with brewing beer and the warm climate, wild yeasts attracted to the flour mixtures created the first sourdough. Recognizing the fermentation process, bakers began to experiment and developed the first purposefully leavened breads. By about 2500 B.C.E. the first true sourdoughs were in regular production in the Middle East and Mediterranean regions.

In about 2300 B.C.E. the cultivation of grain began in India along the Indus Valley. Around 1500 B.C.E. horses took over the task of plowing and the first iron plowshares were introduced. In about 1000 B.C.E. yeasted breads became popular in Rome. The circular quern, the basis for milling until the Industrial Revolution and the basis for so-called stone-ground flours in the twenty-first century, was developed by about 500 B.C.E. The water mill was invented in Greece around 450 B.C.E. Consequently culinary historians credit the Greeks with ushering in bread baking as an art form.

In Rome the first bakers guilds were formed as a means of unifying the craftspeople around 150 B.C.E. Well-to-do Romans insisted on the more exclusive and expensive white breads. Darker whole wheat and bran breads were for the masses, an attitude that persisted well into the twentieth century in Europe and North America. By about 100 C.E. Mexican natives made the first stone-ground corn tortillas. By 300 C.E. the Greeks had developed more than seventy different types of bread, showing their penchant for furthering the bread baking craft. Around 600 C.E. the Persians developed a windmill prototype that changed the face of bread production.

In medieval times bread baking became a status symbol in Britain. The upper classes preferred fine, white loaves, while those of poorer status were left with the whole wheat, bran, and coarser breads. By 1066 hair sieves were employed to sift the flour, producing a finer white flour. In 1569 in England, Queen Elizabeth I united the “white and brown” bread bakers to form the

Worshipful Company of Bakers. The Great Fire of London in 1666 reportedly was started by a baker. In 1683 the bagel was introduced in Vienna as a thank-you gift to the king of Poland.

Wheat was first planted in the United States as a hobby crop in 1777. During this century the earl of Sandwich gave his name to the sandwich, originally meat between two slices of bread. In 1789 mobs calling for bread helped trigger the French Revolution. In 1834 the roller mill was invented in Switzerland. Rather than crushing the grain as in stone-ground methods, the steel roller mill breaks open the grain, allowing easier separation of the germ, bran, and endosperm. This invention drastically changed milling around the world and increased the consistency of milled flour.

Bread in Modern Times

Leavened bread was generally prepared outside the home, and this led to the development of communal bake houses. Usually situated by rivers or streams, these bake houses presented serious fire hazards due to the construction materials of the buildings and ovens. The proximity to water put them near the mills and close to natural fire suppression. Bake houses were usually owned by land barons and lords. Bakers and bakery owners used the ovens on a communal basis for a fee paid either in money or in kind. The very nature of the bake house allowed bakers to bake more bread, thus increasing their ability to distribute it and keep prices down.

The same innovations of the industrial revolution that made white wheat breads more plentiful also made mass production the norm. By 1825 German bakers created the first cakes of commercial yeast, which expedited the process and consistency of yeast activity and influenced taste and visual appeal as well. In the twentieth century hydrogenated oils, artificial preservatives, emulsifiers, and other chemical additives entered the dough to soften the crumb (texture) and to lengthen the shelf life of mass-produced breads. Factory bread has become standard in most industrialized countries.

By the early twentieth century bread flour was largely replaced by bleached, bromated, and enriched flour. The grain is bleached and sterilized with chemicals to make it white and soft. It is then enriched by adding back the vitamins and minerals destroyed in the processing. Obviously this industrialization of bread methodology and production altered the taste and appearance of bread. Some authorities feel this methodology is largely responsible for the mid-century decline of bread consumption in the United States. In 1910 the per capita consumption of bread products was roughly 210 pounds. By 1971 consumption had been cut nearly in half, to approximately 110 pounds per person. This trend turned around with the rediscovery of artisanal breads and methodologies. The trend back to more wholesome and historical breads began in the United States in the 1980s. Some bakers who wanted to be more mindful of the process and their ingredients returned to their baking roots. They produced freshly baked, wholesome, rustic breads that benefited from longer fermentation periods, and they eschewed all chemicals and additives. The result is a more flavorful and nutritious loaf similar to those baked over a thousand years ago. Led by the Bread Bakers Guild of America (modeled after the first European bakers guilds) this reinvention of bread permeated baking cultures throughout the industrialized world.

As bread baking became industrialized during the nineteenth century, professional bakers turned to baking aids like this cream loaf pan of tinned sheet iron, which simultaneously makes six large sandwich "batons." The loaves are perfectly round for slicing. Manufactured about 1890 by Thomas Mills Brothers of Philadelphia. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Buying Bread

By the twenty-first century bread products were sold on three major levels. The first is the traditional neighborhood bakery, still in existence in large urban centers in the twenty-first century. The second is the grocery store, or supermarket. Third is what might be called the bakery café, along with the specialty foods store.

The neighborhood bakery. The neighborhood bakery has its roots in western Europe and is known for its local roots and outreach as well as the freshness of its products. This is particularly true in France, where local boulangeries are numerous. Each one offers local residents their daily bread, fresh, uncommercialized, and unique to that particular bakery.

Local bakeries build their client base from the immediate neighborhood, especially in larger urban centers, where population density and foot traffic allow the independent baker to make a living by directly connecting to his or her customer. Breads are baked fresh daily and are meant to be consumed that day or the following day at the latest. Even though, as a result of the extended fermentation used, many of these breads have a longer shelf life than one or two days, it is the freshness that sells the bread.

Grocery stores. The amount of bread purchased at grocery stores and supermarkets is the largest portion by far primarily because of the convenience of one-stop shopping. These bread products have been developed and baked with a longer shelf life in mind than breads baked in a neighborhood bakery. Frequently made with dough conditioners, emulsifiers, and mold inhibitors, they are meant to withstand plastic bags and to last for several days in the store.

In general the types of breads found in the grocery store are a result of the bread industrial revolution that took place at the beginning of the twentieth century. Consumer desire for white bread with a soft crust along with mechanized developments in the milling and baking industry made it possible not only to mass produce a homogeneous product but also to distribute it over a wide geographic area. While exceptions exist, most of these factory-produced breads have taken a formula detour from similar products produced in neighborhood bakeries. Dough conditioners make it easier for the wholesale bakery's machinery to handle the dough without damaging it and to soften the crumb of the bread. Emulsifiers homogenize the dough (in some cases it is nearly batterlike) so each loaf of bread resembles the ones before and after it. Mold inhibitors are used in the actual formula and are sprayed topically as the bread exits the oven to delay the onset of bread mold.

Bakery departments have also been created in the grocery store itself to reach the customer who wants a fresher product. Breads are baked throughout the day, and in addition to being fresher they generally have a more pronounced flavor. Where the baker gives care and attention, the in-store product can come close to the quality of breads produced by the local neighborhood bakery. However, when the baker is working from a base or mix or even with a par-baked product (a frozen, partially baked bread that is finished off in the store), the overall quality is usually only a slight improvement over the bread on the store's shelves.

Bakery café and specialty foods stores. Bakery cafés and specialty food stores have experienced widespread growth since the early 1980s. Both typically provide a higher-quality product than that found in the grocery store. Whether purchased from a high-quality wholesale bakery or baked in-house from a fresh or par-baked product, baked goods comprised a wide selection.

Bread Preparation: Yeasted Dough

Yeast dough production requires twelve basic steps no matter what type of dough is produced. Dough types are generally classified as lean dough (low in fat and sugar), including French baguettes, rustic breads, Tuscan breads, hard rolls, and pizza; rich dough (with sugar, fats, or eggs added), including brioche, challah, and egg breads; and rolled-in dough (with fat incorporated in many layers using a rolling and a folding procedure), including croissants, Danish pastries, and cinnamon rolls.

The Twelve Steps of Yeast Dough Production

Scaling is the exact measurement of all ingredients (professional bakers and dedicated amateurs measure by weight) and the French term, *mise-en-place*, applies to having all the ingredients scaled or prepped and ready before starting production.

Mixing and kneading involve the incorporation by hand or by machine of the ingredients in proper sequence to form the bread dough, which is then further kneaded. Kneading or working the dough by hand or by machine further disperses the ingredients and develops the gluten in the dough.

Fermentation, also referred to as the first rise, is the process whereby the gluten (protein) in the dough is allowed to relax while the yeast grows and reproduces. The yeast digests the sugars in the flour and produces alcohol and carbon dioxide (CO_2). The carbon dioxide gets trapped in the pockets that result from the kneading process and causes the bread to expand or rise and develop flavor. At this point the dough can be left at room temperature if it is to be baked that day, or it can be retarded; that is, the fermentation period can be extended in a cool environment, usually a specialized refrigerator. Doughs that have been retarded for twelve to twenty-four hours generally have more complex flavors and are easier to fit into the baker's production schedule. There is also a noticeable buildup of natural acidity, which helps extend shelf life.

Punching down or deflating the dough, also called turning, refers to the general deflating of the dough mass by either gently pushing down or folding the dough, not hitting it as implied. The purpose is twofold, to increase the strength and tolerance of the gluten and to de-gas the dough prior to scaling. After punching, the dough is allowed to rest before moving on to the next step.

Scaling is cutting and weighing individual pieces of dough, which will become the actual loaves of bread.

Rounding occurs once the dough has been scaled. Each piece is gently shaped into a round ball before moving on to the next step. This rounding allows uniformity in subsequent steps.

Benching is allowing the dough pieces to rest, usually for fifteen to twenty minutes. The time varies with each type of bread and with the amount of leavening used. Clean, dry towels placed over the dough during this period prevent a dry crust from forming on the dough.

Make-up is forming the individual pieces of dough into their final shapes, free-form loaf, pan loaf, dinner rolls, and so forth.

Proofing, also referred to as the final rise, allows the dough to rise one last time before baking. The yeast is still alive and continues to leaven the dough. Proofing generally takes place in a warm, draft-free environment either at room temperature or in a proof box, where temperature and humidity are controlled. At this point shaped loaves can be retarded for twelve to twenty-four hours and baked at a later time.

Baking is the actual cooking of the bread. When the dough is put in the hot oven, it undergoes oven spring, one last push of the yeast to make the dough rise. The actual temperature and time depend on the oven type (deck, rotary, convection, rack, and so forth) and the use of steam, although yeast breads are generally baked at a high temperature. Technically speaking, this is when the starches gelatinize and sugars caramelize, giving the loaf its final appearance.

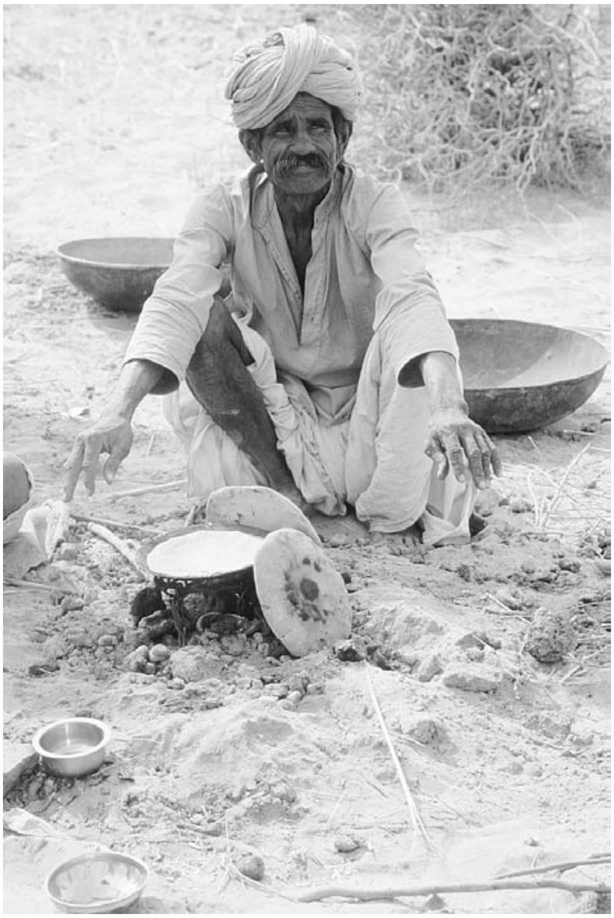
Cooling begins when the finished bread is removed from the oven. The bread cools completely before it is packaged or sliced. Cooling racks are usually nothing more than wire shelves that allow air circulation on all four sides of the bread. Even breads baked in or on pans are quickly removed to a cooling rack so the bread bottoms do not become soggy from continued steaming.

Storing prevents the staling or starch retrogradation that begins as soon as the bread is removed from the oven. To preserve their thin, crisp crusts, some breads are best not packaged (lean breads in particular), but modern baking and distribution practices require many bakers to do so. Once a loaf has been put into a bag, the staling process is somewhat slowed down and the crust becomes soft. Wrapping and freezing help maintain quality for a longer period of time. Refrigeration, on the other hand, speeds up staling.

Methods of Preparation

While the twelve steps of baking are virtually constant for almost any bread form, three predominant production variations exist. Each is a means of manipulating the key ingredients to produce a predictable loaf of bread. Production timing is also influenced. The key difference is fermentation, the natural process that occurs after the ingredients have been mixed and the dough has been kneaded. The length of fermentation time has a significant effect on the overall flavor profile, on the end product, on the baker's production life.

Straight dough method. The straight dough method is perhaps most familiar to all bakers, professional and amateur alike. It incorporates the twelve steps in a direct fashion as dictated by the ambient temperature of the bakeshop, proceeding through the steps with no break. The total time of the cycle would be about four hours from start to finish. Because of the relative shortness of the baking cycle, a higher proportion of yeast is used than in other methods so that fermentation can run its full course. The result is a bread with a stronger yeast flavor than other breads.



In its most rustic form, bread was often baked in the hot ashes of a fire, hence the term "ash bread" or "ash cake." This cattle hand in Pugal, India, has just baked flat bread on a griddle over a small fire. © Zen Icknow/CORBIS.

Sponge method. The sponge method follows the same twelve production steps with a few exceptions. Initially a percentage of the total flour, water, and yeast are mixed to form a sponge or pre-ferment. The sponge method enhances the flavor profile of the final product. Since less yeast is used, a longer, cooler fermentation can be applied, ranging anywhere from three to twenty-four hours. During this time the lactic acid bacteria in the water-flour mixture have full time to develop. The resulting buildup of organic acids and alcohols contributes to a more developed flavor profile. When the sponge is ripe, it is incorporated into the remaining flour, water, salt, and other ingredients. The twelve steps are followed from this point on.

Typical pre-ferment types. Poolish, one of the first pre-ferments made with commercial yeast, originated in Poland and is widely used by French bakers. Made with a higher percentage of water as opposed to flour than other pre-ferments, poolish has a batterlike texture. Biga, a pre-ferment of Italian origin, is more doughlike than a poolish and is commonly made with equal parts (by weight) of flour and water. Old dough is a piece of dough from an earlier batch of bread that is allowed to ferment and then is incorporated back into a fresh batch of dough. Called *pâte fermentée* (fermented dough) by the French, it can be fermented for up to six or eight hours at room temperature or longer under refrigeration.

Sourdough uses wild yeast to build a culture. Wild yeast, the flora, is present in the air and on the skins of fruits and vegetables. The baker basically harvests those wild yeast organisms and creates a culture that will leaven bread dough.

First, a culture is created using water and flour. This mixture is left covered with cheesecloth or another porous material at room temperature until it begins to ripen. At this point, the wild yeasts, having found the food (primarily natural sugars) in the flour, begin to feed and reproduce. A slightly acid smell and bubbling indicate that the culture is alive. The culture is continually fed to increase its volume and leavening strength until there is enough starter (*levain*) to leaven a batch of dough with enough left over to perpetuate the culture. Under the right conditions, cultures can be kept vital and alive for many years. The sourdough method is a time-intensive method, since no commercial yeast is used to speed up production. The benefits are many, however. Due to the lower yeast levels, the slower activity produces a stronger flavor profile and more noticeable sour aroma, an increased level of organic lactic acids, and a greater array of naturally occurring bacteria. It is primarily due to the abundance of naturally occurring acids, alcohols, and bacteria that breads baked with the sourdough method become stale more slowly, have a better shelf life for the vendor and the consumer, and have less molding.

Traditions: A Historical Perspective

Bread and traditions pertaining to it are deeply ingrained in lore and language worldwide. From its beginnings bread has held a special, even sacred sway on humankind. As bread is the staff of life, it is truly all-pervasive.

Challah is the Jewish bread served on the Sabbath and on holidays in which the twelve tribes of Israel are represented by twelve braids on each loaf. For Rosh Hashanah, the Jewish New Year, the challah is wound in a ring to symbolize the continuity of life. Some loaves have a ladder on top, representing the ascent of God on high.

According to legend, a baker alerted the forces of Vienna to the approach of the Turks in the siege of 1683. The bakers commemorated the Viennese victory with a crescent-shaped roll, precursor to the croissant, as the symbol of the Turks was a crescent.

In France a law prevented bakers from increasing the price of bread beyond a point justified by the price of the raw materials. Tuscan bakers, during the time of papal dominance, were subjected to an extremely high salt tax. As a result Tuscan bakers decided to abolish salt in their breads. Tuscan tastes adapted to this custom, and a traveler will note, for example, that Tuscan prosciutto is considerably saltier than its regional counterparts.

Several cultures celebrate the Epiphany (6 January) with a ring cake with a tiny doll representing the Christ child baked in it. Whoever gets the piece with the doll is crowned king or queen for the day and is obliged to reciprocate by giving a party on Candelmas (2 February).

Bread in the Lexicon

Bread has been a part of language for many thousands of years. Because of the importance of bread worldwide, it should come as no surprise that bread talk has permeated the everyday vocabulary. In 1933 nearly 80 percent of the bread sold in the United States was sliced. The expression "the best thing since sliced bread" was coined from this market predominance. The term "break bread," meaning to dine together, highlights the reverence given to bread and its importance at mealtime.

The expression "bread upon the water" describes resources risked without expectation of return. Bread was a form of currency in ancient Egypt, and the term "bread" is colloquially used as a term for money. "Breadwinner" designates the person who earns the better part of the household income.

Bread has long been called the staff of life. This metaphor of the wheat stalk expresses the importance of wheat, grains, and in turn bread. The term baker's dozen refers to a count of thirteen, rather than to twelve, a traditional dozen. Dating back to the Middle Ages, some bakers cheated with undersize and occasionally adulterated loaves. An extra loaf or item was thrown in to reduce suspicion.

Bread and Human Biology

Bread is a great source of energy because it is rich in complex carbohydrates. The human body slowly turns these carbohydrates into sugars, which the body utilizes for energy. Breads and grain products occupy the first and largest rung of the widely accepted Food Pyramid. The Food and Drug Administration (FDA) has indicated that all adults should eat six to eleven servings of carbohydrates daily (depending on age and gender), and bread can make up a large segment of this daily intake. As approved by the FDA and the U.S. Department of Agriculture (USDA), breads rich in whole grains can advertise that they help fight heart disease and cancer. Breads (and grain-based foods in general) that contain 51 percent or more whole grain ingredients by weight can use the following health claim on labels: "Diets rich in whole grains and other plant foods low in total fat, saturated fat, and cholesterol may reduce the risk of heart disease and certain cancers." Whole grain breads are also a great source of fiber and roughage, which aid the body's digestive and waste elimination systems.

Grain products are enriched with iron, folic acid, and other B vitamins, including niacin, thiamin, and riboflavin. Over the years enrichment has helped eliminate nutrition-related diseases, such as beriberi, pellagra, and severe nutritional anemia. Research has shown that folic acid helps prevent heart disease. Women of childbearing age also need folic acid. The daily minimum requirement of four hundred micrograms is essential in preventing birth defects of the spinal cord and brain.

See also **Bagel; Beriberi; Bread, Symbolism of; Judaism; Metaphor, Food as; Niacin Deficiency (Pellagra); Pizza; Symbol, Food as; Wheat.**

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BREAD, SYMBOLISM OF. Bread is among the most popular foods in the world. Whether it is leavened or unleavened, made into loaves or cakes, baked, steamed, or fried in oil, bread is universal. Whatever the grain, bread occupies an important place in every civilization. It has exceptional nutritional value, and as the only nearly perfect product for human nourishment, can be consumed by itself. It is made from flour, water, salt, yeast, and sometimes additives.

Farming has had a profound affect on the religious beliefs of agricultural communities, and the symbolism of wheat is deeply associated with the symbolism of bread. Since the Neolithic period, mythology and ritual representation have tended to be identified with plant life because the mystery of human birth and death was in many respects similar to the life cycle of plants.

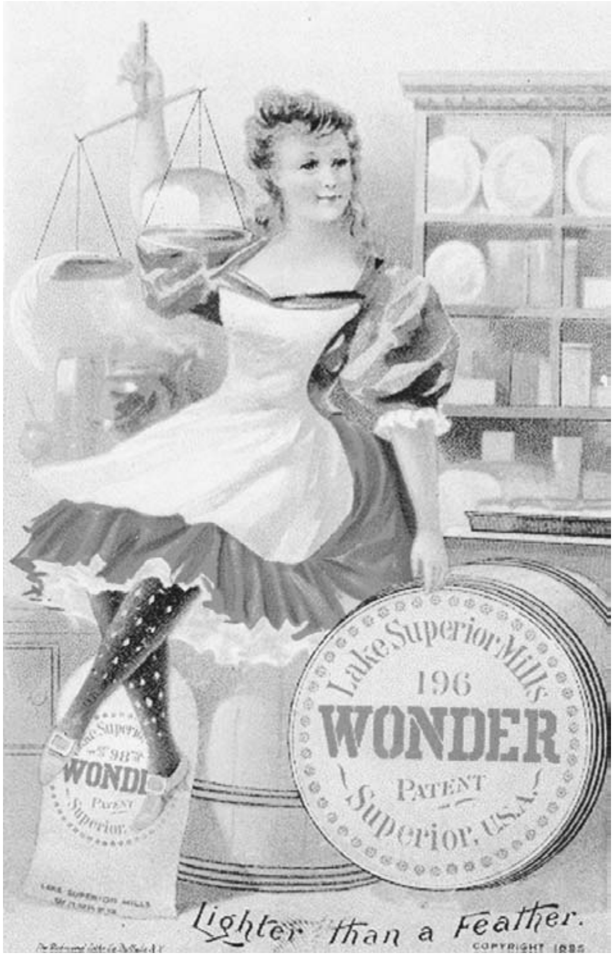
The growth of settlements, which ethnologists refer to as the "great turning point for humanity" and which was indirectly inspired by the search for bread (agriculture was only a means to this end), helped define social and economic institutions (the growth of property rights, the use of wheat as a form of exchange value, and so on). Planting and harvesting as well as the events that endanger crops (flood, drought) were perceived as key events in agricultural life.

During its life cycle the grain of wheat dies and is reborn months later in the form of a spike capable of providing sustenance to human beings. Wheat is the quintessential nutritional plant. It was believed to contain the mystery of life and death and thus it became a sacred plant. One of the essential features of the Neolithic era was plant cultivation. This led to a way of life that had previously been unimaginable and gave birth to new beliefs that completely altered the spiritual universe of humankind.

Religious connections with the animal world were replaced by what might be called a mystical solidarity between humankind and vegetation. Moreover, female sacredness and the female principle in general assumed greater importance because of women's influential role in agriculture. Women's fertility was associated with that of the earth, and women were responsible for the abundance of the harvest because of their knowledge of the mystery of creation. During the fertility festivals in Syracuse (Sicily), loaves of sesame bread shaped like female genital organs were handed out.

This sacred and divine dimension of the wheat spike helped associate it with the symbolism of resurrection. Examples survive on bas-reliefs from the temple of Isis, the Egyptian nature goddess and wife and sister of Osiris, in Philae, an island in the Nile, in which the mummy of Osiris, god of the underworld, presents spikes of wheat watered by a priest, symbolizing the new wheat that will soon grow. This same symbolism is found on clay statuettes of Osiris that contain wheat kernels, which were placed in graves to ensure the survival of the dead.

This close relationship between the celebration of the seasons, the death and rebirth of the god, and the possibility of a life beyond the grave clearly illustrates the connection between wheat and Osiris and the manifest symbolism of resurrection, which he represented in



In this 1883 promotion for Wonder Flour (the ancestor of Wonder Bread) the lightness of the bread is weighed against an ostrich feather, implying that airy bread from processed flour is better than the old hearth-baked kind, a point most artisanal bakers would dispute. The flirtatious woman in red, white, and blue, dressed like a cancan dancer, would have raised eyebrows with her leg-exposing attire. The second implied message, then, is that light bread is sexy. ROUGHWOOD COLLECTION.

Egyptian religion. Ancient Egypt was far from unique, however, for cereal plants were associated with divinities in nearly all cultures, such as the Greek goddess Demeter and the Roman goddess Ceres.

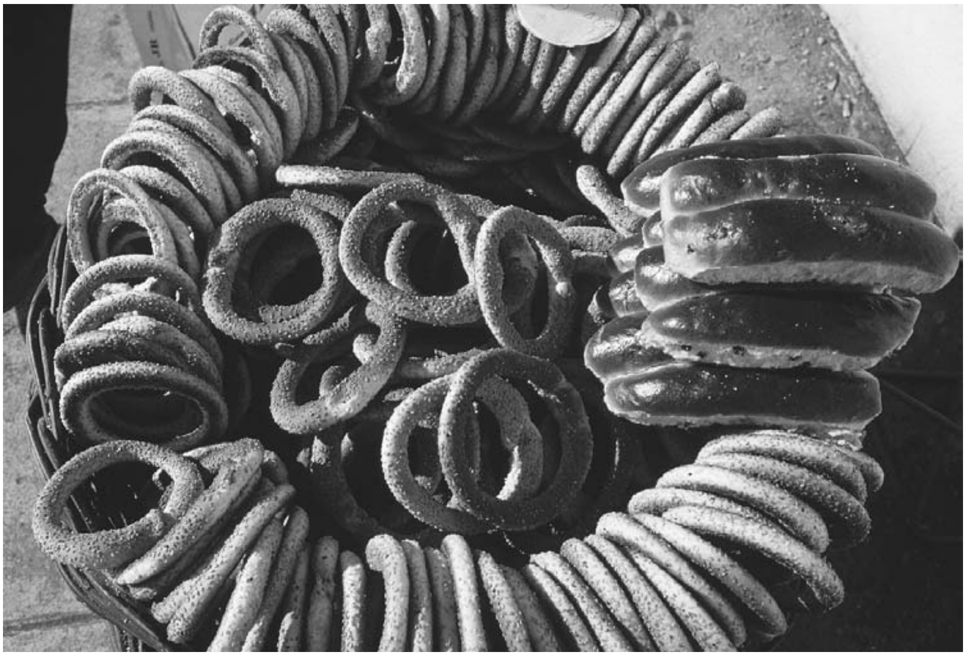
In the Old Testament wheat and bread are symbols of the fecundity of the earth. The New Testament associates the fruits of the earth—a gift of God to humankind—with the symbolism of wheat and associates the gifts of God with the hearts of humans (grace), especially in the parable of the good seed and the bad seed. Bread becomes the symbol of the supreme gift from God to humankind—eternal life, the body of Christ in the Eucharist: "Take this and eat, for this is my body."

In Hebrew "Bethlehem" means 'house of bread'. The city is located seven kilometers (five miles) south of Jerusalem and is considered the place of origin of the house of David and the birthplace of Jesus. In the Old Testament the Eternal sends manna to the Hebrews when they are crossing the desert (Exodus). Manna symbolizes bread and prefigures the Christian Eucharist. It is a sign of the generosity of God toward humankind. Jewish matzoh is an unleavened bread that is eaten to commemorate this event. In the Roman Catholic faith, unleavened bread is used to prepare the hosts for the Eucharist. The Orthodox Church uses leavened bread.

In imperial Rome bakers (*pistores*) celebrated 9 June, the Vestalies, in honor of the Roman goddess Vesta. In the *Fastes* the Roman poet Ovid describes how the Romans came to worship Jupiter Pistor or Jupiter the Baker. According to Ovid, when the Gauls attacked Rome in 387 B.C.E., the Romans invoked Jupiter, and the great god counseled them to throw what was most precious to them over the walls. While praying to Ceres, they prepared small loaves of bread with the remains of their flour and threw the loaves at their assailants. Seeing this, the Gauls believed Rome was well provisioned and had the wherewithal to withstand a lengthy siege, so they abandoned their assault of the city. In recognition the Romans built a temple to Jupiter Pistor that associated the symbolism of wheat (life, death, and rebirth) with the destiny of the city.

Bread is not associated only with spirituality and the afterlife, however. Even in antiquity the production of bread was associated with procreation. The process of loading, baking, and unloading the oven parallels copulation, pregnancy, and childbirth. In Hebrew and Chaldean the word *zera* has several meanings referring to the seed of the plant, to sperm, and to human progeny. Hebrew *zera* became the Greek *sperma*, Latin *semen*, and English "seed." Latin *placenta* was the name of a much appreciated pastry served on feast days in ancient Rome. Leaven, which plays the role of the grain or seed, is also referred to as "mother" in English and *madre* in Spanish. In Egypt the basket in which dough is left to rest is known as a *coffin*. Various popular expressions associate bread with the concept of procreation. In France a young woman who found herself pregnant before marriage was said to have "borrowed a loaf from the batch." In England the expression "a bun in the oven" refers to a woman's pregnancy. Bread symbolizes the forces of life, and an element of eroticism is associated with its manufacture. The French word *four* (once *forn*) for oven is derived from church Latin *fornicatio*, in turn derived from *fornix*, which literally meant a vault but figuratively meant a prostitute. In ancient Rome, prostitutes fornicated with clients in vaulted rooms that resembled ovens.

The French word *miche*, used for a round bread loaf, also signifies breast or buttocks, and a *bâtard* is a thick French baguette. In English buns refer to the buttocks as well as various small round rolls. In Italy, in the region around Naples, a small bread loaf is known as an "angel's penis," and in Germany *Brotleib* can refer to the female body.



While bread is itself a symbol of life, shaped breads carry multitudes of additional meanings. One of the oldest shaped breads is the ring shown here in an Athens market. This is the *bracellus* of ancient Greece and Rome, a form of bread associated with abstinence and even death. In the oldest surviving manuscript of the *Aeneid* (sixth century C.E.), Aeneas and Dido are shown breaking a *bracellus* prior to her self-immolation. © NEIL BEER/CORBIS.

The sickle is often associated with wheat and bread because of its role in the harvest, but it is also associated with the god Saturn, the mistletoe of the Druids, and the silver bow that belonged to Artemis, the sister of the sun god Apollo. That is why, in connection with grain, the sickle fulfills one of the functions of the moon, for the harvest ends a life cycle that begins with the death of the kernel of wheat. Like the scythe, the sickle serves as a positive end to the cycle for it signifies the harvest and nourishment, both physical and spiritual. It also prefigures the symbolism of wheat, the bread of the future, and other promises of transformation.

Bread is an object of belief and superstition in many cultures. The Hittites believed that the bread served to soldiers preserved them from impotence and that leavened bread helped ward off epidemics (providing it was placed in a special barrel). In Belgium during the Middle Ages, bread kneaded on Christmas Eve protected the home against lightning. In many places people give newlyweds bread and salt to express the hope for health and prosperity. In Russia a saltcellar is placed on top of the loaf of bread, which is presented to the couple by one of their mothers.

Many other ancient beliefs have continued into the twenty-first century. In Sweden it is customary to prepare a flat round bread pierced with a hole when a daughter is born, and the bread is eaten the day she gets married. In Hamburg, Germany, a highly suggestive, triphallic bread is offered to the bride and groom on their wedding day. For centuries Christians have made the sign of the cross on the crust of a loaf of bread before cutting it.

Throwing bread out or placing it upside down on the table supposedly brings bad luck. This superstition is connected to an ancient belief that bread turned toward the entrails of the earth, therefore toward hell, attracts evil spirits. In another medieval belief, bakers refused to have any physical contact with or even to serve the executioner of Paris, a man who inspired fear and was held in contempt by the people of the city. Ultimately the king was forced to issue an edict that compelled the bakers to serve the executioner. In protest and as a sign of their dissatisfaction, the bakers turned the executioner's loaf upside down on the rack to distinguish it from the others.

Various powers are attributed to bread blessed by a priest. At the end of the feast in honor of Saint Joseph in Sicily, guests are sent home with a piece of consecrated bread to keep in the house to bring fertility and good fortune in the coming year. On the Feast of Saint Calogero, Sicilians bring ex-votos made of bread covered with poppy seeds to church to be blessed. Islanders keep consecrated bread to throw upon the stormy waters for the safe return of fishermen at sea. *Kulich* (Russian Easter bread), a domed cylindrical loaf, is decorated with religious Easter symbols (notably *XB* for *Khristos Voskrese* or Christ is Risen), surrounded with dyed eggs, topped with a beeswax candle, and taken to church to be blessed.

According to popular belief, the sign of a perfectly baked *kulich* is that it will never mold; some say it will last for a year. *Kulich* is shared with the departed when, on Easter Monday, families go to the cemetery to picnic on the gravesites. In Russia true *bliny*, yeast-based pancakes prepared only once a year during *Maslenitsa* or Butter Week (Mardi Gras), represent the sun—round, golden, and warm—and symbolize the arrival of spring. One is always left in the window for the departed.

Kutya, a sweetened wheat-berry pudding, is traditionally the first or last food eaten on Christmas. Though more of a porridge than a bread, *kutya*, which is decorated with a cross of almond slices on top, is taken to gravesites or even thrown into the open grave. It is also given to propitiate Father Frost. *Kutya* bears an uncanny resemblance to *cuccìa*, a Sicilian wheat-berry pudding served on the feast of Saint Lucy, when traditionally no milled grain is eaten. (Saint Lucy was a blinded martyr, and under the Julian calendar her feast day was on the darkest day of the year, the first day of winter; it is celebrated on 13 December under the Gregorian calendar.)

For centuries bread has been a formidable political and economic weapon, and from ancient Rome onward, those in power have always kept a watchful eye on its availability. Roman bakers, for example, were closely regulated and under the control of the state. The Roman state went so far as to nationalize the baking industry. In France over a millennium and a half later, repeated famines triggered the French Revolution. Napoleon's letters during his campaigns attest to the emperor's extreme preoccupation with the supply of bread to Paris. The weight and price of bread was still regulated by the state in France in the twenty-first century.

Ancient breads have been a source of inspiration. They are a rich trove of ideas for bakers in the twenty-first century. While the techniques for making bread have changed, the human stomach has not. Industrial methods of production and freezing have led to the creation of new bread types, but industrially produced bread will never replace artisanal bread, which has undergone something of a renaissance in the United States in the early twenty-first century. The new gastronomy emphasizes quality much more than quantity.

A symbolic foodstuff international in scope, bread is the quintessential human food. Its history underlies a large part of the history of the human race, the simplest perhaps in the history of everyday life and eating. It connects people to culture, to tradition, and sometimes to religion.

See also **Baking**; **Bread**; **Metaphor, Food as**; **Symbol, Food as**; **Wheat**.

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Lionel Poilâne

BREAKFAST. Breakfast, the first meal of the day, can mean many things to many different people. The English term comes from a Middle English word meaning 'breaking the fast'. Any meal that breaks the overnight fast that occurs while we sleep is considered "breakfast."

Breakfast throughout History

From archaeological evidence at Neolithic sites we know that there was an early reliance on cereal grains; what people consume at breakfast, however, has changed considerably over time and place. Wild emmer and einkorn wheats and a variety of barley were first gathered and then cultivated in the Middle East around 7000 B.C.E. (McGee, p. 233). Maize (corn) was grown in South America and rice in Asia starting around 4500 B.C.E., and rye and oats were cultivated in Europe from about 400 B.C.E. Neolithic peoples used stone querns to grind the hulled grains, then boiled them to make a kind of porridge.

Roman soldiers woke up to a breakfast of *pulmentus*, a porridge similar to the Italian polenta, made from roasted spelt wheat or barley that was then pounded and cooked in a cauldron of water. On the march, they ate *bucellatum*, dried bread similar to Holland rusk (Renfrew, p. 22). People in the Middle East made and grilled flatbreads of all kinds, perhaps accompanied by green onions or another easily cultivated vegetable and a soft cheese, a tradition that carries through to the present time.

When other types of wheat were introduced throughout the Middle East and Europe, higher-rising breads could be baked. Only the wealthy could afford wheat bread because the cultivation of wheat required the most fertile lands. Oats and barley could grow in poorer soils and a colder, wetter climate and provided the basis for heavy breads that peasants ate. Barley was also used to make malt and thus to brew beer from Neolithic times onwards. Water was regarded as unsafe to drink from ancient times through the Renaissance, so beer was the beverage of choice for breakfast. People living in what is now Europe broke their fast with a mug of beer and an oatcake, a heavy bread made from barley and oats, or a bowl of porridge.

In warmer climates, rice became a breakfast staple. In Hong Kong, chicken *congee*, or rice cooked in a rich chicken stock, has been eaten with tea for breakfast for centuries. Likewise in southern India, rice is cooked with fresh ginger, chilies, and spices and served with eggs cooked in ghee or clarified butter.

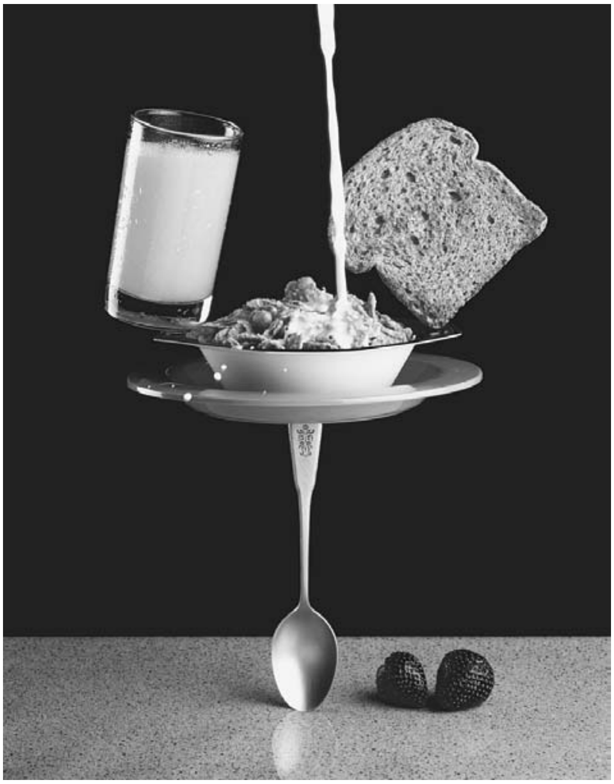
In South America, maize kernels were soaked in lime to remove the hulls and then ground into a moist *masa* to make corn tortillas—the flatbreads of South America. These are still served with eggs, salsa, refried beans, plantains, avocados, and spiced pumpkin seeds or pepitas and other accompaniments for breakfast.

By the end of the 1600s, breakfast throughout most of Europe and the American colonies was a simple affair similar to the current "continental breakfast" offered in hotels in America and Europe. Less affluent households still drank beer for breakfast with their bread or porridge, but wealthier households began to include coffee or tea. Bread and butter, a selection of cold meats, perhaps porridge on a cold day, and coffee, tea, or another hot beverage was the breakfast norm by the early 1800s. In 1821, English writer William Cobbett complained in *Cottage Economy* that "The drink, which has come to supply the place of beer, has, in general, been tea. It is notorious, that tea has no useful strength in it; that it contains nothing nutritious; that it, besides being food for nothing, has badness in it, because it is well-known to produce want of sleep in many cases, and in all cases, to shake and weaken the nerves." England imported 20,000 pounds of tea in 1700 and 20 million pounds by 1800.

Arabs in Ethiopia had been cultivating coffee beans and making the dark, rich beverage since 1000 C.E. Coffee traveled to Turkey, then, by the 1500s, to Venice as part of the spice trade, where it was discovered by the English. Enterprising planters smuggled coffee beans to create plantations in the East Indies and later in South America. By the mid-1650s, coffee was the main attraction at cafés, named after the French word for coffee, in London and Paris. Today, coffee and tea remain breakfast fixtures all over the world.

By Victorian times, when abundance was enjoyed by Americans as well as the British at the height of the British Empire, breakfast was a lavish affair, whether served at a table in a farm kitchen or in an elegant city dining room. Cookbooks from the period provide insight into the breakfast served by affluent households. In the 1861 *Book of Household Management*, Isabella Beeton suggested a daily breakfast buffet that included a cold joint of meat, game pies, broiled mackerel, sausages, bacon and eggs, muffins, toast, marmalade, butter, jam, coffee, and tea.

In the 1877 *Buckeye Cookery and Practical Housekeeping*, the anonymous American compilers suggested breakfast menus for every season. In spring, they recommended fried brook trout, eggs on toast, baked beans and Boston brown bread, rice waffles, coffee, tea, and milk. In summer, the menu included fresh Nutmeg melons, fried fish, Saratoga potatoes, and sliced tomatoes. The fall menu called for oatmeal mush, fried salt pork, corn oysters, baked potatoes, and stewed peaches. In winter, the recommendation was for pork tenderloin, fried apples, buckwheat cakes with syrup, and sliced oranges.



Photographer Michael Neveux has played visual games in this picture called "Balanced Breakfast," which tosses a humorous volley at both nutritionists and gravity. © MICHAEL NEVEUX/CORBIS.

During the nineteenth century, cooks also made breakfast dishes that were a combination of cereals and meats. Scrapple, a blend of pork and cooked cornmeal mush, is sliced and fried for breakfast in Pennsylvania. In Cincinnati, breakfasters still love *goetta* (pronounced "get-uh"), a savory blend of cooked whole oats with pork and onions, also sliced and fried. At this same time, there was a movement against these lavish eating habits, which resulted in the birth of the breakfast cereals we are familiar with today. On 25 December 1865, Ellen White had a vision at her home in Battle Creek, Michigan. She saw the ailing members of her husband Elder James White's congregation returned to blooming health and was convinced that a better diet consisting of more whole grains and fiber was the missing component. And since Battle Creek was the national headquarters for the Seventh-Day Adventists, the Whites' religious affiliation, she wanted all Seventh-Day Adventists to be restored to health. She persuaded her husband to offer a medical scholarship to John Harvey Kellogg, who then set about studying nutrition in New York City.

As a student who wanted a healthier diet, Kellogg cooked for himself and knew how long it took to first soak and then cook whole or cracked grains. He wanted an easier way to eat a nutritious breakfast, and the idea of precooked cereals came to him. However, it took two years of trial and error before he introduced the first ready-made cereal—"Granola," as he called it—to the patients at the Seventh-Day Adventist health sanitarium in Battle Creek. Soon to follow were Grape-Nuts, so named because they were sweetened with dextrose or grape sugar and the product had a nutty flavor, in 1898; they were developed by Dr. Kellogg and his brother Will. Corn flakes flavored with malted barley debuted in 1902. Alexander P. Anderson of the Quaker Oats Company developed the technology for puffed cereals, and puffed rice was introduced to the American consumer at the St. Louis World's Fair in 1904. Today, 66 percent of Americans still eat cold cereal for breakfast (Perryman). Even those who skip breakfast still might drink a glass of orange juice, another breakfast staple.

Breakfast around the World

Americans also enjoy other types of breakfast foods, some more healthy than others. In addition to fruit juices, particularly orange juice, pancakes, biscuits, eggs, bacon, sausages, and other breakfast meats, Americans also consume hash brown potatoes and breakfast pastries such as coffee cakes, donuts, and muffins. About 7 percent of Americans enjoy a Southern-style breakfast with eggs, sausage, grits, and biscuits. On-the-go breakfasters—now about 68 percent of the population—might stop at a fast-food restaurant for a cup of coffee, a breakfast sandwich, a bagel, or a doughnut. Fast-food restaurants have expanded their breakfast offerings while the number of bagel emporiums and coffee shops has greatly increased to meet the growing needs of these breakfasters on the way to work or school. Health-conscious eaters favor breakfast cereal bars, plain bagels, yogurt, and herbal tea or fresh-squeezed carrot juice, and have prompted this segment of the prepared foods market to burgeon (Lach). About 32 percent of Americans currently eat toast for breakfast.

Unlike the sit-down family breakfast of the past, the early-twenty-first century American breakfast is eaten at different times before parents and their children leave for work and school. This trend also fuels the need for easy-to-eat breakfast items such as breakfast bars, yogurt, cereals, toaster pastries, and microwavable frozen breakfast entrees.

In England, the typical English breakfast or "full fry-up" includes fruit juice, a bowl of cereal, eggs with fried streaky bacon or sausages, sometimes grilled tomatoes and mushrooms, perhaps a kipper or other smoked fish, fried bread or toast or scones, and marmalade. In France, a croissant or a baguette with fresh butter and a cup of *café au lait* (coffee with milk) is common. Italians enjoy a light breakfast of pastry or bread and butter with coffee, while the Germans, Swiss, Dutch, and Scandinavians prefer a breakfast of cold sliced meats and cheeses, bread and butter, jam, and perhaps a boiled egg. Dutch and Belgian breakfasters might enjoy a touch of chocolate—as a filling in a croissant or chocolate sprinkles known as *hagel* over buttered toast.

In other parts of the world, breakfast is equally simple. In India, it might mean flatbread with cardamom-scented tea or steamed dumplings with a spicy sauce and coconut chutney (Sahni, p. 104). Mexicans eat *huevos rancheros*, or scrambled eggs with chilies and salsa, or even *menudo*, braised tripe, and burritos. In Saudi Arabia, families eat eggs, baked beans, cheese, olives, and *ma'soub*, or pancakes with bananas, but are also including American cereals.

Breakfast as a Social Ritual

Apart from the necessity of breaking the fast, the first meal of the day can also function as an important social ritual. Retired businessmen and farmers, networking men and women in management, mothers of young children, or singles often meet at a designated restaurant for an early morning breakfast. Schools, churches, and other organizations offer pancake breakfasts as fundraisers. Tailgate breakfasts served from the back of a car or van feed fans at weekend football games; hunt breakfasts served buffet-style feed those about to saddle up.

The wedding breakfast, a more formal affair, brings together the wedding party and the families for an elegant first meal to start the couple's big day—or, often, their first day as a married couple on the day after the wedding. Less hearty foods, such as champagne, smoked salmon, shirred eggs, eggs Benedict, steamed asparagus, and Danish pastries would be on a wedding breakfast menu.

Brunch, a combination of breakfast and lunch served later in the morning, is often a relaxed social occasion, most often held on Sunday in private homes or restaurants. Savory bread puddings, egg casseroles, omelets, waffles, coffee cakes, and fruit compotes are typical brunch fare. Alcoholic drinks such as Bloody Marys (vodka with spiced tomato juice), Mimosas (champagne with orange juice), or screwdrivers (vodka with orange juice) might also be served.

The Best Way to Start the Day

No matter what is on the menu, research shows that breakfast is still a very important meal. In a 1998 study of schoolchildren published in the *Archives of Pediatric and Adolescent Medicine*, researchers found that children who eat breakfast perform better academically and also behave better. The children who ate breakfast functioned intellectually at almost a grade level higher than those who did not, and were less likely to fall asleep at their desks or disrupt class because of hunger. The same goes for adults. Eating breakfast improves the ability to concentrate, reduces the risk of heart disease, improves weight control, and increases strength and energy. Generally, health professionals recommend that we eat a healthy breakfast consisting of protein, whole grains, and fruits that totals about one-third of our daily caloric intake (Maynard).

See also **Beeton, Isabella; Cereal Grains and Pseudo-Cereals; Cereals, Cold; Dinner; Fruit; Kellogg, John Harvey; Lunch; Vegetables; Vitamin C.**

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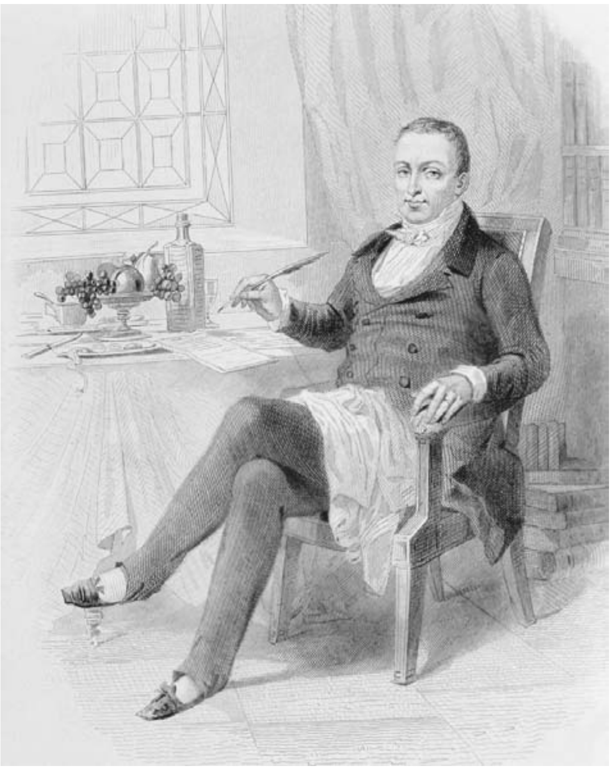
Judith M. Fertig

BRILLAT-SAVARIN, JEAN ANTHELME. The author of the best-known work of gastronomy, Jean Anthelme Brillat-Savarin (1755–1826), was born in Belley in the region of Bresse, studied law in Dijon, became a lawyer and president of the civil court at Ain, a mayor of Belley, and a commander of the National Guard. In 1789 he was chosen to be a deputy to the National Assembly. In 1793 the Revolutionary Tribunal accused him of "moderatism" and he fled to Switzerland, Holland, and finally America. In New York he supported himself for three years by teaching French and playing the violin in the John Street Theatre, but he also traveled north through New England, where he hunted game in good company, and south to Philadelphia where he met Thomas Jefferson. Returned to France in 1796, he was appointed judge to the Supreme Court of Appeals in Paris.



Nineteenth-century print based on a portrait of Anthelme Brillat-Savarin, author of *The Physiology of Taste* (*Physiologie du goût*). © GIANNI DAGLI ORTI/CORBIS.

As a bachelor gourmand, he entertained often in his home on the Rue de Richelieu and frequented such stylish restaurants as Grand Véfour and Beauvilliers. Known to be a learned and witty man, he wrote treatises on a number of different sciences and wished to make a science of culinary art.

In 1826, he published anonymously the *Physiologie du goût: Méditations de gastronomie transcendante, ouvrage théorique, historique et à l'ordre du jour, dédié aux gastronomes parisiens* (Physiology of Taste, or Meditations on Transcendental Gastronomy: a theoretical, historical and contemporary work, dedicated to the gastronomes of Paris), a collection of aphorisms, epigrams, anecdotes, and essays on subjects as diverse as chemistry, physiology, nutrition, obesity, appetite, gourmandism, digestion, dreams, frying, and death. He even included a miniphilosophic history of cuisine from man's discovery of fire to the tables of Louis XVI.

The Physiology of Taste

"Tell me what you eat, and I shall tell you what you are" (Fisher, p. 3).

"The discovery of a new dish does more for human happiness than the discovery of a star" (p. 4).

"A dinner which ends without cheese is like a beautiful woman with only one eye" (p. 4)

"Let one open any book of history, from Herodotus to our own days, and he will see that, without even excepting conspiracies, not a single great event has occurred which has not been conceived, prepared, and carried out at a feast" (p. 54).

"Whosoever pronounces the word "truffle" gives voice to one which awakens erotic and gastronomical dreams equally in the sex that wears skirts and the one that sprouts a beard" (p. 93).

Although his aim was didactic, his gift was for storytelling—his anecdotes rather than his analyses make his work live. His timing and his tone were right for the new bourgeoisie of Paris and the form of his *Physiology* helped establish the popularity of a new essayistic genre, the profile. Translated into many languages, his work has enjoyed a wide readership because of his light and easy style, his facility with a phrase—so quotable that his aphorisms have become clichés—and finally his intellectual solidity in placing the physical and aesthetic pleasures of food in the social–scientific context of human behavior.

In short, he took the subject of food seriously in a new way. Instead of elaborating an aesthetics of taste, based on the idiosyncrasies of individuals in the manner of his aristocratic contemporary Grimod de la Reynière, Brillat-Savarin attempted to find general principles that would liberate taste from autocratic authorities. His attempt to provide a scientific basis for all the pleasures of the table was compatible with the reasoned conservatism of the Enlightenment that had earlier sent him into exile. His *Physiology* is a remarkably egalitarian work.

At the same time, he epitomizes the urbane civility of a man born in the country who rose to high office in the city in the new ranks of the Parisian bourgeoisie. Others, striving to improve their social standing, could identify with him. As Brillat-Savarin outlined them, his standards of excellence were no longer defined by professional chefs of the court or by grand banquets of court cuisine, but by the quality of ingredients and a care of preparation that anyone could learn. He rhapsodizes over cheese, eels, or truffles not because they are extravagant luxuries but because they are part of a well-stocked larder that any man of means could buy and serve at home. For the convenience of his readers, he took care to include the names and addresses of his favorite Parisian suppliers of groceries, pastries, and breads. In effect, although a habitué of the best restaurants in town, he was essentially addressing the home cook and the home diner.

Although writing almost two centuries ago, he describes a culinary world that seems familiar to any inhabitant of a large cosmopolitan city in the early twenty-first century. In praising the Parisian table, he does not ascribe its virtues to an indigenous French character, but rather to the fruits of an increasing internationalism. He lists which ingredients come from France, which from England, Germany, Spain, Italy, Russia, Africa, Holland, and America. He concludes: "a meal such as one can eat in Paris is a cosmopolitan whole in which every part of the world makes its appearance by way of its products" (Revel, *Culture and Cuisine*, p. 218). He fancied himself a citizen of the world and as a result his name has become synonymous, at least in the Western world, with food's most civilized expression of wit and humanity.

See also **Cookbooks**; **Fisher, M. F. K.**; **France**; **Gastronomy**; **Grimod de la Reynière**.

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Betty Fussell

BRITISH ISLES.

This entry includes four subentries:
England
Ireland
Scotland
Wales

England

Since the 1970s, English food appears to have undergone a transformation. A postwar cuisine of plainly cooked meat and vegetables supplemented with baked goods and puddings has apparently given way to multiculturalism. Restaurants serve fusion food. Supermarkets sell chilled meals based on Italian or Asian recipes. The cookery sector of publishing is buoyant. This seems astonishing for a country whose eating habits evolved little between the

The interior of Covent Garden in London, circa 1920. This market hall was one of the largest in England as well as the center of London's food distribution system until after World War II, when it was closed due to traffic congestion. ROUGHWOOD COLLECTION.

mid-nineteenth century and 1953, when Second World War rationing ended; but beneath the metropolitan froth, old ideas about plain cooking live on.

Background

England has an unpredictable but generally benign maritime climate, without extremes; relief is low, the highest mountain standing 3210 feet (978 meters). A basic topographic division runs from northeast to southwest, along the watershed of the Trent and Severn rivers. North and west of this, the land tends to be higher, and the climate colder and wetter. To the south and east, hills are generally low, and summers warmer and drier. Annual rainfall ranges from about 97 inches (2,500mm) in the hills of the northwest to about 23 inches (600mm) in the driest parts of the east; winter temperatures rarely drop more than a couple of degrees centigrade below freezing and the summer maximum is about 86°F (30°C).

England's political and cultural dominance of the United Kingdom makes it difficult to disentangle English food habits from those of the Welsh, Scots, and Irish. Successive waves of settlers have brought ideas about food, but few attributions can be made until the twentieth century. Foreign trade has been important to English cuisine since at least the late Middle Ages. Spices came from the East Indies; sugar and currants were initially imported from the Mediterranean, and later from colonial possessions. A dependence on tropical crops—tea, coffee, chocolate, sugar—developed in the nineteenth century; and the idea of curry came home with the nabobs of the East India Company.

Meat

Localized breeds of cattle, sheep, and pigs developed in the nineteenth century. Grass-fed beef from Aberdeen Angus, Hereford, and other traditional breeds is considered best. Most sheep meat is eaten as lamb, under the age of a year; mutton, from older sheep, formerly important, is now almost unobtainable. Fresh pork was and is popular, as is bacon. Wiltshire became an important center for curing meat in the nineteenth century. Bacon provided a relish for the otherwise monotonous diets of the poor. It remains an English favorite, though much is now imported from Denmark. Regional ham cures that became famous include those of York (or, more properly, Yorkshire), Cumberland, Devon, and Suffolk.

Poultry has long been important for both meat and eggs. In the nineteenth century, the counties around London produced Sussex and Dorking chickens; Surrey was famous for capons, and the town of Aylesbury produced ducks. Turkeys and geese were reared on corn (grain) stubble in East Anglia for sale in the capital. Poultry production is now an intensive industry, though small businesses based on high-quality traditional poultry production are appearing. Only geese have not succumbed to intensive systems.

Game has always featured on the aristocratic menu. Venison was most sought after; deer farming has made this more accessible, but it remains a minority taste, as do hares. Rabbits, nurtured in warrens in the Middle Ages, escaped, naturalized, and became pests, and the only wild creatures easily accessible to the poor. Wildfowl of all descriptions were eaten up to the eighteenth century, but subsequently the choice narrowed to about a dozen species, of which pheasants are most common, yet grouse from heather moorlands, and partridges are most prized.

Meat Cookery

Meat cookery demonstrates a preference for plain roasted (or, strictly speaking, baked) meat. Traditional accompaniments are horseradish sauce for beef; mint sauce (finely chopped mint mixed with sugar and vinegar) for lamb, and sage and onion stuffing and applesauce for fresh pork, which is generally roasted with the skin on to make crackling. Roast potatoes and boiled green or root vegetables are also served. Boiled meat dishes, such as salt beef with carrots, or mutton with caper sauce have almost vanished, though some people still marinate beef with salt, spices, and sugar for several days to make spiced beef. Steaks and chops are used for grilling.

Other meat dishes include pies or steamed suet puddings of beefsteak and kidney; oxtail is made into stews and soups. Skirt of beef is mixed with chopped potato, onion, and turnip in Cornish pasties, popular everywhere but closely identified with Cornwall itself. Northern butchers make a paste of cooked beef beneath a layer of fat; this potted beef is a remnant of an eighteenth-century tradition of potting all kinds of meat. Lancashire hotpot is a traditional stew of lamb or mutton chops with layers of onions and potatoes. It evolved in an area where a high rate of female employment led to a reliance on slow-cooked and ready-prepared foods.

Pork products include fresh sausages of lean and fat meat and some type of grain; the Cumberland type, with a high meat content and distinctive coiled presentation, is considered particularly good. Pork pies, survivors of a great tradition of raised pies, are made with a lard-based hot-water crust. Melton Mowbray in the Midlands is famous for a fine version. Black puddings (blood sausages), highly seasoned mixtures of blood, grain, and cubes of fat, are known everywhere but have a strong association with the industrial towns of south Lancashire (as does ox

PUDDINGS

Pudding has two different but linked meanings. It can indicate any sweet food considered suitable for dessert, ranging from fresh fruit to the most elaborate of sweet dishes. This usage developed after puddings, a fairly neutral staple food in the seventeenth century, evolved a subset of heavily sweetened dishes eaten for the second course at dinner.

Older meanings relate pudding to specific groups of dishes, some savory, some sweet. The oldest group is represented by sausage-type products such as black puddings (blood, fat, and grain) and white puddings, well documented since the sixteenth century. Bag puddings, mixtures of suet and flour or breadcrumbs, wrapped in a cloth and boiled, were known by the seventeenth century, and developed two distinct types. One was the sweet suet pudding with lemon peel, currants, sugar, and spice. Plum pudding, a heavily enriched version with raisins, candied peel, and sugar, has become a symbol of Christmas and remains essentially unchanged since the eighteenth century. Other sweet puddings include versions filled with fresh seasonal fruit, or jam roly-poly, suet crust spread with jam and rolled up, which became a school dinner staple. The second type was the savory suet pudding with a meat filling. These were recorded by the nineteenth century: steak and kidney remains a favorite, though puddings made with steak and oysters, mutton, and game such as partridges are also recorded.

Other ancient pudding types are pease pudding, based on a puree of dried peas, eaten with boiled bacon or ham, and Yorkshire pudding, made from batter baked in a popover pan, the principal survivor of numerous recipes for batter puddings boiled or baked.

In the eighteenth century, many sweet puddings using pastry and fruit or nuts became fashionable. Mixtures of rice or sago with milk and sugar also became common. These remain popular, though often in debased "nursery" versions. Puddings, steamed or baked, based on sponge-cake mixtures, flavored with lemon, ginger, or cocoa, became popular in the mid-nineteenth century, as did summer pudding, based on bread and fresh summer fruit.

Salted kippers from Cumbria, England, are one of the traditional breakfast specialties of the country, but they are an acquired taste for outsiders. They are salted prior to smoking, hence the distinctive flavor. © JACQUI HURST/CORBIS.

tripe). Hog's puddings, of seasoned grain and fat, are popular in the southwest. Other items include faggots, chopped offal wrapped in squares of caul; haslet, a kind of loaf made from scraps of lean and cured pork; and brawn, a cold jellied dish made from meat picked from the head. Lard, beef suet, and drippings are important in traditional cookery.

Chicken, once an expensive treat roasted for special occasions, is now ubiquitous. It is much used in dishes of foreign origin. Rabbit stews and pies became poverty food, and the taste for them has waned. Hare soup and jugged hare—cooked slowly with wine and herbs, the sauce thickened with the blood of the animal—are classic dishes of English game cookery.

Fish

Cod and haddock, though becoming scarce, are staples of fish and chip shops; grilled Dover sole is a standard of English restaurant cookery. Oysters, until the mid-nineteenth century a cheap food, suffered from pollution and disease and are now a luxury. Morecombe Bay shrimps (*Crangon crangon*), potted in spiced butter, are a traditional teatime delicacy. Eels, until the 1970s, were closely associated with the food habits of the London poor. Eel pie, and mash (mashed potatoes) shops sold them cold as jellied eels (boiled and allowed to cool in their liquid) or hot with mashed potato and "liquor," a green parsley sauce. Herrings were important until a recent decline in fish stocks. Some were eaten fresh, but most were preserved. Red herrings (heavily salted and smoked for long-term keeping) were superseded in the nineteenth century by lighter cures: kippers (split and cleaned before smoking) evolved in Northumberland, while Yarmouth favored bloaters (whole, lightly salted smoked herrings). Salmon, which became expensive when rivers were polluted during the nineteenth century, is cheap again because of fish farming, and poached salmon with cucumber is an English summer favorite.

Bread and Baking

White wheaten (wheat) bread is of primary importance. Traditional oblong tin loaves have become degraded under industrial production, and foreign influence makes it easier to buy croissants, ciabatta (a bread of Italian origin with a chewy, open texture), pita, or nan bread than a traditional cottage loaf (two-tiered round loaf). Historically, bread grains included rye, barley, and maslin (mixed grain). In the northern hills, oats, the only reliable grain crop, were used for flatbreads. By the seventeenth century a preference for wheat had developed in the London area. Variety diminished as the taste for wheat spread and grain imports grew in the nineteenth century. Now, only the oat-bread tradition survives. Haverbread (from Old Norse *hafre*, oats), flat ovals about a foot long, can occasionally be found in towns on the Yorkshire-Lancashire border. A stronger custom of baking floppy oatcakes about ten inches in diameter continues in Staffordshire. Barley is now grown for brewing.

There are many small regional breads. Kentish huffkins, Cornish splits, and Yorkshire teacakes are all round and flattish, enriched with a little sugar, lard, and dried fruit. Hot plates are used to bake muffins (made from soft bread dough), and also crumpets, and pikelets (both made from thick, yeast-leavened batter). This trio of foods are all eaten toasted and spread with butter for breakfast or tea. Scones, of flour, sugar, egg, and dried fruit, are common. Chelsea buns and Bath buns are rich and sweet. Hot cross buns, marked with a cross on top, are plainer and spiced; formerly made only on Good Friday, they are now produced for several weeks around Easter.

Lardy cakes made from bread dough folded with lard, sugar, and dried fruit are typical of southern England. Currants, raisins, and candied peel feature in yeast-leavened Guernsey gâches, Cornish saffron cakes, and Yule loaves (sweetened Christmas breads made in the north). Rich fruit cakes are related to these breads historically. Modern versions are heavy with sugar, butter, raisins, currants, and candied cherries. Covered with almond paste and sugar icing, they are essential for Christmas or weddings; baked with a marzipan layer in the middle, they become simnels, for Easter.

The taste for dried fruit extends to Eccles, Chorley, and Banbury cakes—spiced currant mixtures wrapped in puff pastry. Small mince pies, filled with a mixture of dried fruit, spices, and sugar, are eaten all over the country throughout the Christmas season. Originally the mincemeat filling did contain veal, mutton, or beef; now, an enrichment of beef suet is all that survives of this. Such dried fruit and pastry confections have been popular for at least four hundred years.

Ginger is popular in baking. Grasmere gingerbread comes from the Lake District, where local ports were active in the West India trade and a taste for brown sugar, rum, and ginger survives. Parkin is a north-country gingerbread that often contains oatmeal. Cornish Fairings and Ashbourne cakes are also ginger-flavored, and have a crisp, biscuity texture. The diversity of modern British biscuits (cookies) is a product of nineteenth-century industry, but Shrewsbury cakes (related to shortbread) were recorded in the seventeenth century, and Bath Olivers (plain biscuits) in the early nineteenth.

Vegetables and Fruit

The English have never been renowned for sensitivity in cooking vegetables, which were generally boiled and served with butter. Cabbages, carrots, parsnips, spinach, and salads such as lettuce and watercress have a long history of use, as has asparagus: the Vale of Evesham and Norfolk are particularly associated with this crop. One vegetable almost uniquely used by the English is sea kale (*Crambe maritima*); wild plants were overexploited in the nineteenth century but sea kale is now cultivated in small quantities. Potatoes first gained wide acceptance in the north; by the nineteenth century they were eaten everywhere by everyone, and have continued to be so.

FISH AND CHIPS

Fish and chips, a favorite take-away (takeout) food in England, are sold in their own specialized restaurants and shops. There is some debate about when the combination became popular, but fried fish was being sold as street food in London as early as the 1830s, when Charles Dickens mentioned a fried-fish warehouse in *Oliver Twist*. Chips (french fries) appear to have joined the fish by the 1880s, and the pairing has remained popular ever since.

Cod is most commonly used, though haddock is preferred in some areas; the fillets are dipped in batter before deep-frying. For chips, the potatoes are cut in thick fingers and deep-fried. Vegetable oil is the usual frying medium in the south. Beef drippings are often used in the north. On purchase, the cooked fish and chips are seasoned with salt and vinegar as the customer desires. A pot of mushy peas (cooked marrowfat peas) is sometimes added to the order. Traditionally, newspapers are used for wrapping fish and chips, and the smell of deep-frying combined with hot newsprint is part of the experience. Health regulations now demand layers of greaseproof paper to insulate the food from printer's ink.

The center of English social life is the village pub, where all manner of truths and confessions are part of the daily fare. Oftentimes the food is minimal, but at the best establishments it vies with high-class home cookery, as in the case of this famous pub in Boston, England. © JAMES L. AMOS/CORBIS.

Apples, pears, cherries, and plums are traditional fruit crops of the southeast and southwest. Cobnuts are grown in Kent; soft fruit is grown across much of the country, strawberries and raspberries being favorites. Historically, the north, with a more challenging climate, relied on gooseberries, damsons, and rhubarb, the latter mostly grown in West Yorkshire, where it is forced as an early spring crop. Traditional fruit puddings and jams are a strength of the English kitchen. One vital item, the bitter orange, is grown in southern Spain and imported specifically for making breakfast marmalade. A taste for sugar confectionery has led to numerous boiled sugar sweets, many using fruit flavorings.

Dairy Products

Dairy products were considered food for the poor in the seventeenth century, but have become progressively more important. Cream is mixed with fruit purees for fools, and beaten with wine and lemon for syllabubs. Clotted cream,

MUFFINS AND MUFFIN-MEN

As late as the 1930s, muffins were sold in London by muffin-men, street vendors who announced their presence by ringing a bell. In 1851, Sir Henry Mayhew recorded in *London Labour and the London Poor* that muffin-men bought their wares fresh from the bakers. The muffins were kept warm by wrapping them in flannel; they were then carried through the streets in baskets for resale door-to-door. The custom apparently derives in part from genteel ladies who did not keep servants who could be sent on errands, but who liked a slap-up (lavish) tea. The muffin-men recognized this, and made their rounds in mid-afternoon, convenient for tea time. Muffins were most popular in winter. To eat them, they were toasted, pulled apart around the circumference, spread with butter, and the halves put back together to allow the butter to melt.

The origin of the name is a mystery. Recipes appear in the mid-eighteenth century, but the idea is probably much older. Muffins enjoyed great popularity but were considered old-fashioned by the early twentieth century, and had almost vanished by the Second World War. In the 1980s, they were revived by industrial bakeries, and are once again available, in varying degrees of quality. Muffins in England—quite unlike sweetened muffins and what people in North America call "English muffins"—are disks about four inches in diameter and an inch thick, and made from plain, soft bread dough. Size and the use of yeast as a leaven relates them to the many other small breads of English traditional baking, while the use of a hot plate puts them in the same category as crumpets, pikelets, and several Welsh and Scottish specialties.

heated gently to produce a thick crust, is a specialty of Devon and Cornwall. Butter is essential for spreading on bread and toast, as well as in cooking generally. Cheesemaking in Britain was centralized during the Second World War, concentrating on "territorial" cheeses—Stilton, Cheddar, Gloucester, Cheshire, Lancashire, Wensleydale, Derby, and Leicester. All named for their areas of origin, they became generic (apart from Stilton, the manufacture of which was restricted to a small area in 1910). A dwindling nucleus of farm cheese-makers was boosted in the 1980s as "new wave" artisans who injected new creativity and energy into the industry.

Meal Times and Names

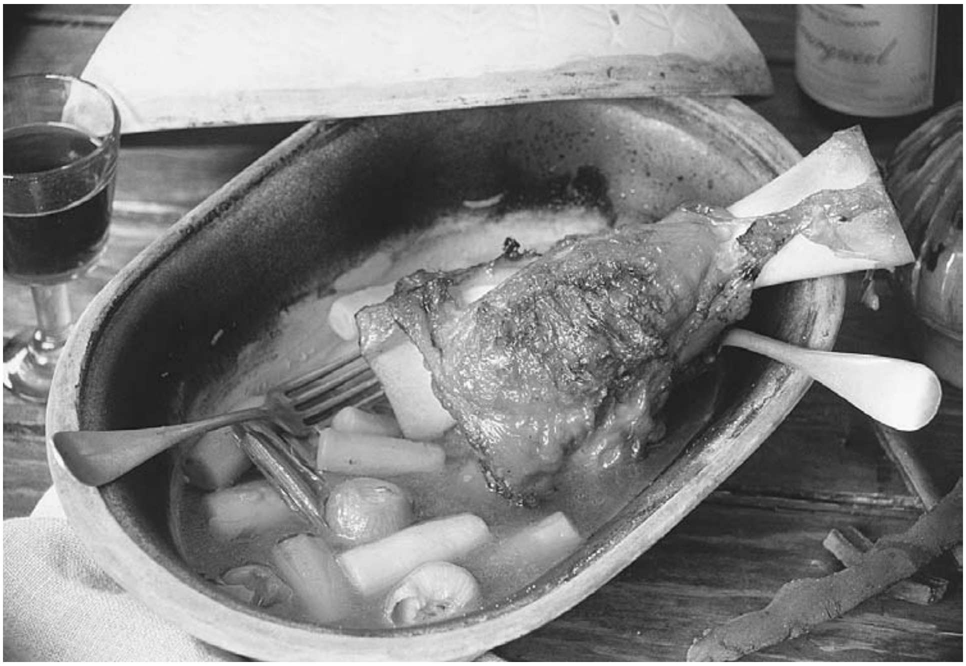
The British all recognize the early morning meal as breakfast, but after that a division becomes apparent. One pattern is a light midday lunch, perhaps afternoon tea, and a large dinner in the evening. The other is midday dinner and a substantial tea in the early evening. Sometimes this is called high tea or supper, though "supper," confusingly, is also used to indicate a light, late-evening repast. This divide originated when dinner, once a midday meal, slipped first to the early evening and then as late as 8:00 P.M. in the early nineteenth century. Lunch and afternoon tea developed to fill the long hours between breakfast and dinner. Wealthy younger people and southeasterners tend toward the lunch and dinner pattern. Poorer people, older ones, and northerners follow, to a diminishing extent, the dinner and tea pattern.

The "full English" breakfast. There is much nostalgia for the full English breakfast, a meal now mostly encountered in hotels, guesthouses, and cafés. Fried bacon and eggs are essential. Tomatoes, mushrooms, baked beans, fried bread, sausages, and black pudding are often added. Toast and marmalade generally follow. In cafés this meal is often available at any time. Time-consuming to prepare and eat, it is rarely made at home on a workday, when breakfast usually consists of cereal or toast, or coffee and a pastry bought on the way to work. However, cooked breakfasts are often made as a weekend treat.

Other items sometimes found at breakfast are oatmeal porridge (now closely identified with Scotland, but a survivor of a general British tradition of grain pottages) and kippers. In India, the British took *khichri*, spiced rice and lentils eaten with dried fish, and transmuted it into kedgeree, a mixture of rice, onions, and smoked haddock, still popular. Substantial breakfasts were most fully developed in country houses in the mid-nineteenth century, when huge buffets including such delicacies as deviled kidneys, raised pies, and cold tongue were laid out.

Lunch. Lunch has few special foods linked with it; though large formal lunches are sometimes eaten, a collation of odds and ends is more frequent. Sandwiches are a popular choice. The English have found sandwiches a convenient handheld meal since the mid-eighteenth century, when the Earl of Sandwich is said to have asked for his meat between two slices of bread, so as to avoid leaving the gaming table. Currently enjoying a zenith of popularity and variety, numerous specialty shops sell them filled with anything from conventional cheese and pickles or roast beef and horseradish combinations to chicken *tikka* or prawns and avocado. For those who want a hot lunch, soup or "something on toast"—cheese, eggs, fish, baked beans—are popular.

Dinner. Dinner is a substantial hot meal, whether taken at midday or in the evening. The traditional pattern is cooked meat or fish with vegetables. A sweet course, usually referred to as pudding, follows. Food may come from the prepared-food counter in a supermarket, and home cooks are as likely to choose dishes from the Mediterranean or the Indian subcontinent as traditional English ones. Take-away (takeout) food, from traditional fish and



English country fare has undergone a revolution, in part due to high-end tourism and to a process of rediscovery among English food enthusiasts who want to see more of the country's culinary treasures showcased to visitors. Here, traditional English veal shin is baked in a clay pot with various root vegetables at Le Manoir, Great Milton, Oxfordshire, England. © Michael Boys/CORBIS.

chips to kebabs, curries, or "a Chinese," are possible choices.

Confounding the lunch-dinner division are the special cases of Sunday dinner and Christmas dinner. These phrases still imply a large midday meal. Sunday dinner is often roast beef and Yorkshire pudding, served with gravy made from the meat juices or a commercial mix. Roasted or boiled potatoes and other vegetables, typically boiled cabbage and carrots, are also served. Lamb, pork, or chicken may take the place of the beef. Pudding choices include trifle (sherry-soaked sponge cake covered with layers of custard and cream); treacle tart (filled with golden syrup, lemon, and breadcrumbs), or lemon meringue pie. Steamed suet or sponge puddings are seen as old-fashioned but remain popular, as do fruit pies.

Christmas dinner usually centers on turkey or goose accompanied by sage and onion stuffing. Bread sauce, milk infused with cloves and shallot, thickened with breadcrumbs, is a classic accompaniment and a survival of a medieval tradition of bread-thickened sauces. Brussels sprouts are generally among the vegetables. This is followed by Christmas pudding flambéed with brandy, served with rum or brandy butter. Turkey is now the general choice, a reflection of centuries of great feasts involving various bird species, though roast beef was also a standard Christmas dish until the nineteenth century.

Afternoon tea and high tea. Tea is overlaid with social nuances. Apart from tea to drink (a beverage of primary importance in England since the mid-eighteenth century), afternoon tea is a dainty meal: bread and butter, small sandwiches filled with cucumber, a cake. Cream tea is a variant on this, with scones, jam, and cream. Elaborate afternoon teas are now most often taken in a café. High tea is a substantial meal, for people returning from work, or for children after school. It involves hot food such as kippers, eggs, pies, or sausages, or, in summer, cold ham or tinned canned salmon and salad. Bread and butter is always on the table, together with jam, and a selection of cakes—large ones, such as fruit cake or a Victoria sandwich (sponge cake filled with jam and cream), and small fairy cakes (similar to cupcakes or miniature muffins), jam tarts, and cookies.

Recent Developments

A trend toward vegetarianism and concern about animal welfare has become apparent since the 1970s, leading to a growth in consumption of organically produced and vegetarian foods. Another development is a taste for ethnic food. Though imitations of Asian food, such as curry, piccalilli, and mushroom ketchup, have been made since the eighteenth century, in the last hundred years immigrant communities have introduced numerous new ideas. Chinese restaurants were widespread by the 1960s and Italian restaurants soon followed. Indian restaurants began to penetrate beyond major centers of immigration in the 1970s, putting dishes such as chicken *tikka masala* on the national menu, especially after pub closing time. West

Indian, Hispanic, Turkish, and Thai restaurants can now be found in most cities.

London restaurant culture now has a global reputation for excellence, and interest in eating healthily has increased; but London is not England, and the high incidence of cardiovascular disease throughout the country is partially attributed to poor diet. Writers, guides, and chefs have raised the variety and quality of ingredients and of ready-prepared food, and cookery is a popular subject for television. But the best traditional English food remains a specialty found mostly in the homes of dedicated cooks.

See also **Custard; Fish and Chips; Pastry; Tea (Meal).**

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Laura Mason

IRELAND

The first settlers, the Mesolithic people, came to Ireland about 7000 B.C.E. and lived by hunting, fishing, and gathering. Neolithic colonists introduced domestic animals and crops about 4000 B.C.E. Cultivated cereals included emmer wheat *(Triticum dicoccum)*, bread wheat *(Triticum aestivum)*, and barley. Wild foods, such as hazelnuts and dried crabapples, were stored. Farming, crops and livestock, continued during the Bronze Age (2000–700 B.C.E.) and the pre-Christian Iron Age (700 B.C.E.–500 C.E.), as is evident from faunal remains and from the range of quernstones for saddle, beehive, and disk querns used to process cereals for domestic use.

In the historical period literary data of various kinds supplement the archaeological record. Religious texts in Old Irish and Latin from the Early Christian period (500–1000 C.E.) describe monastic and penitential diets, and the Old Irish law tracts of the seventh and eighth centuries provide insight into food-production strategies, diets, and hospitality obligations. Prestige foods are correlated with social rank according to the general principle that everyone is to be fed according to his or her rank. Persons of higher social status enjoyed a greater variety and quality of food than those of lower rank. Milk and cereal products were the basis of the diet, and a distinction was sometimes made between winter and summer foods. The former apparently consisted of cereals and meat and the latter mainly of dairy produce.

Milk and Milk Products

Milk, "good when fresh, good when old, good when thick, good when thin," was considered the best food. Fresh milk was a high-status food of sufficient prestige to be served as a refreshment to guests in secular and monastic settings. Many milk products are mentioned in the early Irish legal tracts and in *Aislinge Meic Con Glinne* (Vision of Mac Con Glinne), an early medieval satirical text in the Irish language rich in food imagery and probably the most important source of information about food in medieval Ireland. Butter, curds, cheese, and whole-milk or skim-milk whey were common elements of the diet. Butter was often portrayed as a luxury food. It was part of the food rents a client was obliged to give to his or her lord and a festive food for monastic communities. Curds, formed naturally in milk or by using rennet, were a common summer food included in food rents and apparently a normal part of the monastic diet. Cheese, in soft and hard varieties, was of great importance in the early Irish and medieval diet. Whey, the liquid product of the preparation of curds and cheese, was rather sour, but diluted with water it was prominent in the stricter monastic diets of the early Irish Church. Goat's milk whey, considered to have medicinal properties, was still in regular use in parts of Ireland in the early nineteenth century.

These milk products held their ancient status in the diet to varying degrees until the threshold of the eighteenth century, when forces of commercialization and modernization during the modern period altered levels of consumption and ultimately the dietary status of some milk products. Milk and butter remained basic foodstuffs, and their dietary and economic significance is reflected in the richness of the repertoire of beliefs, customs, and legends concerned with the protection of cows at the boundary festival of May, traditionally regarded as the commencement of summer and the milking seasons in Ireland, when the milch cows were transferred to the lush green pastures. Cheese making, which essentially died out in the eighteenth century, probably due to the substantial international butter and provisions trade from Ireland, made a significant comeback in the late twentieth century.

Cereal Products

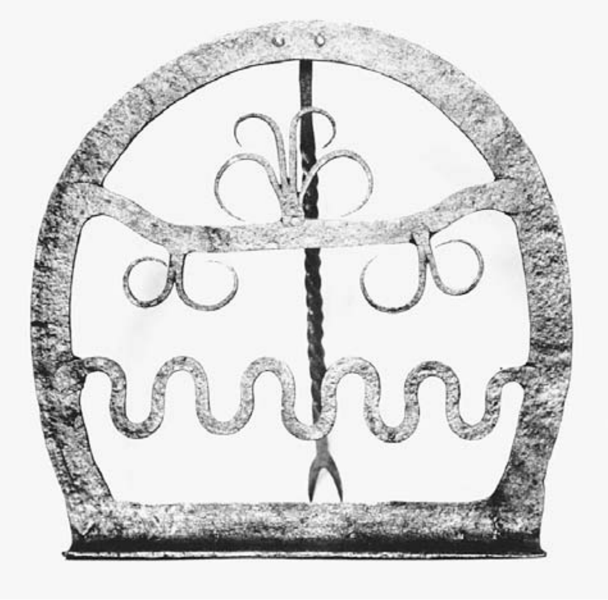
Wheat products were consumed mainly as porridge and bread in early and medieval Ireland. Porridge was food for children especially, and a watery type figured prominently as penitential fare in monasteries. Wheaten bread was a high-status food. Climatic conditions favored barley and oat growing. Barley, used in ale production, was also a bread grain with monastic and penitential connotations. Oat, a low-status grain, was probably the chief cereal crop, most commonly used for oaten porridge and bread. Baking equipment mentioned in the early literature, iron griddles and bake stones, indicates flat bread production on an ovenless hearth. Thin, unleavened oaten bread, eaten mostly with butter, was universal in medieval Ireland and remained the everyday bread in parts of the north and west until the nineteenth century. Barley and rye breads or breads of mixed cereals were still eaten in parts of eastern Ireland in the early nineteenth century.

Leavened wheaten bread baked in built-up ovens also has been eaten since medieval times, especially in strong Anglo-Norman areas in East Ireland, where commercial bakeries were established. English-style breads were available in cities in the early seventeenth century, and public or common bake houses are attested from this period in some urban areas. Built-up ovens might be found in larger inns and prosperous households, but general home production of leavened bread, baked in a pot oven on the open hearth, dates from the nineteenth century, when bicarbonate of soda, combined with sour milk or buttermilk, was used as a leaven.

A refreshing drink called sowens was made from slightly fermented wheat husks. Used as a substitute for fresh milk in tea or for sour milk in bread making when milk was scarce, it replaced milk on Spy Wednesday (the Wednesday of Holy Week) and Good Friday as a form of penance. A jelly called flummery, procured from the liquid by boiling, was widely used.

Meat, Fowl, and Fish

Beef and mutton have been eaten in Ireland from prehistoric times, and meat was still considered a status food in the early twenty-first century. Pigs have been raised exclusively for their meat, and a variety of pork products have always been highly valued foodstuffs. Domestic fowl have been a significant part of the diet since early times, and eggs have also figured prominently. Wild fowl have been hunted, and seafowl provide seasonal, supplementary variations in diet in some seacoast areas.



Wrought iron oatcake drier or hardening stand, Ireland, nineteenth century. Thin, unleavened oatcakes were baked on a griddle then placed upright on the stand to dry before the open fire. COURTESY OF THE DEPARTMENT OF IRISH FOLKLORE, UNIVERSITY COLLEGE, DUBLIN.

Fish, including shellfish, have been a food of coastal communities since prehistoric times. Freshwater fish are mentioned prominently in early sources and in travelers' accounts throughout the medieval period. Fish were included in festive menus in the nineteenth century and were eaten fresh or cured in many ordinary households while the obligation of Friday abstinence from flesh meat remained in force.

Beverages

Milk and whey were the most popular drinks in early and medieval Ireland, but ale was a drink of great social importance. It was also regarded as a nutritional drink suitable for invalids and was featured in monastic diets at the celebration of Easter. Mead made by fermenting honey with water apparently was more prestigious than beer. Wine, an expensive import, was a festive drink in secular and monastic contexts. Whiskey distillation was known from the thirteenth century. Domestic ale and cider brewing declined drastically after the eighteenth century in the face of commercial breweries and distilleries.

Nonalcoholic beverages, such as coffee, chocolate, and tea, were consumed initially by the upper sections of society, as the elegant silverware of the eighteenth and nineteenth century shows. But tea was consumed by all sections of society by the end of the nineteenth century.

Vegetables and Fruit

From early times the Irish cultivated a variety of plants for food. Garden peas and broad beans are mentioned in an eighth-century law text, and it appears that some member of the allium family (possibly onion), leeks, cabbages, chives, and some root vegetables were also grown. Pulses were significant in areas of strong Anglo-Norman settlement in medieval times but were disappearing as a field crop by 1800, when vegetable growing declined due to market forces. Cabbage remained the main vegetable of the poor. Apples and plums were cultivated in early Ireland, and orchards were especially prominent in English-settled areas. Exotic fruits were grown in the walled gardens of the gentry or were imported for the large urban markets. A range of wild vegetables and fruits, especially crabapples, bilberries, and blackberries, were exploited seasonally.

Edible Seaweeds

Edible algae have been traditionally used as supplementary food products along the coast of Ireland. Duileasc *(Palmaria palmata)*, anglicized as “dulse” or “dilisk” and frequently mentioned in the early Irish law texts, is one of the most popularly consumed seaweeds in Ireland. Rich in potassium and magnesium, it is eaten raw on its own or in salads, or it is stewed and served as a relish or a condiment for potatoes or bread. Sleabhach *(Porphyra)*, anglicized as “sloke,” is boiled, dressed with butter, and seasoned and eaten as an independent dish or with potatoes. Carraigin *(Chondrus crispus)*, or carrageen moss, has traditionally been valued for its medicinal and nutritional qualities. Used earlier as a milk thickener and boiled in milk to make a blancmange, it has come to be regarded as a health food.

Collecting shore foods, such as edible seaweeds and shellfish, was a common activity along the Atlantic Coast of Ireland on Good Friday, a day of strict abstinence. The foodstuffs collected were eaten as the main meal rather than as an accompaniment to potatoes.

Potatoes

Introduced in Ireland toward the end of the sixteenth century, the potato was widely consumed by all social classes, with varying degrees of emphasis, by the nineteenth century. Its widespread diffusion is evident in the broad context of the evolution in the Irish diet from the seventeenth century. In the wake of the English conquest of Ireland, the seventeenth and eighteenth centuries were a time of sustained transition in Irish economic, demographic, and social life. Demographic expansion beginning in 1600 led to a population in excess of 8 million by 1800. The food supply altered strikingly during that period. The diet of the affluent remained rich and varied, while commercialization gradually removed milk and butter from the diet of the poor and resulted in an increased emphasis on grain products. The commercialization of grain and the difficulty in accessing land during the eighteenth century forced the poorer sections of society to depend on the potato, which was the dietary staple par excellence of about 3 million Irish people by the early nineteenth century. Fungus-induced potato crop failures from 1845 to 1848 caused the great Irish famine, a major human disaster.

Diets changed gradually in the postfamine years, and while the potato was but one of many staples by the end of the nineteenth century, it never lost its appeal. The ripening of the new potato crop in the autumn remained a matter for celebration. In many parts of the country the first meal of this crop consisted of mashed potatoes with scallions and seasoning. Colcannon, typically associated with Halloween, is made of mashed potatoes mixed with a little fresh milk, chopped kale or green cabbage, fresh onions, and seasoning with a large knob of butter placed on the top. In some parts people originally ate it from a communal dish.

Boiled potatoes are also the basic ingredient for potato cakes. The mashed potatoes are mixed with melted butter, seasoning, and sufficient flour to bind the dough. Cut into triangles, called farls, or individual small, round cakes, they are cooked on both sides on a hot, lightly floured griddle or in a hot pan with melted butter or bacon fat. Apple potato cake or “fadge” was popularly associated with Halloween in northeast Ireland. The potato cake mixture was divided in two, and layers of raw sliced apples were placed on the base, then the apples were covered with the remaining dough. The cake was baked in the pot oven until almost ready. At that point the upper crust was peeled back, and brown sugar was sprinkled on the apples. The cake was returned to the oven until the sugar melted. “Stampy” cakes or pancakes were raw grated potatoes sieved and mixed with flour, baking powder, seasoning, a beaten egg, and fresh milk and cooked on the griddle or pan.

The menus of restaurants that offer “traditional Irish cuisine” include such popular foods, which also were commercially produced by the late twentieth century. But as Irish society becomes increasingly pluralistic, the so-called “international cuisine” and a wide range of ethnic restaurants characterize the public provision of food in major urban areas. In the private sphere, however, relatively plain, freshly cooked food for each meal is the norm. Milk, bread, butter, meat, vegetables, and potatoes, though the last are of declining importance, remain the basic elements of the Irish diet.

See also **Potato; Sea Birds and Their Eggs.**

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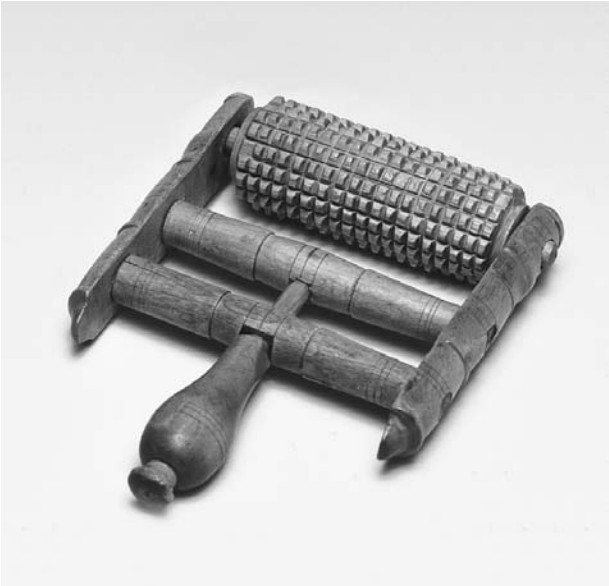
Patricia Lysaght

SCOTLAND

In Scotland food and food traditions have, as elsewhere, changed over time while regional influences have had a major effect. In addition, both Europe and Scandinavia have introduced changes in the food of the country. Geography has played a central role in determining the basic foodstuffs and their place in the diet. The country is divided into two areas, the Highlands in the north and west, and the Lowlands in the south and east. Each has its own distinct language and culture. The Highlands are generally a mountainous region, with an emphasis on pastoral activities, livestock husbandry, crofting (small acreage farming), general agriculture, and maritime activities. The Lowlands are the chief agricultural area.

Beginning with the Agricultural Revolution of the late eighteenth and early nineteenth centuries, the area developed specialized agricultural districts. The east is predominantly an area of arable and crop production; the climate of the west makes it suitable for the raising of livestock. The major towns and cities are located in this region, between the Firths of Forth and Clyde. These two areas are divided into smaller ones. The South-West, including the Inner Hebrides, is a dairying area; the East and South-East are advanced grain-cropping areas with a European reputation for farming; the North-East is a stock rearing area, especially for beef; the Highlands and Islands are another stock area.



Oat cake roller for breaking up oat cakes into coarse crumbs for use in puddings and porridge, circa 1800. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

A number of foods and foodstuffs have been important in the Scottish diet. Cereals have played a central role, especially in rural areas. Bere, a barley, was the traditional grain. By the end of the seventeenth century, it was being rapidly supplanted by oats. Beginning in the eighteenth century oats came to be recognized as a mark of Scottish nationality. As its consumption grew, bere fell down the social scale, though it continued to be eaten in Caithness and Orkney in the early twentieth century. Bere and oats were eaten in a number of ways. Oatmeal was milled into a number of "cuts" or grades, used for specific dishes. It was the basis of brose (mixed with water to make an instant food), porridge (cooked with water or milk), and such foods as sowens and skirley (mixed with fat and onion). Oatmeal was an ingredient in dishes such as haggis (mixed with liver and suet, traditionally cooked in a sheep's stomach). It was baked into bannocks and oatcakes, often toasted over an open fire.

Wheat was a grain grown in only the most favored areas and sold as a cash crop. Wheat bread was at first a prestigious food, eaten by the higher classes; for the lower classes it was eaten on special occasions such as harvesting. In the late eighteenth century, it spread from

Scottish shortbread stamp with swan motif circa 1870. These stamps, or "prints" as they were called, were carved by craftsmen who traveled from village to village selling them during the summer months. Roughwood Collection. Photo Chew & Company.

the towns and cities, where it was accompanied by the rise in baker's shops. Peas and beans were bread crops. Especially in the Lowlands, they were made into meal, but also put into dishes such as broths. These grains also indicated social class, and by the seventeenth century they were confined to the poorer people.

Baking

These grains, especially oats and wheat, were used in the tradition of baking, for which Scotland has become renowned. From oats, bannocks, scones, and oatcakes were baked. These did not use raising agents. From wheat, cakes, pastry, and shortbread were oven-baked. This was a later development, owing to the late introduction of the oven and the initial high cost of sugar.

Potatoes

The potato was introduced as a novelty in the late seventeenth century. In the 1740s there was resistance against eating it. By the 1790s when the "Statistical Account of Scotland" was compiled, it had become an important element of the diet, especially in Highland areas and among the poorer classes of the Lowlands. It was a principal food in the diet and was a cheap and healthy food and a substitute for bread. The potato continued to be an important element and only declined in status in the 1990s in the face of increased use of pasta and rice. Traditionally potatoes were boiled, with or without their skins. In the urban diet of the late nineteenth century and throughout the twentieth century and beyond, they were sliced and deep-fat fried as chips. They were eaten as a meal, as a side dish in a main meal, or as an ingredient in a wide range of dishes such as soups and stews; they were also used in baking, as in potato scones.

Fruits and Vegetables

Fruit and vegetables had a relatively small role in the diet. The traditional staple vegetable was kale, a member of the *Brassica* varieties. Vegetable gardening around the houses of noblemen and lairds, and the rise of market gardening in the vicinity of the large towns, especially from the eighteenth century onwards, meant the development of a wide range of vegetables. Like other foodstuffs, they were at first eaten by the wealthy classes, then spread to the social classes below. Traditionally they were consumed as broth. Fruit was not extensively grown, and a limited number of varieties were raised. Orchard fruit was little cultivated, though soft fruit, especially strawberries and raspberries, has been commercially grown from the late eighteenth century; fruit was supplied from kitchen gardens. Especially where domestic production was limited or not undertaken, fruit growing wild in nature provided an important source. It could be a fruit substitute, as were rosehips during World War II. Fruit was eaten raw, or made into dishes, puddings, sauces, and drinks, including alcoholic ones. When sugar became available, it was made into conserves, jams, and jellies, or was bottled.

Dairy Products

Milk and dairy products have had a number of roles. Much of the supply has been from cows; that from ewes and goats has been minor. Milk has always been an important element in the rural diet. In urban areas and near towns, the supply was traditionally inadequate, though small town dairies filled a gap. Supplies had a seasonal fluctuation. Milk could be processed into dishes such as Corstorphine cream, made from frothed whey. Cheesemaking enabled surplus quantities of milk to be utilized, especially in districts located away from centers of population. A large number of regional recipes and varieties exist, some developed during the expansion of the dairy industry in the nineteenth century. The Highlands are associated with soft cheeses for rapid consumption such as crowdie; the Lowlands have longer-keeping hard cheeses. Butter was the only source of fat in the rural diet, though beef or mutton fat could be obtained.

Meat, Fowl, and Fish

Meat was a foodstuff associated with social status. Among the rural population in the 1790s, it was rarely eaten. Even by the 1840s, it was still not an everyday foodstuff, especially among the poor. Before the Agricultural Revolution, livestock were slaughtered at Martinmas (November 11) as not all animals could be overwintered. Meat from domesticated livestock was supplemented by wild game and animals such as rabbits and hares. Sea fowl was caught in coastal areas. The nobility consumed large quantities of meat, especially on days when rents were paid: payment was made in-kind, of which livestock formed a major element.

There were regional variations in the types of meat consumed. The keeping of pigs became prevalent with the spread of potato growing in the eighteenth century. At that time, mutton became a meat of social distinction, being confined to the higher classes in the Lowlands, and the lower classes in the Highlands and Islands.

All parts of animals were utilized, as food, or as non-food items, such as tallow for lighting or hides and leather goods. Mealy puddings were made from entrails; blood was mixed with oatmeal to form blood puddings (black pudding); heads and trotters from sheep were made into pie and soup stock (powsoddie). Meat was rarely eaten fresh. It was salted, dried, or pickled in brine.

Fish was primarily eaten in coastal regions. With the improvement of transport networks in the nineteenth century, consumption spread to inland regions. Fish was a central element of the diet: it was a subsistence food, it filled the hungry gap before harvest when food was in short supply, and it was a delicacy. The Western Isles and Islands had large quantities of herring, haddock, whiting, and mackerel. Other fish included salmon, cod, ling, and shellfish such as cockles and oysters; around the Orkney Islands, whale was plentiful. Coalfish was widely eaten among the working classes. Inland fish such as trout were caught. Fish were eaten fresh, dried, or smoked. A number of fish dishes, many local in nature, are food identity markers: kippers, salted and smoke-cured fish, usually herring, first developed in Newcastle in the 1840s; salt-pickled herring or Finnan haddock, a lightly salted and smoked haddock; Arbroath smokies, salt-dried and smoked haddock.

Birds and poultry include domestic poultry, especially hens and geese. Their eggs were eaten, as were those of wild fowl. In some districts such as Ness, in the Outer Hebrides, wild bird flesh was eaten from gannets.

Some foods have become associated with geographical areas (see Table 1).

Beverages

The traditional drink crop was bere or barley. Ale was drunk, especially in Lowland areas; in the Highlands, whiskey was distilled, both legally and illicitly. Hot drinks spread from the upper classes. Tea drinking started to become increasingly widespread by the 1790s, though for some time afterwards it remained a drink for special occasions among lower social classes. Cocoa was drunk, as were coffee substitutes such as chicory. Coffee was not a drink of the working class, and even among industrial workers in Edinburgh in the 1950s it was consumed rarely, if at all. In recent decades coffee has increasingly taken the place of tea, among all social classes.

Table 1

Area	Foods and dishes
Edinburgh and the Lothians	Midlothian oatcakes Edinburgh rock (sugary confection)
Angus and Fife, Forfar	Bridies (pastry filled with steak), Dundee marmalade, Dundee cake, Arbroath smokies, Pitcaithly bannock
Glasgow and Clydeside	Glasgow broth
Ayrshire	Cheese and Ayrshire shortbread
Borders	Selkirk bannock (rich yeasted bannock with sultanas and raisins); Eyemouth fish pie
Dumfries and Galloway	Galloway beef
North-East	Butteries, Finnan haddock, Aberdeen Angus steak, skirlie
Highlands and Inner Hebrides	Fried herring, game soup, tatties and crowdie (potatoes and soft cheese), Highland oatcakes, Atholl brose (whisky mixed with oatmeal).
The Outer Hebrides	Whelk soup, barley bannocks, kale soup
Orkney and Shetland	Oatmeal soup, fried herring and onions, potatoes with milk, beremeal bannocks

Special Foods for Special Occasions

Special foods were eaten during festivals. They were specially prepared; they often had ingredients with a certain significance (such as flour from the last sheaf) or were made with ingredients that were expensive, difficult to obtain, or not eaten at other times of the year. Some dishes were served only at a festive occasion, or during part of it, others were not.

Festivals took place around the Celtic Calendar. They were held at the quarters that marked the passing of one season to another (Beltane, Lammas, Whitsun, and Martinmas). Foods included bannocks and oatcakes. Others were associated with the Gregorian Calendar. Hogmany, New Year's Eve, on December 31, was and probably still is the most widely celebrated of all the calendar festivals. Many of its foods were sweet in nature. Shortbread was a rich textured biscuit of flour, sugar, and butter. This could be decorated with a sugar iced or embossed pattern. Pitcaithly bannock was decorated with crystallized lemon and orange peel, caraway comfits, and almonds. Black bun is a rich and spiced dried fruit cake enclosed within a thin casing of bread dough or pastry. During harvest, harvesters were given wheat bread and ale; harvest meals also celebrated the end of harvest.

Rites of passage had foods associated with them. These included many common foods, with special attributes, such as bread, cheese, bannocks, and whiskey.

Meal Times and Menus

Meals had distinct patterns. Eating times were shaped by class, occupation, work hours, and days of the week. In rural areas meals were arranged around the feeding of livestock.

Three main meals were eaten: breakfast in the morning, dinner in the middle of the day, and tea or supper at

The traditional Scottish *quaich* or drinking vessel derives its form from the Late Antique *condy,* a drinking bowl without feet. The Gaulish god Lugh is often depicted holding a *quaich* in one hand, indicating that there may have been religious or ritual associations with this vessel in ancient Scotland and on the Continent. This ceramic *quaich* dates from about 1680. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

five or six in the evening. The main meal was dinner; supper was fairly light but could also be substantial. Although traditionally no food was eaten between meals, changing mealtimes led to the evolution of the high tea, taken in the late afternoon, around four o'clock. It filled the gap between dinner and the evening meal. It developed as tea drinking became popular, especially among the upper classes. By the 1890s sweet and chocolate biscuits were becoming popular additions to the high tea. Meals had a number of courses. Dinner was three courses: a soup, a main course, and what was called a pudding. This varied: if there was soup, there might be no pudding; if there was no soup, the pudding was more substantial.

The eating of dishes, especially the main meal, had a weekly cycle. Sunday, the Sabbath, was reserved for churchgoing for Protestants and Catholics. (Other faiths had their Sabbaths on different days.) On this day meat was eaten. It was roasted, served with dumplings, and accompanied by potatoes and cooked vegetables. The byproducts and leftovers of the Sunday dinner were eaten throughout the working week.

Menus of daily meals are recorded in household accounts, personal and travel diaries, letters, and cookery books. According to Alexander Fenton, house-servants in the 1790s had "breakfast of oatmeal porridge or sowens with milk; dinner of broth and boiled meat warm twice a week, or of re-heated broth, or milk, with cold meat, or of eggs, cheese, butter, and bread of mixed barley and pease-meal; supper was for breakfast, or in winter there might be boiled potatoes mashed with a little butter and milk" (*Scottish Country Life*, p. 170). Ian Carter notes that in North-East Scotland during the 1840s, "the usual food of the farm servants [farm workers] is porridge and milk for breakfast: for dinner, potatoes, bread and milk with perhaps oatmeal brose made with greens, for supper. They do not have beer, except when there is a deficiency of milk. In harvest time an allowance of beer is given then" (*Farm Life in Northeast Scotland*, 1979, pp. 132–133).

Food and the diet have been influenced by a number of factors. Agriculture and changes within it led to changes in agricultural practices and the introduction and spread of new crops and markets. These affected the crops and livestock raised, their quantities, and seasonal availability. Trade and contact with other countries introduced foods, dishes, food habits, names of dishes, and methods of cooking. These were especially noted from the Netherlands during the sixteenth and seventeenth centuries. Political and cultural links have been important, like those from the Auld Alliance with France, which started in the eleventh century and had its greatest impact in the seventeenth and eighteenth centuries. It introduced dishes cooked "in the French way," such as "beef alamonde," dishes such as "omlit of eggs," terminology such as "gigot," a leg of mutton or lamb, and cooking utensils such as the "ashet," a dish for serving meat.

Union with England

Scotland was politically influenced by its larger neighbor, England. The two countries were joined in 1603 by a union of Crowns, then a Union of Parliaments in 1707. These brought the countries closer and shifted the power structure. The English Court influenced the food and eating habits of the nobility. Cultural influences came from the English diet and the introduction of such dishes as roast beef, mutton, and lamb.

Immigrants influenced the native food culture. From those of the sixth to the twelfth centuries, the Scandinavians influenced the use of resources from the sea and introduced dishes such as fish and mustard. Large-scale immigration took place in the nineteenth and twentieth centuries from Ireland, Italy, and India. Italians were noted for fish and chips and ice cream, with all their traditions of these foods. Italian specialty shops such as Valvona and Corolla are a noted feature of some cities such as Edinburgh, where there is a large Italian population.

Social changes created a demand for new foods. Food substitutes, such as margarine, developed around 1870, allowed for greater variation in the diet. So too did new methods of food preservation, such as canning, from the 1860s; refrigeration was first applied to meat imported from the United States in the 1880s; pasteurization was first used in the dairy industry around 1890. These also reduced the influence of season and locality.

See also **Barley; Cereal Grains and Pseudo-Cereals; Fish: Overview; Tea (Meal); Wheat; Whiskey (Whisky).**

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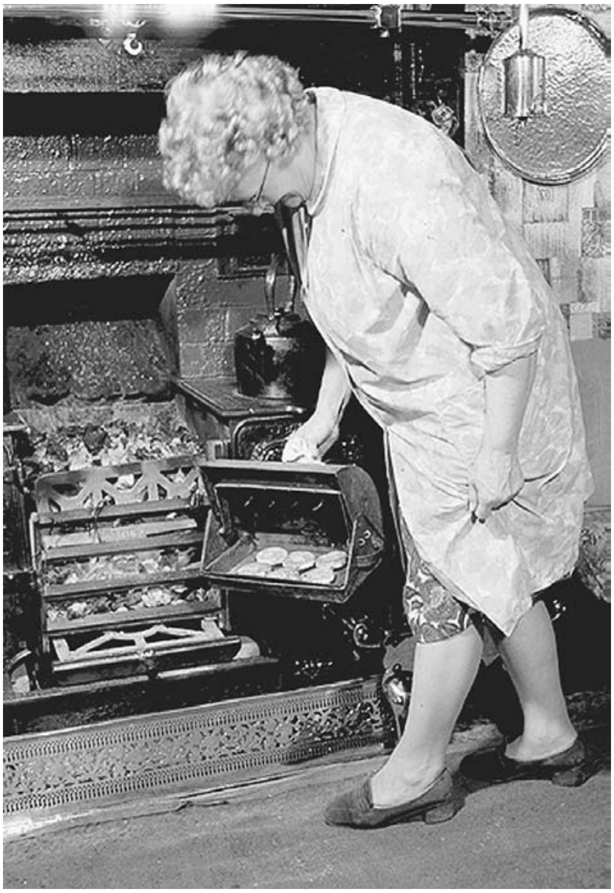
Heather Holmes

WALES

Archaeological and documented evidence show that the early Welsh economy was based on mixed farming. When journeying through Wales in 1188, Giraldus Cambrensis (also known as Gerald de Barri or Gerald of Wales) noted that most of the population lived on its flocks and on milk, cheese, butter, and oats. Numerous references to foods in literary works establish that this was generally how the Welsh subsisted until well into the nineteenth century.

Ingredients of the Traditional Diet

The Report of the Royal Commission on Land in Wales (London, 1896) shows that small farmers and tenants survived on home-cured meat from domestic animals, home-grown vegetables, dairy products, and cereal-based dishes. Farmers and cottagers would fatten and slaughter at least one pig a year to provide a constant supply of salted bacon. On larger farms, a bullock or barren cow was also butchered and the meat shared between neighboring farms. Keeping cattle provided sufficient milk to produce butter and cheese; vegetables were grown in the kitchen garden and fields, mostly leeks, carrots, cabbages, herbs, and, from the eighteenth century onward, potatoes. Wild fruits, plants, berries, wild animals and birds were utilized in season, and communities living close to coastal regions varied their diet by fishing and collecting shellfish such as cockles, mussels, periwinkles, and limpets. Inhabitants along the coastal regions of the Gower peninsula, Pembrokeshire, and Anglesey gathered the edible seaweed laver (*porphyra umbilicalis*). Prepared as a commercial product by Glamorgan families, it was sold along with cockles and mussels in the market towns of south Wales, famously Pen-clawdd. It was usually tossed in oatmeal and fried in bacon fat; today laverbread is a recognized Welsh delicacy, sometimes known as Welsh caviar.



Traditional Welsh cakes were baked in a small reflector oven on the hearth. The bottle jack to the right of the mantlepiece was used for roasting meat. COURTESY OF THE NATIONAL MUSEUM OF WALES.

Traditional Dishes

The topography determined that oats and barley were the most commonly grown cereal crops, with wheat confined to the fertile lowlands. Oatmeal in its various forms was one of the basic elements in the diet of the Welsh. *Llymru* (flummery) and *sucan* (sowans), consisting of oatmeal steeped in cold water and buttermilk, boiled until thickened and served cool with milk or treacle, as well as *bwdram* (thin flummery), *uwd* (porridge), and *griwel blawd ceirch* (oatmeal gruel) were among the everyday fare served in most rural districts until the early twentieth century. The bread most regularly eaten throughout Wales until the late nineteenth century was oatbread, formed into wafer-thin circular loaves and baked on a bakestone or griddle over an open fire. It was used in the counties of north Wales as a basic ingredient in cereal pottages such as *picws mali* (shot) or *siot* (shot); a popular light meal consisting of crushed oatbread soaked in buttermilk. Brŵes (*brose*) was a common dish in the agricultural areas of the north and regularly prepared as a breakfast dish for the menservants. It was made from crushed oatbread steeped in meat stock and sprinkled with crushed oatbread before serving.

Welsh rural society was largely self-supporting with the exception of sugar, salt, tea, rice, and currants, which had to be purchased. Sundays and special occasions usually merited a roast dinner for which a joint of fresh meat would be purchased from the local butcher; this was followed by homemade rice pudding. Very little fresh fruit was purchased, and eggs were eaten only on very rare occasions. The limited range of supplies also demanded great resourcefulness to provide an assorted menu. The ability to prepare an assortment of stews from one basic ingredient, namely oatmeal, required considerable dexterity. Similar skill was required for broths such as *cawl* and *lobsgows* using home-cured meat.

The open fire with its many appliances was central to cooking throughout the eighteenth and nineteenth centuries, and, in many rural homes, well into the twentieth century. Such limited cooking facilities also governed what could be prepared. Stews, joints of meat, and puddings were boiled in a cooking pot or cauldron. Pot ovens were used for roasting meat and baking cakes and fruit tarts, and the bakestone was widely used to bake oatcakes, drop scones, soda bread, pancakes, and griddlecakes (such as Welsh Cakes). Additionally, spits, Dutch ovens, and bottle-jacks, clockwork implements in the shape of a bottle that were hung in front of the fire, were used for roasting meat.

The preparation and consumption of traditional foods were closely integrated with patterns of life in rural Wales. Before labor-saving agricultural machinery, farmers were dependent on the cooperation of their neighbors to fulfill seasonal work. Corn (grain) or hay harvesting, corn threshing, and sheep shearing were essentially communal efforts requiring communal meals and celebrations. By the end of the nineteenth century, the *Boten Ben Fedi* (harvest pie), consisting of mashed potatoes, minced beef, bacon, and onion was served for the corn harvest supper. Threshing and shearing days were also marked with plentiful meals of cold lamb or beef, potatoes, and peas followed by rice pudding for dessert. *Tatws popty*—beef, onions, and potatoes—was a favorite in parts of Gwynedd, and afternoon tea consisted simply of home-baked bread, butter, cheese, and jam; while rich yeasted fruitcake and gooseberry pie were considered as shearing specialties in most regions.

In the industrial towns and villages during the late nineteenth century and early twentieth century, wives would often help to support their families in periods of hardship by preparing and selling home-cooked dishes, considered delicacies by members of the local community. Coal-miners' wives or widows prepared dishes of minced seasoned liver and pork fat called *faggots*, which were served with peas and sold from the women's homes or from market stalls. Pickled herrings were a comparable savory dish sold by women in the slate-quarrying communities of north Wales and consumed with homemade oatcakes by quarrymen and farm servants.

Although the tradition of living off the land survived until a later period, in the rural areas change came with improved roads, modern shopping facilities, refrigerators, and freezers. By the early twenty-first century, the majority of the above-mentioned dishes are mostly eaten on special occasions as traditional food.

See also **Cake and Pancake; Cattle; Cereal Grains and Pseudo-Cereals**; **Dairy Products**; **Herding**; **Hearth Cookery**; **Meat, Salted**; **Stew.**

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Mared Wyn Sutherland

BROASTING. "Broasting" is a trademarked term for frying chicken, potatoes, and other food in a pressure cooker using equipment and ingredients obtained under license from the Broaster Company of Beloit, Wisconsin. More broadly speaking, pressure frying is a technique for frying foods in oil under pressure, which is intended to seal the surface of the food and hold in its natural moisture while producing a crisp exterior.

Broasting is found only in food-service settings, since Broaster Company sells equipment and ingredients and licenses its name and program only to retail operations, such as restaurants, fast-food outlets, and grocery stores. Broaster Company, which was founded in 1954, had about five thousand licensees in 2002. Pressure frying is also used by some of the larger food-service operations, such as KFC (formerly known as Kentucky Fried Chicken) and Chick-Fil-A. These companies do not use the term "broasted," however, since it is trademarked by Broaster Company.

Pressure frying can be attempted at home using special equipment. The manufacturers of pressure cookers, however, do not recommend using them as pressure fryers. Manufacturers specifically advise the user not to put more than ¼ cup of oil in a pressure cooker, which is less than needed for frying. Use of a large amount of oil under high heat can damage the pressure seal of the lid and lead to the escape of steam or hot oil. A few companies manufacture units specifically designed to contain hot oil under pressure, and only these pressure fryers should be used at home.

Commercial units use gas or electricity to heat oil in a fry pot sealed to hold in steam. The pressure builds up to about fourteen pounds per square inch, with the food reaching an internal temperature of approximately 250°F (120°C) as compared with the 215 to 220°F (about 100°C) that occurs in conventional frying. Cooking time is reduced nearly in half as compared to conventional units, which is a significant advantage in the quick-service setting. A single unit can cook several racks of pork ribs in one batch in seven minutes, for example.

If all goes well, the cooked product will retain less than half as much oil as food cooked in a conventional open fryer. It is believed that this occurs because natural moisture escapes through the oil in the form of steam in conventional frying. In pressure frying, steam is locked into the fry pot, and natural moisture is forced to stay inside the food, which also prevents oil from getting in and producing a greasy product. Beck Sales Company, which makes the Fagor Classic brand of pressure fryer for home use, says its fryer will produce chicken with 44 percent more moisture than open-fried chicken, with 40 to 70 percent less fat and fewer calories.

The pioneer in pressure frying was "Colonel" Harland Sanders, founder of Kentucky Fried Chicken (KFC). At his restaurant in Corbin, Kentucky, Sanders sold fried chicken prepared in the traditional southern method of frying in a skillet. He preferred this to deep-fat frying because skillet frying produces a less-greasy product, but the method takes considerably longer than deep-fat frying. When the pressure cooker was marketed in the late 1930s as a time-saving device, Sanders purchased one and experimented with using it as a fryer. He eventually came up with the right combination of time, pressure, amount of oil, and temperature, and he began to use a pressure cooker in his restaurant. By the twenty-first century, all KFC restaurants used pressure frying to cook the company's Original Recipe Chicken. Various KFC outlets use several different types of pressure cookers.

The procedure specified by the Broaster Company is typical of pressure frying operations. The chicken is marinated and breaded, in both cases with proprietary ingredients, and oil is heated in the fryer pot to 360°F. A stainless steel basket is then lowered into the boiling oil, and pieces of chicken are loaded, up to fourteen pounds per load. Since dark meat takes longer to cook, thighs are loaded first, followed by legs, breasts, and wings. The cover is then locked in place, and the pressure valve is closed, allowing pressure to build up quickly. The chicken is cooked at 360°F for eight to nine minutes, at which time the pressure valve is opened to release the steam, the cover is removed, and the chicken is drained.

It is considered important to keep the oil in the pressure fryer as clean as possible, which can be a problem when breaded products are cooked. Loose breading can create smoke and an off flavor due to the intense heat of the operation. Commercial units therefore have systems that recirculate the oil and filter out breading, carbon, excess moisture, and other impurities. This also extends the useful life of the oil. Steam can be used to force the oil out of the cooking pot and into the filter at the bottom of the cooker when the cooking cycle is completed, thus reducing the oil retained in the food and also lessening the chance of injury from hot oil when the pressure is released and the pot is opened. Pressure frying is safe when conducted according to manufacturer's instructions, but some units are equipped with built-in fire suppression systems. These systems, plus the heavy-duty construction needed for pressurized operation, make pressure fryers more expensive than conventional open fryers. Generally, pressure fryers are found only in restaurants that sell large amounts of fried chicken or other fried items.

While chicken is the best-known product in broasting or pressure frying, other foods can also be cooked in the same type of unit. Broaster Company provides its licensees with recipes, cooking instructions, coatings, seasonings, and marinades for potato wedges, catfish, pork chops, ribs, fish, shrimp, and mushrooms, among other items. While pressure frying normally uses fresh food, frozen items can also be pressure fried successfully. The finished chicken product should have a crispy, golden-brown exterior and should be tender and juicy throughout.

See also **Chicken; Fast Food; Frying; Poultry; United States: The South.**

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Richard L. Lobb

BROCCOLI. *See* **Cabbage and Crucifer Plants.**

BROILING. Broiling is a dry-heat method of oven cooking meats and vegetables in which the food is exposed to direct, radiant heat from a gas or electric element at about 550°F. The food is placed in a special pan and set several inches below the heating element until the desired state of doneness is achieved. Because little or no fat is added, broiling is considered a good method of cookery for those who are counting calories.

In Europe, broiling is considered virtually synonymous with grilling, but in America, the term "broiling" is usually applied to cooking in an oven, while "grilling" usually denotes the use of an outdoor or indoor grill.

In broiling meat, the objective is to sear the outside of the piece and seal in its natural juices or moisture, producing a browned, crusty exterior while bringing the interior to the doneness desired by the cook. In beef, this ranges from a state so rare that it appears to be tinged blue, to "well done," with no hint of pink. The classic beefsteak is cooked medium rare. Beefsteak, pork chops, chicken, and fish are the most commonly broiled foods, but a wide variety of foods can successfully be broiled, even fruit, such as bananas.

Broiling uses a sturdy, two-part pan that fits well in the oven and is normally provided with the oven when new. The top part is the cooking surface and is slotted to permit juices to drip into the bottom part, which can be lined with aluminum foil to make cleaning easier. Either gas or electric heating elements can be used. While restaurants almost always use gas, many home kitchens are equipped with electric broilers. An electric broiler can be an advantage for some foods, such as fish, for which a temperature lower than 550°F is desirable, since the broiler can be set to the desired temperature. Some, but not all, gas broilers can be similarly adjusted.

Since heat rises, it may seem odd that the food is put under the heating element. However, broiling works by radiant energy, in which the heat is applied directly from the gas flame or red-hot electric element, rather than by convection, in which hot, moving air carries the energy.

While the broiler should always be pre-heated for ten to fifteen minutes before the cooking begins, the broiling pan should be left out so that the food is put on a cold surface and then put in the oven. This is to ensure that the food is cooked on one side at a time; otherwise, a hot pan would begin an inadequate cooking process on the "down" side before the piece is turned and becomes the "up" side, exposed to the heating element.

No moisture is added in broiling. To assist in the browning process, however, a thin film of oil can be brushed onto the food piece. Salt and pepper should be added after each side is cooked, but not before; salt can draw out moisture and slow down the browning process, while pepper will burn at high temperatures.

Before broiling beefsteaks and pork chops, most of the external fat should be trimmed, since it will create smoke and contribute nothing to the cooking of the meat. (The juiciness of beef comes from the internal fat known as marbling and a substance called myoglobin rather than from its external fat.)

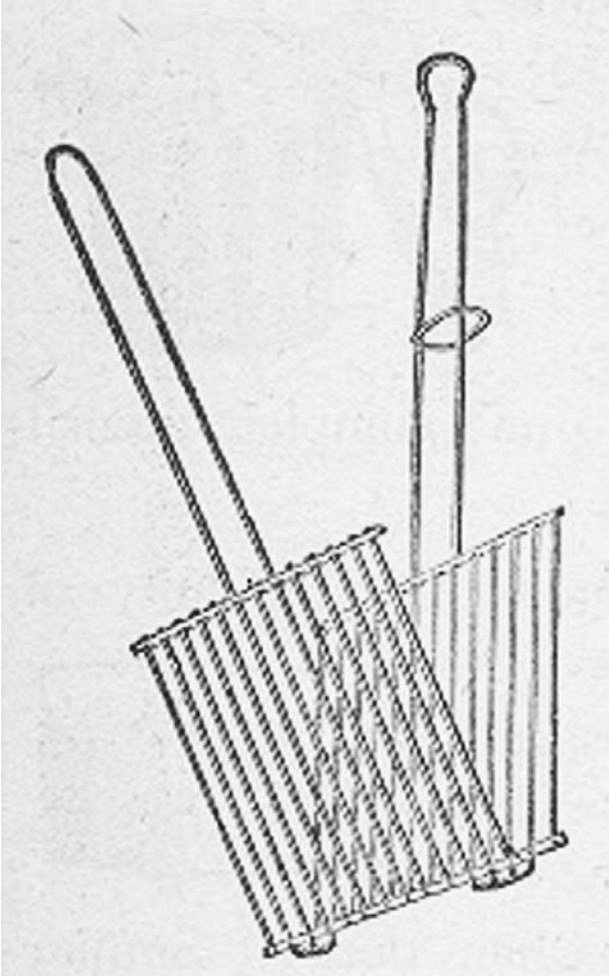
Basic Technique

Adjust the rack so that the surface of the food will be the desired distance from the broiler (see "Position," below). Keep in mind that the pan and the food together will be two or three inches deep at least. Slash the external fat vertically at several points to keep the steak from curling up as the fat shrinks. Place the food on the broiler pan and put it in the oven; sear one side, add salt and pepper to the cooked side, and turn the piece to cook the other side. Remove when the desired state of doneness is reached; let stand for a few minutes to allow the juices to settle, and serve with sauce or a pat of butter.

"Broiling" used to mean bringing food into contact with an open flame. The term has been largely replaced by "grilling." These Thai sausages are being broiled on a broiling screen in Lap Lae, Thailand. © MICHAEL FREEMAN/CORBIS.

Position. The distance of the food piece from the broiler depends on the thickness of the piece. Pieces of meat that are an inch or less thick should be placed about two or three inches from the broiler, with thicker cuts set farther away. Very thick steaks (three or four inches thick, such as a filet mignon) should be broiled on one side about four inches from the broiler, and then the pan should be moved to a lower rack, eight or nine inches from the boiler, to finish.

Time and doneness. While a well-done steak was once considered a mistake if not a tragedy, many restaurant patrons and home cooks have come to tolerate this cooking method. The reasons for this may have to do with the fact that the best steaks—those labeled "prime" according to the grading system of the U.S. Department of Agriculture—are expensive and sold mainly to restaurants or high-end food stores, so that most supermarket shoppers have little acquaintance with steaks whose flavor is at its peak before they are thoroughly cooked. Also, some people believe that undercooked steak is dangerous. In fact, harmful bacteria, if present at all, are present only on the surface and are quickly destroyed by the heat of normal cooking. Deep muscle meat is sterile except under very unusual circumstances, such as extreme illness in the animal, or mishandling of the food. This observation does not apply, however, to hamburger,



Shown here is a handheld double broiler used for broiling fish, sausages, oysters, and small pieces of meat. The broiler was called "double" because it could be flipped over so that food could be cooked on both sides. From a wood engraving, circa 1880. ROUGHWOOD COLLECTION.

which consists of ground meat that could include contaminated portions; the USDA recommends thorough cooking of hamburgers and other ground meat products.

The timing for beefsteaks of about one inch thick, placed two inches from the broiler is: very rare, one to two minutes per side (the interior will be purple with a hint of blue); rare, two to three minutes per side (red inside); medium, three to four minutes per side (pink in the center); well done, broil three minutes per side, then lower the rack several inches and cook six to ten minutes more (the steak will be grayish or brown all the way though).

Suitable foods. Beef cuts suitable for broiling include the tenderloin or fillet (the center part is used for châteaubriand, and the tip is the filet mignon); rump steaks; flank steak (for London broil); sirloin, rib-eye, and round steak.

Chicken legs, thighs, and wings can be broiled. Bone-in chicken breasts, as a result of their bulk, are better roasted or grilled than broiled in the oven; boneless chicken breast, however, is perfect for the broiler. The pan should be coated with oil to keep boneless breast from sticking, since it has almost no fat of its own.

Broiling is a good method for pork tenderloin but can easily dry out leaner cuts, such as pork chops, which usually benefit from cooking in liquid on the stovetop. Lamp chops broil well but will cook very quickly, taking two or three minutes per side for medium rare.

Fish fillets are thin enough to be broiled on a single side. Whole, cleaned fish (such as bluefish or mackerel) and fish steaks (such as salmon or tuna) can be broiled on both sides. A whole fish should have the head and tail left on for cooking and should be slashed in two places in the thickest part of the fish to let the heat reach the middle.

Some fruits and vegetables can be broiled, including asparagus; firm tomatoes, cut in half; and peppers. Broiling separates the skin from the pepper, leaving soft, cooked meat. Broiled grapefruit and bananas make tasty side dishes or desserts. Grapefruit, cut in half and topped with sugar, can be broiled until bubbling. Bananas can be peeled, cut lengthwise, and dotted with butter and sugar before broiling.

See also **Barbecue**; **Cooking**; **Grilling**; **Hamburger**; **Iron Cookstove; Meat**; **Roasting**.

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BRUNCH. *See* **Breakfast; Lunch.**

BRUSSELS SPROUTS. *See* **Cabbage and Crucifer Plants.**

BUDDHISM. Buddhism originated in India in the fifth century B.C.E. and from there spread to many lands. The historic Buddha, born around 563 B.C.E., spent most of his eighty years traveling throughout north India preaching the way to salvation by reaching Nirvana and the cessation of rebirths. In some Buddhist traditions, respect for earth deities continues as a reflection of earlier cults of the soil. Animal sacrifices can still be seen in rituals requesting a boon from deities, ancestral spirits, and guardian spirits of localities. Food offerings may be left at stone monuments often containing relics commemorating the life and teachings of the Buddha. But these food practices are not Buddhist.

Buddhism is divided into several branches or ordination traditions. The Mahayana tradition, based on Sanskrit texts, spread into China, Korea, Vietnam, and Japan. The Buddhism of Tibet, Nepal, and Mongolia is also known as Vajrayana. Theravada Buddhism, "the way of the elders," is the form of Buddhism found in Sri Lanka, Burma, Thailand, Laos, and Cambodia. It is based on Pali texts. More recently, Buddhism has spread to Europe, Australia, and North America, where people are converting in large numbers, partly out of interest in Buddhist meditation practices.

The kneeling women are giving donations of rice to a procession of monks in Luang Prabang, Laos, March 1993. The monks collect rice every morning. © MICHAEL S. YAMASHITA/CORBIS.

Food Rituals

Food rituals transmit collective and individual messages about religious principles. Religion influences dietary intake by prescribing or proscribing certain foods, providing ritual foods or meals, and reinforcing key cultural and social values. Unlike Hinduism, Islam, and Judaism, Buddhism has less rigid dietary laws defining what people can eat and with whom they can dine. However, fasting and feasting are integral parts of most religious traditions, and Buddhism is no exception. The special foods used in the annual cycle of Buddhist holidays and festivals differ by country. Food is both a marker of religious affiliation and a marker of ethnic identity. It is therefore impossible to identify foods as specifically Buddhist, as opposed to Thai Buddhist or Japanese Buddhist, for example.

In rice-growing Asian communities where Buddhism is practiced, food in rituals reflects the rhythms of food production, including its scarcity or abundance during the year. In some countries, it is possible to see a contrast between ascetic approaches to food (for example, during the rains' retreat from July to October) and festive excess (for example, after harvest in November and December).

Food rites mark changes in personal status as well, serving as temporal boundary markers through the life cycle. Special foods may be prepared for birthdays, weddings, funerals, tonsures, and ordinations, for example, particularly if monks officiate. In Theravada traditions, some of these rituals are Brahmanic in origin and feature rice and milk-based dishes. Harvest celebrations also make confections from foods such as rice, peanuts, sugar, sesame seeds, and coconut, possibly related to the sweet offerings of South India, called *panchakadjaya* (five foods). Puffed rice is used at funerals to symbolize rice that cannot be grown again.

Monastic Traditions

Dietary abstinence relates to a very widespread idea that giving up something desirable increases spiritual potency. In many religious traditions, food refusal also represents a denial of social relationships, a denial of sociability. Fasting is not central to Buddhist practice except for the monastic community. Most Theravada monks eat only once or twice a day, in the early morning and just before noon, as a part of monastic discipline and their dedication to following the path of the Buddha. The Sanskrit term *sambhogakaya* refers to the monastic practice of eating together. Theravada monks fast after noon and all night, often joined by pious laypersons who partially withdraw from the lay life of the householder on special holidays.

Monks are expected to show moderation and control in all things, including eating. They are warned that wrong mental states easily come to the surface when collecting or eating food. When Theravada monks go on begging rounds, giving people an opportunity to put food into their bowls, they are expected to show no interest in the qualities of the food and even mix the food donations together.

Chinese Buddhism regulates communal meals as part of monastic discipline. Rather than food being collected from begging or donations as in Theravada communities, food in Chinese monasteries is often prepared at the temple by lay devotees. Mahayana monasteries used to grow their own food to provide vegetables for simple meals with rice or rice porridge. Occasionally lay donors might provide a vegetarian feast to celebrate Buddha's birth, enlightenment, and death, or *parinibbana*, in order to gain merit.

Zen cooking (*shojin ryori*) is a style of vegetarian cooking developed by Zen monks that acts as an aid to meditation and spiritual life. Food is prepared as a spiritual exercise with attention to balance, harmony, and delicacy. Some Zen and Chinese Mahayana temples practice the three-bowl eating style, making eating a ritual training. The three bowls contain rice, vegetables, and soup. In fact, eating can be a kind of meditation—remembering to let go of evil, to cultivate good deeds, and to save sentient beings—as each food is put into one's mouth. In such events, food is consumed according to need with no waste and no overconsumption.

Theravada Buddhists believe that by feeding monks they obtain religious merit that assures them of a good rebirth. Laypeople advance on the path to Nirvana by striving for moral purity and doing good works, especially by giving food to the monks. People also believe that giving food to the monks transfers merit to the dead. By going to the temple on the holy day and giving food to the monks, people hope to help their dead relatives who may be wandering the earth as hungry ghosts or living in hell.

Food as Metaphor

Food is often used in Buddhist texts to explain complex ideas in an easily understood manner. Buddhism rejects the asceticism of fasting and denial found in many religious traditions. After the Buddha fasted for six years, he rejected the extreme of starvation as a route to salvation. Instead, he used the experience of eating and digesting food as a means to understand the instrumentality of food. The element of heat transmutes food into body during the process of digestion. Thus, eating is an important metaphor for understanding bodily existence and the transformation of matter and substance. Eating literally makes us human and embodies us.

The Buddhist path is the middle way requiring monks and laity to eat to maintain life and nourish the body but not to cling to the sensual pleasures of eating. In this philosophical interpretation, it is not material substances such as food that block salvation but the craving for them. When Buddhists gain right understanding, they can use this analytical knowledge to guide daily life, as well as for meditation. Food as an object of meditation is a metaphor for the foulness of the body. Monks concentrate on the repulsiveness of food in order to reduce their craving for food. The cessation of craving food is equated with the cessation of the body and the end of the cycle of rebirths.

Commensality

For the laity, eating, particularly eating rice, is a means of orienting oneself in relation to all sentient beings whose lives are sustained by food and religion. Reciprocal food giving sustains lay communities as well as the monastic community. In general, Buddhist rituals imbue food with sanctity; the sanctity remains in the food after it has been received by the monks. Communal eating is one means of experiencing Buddhist precepts and concepts in a direct and sensory way.

In some Buddhist communities, members of the laity serve monks and the community by preparing and serving food from a communal kitchen. Mahayana services and ritual events are likely to be vegetarian. Most Chinese gods and goddesses are presumed to be vegetarian, but they may be offered meat in an attempt to provide the best, most valued food. Chinese Buddhism honors a number of deities, such as Kwan Yin, the Goddess of Mercy. A home altar might contain incense, flowers, tea, and fruit to be consumed later. The Kitchen Goddess helps one eat and drink healthily, and representations of her may be seen in household and restaurant kitchens.

Food given to Chinese deities is considered blessed; its essence is consumed by gods and Buddhas before it is eaten by the worshipers. Following chanting services in many temples, a communal meal is served, which may include beans, bean sprouts, vegetables, fruit, and always rice for prosperity.

Food Distribution in Theravada Communities

Four times in the lunar month, or weekly, the following practices might be seen repeated in Theravada communities throughout the rural areas of Southeast Asia. On a holy day, people bring such food as rice and dishes to eat with rice to the temple. Although the food is the best a household can prepare, people bringing the food cannot taste or even smell the food. A true gift that will gain religious merit must be well intentioned, and only by denying themselves even the smell of the food will the offering bear fruit. The monks chant to accept the food and confer blessings on those who have given food.

At the end of the morning service, after the monks have eaten, the laypeople consume the remaining food offered to the monks. By giving to monks who must follow rules of celibacy and denial, religious merit is increased at a greater rate. Generally, everyone who participates in the service shares in consuming the food that has been accepted or blessed by the monks. Even those who have not contributed food are actively encouraged to share the meal, as if the sharing of food may cause the intention to give generously to arise among all partaking of the meal. Following the meal, participants share the merit accrued from feeding monks with all sentient beings.

Buddhism and Vegetarianism

Buddhism in North America is widely associated with vegetarianism, although not all Buddhists are vegetarian and vegetarianism is not part of canonical Buddhism. This association with Buddhism developed because the key principles of Buddhism include ahimsa, or nonviolence and the avoidance of suffering. Theravada Buddhists in Southeast Asia are not generally vegetarian, although their daily meals may not include much meat. Meat dishes are even given to monks since meat is not explicitly forbidden to them by the rules of monastic conduct. Buddhist texts such as the *Majjhirma Nikaya* refer to the Buddha eating the proper proportion of curry to rice, experiencing flavor but not greed for flavor.

As more Westerners become Buddhist and as more Buddhist immigrants and refugees settle in North American and European cities, Buddhist vegetarian restaurants have prospered, offering devotees and secular vegetarians an opportunity to consume food exemplifying the Buddhist principle of nonviolence. Practicing Buddhist chefs prepare vegetarian feasts for events such as meditation retreats and cater meals for vegetarian practitioners and health-conscious diners. They may also perform *dana*, or selfless giving, by providing free food to the hungry.

Values of reciprocity and sharing are extremely important to Buddhists. In the strongly individualized and materialistic communities of North America, it is particularly difficult to maintain models of generosity and reciprocity. Commensality—the shared meal of Buddhist merit makers—is a model of reciprocity, redistribution, and generosity. The act of eating together and sharing each other's food is a concrete and reliable means of establishing a moral community where people know they can develop relations of trust with others and cooperate in joint activities within the domain of religion and in other domains.

See also **Fasting and Abstinence: Hinduism and Buddhism; Feasts, Festivals and Fasts; Hindu Festivals; Hinduism; Metaphor, Food as; Religion and Food; Rice; Sensation and the Senses; Southeast Asia; Vegetarianism**.

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Penny Van Esterik

BUFFALO. *See* **Cattle; Mammals; Meat.**

BUTTER.

Butter is made by churning milk fat. It has a solid, waxy texture and varies in color from almost white to deep yellow. It is mostly made from cow's milk, but water buffalo milk is used in the Indian subcontinent, yak milk in the Himalayas, and sheep milk in central Asia. Butter is an important food in North America, Europe, and western and central Asia but is of lesser importance in the rest of the world.

Butter Making

Until the late nineteenth century, butter was made by traditional small-scale methods. Milk was "set" in bowls until the cream rose and could be skimmed off. It was used fresh for sweet cream butter or "ripened" (soured) as the bacteria it contained converted the lactose (milk sugar) to lactic acid. Sometimes clotted (scalded) cream was used, and milk fat retrieved from whey after cheese making can also be used for making butter.

Once or twice a week the cream was churned in a standing churn with a plunger or in a barrel turned end-over-end. Eventually, granules of butter separated out, leaving buttermilk, which was drained off and used for drinking and baking. The butter was washed and worked (kneaded with a paddle) to get rid of excess liquid, then salted. Butter-making implements were wooden; they included bowls, butter paddles, and prints carved with motifs, such as swans or wheat ears, used to stamp finished pats.

In modern industrial manufacture, cream is separated by a centrifugal process to give a fat content of 30 to 38 percent. It is always pasteurized, and ripening is induced by adding a bacterial culture. The cream is churned at a temperature of 53 to 64°F (12 to 18°C). High-speed continuous churns were introduced after World War II. In these the cream is mixed by revolving blades, which induces granulation quickly. The butter granules are forced through a perforated plate and are worked mechanically. Salt and annatto (coloring) are added if desired. About twenty liters of milk are needed to make one kilogram of butter.

Physical Descriptions

The mechanism of butter production is not fully understood. The process inverts cream, an emulsion of minute fat globules dispersed in a liquid phase (water), to become butter, an emulsion in which minute drops of liquid are dispersed in a solid phase (fat). Churning first traps air in the cream, producing a foam. Continued agitation destabilizes the fat globules, disrupting the fine membranes that surround them and releasing naturally occurring emulsifiers such as lecithin. As agitation continues, the foam collapses, and the fat droplets are forced together in grains. Gradually they increase in size and become visible.

FLAVOR IN BUTTER

Flavor in butter is influenced by many factors. Two basic types exist in European and North American tradition: sweet cream, churned from fresh cream, with a mild, creamy flavor and ripened; or lactic butter, made from soured cream, which should have a fuller, slightly nutty flavor. Salt butter can be of either type. Regional tastes in this vary widely. In Europe, Welsh butter is noted for being very salty, whereas French butter is often not salted at all. Under modern conditions, salt is only added for flavor, its original preservative function now obsolete.

The characteristic butter flavor comes partly from the high proportion of short-chain fatty acids milk fat contains, especially butyric acid. Ripening gives a "lactic" flavor derived principally from a substance called diacetyl, produced by the bacterial species involved. In the United States, most butter has a mild lactic flavor, although it is stronger in "cultured" butter, which is closer to that produced in Germany and central Europe, where strongly flavored butters are preferred.

Differences in butter flavor were far more apparent in the past. Factors that influenced the flavor of farm-made butter included the food the cattle ate. Turnips, introduced as a fodder crop in eighteenth-century England, were notorious for giving a characteristic and much-disliked taint to butter. Some pastures, such as those of Normandy, are recognized as producing excellently flavored butter. Poor storage conditions for milk or butter also led to taints, as fats pick up odors quickly. Storage in rooms that also contained, for instance, onions was not recommended. Care during handling is also important. Length of ripening time, hygienic handling, and complete expression of the buttermilk from the finished product influence flavor.

Finally, from the moment it is finished, butter is susceptible to rancidity of two types. Hydrolitic rancidity is produced by the presence of moisture and is hastened by enzymes and microorganisms, and consumers have developed a taste for some forms. Oxidative rancidity, produced by reaction with oxygen in the air, is found unacceptable by everyone.

Finished butter has a complex structure of minute water droplets, air bubbles, and fat crystals distributed through amorphous fat. Proportions of solid and liquid fats present in butter vary. A lower churning temperature increases the proportion of crystalline fats, giving a harder, almost crumbly product. Higher temperatures produce a softer butter. Butter can also be whipped after churning to make it softer and easier to spread. Flavor is influenced by many factors (see sidebar).

Salt was originally added as a preservative. Butter made from unpasteurized milk is susceptible to bacterial spoilage. Even under modern conditions of hygiene, it is susceptible to oxidative rancidity. One way of extending shelf life is clarification, which includes two basic methods. One is to melt the butter gently and pour the fat off, discarding the milky residue. The second, used in India, is to simmer the butter until the water evaporates and the protein and milk sugar form a solid brown deposit. The fat, now with a nutty flavor, is strained off and stored as ghee, which keeps for months. Butter and ghee are significant in Indian cookery and Hindu religious ritual. In the Arab world *samneh*, a form of clarified butter, is also used for cookery. In Morocco it is mixed with herbs to make *smen*, a strongly flavored aged butter.

Nutrition

Nutritionally the composition of butter is roughly 80 percent fat (mostly saturated), 12 percent water, 2 to 3 percent nonfat milk solids (lactose, protein), and 2 percent added salt. It is the most concentrated of dairy products, containing about 740 kilocalories per 100 grams (210 kilocalories per ounce). Butter is a valuable source of vitamin A, plus it has a little vitamin D. It is also a source of dietary cholesterol. Vitamin content is higher in summer, when the cattle feed on fresh grass.

Nutritional debates over saturated fatty acids and cholesterol in relation to coronary heart disease have centered on butter. High fat consumption can be related to raised blood lipids, but the relationship of dietary cholesterol to blood cholesterol is less easy to demonstrate. Evidence for or against is seized in the debate between butter and margarine manufacturers over which is superior. The two groups have competed since margarine was invented in the 1870s. Their arguments were originally couched in terms of economics but subsequently obscured important health issues. In the United States butter consumption stands at about 500,000 metric tons per annum, as opposed to the European Union, which consumes almost 1.5 million tons with only about one-third more population than the United States. Much of the difference is probably due to preferential consumption of margarine for perceived health benefits by U.S. consumers.

Development of Production

Annual world production of butter (including ghee) rose from about 5.35 million metric tons in 1961 to about 7.551 million metric tons in 2001, during which time the

TABLE 1

Butter and ghee production

Butter and ghee production (mt)	Year 1961	1971	1981	1991	1998	1999	2000	2001
World	5,344,948	5,712,823	6,846,762	7,230,231	6,842,943	6,991,151	7,201,428	7,551,093
Latin America & Caribbean	129,415	155,307	206,855	191,692	204,587	209,485	210,840	219,718
Canada	165,107	134,309	116,915	101,059	90,600	92,060	92,060	92,060
European Union (15)	1,825,529	1,916,890	2,396,300	1,931,824	1,794,111	1,768,090	1,738,656	1,730,629
India	433,000	432,000	670,300	1,050,000	1,600,000	1,750,000	1,950,000	2,250,000
Japan	13,214	47,699	63,636	75,922	88,931	85,349	87,578	82,000
New Zealand	213,500	230,800	247,200	250,881	343,658	317,000	344,000	384,000
United States	696,629	520,268	557,095	621,500	529,800	578,350	578,350	578,350

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Butter imports

Butter imports—qty (mt)	Year 1961	1971	1981	1991	1998	1999	2000
World	566,571	786,113	1,524,808	1,333,061	1,214,011	1,213,135	1,256,727
Latin America & Caribbean	15,092	61,809	71,324	87,551	65,778	70,056	71,217
European Union (15)	467,074	527,783	705,015	615,223	657,293	668,492	698,404
Canada	0	1,399	28	164	3,275	5,820	14,477
India	100	2,951	18,675	3,192	4,311	10,255	6,535
Japan	376	923	1,734	20,524	565	548	391
New Zealand	0	11	27	14	822	500	652
United States	390	320	938	2,381	40,096	29,468	22,160

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Butter exports

Butter exports—qty (mt)	Year 1961	1971	1981	1991	1998	1999	2000
World	629,535	842,045	1,473,373	1,364,364	1,322,174	1,301,421	1,311,496
Latin America & Caribbean	14,799	8,612	10,088	8,126	17,380	25,654	24,249
European Union (15)	260,405	446,090	1,087,809	983,892	718,992	692,079	660,345
Canada	3	2,029	61	12,415	12,077	10,932	6,711
India	7	181	240	340	909	1,700	1,815
Japan	10	1,108	313	3	0	17	7
New Zealand	165,690	194,463	203,058	176,148	315,850	298,034	358,528
United States	2,597	43,006	54,207	32,006	9,024	3,536	8,906

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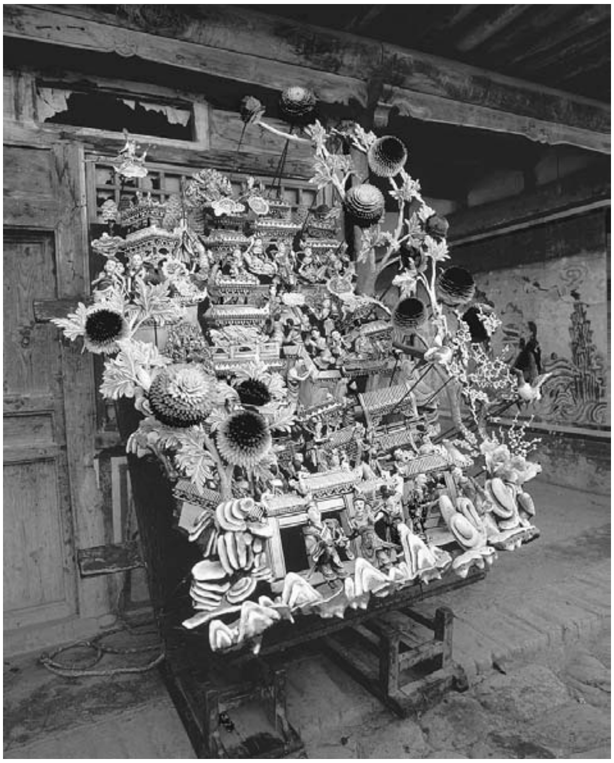
global population doubled. By the twenty-first century, India was the world's largest butter and ghee producer. Its production increased fivefold between 1961 and 2002, whereas the country's population increased about 2.25 times. The European Union, an area in which butter has enormous importance in traditional eating habits, is the next most important producer, followed by the United States. New Zealand, with a small population, produces much butter for export, but production in Canada, formerly an important exporter, has fallen.

The origins of butter are unknown. One theory is that migrating nomads discovered that milk they carried with them became butter (much as American pioneers made butter by allowing the motion of the wagons to churn milk as they traveled). Butter has been known in Eurasia since ancient times, although the classical Greeks regarded it as barbarian food. Later friction arose over Lenten food prohibitions by the church in medieval Europe. Oil, a southern staple, was allowed, but butter, derived from animals, was forbidden, creating difficulties for northerners who had to buy expensive imported oil or pay a fine to use butter.

In northern and western Europe, butter was an integral part of the pastoral economy. It was churned from surplus summer milk and was stored in wooden barrels. Butter production was women's work and in many places,



Traditional Chinese butter sculpture. Some of the butter has been dyed to create brilliantly colored images. © JOHN SLATER/CORBIS.

such as early modern England, provided an income for farmer's wives, hence the frequency of Butter Market as a street name in English towns. Certain areas developed dairy food production as a specialty. By 1750 the Low Countries exported butter and cheese to neighboring regions. In Ireland butter is the most esteemed of all dairy products. In the Middle Ages it was used to pay taxes and was buried in peat bogs for preservation. Archeologists still find the occasional cache of "bog butter," which made Irish oat cake and later potatoes palatable. Migrants from the Low Countries, Britain, and Ireland took their taste for butter to North America, where observers remarked on the lavish use of it in cookery and at the table.

Creamery production of butter, in which milk collected from a large number of farms was taken to a central point for processing, began in the late nineteenth century. It gave benefits in economies of scale and quality control but reduced regional nuances. An important step toward the process was the introduction of a mechanical cream separator by Gustav de Laval in Denmark in the 1870s. In 1881 Alanson Slaughter built a creamery in Orange County, New York, using the milk produced by 375 cows. By 1900 a creamery in Vermont used the milk from thirty thousand cows to make over ten tons of butter a day, and the production of country butter declined rapidly. Canada and New Zealand developed butter as an export commodity for the British market. Most butter produced in the developed world is made in creameries.

Butter is important in European food habits and cuisines derived from them. It is used as a spread for bread, crackers, and toast and to dress cooked vegetables and pasta. In baking it adds flavor and shortness to cakes and some pastries. Butter has a privileged position in French cookery, especially in sauces, such as beurre blanc, hollandaise, and béarnaise. It is not ideal for frying as the protein it contains burns at about 250°F (120°C), but clarified butter can be heated to about 375°F (190°C) and is often used for shallow frying fish. Butter or ghee also gives character to northern Indian food. For instance, a small amount heated with spices is added to pulse dishes for richness and to finish the cooking process. In Tibet butter is floated on bowls of tea, the residues of which are mixed with *tsampa* (barley flour) and eaten.

See also **Dairy Products; Margarine.**

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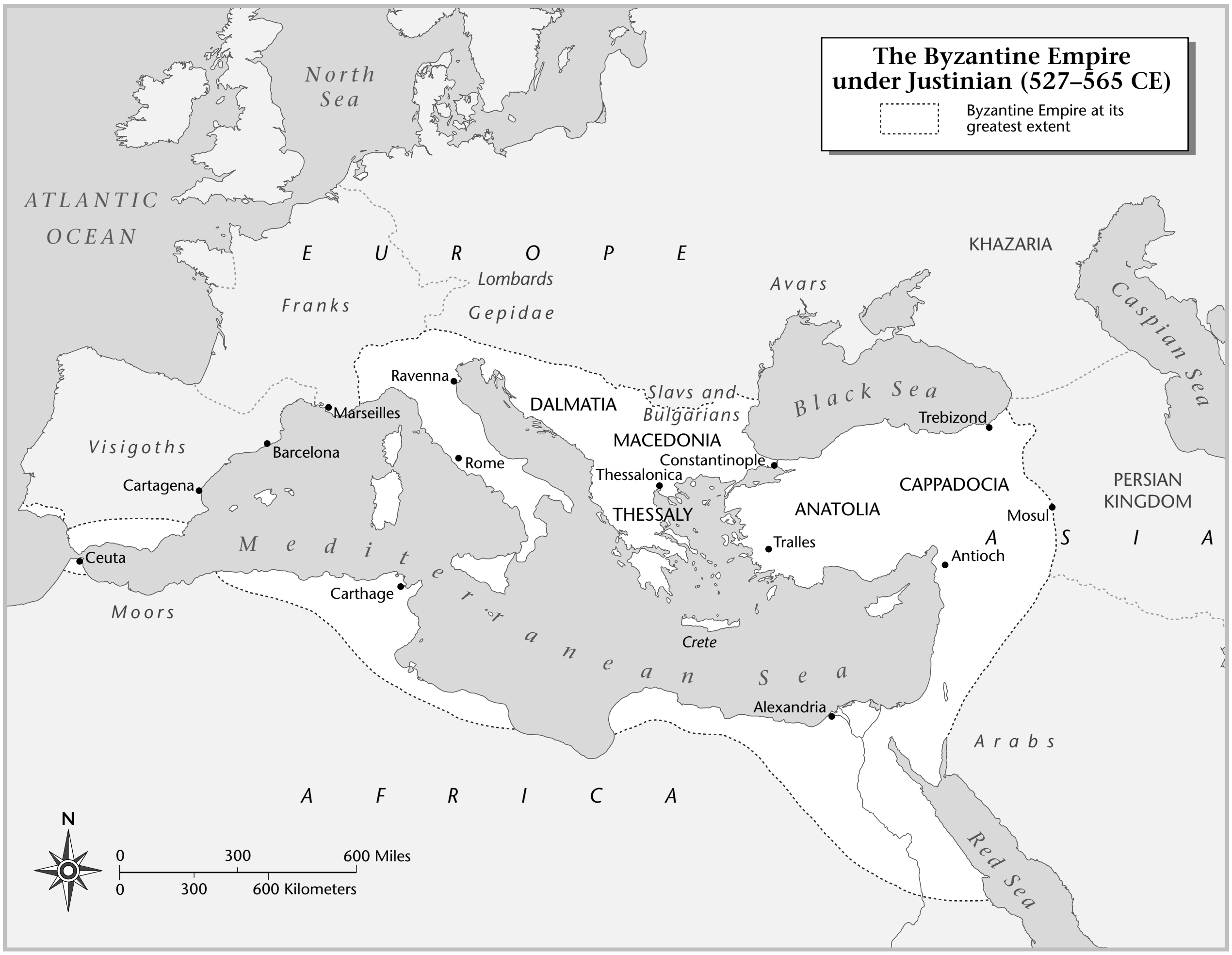
Laura Mason

BYZANTINE EMPIRE. Constantine I, the first Christian emperor of Rome (reigned 306–337), established a new eastern capital in 330 at a site unrivaled for its beauty and unmatched as a center for administration and trade. The Greek colony of Byzantium had prospered on its exports of salted bonito and other seafood. Now renamed Constantinopolis (modern Istanbul), it was destined to be the capital of the later Roman or Byzantine Empire for eleven hundred years.

The civilization of Constantinople is sometimes misunderstood as a poor imitation of classical Greece and Rome. From the perspective of medieval western Europe, however, Constantinople was a city of magic and mystery. Early French epics and romances tell of the wondrous foods, spices, drugs, and precious stones that could be found in the palaces of Constantinople.

Byzantine culture never ceased to develop and to innovate, and this is certainly true of its cuisine. Among favored game were the gazelles of inland Anatolia, and wild asses, of which herds were maintained in imperial parks. The seafood most appreciated by the Byzantines was bo-


The Byzantine Empire under Justinian (527–565 CE)
Byzantine Empire at its greatest extent
North Sea
ATLANTIC OCEAN
EUROPE
Franks
Lombards
Gepidae
Avars
KHAZARIA
Caspian Sea
Black Sea
Slavs and Bulgarians
DALMATIA
MACEDONIA
THESSALY
ANATOLIA
CAPPADOCIA
PERSIAN KINGDOM
ASIA
Visigoths
Moors
Mediterranean Sea
Crete
Arabs
Red Sea
AFRICA
Ravenna
Marseilles
Barcelona
Cartagena
Ceuta
Carthage
Rome
Thessalonica
Constantinople
Trebizond
Tralles
Antioch
Mosul
Alexandria
N
0
300
600 Miles
0
300
600 Kilometers

targo (salted mullet roe), and by the twelfth century they were familiar with caviar. Fruits largely unknown to the ancient world but appreciated in Constantinople included the aubergine (eggplant), lemons (via Armenia and Georgia), and the orange. The Byzantines were the first to try rosemary as a flavoring for roast lamb; they first used saffron in cookery. These aromatics, well known in the ancient world, had not previously been thought of as food ingredients.

Byzantine cheeses included mizithra (produced by the pastoral Vlachs of Thessaly and Macedonia) and Cretan prosphatos. As for bread, the bakers of Constantinople were in a most favored trade, according to the ninth century Book of the Eparch, a handbook of city administration: "bakers are never liable to be called for any public service, neither themselves nor their animals, to prevent any interruption of the baking of bread." Mastic and anise were among the aromatics used in baking.

The distinctive flavor of Byzantine cookery is best represented by sweets and sweet drinks. There are dishes that we would recognize as desserts: *grouta*, a sort of frumenty, sweetened with honey and studded with carob seeds or raisins; and rice pudding served with honey. Quince marmalade had been known to the Romans, but other jellies and conserves now made their appearance, based on pear, citron, and lemon. The increasing availability of sugar assisted the confectioner's inventiveness. Rose sugar, a popular medieval confection, may well have originated in Byzantium.

Flavored wines, a variant of the Roman *conditum* (spiced wine), became popular as did flavored soft drinks, which were consumed on fast days. The versions that were aromatized with mastic, aniseed, rose, and absinthe were especially popular; they are distant ancestors of the mastikha, vermouth, absinthe, ouzo, and pastis of the modern Mediterranean. A remarkable range of aromatics, which were either unknown to earlier Mediterranean peoples or used only as perfumes or in compound drugs, were added to Byzantine spiced wines: spikenard, gentian, yellow flag, stone parsley, spignel, valerian, putchuk, tejpat, storax, ginger grass, chamomile, and violet.

Two influences combined to produce the great range of powerful flavors at the heart of Byzantine cuisine. One was the Orthodox Christian church calendar, with its numerous fast days on which both meat and fish were proscribed: the rich (including rich abbots and ecclesiastics) gave their cooks full rein to produce fast-day dishes as piquant and varied as could be imagined. Byzantine pease pudding, a fast-day staple, was aromatized with nutmeg, an eastern spice unknown to the classical Greeks and Romans.

The second influence was that of dieticians. Ancient Greek and Roman dietary manuals had been addressed to experts. The Byzantine ones, however, were written for nonspecialists. As in classical Greece and Rome, physicians relied on the theory of the "four humors" (blood, phlegm, yellow bile, black bile) and prescribed diets aimed to achieve a proper balance of humors in each individual. The effect of each ingredient on the humors was therefore codified so that the desired balance could be maintained by a correct choice of dish and by a correct adjustment of ingredients, varying for the seasons, the weather, the time of day, and each individual's constitution and state of health. Dieticians sometimes recommended vegetarian meals, eaten with vinegar or other dressing. Spices and seasonings became ubiquitous, used both during the cooking process and at the table to amend the qualities of each dish. Fresh figs, if eaten in July, must be taken with salt. A daily glass of conditum, strong in spikenard, was recommended in March; anisaton, anise wine, was appropriate for April. These Byzantine dietary manuals are important sources of culinary history; botargo is first named in the eleventh century by the dietician Simeon Seth, who notes that it "should be avoided totally." The earliest work in this tradition is Anthimus's *On the Observance of Foods*, compiled by a Byzantine physician for a gothic monarch in the early sixth century.

The food of the poor of Constantinople was no doubt limited, though a poetic catalog of a poor family's larder (*Prodromic Poems* 2.38–45, probably twelfth century) includes numerous vegetables and locally grown fruits along with a considerable list of flavorings: vinegar, honey, pepper, cinnamon, cumin, caraway, salt, and others. Cheese, olives, and onions perhaps made up for a scarcity of meat. *Timarion*, a satirical poem of the twelfth century, suggests salt pork and cabbage stew as being a typical poor man's meal, eaten from the bowl with the fingers just as it would have been in contemporary western Europe. The staple of the Byzantine army was cereal food—wheat or barley—which might be prepared as bread, biscuits, or porridge. Inns and wine shops generally provided only basic fare. However, in the sixth-century *Life of St. Theodore of Syceon*, a Byzantine text, there is a reference to an inn that attracted customers by the quality of its food.

Annual fairs were a focus for the food trade. Important fairs were held at Thessalonica and Constantinople around St. Demetrius's day. Constantinople was known for specialized food markets. Sheep and cattle were driven to market to Constantinople from pastures far away in the Balkans, and eastern spices followed long-established trade routes through Trebizond, Mosul, and Alexandria. The populist emperor Manuel (1143–1180) liked to sample the hot street food of the capital, paying for his selection and waiting for change like any other citizen.

Medieval travelers to Byzantium did not always like the strange flavors they encountered. Garos, the fish sauce of the ancient world, which was much used as a flavoring by the Byzantines, was unfamiliar and often unappreciated. Many disliked resinated wine (comparable to modern retsina), which was simply "undrinkable" according to one Italian traveler, Liutprand of Cremona. However, foreigners were seduced by the confectionery, the candied fruits, and the sweet wines. William of Rubruck, a thirteenth-century diplomat who was looking for presents to take from Constantinople to wild Khazaria, chose dried fruit, muscat wine, and fine biscuits.

The cuisine of the Byzantine Empire had a unique character of its own. It forms a bridge between the ancient world and the food of modern Greece and Turkey. In Constantinople astonishing flavor blends were commonplace. For example, roast pork was basted with honey wine; skate was spiced with caraway; wild duck was prepared with its sauce of wine; there was garos, mustard and cumin-salt, and black-eyed peas served with honey vinegar. Old recipes were adapted to new tastes; whereas ancient cooks had used fig leaves, *thria*, as edible wrappings for cooked food, during Byzantine times vine leaves were used in recipes, the precursors of modern dolmades.

When the future emperor Justin II (reigned 518–527) walked from his Dalmatian homeland to Constantinople in 470 as a penniless young man seeking service in the Imperial guard, we are told that he had nothing but army biscuits to keep him alive on his long march. This *paximadion*, or barley biscuit, makes the perfect link from the ancient, via the Byzantine, to the modern period. A classical Roman invention, popularized in the Byzantine Empire, it has many modern descendants: the Arabic *bashmat*, *baqsimat*, the Turkish *beksemad*, the Serbo-Croat *peksimet*, the Romanian *pesmet*, and the modern Greek *paximadi*.

Beyond the old boundaries of the Byzantine Empire, Byzantium's greatest legacy to western cookery may be summed up in these four things: the table fork, which entered Europe through Italy; marzipan, which appears to have originated in Armenia (the word is of Armenian origin); the samovar, which moved northward into Russian culture via the Greek Church; and the Cult of St. Nicholas, together with the gingerbread cookies associated with this Christmas saint.

See also **Balkan Countries**; **Greece, Ancient**; **Mediterranean Diet**; **Middle East**; **Rome and the Roman Empire**.

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Andrew Dalby

C

CABBAGE AND CRUCIFER PLANTS. The cole crops broccoli, brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi belong to the same species (*Brassica oleracea* L.) in the Brassicaceae or mustard family. Kale most closely resembles the progenitor to this group of vegetables. Native to European coasts, wild *B. oleracea* and related species are one to two meters in height with large lobed leaves and a terminal inflorescence of yellow flowers. Different portions of the plant were emphasized during domestication. Broccoli and cauliflower were selected for large edible inflorescences, kohlrabi for an enlarged basal stem, and brussels sprouts and cabbage for leafy buds (axillary and terminal buds, respectively). These vegetable crops grow best in cool climates with adequate soil fertility and ample water. *Brassica* species are unique in producing glucosinolates, the compounds that impart pungency to various cole crops. Certain forms of these compounds are antinutritional while others are beneficial. On the balance, consumption of cole crops has a positive influence on human health. Cole crops are used fresh, may be canned, frozen, dehydrated, pickled, and fermented. Sauerkraut, made from fermented cabbage, is an ancient process that was used to preserve this vegetable as a source of vitamins and minerals during the winter months.

Plant Biology

Plant description. The cole crops are members of the Brassicaceae family (formerly Cruciferae). This family includes over three thousand species in more than three hundred genera. Plants are usually herbaceous annuals, biennials, or perennials. Cabbage and related cole crops belong to the species *Brassica oleracea* L.

With exception of certain cabbages and some types of kale, this group has smooth, alternate leaves with lobed or wavy to highly dissected margins. Leaves may be thick and succulent, with or without a waxy bloom. Some types grow to over two meters on a shallow and fibrous root system. The inflorescence is a terminal raceme of showy yellow or white flowers. Flowers possess four perpendicular petals that the medieval Europeans thought resembled a crucifix (thus the former family name Cruciferae). Flowers also have four sepals, a two-celled, superior ovary with a single stigma and style, and six stamens, two of which have shorter filaments than the others. The fruit (seed pod) is a silique with a persistent, beaked style. At maturity, siliques dehisce longitudinally to release the small round brown or black seeds. Seeds mature fifty to ninety days after fertilization. The species is insect cross-pollinated with self-pollination prevented by a sporophytic self-incompatibility system. All naturally occurring *B. oleracea* are diploid with nine pairs of chromosomes.

With the exception of some cauliflower and broccoli cultivars, the cole crops have a biennial reproductive cycle. Broccoli and cauliflower may be either annual or biennial (Table 1). Except for tropical cauliflowers, vernalization is required for flowering.

During domestication, different plant organs were emphasized. Kale and collards are the least modified from the ancestral form. Cabbage possesses a head composed of overlapping leaves formed on a shortened stem. Brussels sprouts form smaller heads in the leaf axils of the stem. The edible portion of kohlrabi is a shortened and swollen stem. Broccoli has been selected for an enlarged stem and inflorescence that is consumed when flowers are fully developed but have not yet opened. Like broccoli, the head of cauliflower is eaten. However, the head consists of a highly branched mass of undifferentiated shoot apices (curd) that only later may differentiate into floral primordia.

Growth requirements. The *B. oleracea* are cool season crops, with optimum growing temperatures of about 59–68°F (15–20°C), but plants will grow slowly even at 14°F (5°C). Cole crops are cold and frost tolerant, but developmental stage and type of crop affects the degree of cold tolerance. Young plants are more tolerant than are older plants, and crops whose vegetative parts are eaten are generally more tolerant of low temperatures than crops whose reproductive parts are consumed. Kale and brussels sprouts are the most cold hardy, and can withstand temperatures as low as 14 to 23°F (−5 to −10°C). High temperatures (>77°F or >25°C) will inhibit or impair head development in broccoli. Almost no broccoli cultivars can be grown in the warm tropics because plants fail to form heads. Winter, summer, and tropical cauliflower cultivars have been developed, each of which has a different optimal temperature range. For summer types, the optimum temperature for curd development is 62 to 64°F (17 to 18°C) with small "button" heads induced at temperatures above 68°F (20°C). Some winter types develop curds even at 50°F (10°C) while some tropical types will tolerate temperatures up to 86°F (30°C).

Botanical types and horticultural characteristics. *Brassica oleracea* vegetables show amazing diversity in form that is reflected in the different botanical variety names assigned to them (Table 1). These names generally describe the origin of the crop, or the edible part that has been accentuated.

The cabbage group is differentiated based on head shape and color, leaf texture, and intended use. Savoy types, with crinkled leaves and looser heads, are used primarily fresh in salads. Smooth-leafed, firm-headed cabbages are used for fresh market and processing. Fresh market types are typically small-headed and may be green or purple. Fresh market types are further differentiated into those sold immediately, and those stored for several months before sale. Processing types (mainly used for sauerkraut) have large heads (up to 4 kg) that are high in dry matter. Cabbage heads can vary in shape from pointed, to round, to oblate.

Firm heads (which depends on the arrangement and thickness of leaves, leaf angle, and freedom from axillary cavities) are preferred. The core (main stem within the head) should be small in diameter and less than half the height of a mature head. A dark-green or purple external color is preferred for market. Fresh market and storage cabbage can have white, green, or purple internal color, but for sauerkraut, white internal color is essential. Uniform size and maturity are necessary for efficient harvest and packing.

While the term "broccoli" is commonly used in the United States to refer to *B. oleracea* var. *italica*, elsewhere this crop may be called "sprouting broccoli" or "calabrese" (after a landrace, or farmer-selected variety, from the Calabria district of southern Italy). Other crops that use the name "broccoli" are "broccoli rape" (turnip or *B. rapa* inflorescences), "heading broccoli" or "cauliflower broccoli" (*B. oleracea* var. *botrytis*), and "Chinese broccoli" (*B. oleracea* var. *alboglabra*). Broccoli may have purple or green heads, be single or multiple-headed, and have annual or biennial (winter type) habit. Cultivars also vary in plant height, head shape, size of flower buds, and stem length.

Important horticultural characteristics for broccoli include yield (which is related to uniform field matu-

TABLE 1

The cole crops, their uses and plant biology

Crop	Species and botanical name	Part used as food	Flowering habit	Internodes elongate in first year	Temperature requirements for flowering
Kale	*Brassica oleracea* var. *acephala*	Leaves	biennial	yes	Approximately 6 weeks at 4.5°C after reaching a minimum stem diameter (3–4 mm)
Collards	*B. oleracea* var. *acephala*	Leaves	biennial	yes	Similar to kale
Cabbage	*B. oleracea* var. *capitata*	Leafy head or apical bud	biennial	no	Approximately 8 weeks at 4.5°C after reaching a minimum stem diameter (usually 6-8 mm)
Brussels sprouts	*B. oleracea* var. *gemmifera*	Axillary heads or buds	biennial	yes	Similar to cabbage; specific data not available
Kohlrabi	*B. oleracea* var. *gongylodes*	Fleshy stem	biennial	no	Little juvenile period; one week at 10°C sufficient to cause bolting
Cauliflower	*B. oleracea* var. *botrytis*	"Curd"	annual	yes	Summer and tropical varieties: Will form curds without cold and proceed to develop flowers. Late varieties may not have time to flower during growing season.
			biennial	no	Winter varieties: Low temperature exposure after about 6 weeks of age will cause curd formation; flowering follows without additional chilling.
Broccoli or Chinese kale	*B. oleracea* var. *italica*	Young inflorescence	annual	yes	Low temperature hastens heading but not required for head formation and flowering.
Kai lan, Chinese broccoli, or Chinese kale	*B. oleracea* var. *alboglabra*	Leaves, young inflorescence	annual	yes	Specific data not available

Cabbage figures prominently in the diet of Caribbean and Central American countries. These cabbage fields are in the mountainous region of Valle Nueva near Constanza, Dominican Republic. © RICHARD BICKEL/CORBIS.

rity, and head size and stem weight), and head and stem color (dark green is preferred for processing). Heads should be firm and supported by a deeply branched stem. Domed heads shed water and are less susceptible to head rot than are flat heads. Smooth heads are needed for fresh market, whereas processors prefer segmented heads. The individual branches or florets should be small, firm, and even in maturity and color. Small flower buds (called "beads") are preferred. Defects include uneven flower bud development ("rosetting"), large bead size, loose heads, depression in center of the head, dead flower buds, leaves in head, and yellow color.

Cauliflower cultivars are differentiated mainly by maturity as previously described. Curds are commonly white, but may also be green, orange, or purple. Summer and some winter types have been selected for leaves that wrap tightly about the head to facilitate curd blanching, while tropical types may lack adequate wrapper leaves for self-blanching. For some cultivars, field workers must break or band the wrapper leaves to provide adequate covering for the curd. Cauliflower is perhaps the most fickle of the cole crops to grow because of its exacting climatic requirements.

Important horticultural characteristics include head size (medium is preferred for fresh market, but it can be large for processing), head weight (less cavity space is better), and large, clasping wrapper leaves that prevent curd exposure. Yield depends on good cover, which permits heads to grow larger before exposure. Heads must be pure white for processing and fresh market. Uniform maturity is important but difficult to achieve, even in F_1 hybrids. Over-mature heads will begin to show curd differentiation ("riciness"). Heads should be free from leaves.

Brussels sprouts are late maturing biennials. The main difference among cultivars is in stem length and maturity. Shorter types, while earlier maturing, also tend to be lower yielding than the tall types. For processing, sprouts should be firm and about 1.5 to 3 cm in diameter. Cultivars may have green or purple sprouts.

CULTIVARS

The term "cultivar" is used to distinguish a kind of vegetable from a botanical variety. Cultivars are things like "Excelsior" broccoli or "Snow Man" cauliflower. Cultivars may be open-pollinated, pure lines or inbreds, or F_1 hybrids. A botanical variety refers to a group of similar cultivars. For example, broccoli is classified as *Brassica oleracea* var. *italica* (the botanical variety of the cole family that comes from Italy). Sometimes the term "variety" is used interchangeably with "cultivar." For example, many garden seed catalogs use the term "variety." The terms "open-pollinated," "pure line," "inbred," and "F_1 hybrid" refer to the genetic structure of a cultivar. Open-pollinated varieties (often referred to as OPs) are usually a mix of genetically heterozygous plants forming a heterogeneous population. OPs are usually cross-pollinated and can be variable for horticultural traits. If a plant from an OP population is self-pollinated for several generations, it becomes an inbred line. With approximately six generations of self-pollination, a line will become genetically homozygous, and the population will be homogeneous. Crops that are normally self-pollinated (such as beans or peas) are called "pure lines" when inbred. F_1 hybrids are developed by crossing two inbred lines. The cross must be repeated to produce F_1 hybrid seed because selfed or crossed seed from the F_1 hybrid will not breed true. F_1 hybrids are genetically heterozygous but form homogenous populations.

Cultivar types. Cole crop landraces and cultivars were originally open-pollinated populations, consisting of genetically heterogeneous individuals. Such populations are subject to inbreeding depression in subsequent growing seasons if the grower saves seeds from too few individuals. Some open-pollinated cultivars are still grown, but the majority of contemporary cultivars are F_1 hybrids. Breeders develop inbreds, which are then planted in isolation in pairs to produce the F_1 hybrid seed, relying on self-incompatibility or cytoplasmic male sterility to enforce outcrossing.

Isolation of one-half to one mile between seed fields is required to prevent unwanted cross pollination. Any combination of *B. oleracea* crops and their wild forms may cross with one another and produce contaminants in a seed lot. *B. oleracea* does not need to be isolated from *B. rapa*, *B. juncea*, *B. nigra*, *B. napus*, and *Raphanus sativus* because these species will cross only with great difficulty.

Phytonutrient constituents. The Greeks and Romans recognized the nutritional and medicinal benefits of cole crops. Today, cole crops are recommended for increased consumption by people in developed countries. Cole crops supplement staple foods of higher caloric value with protein, vitamins, minerals, and dietary fiber. While epidemiological studies have demonstrated the health benefits of cole crops, they do contain some antinutritional constituents.

The vegetable parts of the cole crops have a high water content, are low in lipids and carbohydrates, and as a consequence, have relatively low caloric value (Table 2). They are most notable as a source of soluble and insoluble fiber, calcium and potassium, vitamin C, folate, and carotenoids (b-carotene [beta-carotene] and lutein) when compared to other vegetables of similar water content. Although the protein level is low, cole crops do contain significant levels of the essential sulfur-containing amino acid methionine, but not cysteine.

Several compounds give cole crops their characteristic flavor, and affect health and nutrition (Table 3). Glucosinolates and their breakdown products are the best characterized of these compounds. Glucosinolates are a class of sulfur-containing glucosides of which about fif-

TABLE 2

Nutritional composition of the major cole crops. Comparisons based on 100 grams edible product. Cabbage and cauliflower are raw; broccoli and brussels sprouts are cooked.

Crop	Water	Calories	Protein	Fat	Total carbohydrate	Vitamin A	Vitamin C	Fiber
	(%)	kcal	g	g	g	IU	mg	g
Cabbage	94	22	1.0	0.4	4.5	132	20	2.3
Savoy cabbage	92	24	1.8	0.1	5.4	889	17	2.8
Broccoli	91	28	3.0	0.4	5.1	1,388	75	2.9
Cauliflower	93	23	1.8	0.5	4.1	17	44	2.7
Brussels sprouts	87	39	2.6	0.5	8.7	719	62	2.6

SOURCE: USDA Nutrient Database for Standard Reference (http://www.nal.usda.gov/fnic/cgi-bin/nut_search.pl) teen occur in significant quantities in the Brassicaceae. Within a given species, only three or four glucosinolates may be present in high concentrations. Glucosinolates are found in all *Brassica* tissues, and are generally highest in seeds, intermediate in young vegetative tissues, and lowest in older vegetative tissues. Myrosinase metabolizes glucosinolates to various isothiocyanates. Normally stored apart from glucosinolates in myrosin cells, myrosinase only comes into contact with its substrate when cells are ruptured. The type of isothiocyanate formed depends on the composition of the precursor glucosinolates, the pH, and the presence of certain cofactors such as ferrous iron. Glucosinolates have little flavor; rather, the breakdown products are responsible for the characteristic flavors of the cole crops. In their most extreme form and concentration, isothiocyanates cause the pungency of horseradish. In the cole crops, these compounds in too high a concentration may impart a bitter or “spicy” flavor. The wild cole crop progenitor has fairly high glucosinolate concentrations, which have been reduced in the domesticated species.

Glucosinolate-derived compounds have both positive and negative nutritional effects. Isothiocyanates are goitergenic in animals and people if consumed in sufficient quantities. In brussels sprouts, degree of bitterness correlates with level of the isothiocyanate goitrin, so named because of past association with goiter.

On the positive side, epidemiological studies have demonstrated that a diet high in fruits and vegetables, and in *Brassica* vegetables in particular, limits the risk of certain cancers. Glucosinolates may prevent cancer by acting as metabolic detoxicants to facilitate alteration and excretion of cell carcinogens. Sulphoraphane, a sulphinyl-containing isothiocyanate, is a strong inducer of the phase II enzymes responsible for anticarcinogenic activities. While sulphoraphane is found in most cole crops, sprouted broccoli seeds have the highest concentrations. This finding by Paul Talalay’s group at John Hopkins University has stimulated the commercial production of broccoli sprouts.

GLUCOSINOLATE-DERIVED COMPOUNDS

Glucosinolate-derived compounds have also been implicated in plant defense against pathogens and vertebrate and invertebrate pests. While they may deter generalized predators and pathogens, certain pathogens and insects can detoxify these compounds, and they may in fact serve as an attractant. Further research is needed to clarify the complex and varied roles played by glucosinolate-derived compounds. If consumed in moderation, the beneficial effects of cole crops on health far outweigh deleterious effects.

Glucosinolate-derived indole compounds are inducers of liver and intestinal enzymes that reduced tumor formation in rats. Timing is critical, in that while these compounds were effective when ingested prior to the carcinogen, administration after introduction of the carcinogen increased carcinogenesis in rainbow trout.

Other compounds of nutritional importance are flavonoids and S-methylcystine sulfoxide. Broccoli contains relatively high levels of the anticarcinogenic flavonoids kaempfrol and quercetin. Purple cabbage and other purple- or red-pigmented cole crops contain various anthocyanins. While anthocyanins in other crops

TABLE 3

Secondary nutritional compounds found in various raw cole crops[z]

Crop	Total glucosinolates (mmoles 100g^{-1})	Carotenoid	mg 100g^{-1}	Flavonoid	mg 100g^{-1}	a-amino acid	mg 100g^{-1}
Brussels sprouts	367.2–553.0	Lutein	610	—	—	SMCSO[x]	68.0
		β-carotene	441				
Broccoli	161.9–248.4	Lutein	1,614	Quercetin	1.8	SMCSO	19.1
		β-carotene	800	Kaempferol	2.5		
White cabbage	68.6–238.3	Lutein	80	—	—	SMCSO	18.5
		β-carotene	51				
Savoy cabbage	164.5–461.3	Lutein	103	—	—	—	—
		β-carotene	50				
Savoy cabbage (outer leaves)	—	Lutein	14,457	—	—	—	—
		β-carotene	10,020				
Cauliflower	94.6–178.2	Lutein	trace			SMCSO	14.3
		β-carotene	none	—	—		

[z] Data compiled from Gomez-Campo, 1999.
[x] S-methylcystine sulfoxide.

The world's most famous cabbage dish is doubtless Alsatian *choucroute garni,* sauerkraut buried under a mountain of sausages and meats. © NIK WHEELER/CORBIS.

have shown anticarcinogenic properties, similar studies have not been carried out for cole crop anthocyanins. S-methylcystine sulfoxide is hydrolyzed by cystine lyase to methyl methanethiosulphinate, a compound that is similar to allyl thiosulphinate found in garlic. These compounds influence flavors, and are anticarcinogenic. Because of the similarities, and the health benefits found associated with these compounds in *Allium*, further study is warranted in the *Brassica*.

History

Original extent and domestication. The wild progenitor of *Brassica* is found on the rocky Atlantic coasts of Europe (Bay of Biscay) and Britain. Researchers now believe that the free living *B. oleracea* populations found along the Mediterranean coast are feral and weedy escapes from cultivation. Related wild Mediterranean species (*B. cretica*, *B. insularis*, *B. montana*, and *B. ruprestris*) may have contributed genetically to the domesticated crops, although molecular data does not support this hypothesis. Definitive archaeological evidence is lacking, but the crop was almost certainly a late domesticate compared to the primary domesticates of the Near East center such as emmer wheat, barley, pea, and lentil.

Different cole crops were likely domesticated in different places at different times, and multiple domestication within a type cannot be ruled out. More recent hybridizations among different types further complicate the picture. Leafy kales and nonheading cabbages were most likely the first domesticates, with some researchers hypothesizing that separate domestications occurred from Greece to Wales. "Stemkales" and headed and sprouting cabbages were described by Greek and Roman writers, although it is unclear whether these crops were the ancestors to the modern cabbage and broccoli. Domestication occurred prior to 1000 B.C.E., and possibly a millennia or more earlier. Broccoli and cauliflower are recent domesticates (possibly as old as 500 B.C.E.) from the eastern Mediterranean, and perhaps as localized as Cyprus and Sicily. The first clear description of broccoli and cauliflower was written about 1100 C.E. in Spain. Brussels sprouts were domesticated in northern Europe (some say Belgium) in about the fourteenth century. Early herbals depicted a kale with enlarged leaf axil buds, inferring that brussels sprouts were derived directly from kale. Kohlrabi may have been derived from marrowstem kale, or from a cross of marrowstem kale with cabbage. The origin of collards is closely associated with cabbage; whether collards are an ancestor or descendant of cabbage is unknown.

Historical diffusion. From Europe and the Mediterranean, cabbage and kale dispersed into Mesopotamia and Egypt. These crops later spread throughout the Old World along trade routes, eventually reaching China where distinctive kale and broccoli types were to compete with the *B. rapa* cabbages of East Asian origin. When trade with the New World began, all of the cole crops were taken to the Americas. In the tropics, cole crops were widely accepted, except for broccoli, which does not form heads under tropical conditions.

Broccoli and cauliflower diffused from the Mediterranean (cauliflower earlier than broccoli) to elsewhere in the Near East, northern Africa, and Europe. Cauliflower was mentioned in Turkey and Egypt in the sixteenth century and in England and France in the seventeenth century. Both broccoli and cauliflower were first described in the United States in 1806, but production did not flourish until the 1920s. The broccoli industry became established about 1923 when the D'Arrigo Brothers Company began growing broccoli in California and catering to the large Italian immigrant population on the East Coast. Interest in broccoli in central and northern Europe increased after the crop became popular in the United States, and worldwide, broccoli production is increasing.

Procurement

Agriculture and crop husbandry. The majority of cole crop hectarage is found in the milder growing areas. The optimum growing season is determined by an interaction among latitude, altitude, and time of the year, as well as proximity to temperature-moderating oceans and lakes. In the United States, most of the cole crops for processing are produced at northern latitudes (New York, Wisconsin, Oregon, and Washington), the exception being California. The leading state for fresh market production is California, followed by New York, Georgia, Arizona, Texas, and Florida. Winter production in the United States of cole crops is done in Florida, Texas, and California. In the subtropics and tropics, cole crops are generally produced at higher altitudes. Commercial cauliflower production is restricted to the maritime climates of the United States because of its sensitivity to heat during curd formation.

For commercial production, the crops are generally grown in monoculture in 50–75 cm rows with within row spacing of 15–30 cm. Crops may be direct seeded or transplanted. Direct seeding is cheaper, but transplanting generally produces a more even stand with more uniform maturity. Cole crops require about 2.5 cm per week of moisture applied regularly throughout the season. In most production areas, natural precipitation is supplemented with irrigation.

Optimum soil pH is 5.5–6.5. Liming low pH fields improves micronutrient uptake and reduces incidence of club root. Plentiful amounts of nitrogen, potassium, and phosphorus are required for optimum plant growth. Nitrogen may be applied as a split application. Cole crops require adequate quantities of boron, calcium, and magnesium.

Harvesting and packing. Cabbage may be hand- or machine-harvested. Generally, heads intended for fresh market are hand-harvested, while those destined for storage or sauerkraut are mechanically harvested.

Broccoli and cauliflower are entirely hand-harvested. The greatest impediments to automating harvest are lack of cultivars with suitable plant architecture and a nonuniform maturity across a field. Even with F_1 hybrids and transplants, microenvironment differences will cause differential maturation in different parts of the field. Growers typically harvest two or three times at several-day intervals to maximize harvest of heads at optimum maturity. Attempts to develop a selective harvester for these crops have not been successful to date.

Brussels sprouts may be hand- or partially machine-harvested. The lower buds on the plant mature before those on the upper portion of the stem. Sprouts are harvested by hand at three or four-week intervals during the growing season by breaking the petioles of the lower leaves, then snapping the mature sprouts. If a single harvest is desired, the terminal growing point is removed when sufficient height and lower bud development has been achieved. Upper buds will then catch up with lower buds in growth, resulting in near-uniform-sized sprouts along the stem. Plants are then cut in the field; the leaves are removed and sprouts are sheared from the stalk using a sprout cutter.

SAUERKRAUT

Fermenting cabbage to make sauerkraut is an ancient practice. The process is simple, and facilitated long-term storage of the crop. Sauerkraut is made by salting shredded cabbage and placing the mixture in an anaerobic container to ferment. Salt draws moisture from the cabbage leaves to produce a brine solution (ideally 2.25 percent). The brine inhibits growth of most microorganisms but allows certain anaerobic bacteria to propagate. *Leuconostoc mesenteroides* initiates the process, while others (primarily *Lactobacillus, Streptoccocus*, and *Pediococcus* spp.) continue fermentation. There are a number of conditions that need to be met, or a poor quality product will result. Salt must be evenly distributed, otherwise soft or pink kraut will form. Temperature will affect the composition of the microbial population, which in turn determines the pH and mix of flavor components. Temperatures below 18°C will produce sauerkraut with the best flavor, highest acidity, and ascorbic acid. Nonanaerobic conditions will allow yeast and molds to grow, which will impart undesirable flavors and odors, and will cause spoilage. Sauerkraut is preserved by canning. Sauerkraut is typically consumed with meat or poultry, but may also be used in salads. Sauerkraut juice may be blended with other vegetable or fruit juices to produce a novel and pleasing product.

Today, many people mainly associate sauerkraut with a condiment served on their hotdog bun at a baseball game. In northern Europe during the winter and on Western sailing ships, sauerkraut was an essential staple. The pickling process preserved about one-third of the vitamin C contained in the cabbage leaves, and provided a source of this essential vitamin at times when it was unavailable from other foods. For example, Captain Cook carried sauerkraut on his voyages of exploration as a preventative for scurvy. Fermented products, such as kimchi in Korea, which is made with Chinese cabbage (*B. rapa*) or Daikon radish (*Raphanus sativus*) serve a similar purpose in the temperate Asian world.

In large-scale operations, broccoli, cauliflower, and cabbage harvested for fresh market are packed in the field.

After broccoli heads are cut from the plant, leaves are removed and a mechanical cutting and banding machine is used to trim the stems to 15–20 cm in length. Two to four heads are bundled using rubber bands or a twist-tie. The prepared heads are then packed in a box and quickly cooled to 32°F (0°C) using slurry ice (40% ice and 60 percent water), which is hosed directly into the box. Cauliflower heads are harvested for fresh market when they grow to 15–20 cm in diameter. They are trimmed of most leaves (leaving a few basal leaves to protect the heads from damage), sorted to uniform size (typically six, twelve, or twenty-four heads per crate), and packed into crates or cartons. Individual heads may be wrapped with perforated film. Cauliflower is cooled to 32–36°F (0–2°C) for shipping and storage. Cabbage heads are harvested when firm and 1–1.5 kg in weight. Wrapper leaves are trimmed and heads are sorted and packed into crates or cartons and cooled to 32–36°F (0–2°C). Vacuum cooling, rather than slurry ice, is used to cool cabbage and cauliflower. Hand-harvested brussels sprouts are carried from the field in containers, washed and sorted for size and firmness, and quickly cooled (usually vacuum cooling) to 32°F (0°C). Sprouts are packaged in cellophane bags or baskets.

Storage and Processing. All of the cole crops are stored at near freezing, typically 30–36°F (−1–2°C) and at high (90–100 percent) relative humidity. Cabbage can be stored up to four months under ambient conditions and up to six months in modified atmosphere storage. Broccoli can be stored for only one to two weeks, cauliflower for two to three weeks and brussels sprouts for three to four weeks under optimal conditions in normal atmosphere storage.

The cole crops may be preserved by canning, freezing, pickling, dehydration, or fermentation. Broccoli, cauliflower, kale, collards, and brussels sprouts are usually processed by freezing. Cabbage may be dehydrated, or fermented to produce sauerkraut. Brussels sprouts, cabbage, and cauliflower may also be pickled. Kale and collards may be canned.

Seeds of the cole crops, especially broccoli, are consumed as sprouts. Extracts of cabbage-derived anthocyanins are being used commercially as red food colorants.

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James R. Myers

CACTUS. Cacti are succulent perennials that are native to arid and semi-arid regions and are cultivated extensively, except where freezes regularly occur. The land area devoted to cactus cultivation in 2001 was about 1.8 million hectares (4.4 million acres), mostly for fodder, and over half of which was in northern Africa and northeastern Brazil. Cacti are also cultivated in over twenty countries for their fruits, which commercially fall into three categories: cactus pears, which are the fruits of the prickly pear *Opuntia ficus-indica* and certain other cacti with flat stems (cladodes), and represent over 90% of the cactus fruits sold; pitahayas, which are the fruits of vine cacti in the genera *Hylocereus* and *Selenicereus*; and pitayas, which are the fruits of columnar cacti. Young cladodes are consumed as a vegetable *(nopalitos)*, particularly in Mexico. Nearly all cacti employ a photosynthetic pathway known as Crassulacean acid metabolism (CAM), in which the stomates (shoot pores that allow CO_2 entry) open primarily at night, when temperatures are lower and water loss is lower than for the overwhelming majority of plants, whose stomates open during the daytime. The best known edible CAM plant is pineapple, which is cultivated on about half as much area as cacti. Because of their lower water loss, cacti and other CAM plants thrive in dry regions (and also require little or no irrigation when cultivated in other regions.

History

Although evidence for cacti in human diets goes back more than 8,000 years in present-day Mexico, worldwide consumption has developed only in the last few hundred years. Cacti were introduced into Europe in 1495 from the second trip of Christopher Columbus to the New World. *Opuntia ficus-indica* spread across the Mediterranean region in the sixteenth century, where it readily grew under the local semi-arid conditions. Also in the sixteenth century, Spaniards introduced *Hylocereus undatus* into the Philippines, whence it spread throughout southeast Asia. In the nineteenth century, it became established in Viet Nam and is now extensively cultivated in the Mekong Delta, where its tasty fruit with red peel and white pulp is called "dragon fruit." Also in the nineteenth century, the columnar *Stenocereus queretaroensis* was domesticated in Jalisco, Mexico. None of these species received much agronomic attention until the end of the twentieth century, and even then the money for research and development was meager. Both fruit crops and young cladodes used as vegetables require much hand labor. Although machines have been developed to remove the irritating small spines (termed "glochids") from cactus pears, many improvements in their cultivation await future research.

Fruits

Fruits of many cacti are edible. Indeed, the Seri Indians of the southwestern United States and northwestern Mexico consumed fruits from over twenty species, including those of the saguaro cactus (*Carnegiea gigantea*), used by various Native Americans for fruits and wine. Fruits collected from the wild influenced the species selected for domestication. Such selections involved various species of *Opuntia* in Mexico, eventually leading to the presently planted cultivars.

Cactus pear. The fruits of *Opuntia ficus-indica* and a few other prickly pears are harvested in the summer from plants that are one to three meters tall. Harvest can be delayed by removing the early flowers, as is commonly done in Sicily, leading to a second harvest in the autumn that is more valuable per fruit due to lessened competition from other species. One-year-old cladodes can bear five to fifteen fruits each; terminal cladodes with fewer fruits tend to bear larger ones (over 150 g each), which command higher prices. After harvesting, the fruits must have the glochids removed mechanically, after which they are often packaged by color and weight. Fruits with red pulp are prized in the United States and certain European countries, whereas greenish pulp for mature fruits is generally preferred in Mexico. Although sold in supermarkets worldwide, fruits are also sold by street vendors, who slice the peel and provide the exposed pulp directly to the consumer. The relatively large seeds are a detriment to fruit consumption by many, but the seeds are harmless and readily swallowed by aficionados.

The country with the greatest land area devoted to cactus pear cultivation is Mexico (Table 1). Annual production can be over fifteen tons fresh weight per hectare under intensive management. In Mexico, Sicily, Israel, and the United States, most production is from commercial plantations, whereas in other Latin American countries and in northern Africa, a large amount of the fruit is collected from hedges and other informal plantings.

TABLE 1

Land areas and harvests for fruit production by *Opuntia ficus-indica* and closely related species in 2001

Country	Area (hectares)	Annual harvest (tons fresh weight)
Argentina	900	8,000
Bolivia	1,300	3,500
Chile	1,200	9,000
Israel	400	7,000
Italy	7,500	80,000
Mexico	70,000	400,000
Northern Africa (Algeria, Morocco, Tunisia)	~20,000	—
South Africa	200	1,500
United States	200	3,600

Pitahayas and pitayas. The most widely cultivated pitahaya is *Hylocereus undatus*, which in 2001 was cultivated on about 12,000 hectares in many countries, including Viet Nam, Taiwan, the Philippines, Mexico, Guatemala, Peru, Colombia, and Israel. It is a vine that is trained to grow on posts, trellises, or arbors. Its relatively large fruits (generally 250 to 500 g) are harvested after the peel, which has no spines or glochids, turns red. The pulp is

Vendor selling cactus pads in Guanajuato, Mexico. © DANNY LEHMAN/CORBIS.

whitish with small black seeds. Other species of *Hylocereus* and *Selenicereus megalanthus* have peels and pulps of various colors, leading to a wide choice of tasty and visually appealing fruits.

Although their cultivation is expanding rapidly, in 2001 pitayas were harvested on only about 3,000 hectares worldwide, mostly in Mexico, from species like *Cereus peruvianus*, and especially *Stenocereus queretaroensis* and other *Stenocereus* species. Fruits grow along the main stem and branches about two to six meters above the ground, requiring a pole with a basket-like attachment for harvest of individual fruits. Fruits of *Stenocereus queretaroensis* have an attractive and tasty dark red or purple pulp with small seeds (like those in kiwis) that are easily swallowed. However, the fruits tend to split within two or three days after harvest, requiring rapid local consumption.

Vegetables

Tender young cladodes about 10 to 15 cm long of *Opuntia ficus-indica*, *Opuntia robusta*, and a few related species are used in Mexico as *nopalitos*. About 6,000 hectares were cultivated for this purpose in 2001, and *nopalitos* are also prepared from plants in the wild or growing around houses, or as hedges. The raised portions of the stem containing spines and glochids are readily removed with a knife or by machine. The cladodes are then generally sliced or diced and blanched in a weak saline solution for a few minutes to remove excess mucilage. After draining, the material can be cooked, yielding a vegetable with a taste not unlike string beans or okra. Because of their high fructose and mucilage content, *nopalitos* are highly recommended for people with type II diabetes. Often the blanched material is pickled and used as a relish or in salads. More than thirty companies sold pickled *nopalitos* in Mexico in 2001, and this product is in supermarkets worldwide.

Other Uses

Other uses of cacti range from candy made from the stems of barrel cacti that have been infused with a sugar solution to peyote from dried stems of *Lophophora williamsii*, used by Native Americans for ceremonial purposes. Flowers have been used for medicinal purposes and to make perfume. The seeds of cacti such as *Opuntia ficus-indica* have been dried, ground, and then used as a flavoring paste for cooking. Carminic acid, an important red dye for food coloring, can be extracted from dried cochineal insects that feed on *Opuntia ficus-indica*. Although most cactus pears are consumed fresh, sorbets and marmalades are also prepared from the fruits. The strained pulp of fresh fruits is used as a fruit drink or fermented to make wine. Fruits of cactus pears are also partially dried and sold in brick-sized blocks in Mexico. More than thirty brands of dried and powdered cladodes are sold in Mexico as a dietary supplement. The range of edible products from cacti is indeed great and their use is steadily increasing, as more people become willing to try new and natural foods, and growers search for crops that do not need irrigation.

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Park S. Nobel

CAJUN CUISINE. *See* United States.

CAKE AND PANCAKE.

The cake, as we now understand it in Anglo-American cookery, is the product of western European culture, with few parallels in non-European cookeries. It is commonly expressed in French by the word *gâteau*, a term without specific meaning (*gâteau de pomme* is both an apple cake and a molded apple jelly) and whose origin remains undetermined. Nevertheless, since the nineteenth century, the culture of the cake has spread to many parts of the world as the result of colonialism and the internationalization of French, English, and more recently of American cookery.

In Latin America, for example, American-type layer cakes are called *queques*, but the more traditional Spanish term *pastel* is often employed for birthday cakes of similar shape and structural arrangement. The use of conflicting terminologies for cakes, and the multitudes of types of foods defined as cakes, make it difficult to create a standard logic and a simple definition. No scholarly undertaking has thus far tackled the cake to create a unifying thesis about its diverse evolutionary forms. This would require a detailed analysis of the huge vocabularies for cake and cakelike pastries that exist in many European languages both ancient and modern. The discussion here will focus on the cake in relation to American cookery.

The concept itself is quite basic: cake is bread, if bread is defined as something baked from flour or meal, as in Welsh oatcake. However, this basic idea has evolved in English to cover a number of preparations also generally categorized as sweet and normally considered dessert or special occasion foods. While nearly all types of modern cakes are thought to have evolved out of some form of enriched bread, that course of evolution is highly varied from culture to culture and encompasses a great many regionalized forms and colloquial names. Both the word *cake* and the preparations associated with it have experienced sometimes separate and convoluted histories.

The word is generally assumed to have entered English via Old Norse *kaka*, although this line of derivation is doubtful, since the Norse word itself was assimilated from Vulgar Latin, for a similar root may be observed in such terms as the Dutch *coeke* and *koek*. *Koekje*, the diminutive of *koek*, was corrupted in colonial American English as cookie (literally a "little cake"), yet it preserves the essential concept that the cake is flat and baked, regardless of size—an important point. Since a similar term *kuoche* appears in medieval German, also for a type of enriched bread flat in shape, it is quite probable that cake entered modern English as a Latin loan word via ancient British or Anglo-Saxon rather than Old Norse, although literary documentation does not surface until the 1300s. Neither Billy (1993) nor Lambert (1997) has ascertained Celtic roots for the term; thus a Latin origin must be presumed.

Whatever the route of assimilation, the root meaning of cake is quite clear, for it is expressed in the Latin verb *coquere*, to cook or prepare food in the limited sense of baking or exposing it to heat it in some way. German and the other languages that assimilated this verb-concept also extended it to mean something baked that is both flat and made with or covered with ingredients that differentiate it from common flat bread, hence terms like *Kuchen*, *Fladen*, *Wähe*, and *Zelten* in German-speaking Europe. *Torte*, a word derived from Latin *tortum*, moved into German and other northern European languages (such as Polish) via French or Italian during the Renaissance and entered English as tart. The fruit tart of Renaissance England evolved into the colloquial fruit pie of colonial America and there departed from its ancient flat cake ancestry, which may be said to linger on only in the shape of the bottom crust.

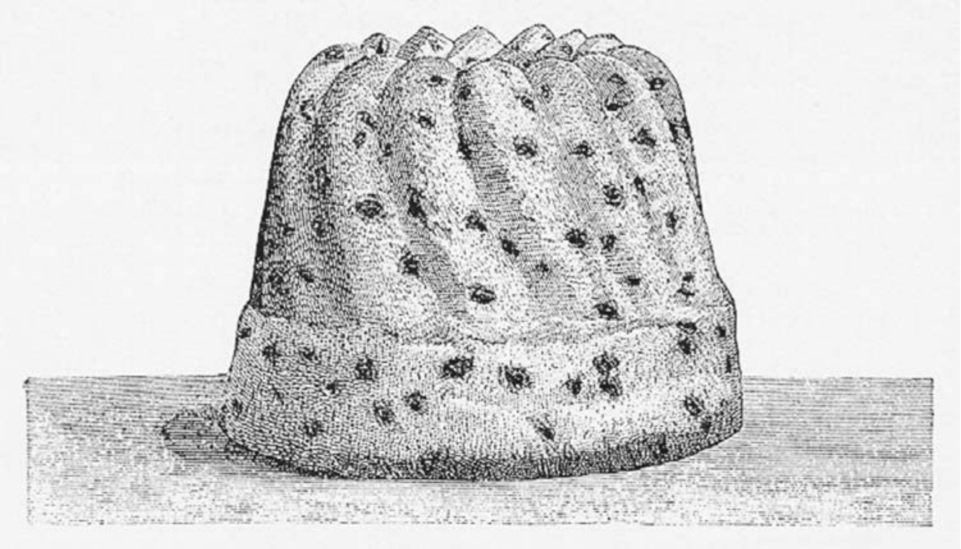
However, very primitive types of cake do survive in the form of the Alsatian *quiche* (derived from German *Kuchen*)—where the rim of the cake dough is turned up to allow for a deeper covering or filling (common cheesecake also belongs to this category). Another type is like the so-called *galette bretonnaise* (Breton flat cake), which is round, flat, sweet in taste, and enriched with butter. It is baked on a griddle or bake stone and thus shares a common lineage with the bannock and *scon* of the insular Celts. A Mediterranean counterpart would be the *karydopita nistisimi* (Lenten walnut cake) of Greece eaten with syrup. The sweet johnnycake of colonial America is a New World extension of this primitive flat cake concept. The hoecake (a flat bread baked on a shovel) and the ashcake (a flat bread baked under hot coals) are both variants of this basic type.

It is also clearly evident from surviving written evidence that medieval cakes were not necessarily sweet, for they could include such ingredients as cheese and herbs, a batter of cheese and eggs, a few slices of sausage, or even a mixture of fruit and vegetables. In their original dietary contexts, such cakes were not viewed as everyday fare, but were reserved for special occasions such as time of harvest, a village fair, a saint's day, or some similar event. The most festive cakes were those enriched with fat and fruit, or sweetened with fruit and honey, and out of that tradition of elaborately flavored bread evolved most of the rich cakes we know today. French pastry cooks generally divide cakes into eight categories based on the type of doughs employed, but these are merely terms of convenience. There are only four structural families.

Cake stand and glass bell cover manufactured by Whitehall & Tatum, Millville, New Jersey, circa 1840. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

The Galette or Short Bread

The galette or short bread is the type described above in connection with *galette bretonnaise* and American sweet johnnycake. The unifying features include an enriched, stiff unleavened dough—which may be molded or flattened by hand or with a rolling implement—a round shape, and a brittle texture once baked. The cake may be further ornamented by impressing images or patterns into the surface. These cakes rely for their tenderness or soft texture on a combination of fat (usually butter) and specially selected flours, such as soft wheat flour or a mixture of barley flour and wheat, or even to some extent on breaking the dough by beating it. They are now commonly categorized as pastries, especially since this type of dough is now employed to make cookies, but historically, such short doughs were treated as cakes as long as they conformed to a flattened shape. When the short breads are stacked and interfilled with rich ingredients, they are almost always referred to as *tortes* or *gâteaux*. An example of the former would be the linzer torte of Austria, while the French *gâteau mille-feuille* would be an



A yeast-raised Gugelhopf cake with raisins, as depicted in a nineteenth-century German wood engraving. ROUGHWOOD COLLECTION.

example of the latter. This French cake is perhaps the most fragile of all, since it is constructed of layers of round sheets of puff pastry interfilled with various sorts of cream and jam.

Bread Cakes or Loaf Cakes

These may be further divided into sweet and savory types. An example of the latter would be the common Italian *foccacia* covered with herbs, cheese, and sliced tomatoes. An example of the sweet type would be the early American Moravian sugar cake, which is essentially a sweetened yeast-raised dough into which is inserted a mixture of brown sugar, cinnamon, and butter. This is accomplished by making holes in the surface of the dough and pressing the mixture in with the index finger. The common thread is that these cakes are yeast-raised and therefore most like bread in texture. Furthermore, they were meant to be eaten out of hand like a piece of bread. Many sweetened festive breads of the Mediterranean preserve this old form, especially in the elaborate preparations of Greek *Vasilopita* (St. Basil's cake) for the New Year and the numerous traditional Cypriot breadlike cakes ornamented with dried fruit, almonds, and brightly colored comfits.

The yeast-raised *Gugelhopf* or *Napfkuchen* of southern Germany and Austria are further extensions of this basic idea, with the additional refinement that the bread is baked in a form so that it acquires an impressive ornamental shape. Rather than sticking fruit into the surface, it is chopped and worked into the dough itself. The Worcester loaf cake of New England, which was similarly baked in a shaped cake pan, provided early Americans with an equivalent example. Its vernacular name, however, indicates that originally (in the 1600s) it was baked round to resemble a loaf of bread, and like bread, it was not made too sweet since it was served with jam or preserves on ceremonial occasions such as funerals. This type of yeast-raised cake achieved its most monumental and most vertical expression during the Renaissance and Baroque periods in such phallic shaped cakes as the Russian Easter cake and the Polish baba.

Baked Pottages or Plum Pudding Cakes

Plum pudding cake was once found in many parts of medieval Europe, but quickly disappeared during the Renaissance in favor of lighter and sweeter preparations. Since the plum cake was associated with traditional fall butchering and Christmas feasting in England (and may be traced to pagan times), it has lingered on in British cookery to this day. It was also brought to colonial North America, where it continues as a feature of Christmas fare under the name of fruitcake. Fruitcake is especially popular in the American South.

In order to understand the origin of this cake, we must start with something similar to mincemeat thickened with meal, cracked wheat, or flour, to which is added a variety of rich ingredients. These would include blood from butchering (hence the term black cake), suet, butter, dried fruits, honey, and a variety of spices. This could be served freshly made as a festive pottage, or baked thick in a pan or shallow crock and later turned out like a wheel of cheese. The use of pottery for such purposes is attested to by Michael Hero, who illustrated something similar called *Scherbenbrodt* (crock bread) in his *Schachtaffeln der Gesuntheyt* (Strasbourg, 1533).

At this point, the baked mass becomes a cake due to its round, flattened shape and solid texture, and black cake it is indeed. Furthermore, it can be sliced and eaten with the fingers; thus it migrates from the medieval pottage course to an *entremet* for the final course, when various sweets and delicate foods are served. From here, the cake undergoes rapid metamorphosis, with increasingly more eggs, sugar, spices, candied fruits, and other ingredients associated with luxury, leaving the homey pottage altogether to evolve along a separate line into plum pudding. One unifying feature, however, is the dark color that came initially from blood, but which is later derived from molasses or brown sugar. Both plum pudding and fruitcake retain this visual allusion to their ancient association with butchering. And to some extent, both have retained their medieval role as visual centerpieces during the course of the meal.

The festive nature of this type of cake, which eventually comes to rely on beaten eggs for its lightness, is preserved in names like rich bride cake, Twelfth Night cake, and Christmas plum cake. More refined (less dark) versions developed into tea cakes, such as Dundee cake and Cumberland fruit cake. The latter preparation has many counterparts in Victorian cookery books. Both the bride and Twelfth Night cakes were similarly ornamented with elaborate icings, but the bride or wedding cake has since evolved into something quite different, having crossed over the line into the next category of cake discussed below.

The traditional bride cake made with fruit as described here probably fell out of fashion due to its dense weight, since it could not be stacked to a great height without crushing the layers underneath. Furthermore, there is considerable work involved in icing it, since it must be coated with a hard layer of marzipan to keep moisture from seeping out into the highly ornamented royal icing encasing the whole creation. Such seepage would stain the work or dissolve it altogether. This telling detail is evident in the fact that most commercial American fruitcakes are no longer sold iced, since this requires a level of competence now dispensed with in large-batch operations.

Pancakes and Batter Cakes Baked in Pans

This takes us into a realm of research that on one level is refreshingly simple, yet on another, perplexing and ambiguous. Let us deal with the ambiguities first. Most of the cakes in the category of pancakes and batter cakes cooked in pans are referred to in French as *gâteaux*, since they are now of a large and impressive sort. Unfortunately, the origins of the word *gâteau* are obscure, although the *Viandier* of Taillevent (1380s) mentions something called a *gaitellet*, which has been glossed as a little cake. This would imply that there were cakes larger than a *gaitellet* and known by another closely related name (*gaitelle*). If this has a Gaulish root (which is possible), it may derive from a cognate of the Latin *catinus*, a deep dish or bowl, or more specifically from *catillus*, the diminutive for a dish or plate (here again the inference is something flat in shape). This is, of course, quite speculative, but leaves one fact beyond doubt: the cake in question is created from batter, from something liquid that is first beaten light.

Stacked tube pans for *gâteau breton.* Made by E. Dehillerin, Paris, ca. 1912. White metal. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

We are on firmer ground with the 1398 observation of John of Trevisia who saw in England a cake "tornyd and wende" at the fire. He even said that it was called a cake and his comment is in fact considered one of the earliest documented uses of the word. What he observed was the preparation of the once popular spit cake (*Spiesskuchen*) much depicted in the paintings of Bruegel and other north German artists. This is created by dripping well-beaten batter onto a hot spit as it turns before the fire, thus spinning out a series of flat irregular cakes in accordion fashion. This was served set on end as a type of wedding cake, one of the few ways in which medieval cooks could raise a batter cake to great heights. Verticality is a feature of many cakes of a highly festive nature, and this cake is still made today by professional bakeries in France, Belgium, Holland, and Germany.

The spit cake is an anomaly in its unusual method of baking. Most batter cakes were created in a much more straightforward manner: down hearth in a bake kettle (Dutch oven). However, this takes us into yet another region of ambiguity concerning the origin of the cake, since we must now confront the pan and the ways in which it dictated the evolution of all cakes composed of batter. It would seem logical to presume that the *pan-* in "pancake" refers to Vulgar Latin *panna*, which is normally glossed as a shallow pan or vessel. But all things did not flow from Rome. Thus we might also look to words such as the Belgic and Treverian Gaulish *panna* (a likely source for the Vulgar Latin in any case) for a more basic explanation and a richer understanding of the batter cake.

The meaning of *panna* is well attested to by its survival in Westphalian German under the name *Pannas*, a festive pot pudding made during the butchering season that is solidified in a pan, then sliced and fried in little cakes. One of the original Belgic meanings of *panna* was a cauldron or kettle (in which the pudding was boiled), but more abstractly a cooking implement or ceramic form of varying depth. These alternative meanings survive in German as *Pfannkuchen* or *Pfannzelten* (south German), cakes that are hearth-baked in a kettle—a concept that survives in the form of the Dutch oven and colonial American spider corn cake.

The thinnest sorts of batter cakes are those most like the pancakes and crepes made from milk, flour, and egg and served today as breakfast foods. They evolved out of omelets to which flour, fat, and other ingredients were added in ever-increasing amounts. The next immediate stage would be cakes resembling the Italian *fritatta*, then soufflés (cakes that deflate), and finally batters that actually contain enough structural material to bake firm and retain their shape. Such pan-baked delicacies were known even in the early Middle Ages, for in his *De honesta voluptate et valetudine* (1465) Platina published a recipe for a Byzantine *artolaganos* (pan or layer cake) prepared with eggs, sugar, cheese, and finely ground millet. His recipe came from Milanese chef Martino di Rossi under the name *migliaccio* (millet cake), proof that delicate, batter-based cakes were already a feature of Italian court cookery by that time.

At this point, the pancake moves further along two separate lines of evolution. Since thickness and lightness were increasingly sought after, the pan itself became taller and taller to contain the new heights being achieved. More closely controlled results could be expected in an oven, so batter cake cookery was soon transferred to the bake oven. It is important to remember that Rossi's *migliaccio* was baked in a kettle down hearth, as most peasant variants of this type of cake continued to be baked well into the nineteenth century. However, cakes with heavy ingredients, like the *migliaccio*, soon evolved into delicate pound cakes once freed of the smoky, drafty atmosphere of the hearth, while batters with reduced fat and more beaten egg whites followed the *fritatta* to its ultimate conclusion in Savoy and sponge cakes. Denser batters were baked in pans—at first round, like hearth implements, then square; finally, during the late Renaissance we witness the cake evolving into the multitudes of shapes depicted in many French cookery books of the period.

The replacement of flour with highly refined commercial starches and the replacement of eggs with chemical leavenings allowed the development of lighter and lighter cakes during the nineteenth century. The angel food cake invented in the 1870s by Linus Dexter of Vineland, New Jersey, was the product of just such a technological shift. Likewise, American cooks began to stack one cake upon the other to create the thick layer cake, a response no doubt to a similar evolution in the wedding cake, which soared to great heights once freed of its old fruit cake foundation. The opposite may be said for chocolate cakes, which now vie for density and richness. They may have replaced the sinfully greasy baked pottages of the Middle Ages (although still dark in color), and they may be relegated to dessert carts in the scheme of many modern restaurants, yet fine cakes still command a place of high esteem by virtue of their sheer voluptuousness. They have become the alter ego of a society obsessed with the ills of overabundance.

See also **Bread; Pastry; Wedding Cakes.**

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William Woys Weaver

CALCIUM. Calcium (Ca^2) is a silver-white metallic element of the alkaline-earth group. Ninety-nine percent of calcium in the human body is in bone and teeth. The remaining one percent is in blood and body fluids. In addition to its role in maintaining strength of bone and teeth, calcium is involved in nerve cell function, control of muscle tone, and blood clot formation. Calcium is also necessary in order for many important proteins to properly perform critical metabolic functions throughout the body.

Functions

Cells. Calcium concentrations in the fluids outside cells are much larger than calcium concentrations inside cells (the cytosol). Unequal calcium concentrations in the extracellular fluid and cytosol are required for cells to carry out many crucial functions. For example, when a hormone in the blood binds to a receptor on the cell, calcium pours into the cytosol from extracellular fluid. This change in the amount of calcium in the cytosol signals the cell to perform some critical function. The critical function that is triggered depends on the type of cell. (In muscle cells, for example, a nerve signal triggers the release of calcium into the cytosol, allowing muscle contraction to occur.) After the critical function is performed, calcium is rapidly pumped out of the cell, and the calcium concentration in the cytosol returns to the normal (low) level.

Structural. In addition to cellular functions, calcium's more familiar role is a structural one—as a component of bones and teeth. Blood calcium levels are maintained strictly even if calcium has to be taken from bone. Bone mineral (hydroxyapatite) is made up primarily of calcium, phosphate, and carbonate. Bone constantly changes during growth and throughout adulthood. Changes in bone occur through balancing activities of bone-destroying cells (osteoclasts) and bone-forming cells (osteoblasts), which act together to remove and replace bone, respectively. During growth, bone formation generally exceeds destruction, yielding net bone-mass gain in the whole skeleton.

Bone-mass accumulation continues until peak bone mass is achieved, generally during the third decade of life. The age at which peak bone mass is reached varies by gender and differs by skeletal site. Males achieve peak bone mass later than females and gain more bone during puberty than females, resulting in larger bones. Although peak bone mass at all skeletal sites is generally reached by age thirty, bone accumulation is nearly complete by age twenty in the lumbar spine and in portions of the hip for both males and females. Genetic, environmental (for example, physical activity or mechanical "loading" of the skeleton), hormonal, and nutritional factors interact to influence peak bone-mass levels. Failure of an individual to reach the maximum peak bone mass permitted by his or her genetic makeup can be related to low calcium intake or a sedentary lifestyle without adequate physical activity. Parathyroid dysfunction, genetic or nutritional skeletal disorders, or medication use may affect peak bone-mass accumulation and overall bone health adversely. Smoking and excessive alcohol consumption also are likely to be detrimental to skeletal health.

After an individual reaches peak bone mass, net bone gain in the whole skeleton generally does not occur. Age-related bone loss occurs in both genders, but the rate of bone loss increases with estrogen loss at menopause in females. Age-related bone loss is caused by increased osteoclast (bone-destroying) activity compared to osteoblast (bone-building) activity. Physical activity during adulthood, combined with adequate overall nutrition and calcium intake, can help to maintain bone strength.

Metabolism

Absorption. Calcium absorption across the intestinal wall into the blood occurs by different mechanisms. Two major mechanisms include passive diffusion and active transport. Vitamin D is required for the active transport mechanism but not for the passive diffusion mechanism. The percent of calcium that is absorbed into blood generally decreases with higher calcium intakes; however, the total amount of calcium absorbed is usually greater with higher calcium intakes. The percent of calcium absorbed into blood is highest in infants, spikes again at the start of puberty, then gradually declines with age. The percent of calcium absorbed into blood also increases during the last two trimesters of pregnancy.

Homeostasis. The body keeps tight control (homeostasis) of blood calcium concentration by continuously changing various factors. When blood calcium concentration falls below normal, the parathyroid gland releases parathyroid hormone (PTH). PTH stimulates increased removal of phosphate into urine by the kidneys. This increased phosphate removal triggers the kidneys to keep calcium in the blood rather than excrete it in the urine. PTH also stimulates osteoclasts to remove calcium from bone in order to help restore normal blood calcium concentration. Finally, PTH is involved in making certain that enough vitamin D is present in the intestine to allow for increased calcium absorption from the gut into the blood. PTH decreases to normal once calcium homeostasis is reached. Another hormone, calcitonin, is responsible for stopping bone breakdown by osteoclasts when blood calcium concentration is above normal. Thus, the hormones PTH and calcitonin work together to keep blood calcium concentration within a very narrow range.

Dietary Requirements

Bioavailability. Both dairy products and most dietary supplements provide adequate amounts of calcium. Calcium is present in smaller amounts in grains, fruits, and vegetables. Because grains are eaten in high amounts, however, they are an important source of calcium. Other calcium-rich foods include bok choy (Chinese cabbage), kale, cabbage, and broccoli. Calcium from some foods containing high levels of oxalic acid (spinach, sweet potatoes, rhubarb, beans) or phytic acid (unleavened bread, nuts and grains, seeds, raw beans) is absorbed poorly due to formation of insoluble calcium salts. The ability to enhance dietary calcium intake by consuming calcium-fortified food sources is increasingly common.

Although high protein intake temporarily increases urinary calcium excretion, there is no evidence to indicate that calcium intake recommendations should be adjusted according to protein intake. Although caffeine has a slightly negative impact on calcium retention, the modest calcium loss can be offset by a similarly modest increase in calcium intake. High salt (sodium chloride) intake usually results in increased urinary calcium loss because excretion of sodium and calcium at the kidney are linked. High salt intake triggers increased urinary sodium loss and, therefore, increased urinary calcium excretion. However, as with protein and caffeine, there is no evidence to indicate that calcium intake recommendations should be adjusted according to salt intake.

Dietary requirements and bone mass. Because circulating calcium levels are so strictly controlled, blood calcium concentration is a poor indicator of calcium status. Chronic inadequate calcium intakes or poor intestinal absorption leads to reduced bone mass as PTH acts to maintain homeostatic blood calcium at the expense of skeletal strength. Bone mineral content (BMC) and bone mineral density (BMD) are common measures of bone strength and fracture risk. BMC is measured in grams, the amount of bone mineral at the selected site (for example, whole skeleton, lumbar spine, hip, forearm) and BMD (g/cm^2) are calculated as BMC divided by bone area in the region of interest. An adult is defined as osteoporotic by the World Health Organization if his or her BMD is more than 2.5 standard deviations below gender-specific normal young adult BMD. Osteoporosis and related spine, hip, and wrist fractures are major public health concerns.

Recommended daily calcium intakes (measured in milligrams) increase from infancy through adolescence. The rate of calcium accretion relative to body size is greatest during infancy. Infants accrete approximately 140 mg of calcium per day during the first year of life. This need for calcium during the first year of life is reflected in the amount of milk consumed by human milk-fed infants. Although evidence indicates that feeding of formula results in greater bone mineral accretion than human milk feeding during the first year of life, there is no indication that this effect is beneficial either short- or long-term.

Calcium accretion continues in childhood, and maximal accretion occurs during puberty. Children of ages one to eight years accrete 60 to 200 mg of calcium per day. Peak calcium accretion occurs during puberty for both males (mean age 14.5 years) and females (mean age 12 years). Accordingly, calcium intake requirements are highest during adolescence.

Calcium retention and bone turnover decline after menarche in females, but the amount of calcium women need does not change because the percentage of calcium absorbed into the blood decreases. In males, bone mineral accretion occurs until mean age 17.5 years. Evidence from clinical trials indicates that calcium supplementation in children can increase BMD, but the effect occurs primarily among populations who usually have low calcium intake, is not apparent at all skeletal sites, and probably does not persist when supplementation is stopped. Apparently the benefit is short-term only.

Dietary calcium requirements decline for both males and females once adulthood is reached and remain constant throughout the reproductive years. Intestinal calcium absorption, however, also decreases with age. At the end of the reproductive years (approximately age fifty), bone-mass loss occurs in both males and females. Bone-mass loss is particularly pronounced in females during the first few years following menopause. The bone loss that occurs with the loss of estrogen at menopause cannot be reversed simply through increased calcium intake. Reductions in age-related bone loss through calcium supplementation have been demonstrated in postmenopausal women, but the effects vary by skeletal site, usual calcium intake, and postmenopausal age. Because of the reduction in intestinal calcium absorption with age in all individuals and the potential of increased calcium intake to offset bone loss due to estrogen depletion, increasing the amount of calcium in one's diet is recommended for all individuals over fifty years of age.

Maternal calcium requirements increase during the third trimester of pregnancy in accordance with fetal growth needs and to prepare for lactation, and the mother's intestinal calcium absorption efficiency increases in order to meet her increased need for calcium. If this need for more calcium is not met, the mother's skeleton will be depleted to meet the calcium demands of the fetus. Furthermore, calcium loss from the mother's skeleton occurs during lactation and cannot be prevented by calcium supplementation. However, evidence indicates that maternal bone density is recovered to prelactation levels within approximately six months after the recurrence of menses.

Toxicity. Calcium toxicity is uncommon but can occur if too much calcium is taken in through dietary supplements. In susceptible individuals, excess calcium intake can lead to the formation of kidney stones (renal calcium deposits); however, dietary calcium is not a common cause of kidney stones. Hypercalcemia from ingestion of large quantities of calcium supplements is rare but the resulting kidney problems and ramifications to cell function affect major tissues and organs. In the United States, the maximum daily calcium intake judged likely to pose no adverse health effects—Tolerable Upper Intake Level (UL)—is set at 2,500 mg per day for all ages beyond one year of age. There are insufficient data to determine a UL for calcium for infants less than one year of age.

Summary. Changes in dietary calcium requirements throughout the lifespan reflect concurrent alterations in growth rate, intestinal absorption efficiency, and reproductive and estrogen status. Because calcium plays vital roles in critical cell responses, plasma calcium levels are strictly homeostatically controlled at the expense of skeletal integrity, if necessary. Homeostatic control of circulating calcium involves PTH, vitamin D, and calcitonin.

Appropriate lifestyle choices (for example, physical activity) and adequate calcium nutrition promote optimal bone-mass accretion during growth and young adulthood, possibly resulting in reduced current and future fracture risk. Dairy products and dietary supplements provide similarly adequate amounts of calcium to the body. Grains, fruits, and vegetables contain smaller amounts of calcium, and calcium absorption from foods high in oxalic acid or phytic acid is limited. Calcium-enriched products such as bread and fruit juice are becoming increasingly important sources of dietary calcium.

See also **Dairy Products; Lactation; Milk, Human; Nutrition; Phosphorus and Calcium; Trace Elements.**

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CALIFORNIA. *See* United States.

CALORIC INTAKE.

The calorie is a unit of heat energy required to raise the temperature of 1 gram (1 milliliter) of water 1°C from 14.5° to 15.5°C. The calorie is a very small unit; and although it is used colloquially, the energy measured is 1,000 gram calories or kilocalories (kcal). Another unit of energy is the joule: 1 kcal = 4.184 kJ. Calories are used as a unit to measure the energy in food as well as the energy produced, stored, and utilized by living organisms.

Calories in Food

Foods are comprised of carbohydrates, fats, proteins, vitamins, minerals, and water. The energy-yielding nutrients

TABLE 1

Caloric content of common foods

Food	Serving size	Weight (grams)	Calories
Beer	12 fl. oz.	356	146
Cheddar cheese	1 oz.	28	114
Margarine	1 Tbsp.	14	50
Apple	$2\frac{3}{4}$ in. diameter	138	80
White bread	1 slice	25	65
Doughnut, cake plain	$3\frac{1}{4}$ in. diameter	50	210
Rice, white	1 cup cooked	205	264
Beef patty	3 in. X $\frac{5}{8}$ in., 21 percent fat	85	236
Chicken breast, fried	1 piece batter dipped	140	364
Broccoli	1 cup cooked	180	50
Corn	On cob, 5 in. long	77	83

are carbohydrates, fats, and proteins. When foods are oxidized or burned, they yield approximately 4.0 calories/gram for proteins and carbohydrates and 9.0 calories/gram for fats. Most foods contain mixtures of the three macronutrients but are classified by the predominant nutrient. For example, protein-riched foods such as beef also contain fat. Table 1 presents a sample of ten common foods, their weights, serving sizes, and calories. Daily caloric consumption is assessed in a number of ways: 24-hour dietary recalls, food intake diaries, weighing food before it is eaten, and using food labels on packaged foods.

In the early to mid-1990s, world food supply estimates of available calories per person per day ranged from 2,099 kcal in sub-Saharan African countries to 3,600 kcal in North America with averages of 2,573 kcal for developing countries and 3,356 kcal for industrialized countries. The percentages of calories are estimated to be 70.4 and 52.3 from carbohydrate, 19.6 and 35.4 from fat, and 10.0 and 12.3 from protein for developing and industrialized countries, respectively.

The energy requirements for humans are established by national and international organizations (for example, World Health Organization). The Recommended Dietary Allowances (RDAs), or more recently, the Dietary Reference Intakes (DRIs) are shown in Table 2. These caloric recommendations are based on the average needs for an individual based on age and sex with additional allowances for pregnancy and lactation. Restricted intakes lead to growth faltering in weight and height; and conversely, a surfeit of calories leads to excess energy stores and obesity. For example, a short and thin, preadolescent child with a slow rate of growth along the fifth percentile requires about 17 percent less dietary energy than a child following the average growth trajectory at the fiftieth percentile.

Energy Expenditure

Caloric needs are based on energetic demands related to body size and activity. Overall caloric demands per kilogram of body weight are extremely high from conception through infancy, and decrease thereafter. Total Daily Energy Expenditure (TDEE) is a combination of the Basal Metabolic Rate (BMR) sometimes called the Resting Metabolic Rate (RMR) and Physical Activity Level (PAL). The BMR is the minimum energy expenditure for maintenance of respiration, circulation, body temperature, and other vegetative functions. It is based on body size, growth, reproduction, diurnal hormonal variation, other physiological conditions, and thermoregulation related to environmental temperature. The BMR accounts for approximately two-thirds of the TDEE. In addition, about 10 percent of energy intake is expended in dietary thermogenesis or the energy costs of processing food.

Metabolic rate can be obtained by direct calorimetry that measures the total quantity of heat liberated from the body in a specially constructed chamber. With direct calorimetry, a young male with an average American diet generates 4.82 calories for every liter of oxygen consumed. Because direct measurements involve expensive equipment in a laboratory setting, most of the calculations for caloric needs are done with indirect calorimetry. Indirect calorimetry uses the differences in the concentrations of inhaled and exhaled oxygen to estimate energy use. The law of conservation of energy states that there must be a balance between all forms of energy expended or absorbed.

Reference equations are used most frequently to estimate energy needs and expenditures. Sets of reference

TABLE 2

Recommended dietary allowances for energy

Age (year)	Energy (kcal)
Infants	
0.0–0.5	650
0.5–1.6	850
Children	
1–3	1,300
4–6	1,800
7–10	2,000
Males	
11–14	2,500
15–18	3,000
19–24	2,900
25–50	2,900
51+	2,300
Females	
11–14	2,200
15–18	2,200
19–24	2,200
25–50	2,200
51+	1,900
Pregnant	+300
Lactating	
1st 6 mo.	+500
2nd 6 mo.	+500

equations for BMR and standard energy expenditures for activities or PAL are routinely used in assessing an individual's TDEE. For adults, PAL ranges from 1.4 to 2.10 for light to very heavy work. For example, daily energy expenditure for a 120-pound (54.4-kg) woman who has a sedentary office job would be approximately:

$$\text{BMR} = 14.7(54.4) + 496 = 1{,}296 \text{ kcal}$$
$$\text{TDEE} = \text{PAL} \times \text{BMR} = 1.56 \times 1{,}296 = 2{,}022 \text{ kcal.}$$

Body weight is a key variable in energy expenditure. Walking at 3.5 miles/hour expends 0.035 kcal/min which would be 3.9, 5.2, and 7.0 kcal/min for individuals weighing 110, 150, and 200 pounds, respectively.

Individual differences in metabolic mechanisms are not well understood. Remarkably, for most adults, the sensitivity of the energy balance system for change is less than one percent per year. The "average" American adult male contains 140,000 kilocalories of energy in body fat, 24,000 kilocalories in protein, and only about 800 kilocalories in carbohydrate. Consequently, an individual consuming 2,000 kilocalories per day of which 40 percent is carbohydrate will ingest an amount of carbohydrate comparable to body stores, protein intake will average only about one percent, and fat intake will be considerably less than one percent of total body stores.

Weight Control and Energy Balance

Caloric intake and expenditure are factors in the growing worldwide epidemic of obesity. It is estimated that in the United States, 35 percent of adults eighteen years of age and older are overweight or obese based on weight for height standards. The rising prevalence of obesity is due to an increase in intake of calorically dense foods and a decrease of energy expenditure with modernization, including increases in transportation, decreases in subsistence activities, increases in thermally regulated environments, and decreases in energy demands due to chronic illness. Weight reduction hinges on reducing caloric intake while maintaining micronutrient balance and fiber and water intake. Traditionally, recommended diets were labeled by their caloric content, such as the "1,200 calorie diet." Some diets have focused on the reduction of fat because each gram of fat is twice as calorically dense as a gram of carbohydrate or protein. Interventions also emphasize increased voluntary energy expenditure through daily routines such as walking or formal exercise programs. Pharmacological interventions directly influence energy balance by increasing BMR, decreasing absorption of fat calories, or decreasing transit time through the gut, and indirectly by altering hunger and satiety.

Low-energy intake compromises growth in vital tissues, lowers basal metabolic rate, and reduces work capacity relative to individuals with sufficient energy intake. People develop behavioral strategies to reduce muscular activity to conserve energy. For undernourished populations, interventions target increasing caloric intakes and reducing macro- and micronutrient deficiencies.

Finally, energy in kilocalories or joules has been used for measuring the flow of energy through ecological systems. Energy flow analyses measure time and task allocations in various subsistence activities as well as the biological characteristics of human and nonhuman populations in an ecosystem.

See also **Assessment of Nutritional Status; Composition of Food; Dietary System: A Historical Perspective; Eating: Anatomy and Physiology of Eating; Nutrient Requirements; Nutrition; Obesity; Physical Activity and Nutrition.**

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CALORIE. The calorie is a unit for measuring heat energy, and it is usually used as the unit for food energy and of energy expenditure. Media and lay attention to food, exercise, and health, as well as the greater prevalence of obesity during the past few decades, has resulted in a cultural preoccupation with caloric intake and expenditure in industrialized nations. Heat is that which produces a change in temperature. Heat was formerly regarded as a substance called "caloric," but it came to be viewed as the random motion of molecules.

The calorie has traditionally been defined as the amount of heat required to raise the temperature of 1 gram of water by 1.8°F (1.0°C), usually defined as from 58.1°F to 59.9°F (14.5°C to 15.5°C), under normal atmospheric conditions. Because electrical measurements can be standardized more accurately than heat measurements, a calorie is officially defined as equivalent to 4.186 joule. A joule is defined, in "force × distance" units, as 1 Newton meter, which is equal to (1 kg m/s^2) × (1m) or 1 kg m^2/s^2. Energy values are expressed as joules when the Système International d'Unités, which is recommended for all scientific purposes, is required.

Food energy values and energy expenditures are commonly expressed as the number of kilocalories (kcal). One kcal is equal to 1000 calories or 4.186 kJ or 0.004186 MJ. Although the terms "calorie" and "large calorie" have frequently been used in place of kilocalorie in the nutrition literature and for food labeling purposes, these alternative terms are confusing, and their use is discouraged.

Measurement of Energy Values of Foods

The energy in foods is present as chemical energy; it can be measured by the heat evolved when the food is oxidized or combusted. Although energy transformations normally involve friction and heat conduction, which cause the changes of one form of energy to another to be incomplete, various forms of energy normally can be converted completely to heat. The caloric value of a food may be determined by burning weighed samples of the food in an oxygen atmosphere in an apparatus called a calorimeter, which is designed to allow measurement of the heat released by combustion of the fuel or food. The total amount of heat produced or consumed when a chemical system changes from an initial state to a final state is independent of the way this change is brought about (the law of Hess or the law of constant heat sums). Thus the complete oxidation of a compound, such as glucose, to CO_2 and H_2O produces the same amount of heat whether the process is carried out in a calorimeter or by metabolism within the body.

Heats of combustion are not accurate reflections of the amount of energy available to the body, however, because the body does not completely absorb and metabolize ingested nutrients. The energy lost in the excreta (feces and urine) must be subtracted from the total energy value of the food to obtain the amount of energy available to the body from consumption of the food. The caloric values of foods reported in food composition tables are "physiological fuel values," also referred to as "available energy" or "metabolizable energy" values. They are not total energy values.

Physiological Fuel Values of Foods

The physiological fuel value of a food or a food component may be determined by measuring the heat of combustion of the food in a calorimeter and then multiplying the heat of combustion by correction factors for incomplete digestion and incomplete oxidation of the food in the body. In about 1900, Wilbur Olin Atwater and his associates at the Connecticut (Storrs) Agriculture Experiment Station used this approach to determine the physiological fuel values of a number of food components (i.e., the protein, fat, and carbohydrate isolated from various foods). They determined factors appropriate for individual foods or groups of foods, and they proposed the general physiological fuel equivalents of 4.0, 8.9, and 4.0 kcal per gram of dietary protein, fat, and carbohydrate respectively for application to the mixed American diet. These factors are commonly rounded to 4, 9, and 4 kcal per gram (17, 36, and 17 kJ per gram) respectively for protein, fat, and carbohydrate. The conversion factors determined by Atwater and his associates remain in use in the twenty-first century, and energy values of foods are calculated using these factors. The energy values (physiological fuel values) reported in food composition tables are commonly estimated by determination of the proximate composition of each food (i.e., the water, protein, fat, carbohydrate, and ash contents) followed by multiplication of the amount of each energy-yielding component by the appropriate conversion factor.

See also **Caloric Intake**; **Dietary Assessment**; **Nutrition.**

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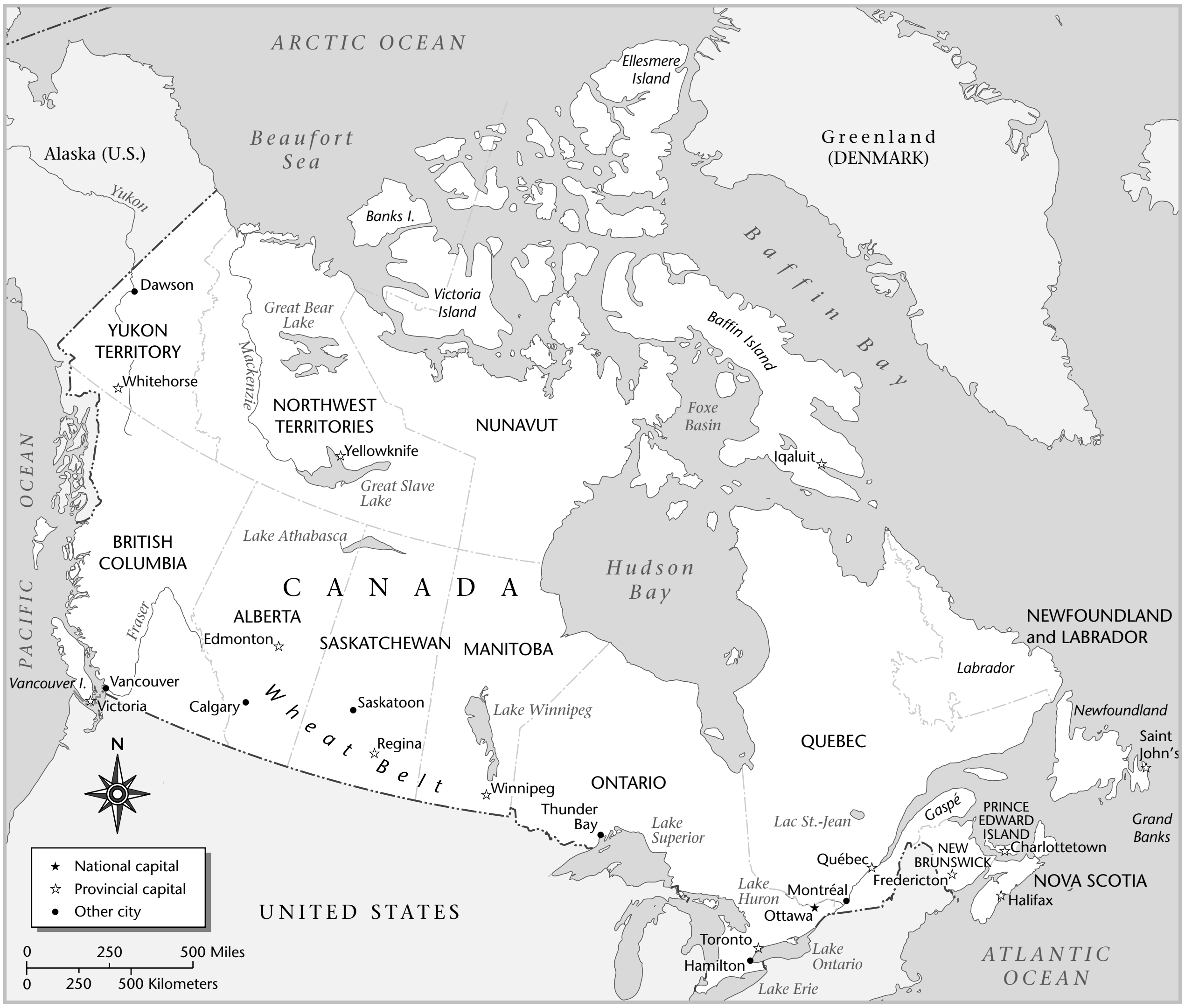
CANADA. Canada is a vast country touched by three oceans, and it holds within its boundaries prairies, hills, mountains, semidesert and desert country, rocky thin-soiled lands, a multitude of lakes, enormous forests, and Arctic tundra. While the terrain varies greatly, there is a commonality across Canada, and that is the severity of winter. Few European immigrants in Canada's early history were prepared for the cold, and from the beginning, Canadians struggled with the elements for their survival. This was a defining factor in the development of Canadian cuisine. But it is the people of Canada who, more than the land and weather, created Canada's cookery. From the First Nations people to the waves of immigrants from every country in the world, Canada's cuisine became distinctly regional.

Diversity has been a characteristic of Canadian cuisine from the beginning of settlement. In the seventeenth century, the first Europeans in Canada encountered a highly varied population of Native Peoples, for example, hunters and gatherers including the Inuit in the Arctic; agricultural people in parts of southern Quebec and Ontario; buffalo hunters on the plains; and fishermen on the West Coast among the nearly sedentary Pacific North Coastal people.

By the end of the eighteenth century, the dominant groups in Canada were British (particularly English and Scots), French, and American Loyalists. The cuisine that


ARCTIC OCEAN
Ellesmere Island
Beaufort Sea
Greenland (DENMARK)
Alaska (U.S.)
Yukon
Banks I.
Baffin Bay
Dawson
Victoria Island
Great Bear Lake
Baffin Island
YUKON TERRITORY
Mackenzie
Whitehorse
NORTHWEST TERRITORIES
NUNAVUT
Foxe Basin
Yellowknife
Iqaluit
PACIFIC OCEAN
Great Slave Lake
Lake Athabasca
BRITISH COLUMBIA
Hudson Bay
C A N A D A
ALBERTA
Fraser
Edmonton
SASKATCHEWAN
MANITOBA
NEWFOUNDLAND and LABRADOR
Labrador
Vancouver I.
Vancouver
Victoria
Calgary
Wheat Belt
Saskatoon
Lake Winnipeg
Newfoundland
N
Regina
QUEBEC
Saint John's
Winnipeg
ONTARIO
Thunder Bay
Lake Superior
Lac St.-Jean
Gaspé
PRINCE EDWARD ISLAND
Grand Banks
Charlottetown
NEW BRUNSWICK
Québec
Fredericton
NOVA SCOTIA
Lake Huron
Montréal
Ottawa
Halifax
★ National capital
☆ Provincial capital
● Other city
UNITED STATES
Toronto
Lake Ontario
ATLANTIC OCEAN
Hamilton
Lake Erie
0 250 500 Miles
0 250 500 Kilometers

developed during the nineteenth and first half of the twentieth century reflected these influences. There were strong overtones of French cookery in Quebec, British influences in English-speaking Canada, and a strong import of culinary culture from the United States. While there were many ethnic groups in Canada by the end of World War II, British-American cookery dominated Canadian cookery. A partial exception to this generalization was the Chinese influence. Peasants from southern China immigrated to "Golden Mountain" (Canada or, more specifically, British Columbia) beginning in the 1850s. Many were employed in construction and the building of the railroad. As with other cultural groups, they were discriminated against, but they introduced Canadians to Chinese cuisine by opening Chinese restaurants in nearly every village and city across Canada.

In spite of the cultural dominance of English-speaking Canadians, other ethnic immigrant groups often settled in regional pockets where they maintained their language and their culinary traditions. Coming from different regions in their home countries, they melded traditions together. For example, in the Ukraine, women made *pysanky* (eggs decorated with ritualistic symbols) according to their local traditions, but in Canada, they drew designs from many regions of Ukraine. Northern and Southern Italian foods such as pasta and polenta, likewise, were simply "Italian" in Canada.

Until after World War II, ethnic foods were rarely written about in Canadian food magazines or cookbooks, and ethnic recipes were highly modified. In a 1920s community cookbook, for example, a chop suey recipe was a mixture of fried hamburger, rice, tomatoes, and onions, baked for an hour; and spaghetti was cooked meat, spaghetti, onion, butter, green pepper, and canned tomato soup, baked with buttered bread crumbs; both were seasoned only with salt and pepper. In the 1970s the milieu changed when, under the leadership of Pierre Trudeau, Canada adopted a policy of multiculturalism. It then became the fashion to share ethnicity, and the easiest way was through cookery. The foods that ethnic

Like the United States, Canada is home to many ethnic communities. These Greek Canadians are preparing traditional Easter pastries in Vancouver, British Columbia. © ANNIE GRIFFITHS BELT/CORBIS.

groups had eaten in the privacy of their homes became de rigueur.

After World War II, fast-food eateries and chain restaurants serving inexpensive, mass-produced foods swept across North America. Franchises on the U.S. model were adopted and Canadians quickly developed their own fast food restaurants for hamburgers, fried chicken, and pizza. A favorite fast-food chain is Tim Horton Donuts, a coffee and donut shop. Popular Canadian restaurant chains that developed were "road houses" serving grilled foods and pasta. The Americanization of Canadian foods and foodways was influenced also by food articles in American magazines and by television food shows.

Canadian cuisine is strongly regional in character with American influences. The eating pattern of three meals a day, the popularity of many foods, the importation of fresh produce and manufactured foods, and the eating of particular foods at the feasts of Thanksgiving, Christmas, and Easter are common denominators of the cuisine of both the United States and Canada. The real difference is the highly visible regional cuisines of Canada, based on the available ingredients and the ethnic groups who settled in these regions. Canadian cuisine cannot be understood without examining these regional traditions.

Newfoundland: A Survival Cuisine

From the early sixteenth century, the huge and lucrative cod fisheries on the coasts surrounding this island province and the Grand Banks offshore attracted fishing vessels manned by Basque, Portuguese, French, and British sailors. Before settlement, these groups salted cod in summer fish-drying camps, and then dried it on "flakes." A product that could keep indefinitely, salt cod was eaten in Europe for centuries. Eventually the English settled in the north and west, followed by the Irish, in St. John's and the east coast, and French along the south shore. Newfoundland's environment is harsh and demanding with deceivingly warm but short summers. The cuisine that developed was simple and entrenched.

Only a few ingredients are needed to make rib-sticking, hearty, and soul-satisfying meals. Fish (cod) and root vegetables form the basis of the Newfoundlanders' diet. There is little agriculture on the island, but root vegetables can be grown there, and tiny vegetable garden plots are often found along the roadside on the western coast. Potatoes, carrots, onions, turnips, parsnips, and cabbage are mainstays.

In 1992 the cod stocks crashed on the Grand Banks, and a moratorium was placed on commercial fishing in Canadian waters on the Banks. Although a way of life for Newfoundlanders seemed to have been lost, cod remains their favorite food. While the major cod fisheries are still closed, some fish is available on the southern coast, and local inhabitants are allowed to "jig" for cod two weekends a year. When a Newfoundlander says the word "fish," he or she means "cod," which, over the centuries, has been the preferred dish. A fresh cod dinner is Newfoundland comfort food. A thick piece of cod, usually grilled or poached, is served with mashed potatoes, mixed peas and carrots, coleslaw and fluffy white rolls. Delicacies are cod tongues and cheeks, either sautéed or deep-fried. Salt cod is prepared most commonly as fish 'n' brewis (also called "fisherman's brewis"). The salted fish is soaked, shredded, and cooked with dried bread chunks (hardtack) until thick, and schruncheons (fried diced salt pork) with its fat is poured over the mixture.

Pea soup (a thick potage of yellow split peas with diced turnips, carrots, and potatoes) can be traced back to the daily fare of sixteenth-century fishermen—with salt beef added on Sundays. Split peas are also used to make pease pudding by dropping a pudding bag of peas into Jigg's dinner, a boiled dinner of salt beef, onions, potatoes, carrots, and turnips.

To supplement and vary the fish and salt-beef diet, many men hunt partridge, ptarmigan, rabbits, turr (a seabird), moose, caribou, and deer. Moose is preferred only because it will fill the hunter's freezer—and his neighbors'—and last through the winter. A traditional wild-game dish is flipper pie made from seal flippers, carefully prepared and cooked in a pastry. The wilds also provide berries in abundance, eaten fresh and preserved for the long winter, either frozen for pies and other desserts or made into jams. Favorites are blueberries, strawberries, blackberries, raspberries, partridgeberries (lignonberries), and yellow baking apples (cloud berries).

More than anything else, Newfoundlanders are known for fun: parties, Newfoundland fiddling, and rum. Screech, a dark rum, was named because American servicemen during World War II found it made them "screech." Those "from away" may undergo a Newfoundland initiation by tossing back Screech and reciting an intonation, always with good humor, and sometimes accompanied by kissing a cod.

The Maritime Provinces: An Entrenched Cuisine

The cuisine of the Maritime provinces of Nova Scotia, New Brunswick, and Prince Edward Island (P.E.I.) is a bittersweet one—bitter because so many people were dislocated, either within the Maritimes or because they had to leave their homelands, sweet because the Maritime cuisine was a result. Early migration into the Atlantic provinces generally took place of necessity. Power struggles between France and England led to the forced displacement of the French Acadians in 1755, and American planters took over their rich farmlands. Scattered to many countries, some Acadians returned after 1763, not to their rich farmlands but to less desirable land, or they turned to fishing. Settling in parts of New Brunswick, Nova Scotia, and Quebec, they developed a distinct cuisine in each area: buckwheat pancakes, *poutine râpée* (dumpling stuffed with salt pork), *râpure* (grated potato and chicken or seafood pie), *fricots* (stews), rabbit pies, and many other traditional dishes.

Later in the century, in 1783, United Empire Loyalists, scorned in the United States, made their way into the Maritimes. These American Loyalists brought New England food traditions, popularizing corn in many forms (corn-on-the-cob, johnnycakes, corn puddings, and Anadama or Yankee bread), and the Saturday night custom of baked beans and brown bread. Freed African loyalists and others of African descent also came north. Blacks settling in the Shelburne area brought Southern American cooking: deep-fat frying, barbecued meat, the use of corn meal and hominy, pork, rice, and fish. Germans left for Lunenberg, Nova Scotia, in 1753 and contributed Solomon Gundy (pickled herring), soused eels, and sauerkraut. Scots in Cape Breton brought oat cakes and porridge bread. These early settlers created distinct regional cuisines. But the one traditional meal common to the Maritimes is Dutch mess, also called hugger-in-buff, fish and schrunchions, or house bankin, depending upon where one lives. Salt cod is soaked, then cooked; potatoes are boiled in the fish broth; salt pork and onions are fried, vinegar and cream added and poured over the cod and potatoes. The next day, leftovers are mashed and made into fish cakes.

The abundant fish and shellfish were the key ingredients defining early Maritime cuisine, and they continue to do so today. These seafoods, along with root vegetables, dried peas, cabbage, and trade goods from Britain formed the basic components used in early eastern Canadian cookery. Early English colonists were dependent upon Great Britain for food, and these supplies grew into a thriving trade of tea, sugar, spices (ginger was a favorite), and dried fruits. The triangular trade between England, New England, and the Caribbean brought molasses, rum, and ginger from the Caribbean. Halifax, the early center of British social life, retains a distinct English character. Gaily signed pubs serve meat pies and fish and chips. British dishes linger—roast beef with Yorkshire pudding, trifle, and gingerbread.

The Order of Good Cheer

The small band of French explorers at Port Royal, Nova Scotia, anticipated the winter of 1606 with dread. The previous winter many of their men had died from a mysterious "land-sickness." The illness was thought to be caused by ill-temper, idleness, and discontent. Samuel de Champlain, a member of the band, founded *L'ordre de bon temps* (the Order of Good Cheer) to prevent the illness. The object of the society was to go hunting and fishing for wild game and seafood that could be served up in a series of feasts held throughout the winter.

The feasting was met with great enthusiasm by Chief Henri Membertou and his Mi'kmaq followers, who joined the hunting forays and were invited to the grand dinners. It was the custom of the Mi'kmaq to share their food with whoever was in the vicinity, and the French reciprocated this generosity. The variety of raw ingredients for their meals was extensive—venison, moose, beaver, ducks and geese, salmon and trout caught through the ice, scallops, cockles, sea urchin, crabs, and lobster. In addition to these foods, there was plenty of wine and provisions from France.

Although we do not know the dishes prepared for the feasts, the gentlemen in the group were accustomed to sophisticated food. Champlain had been a visitor to the court of Henry IV; one of the men wrote in his diary that their food was as good as roastmeats from the cook shops of Paris. As well, Champlain kept stocked fish ponds near the Habitation.

The Order did help to fend off the illness (scurvy) during the winter. More than anything else, however, the lasting benefit of the dinners was an enduring friendship between the Mi'kmaq and the French. As others have found, the dining table is much better than a negotiating table for mediating conflicts between cultures. The spirit of the Order of Good Cheer is a culinary legacy to Canadians.

Each Maritime province has vast coastal areas, and cod is common to all. Products of the sea vary somewhat in each province. Prince Edward Island is associated with lobster fisheries, aqua-cultured blue mussels, Malpeque oysters, and Irish moss. Nova Scotia is known for Digby scallops and dulse (a reddish seaweed). New Brunswick

Poor Man's Fare

Pâté à la râpure (or rappie pie, the English name) is a traditional Acadian dish with its roots in the frugality of French women. After the British victory in Nova Scotia in the late eighteenth century, some families who had been expelled from the fertile Annapolis Valley returned, but to fishing or to farming marginal land. Times were extremely hard, but they were able to cultivate potatoes—and the men liked their white shirts starched. The women made starch by grating potatoes, squeezing out the starch, and boiling the white shirts in the extract. Since they couldn't waste the potato gratings, they put them into a pan with lobster or fish and baked this mixture. The result, distinctly different from sliced and baked potatoes, was a gelatinous, translucent mixture flavored with seafood, called *râpure.* Today the tradition continues and, although they still squeeze out the starch to give *râpure* its distinct character, the starch is seldom used for stiffening white shirts.

fishes for Fundy salmon, smelt, trout, and shad. Samphire greens (eaten locally) are harvested from the shores of each of these provinces. In countryside Nova Scotia, roadside "canteens," one-room buildings, sell some of the region's best seafood: lobster or clam rolls, fried scallops, or fried fish—all seafoods cooked fresh from the sea.

The harvest from the land is also regional. Nova Scotia is known for its Annapolis Valley apple orchards, New Brunswick for its maple syrup and wild chanterelles, and P.E.I. for its potatoes. New Brunswick fiddleheads from the Ostrich fern are a gourmet delicacy picked in early spring before the fronds open, and are cooked as a vegetable.

By the early 1800s, established food traditions had become associated with a way of life, and to a great extent, have remained impervious to change. Even the large migrations of ethnic groups after World War II were insufficient to displace these three-hundred-year-old culinary traditions.

Quebec: A Distinct Cuisine

Quebecois consider themselves a distinct society, and this is reflected in their cuisine. Restaurant menus are written in French, and the cuisine is distinctly French, but with a difference: most of all, the love of—even obsession with—good food and its celebration, the use of flavorful sauces, the elaboration of courses, the use of fresh ingredients, and the respect for their chefs. The first European settlers in Canada in the early seventeenth century were French. They maintained close ties with their mother country until after the English conquest in the mid-eighteenth century. At that time, communication with France was cut off.

Thus, many traditional Quebec dishes resemble those prepared in medieval and early Renaissance France. Well-known favorites across Quebec are *cretons* (a rich pork pâté), *tourtière* (meat pie), *ragoût de pattes et de boulettes* (pigs' feet and meatball stew), *les cipaille* or *cipâte* (baked casserole made by layering pastry with meat, poultry, and/or seafood), and *galettes de sarrasin* (buckwheat pancakes). A hearty fare, originally cooked for fishermen, farmers, and loggers, they are today reserved for family gatherings and holidays.

The abundance of wild game and the land available to provide forage for it probably influenced Quebec's cuisine more than any other factor. This provided ordinary settlers with meat and gave them an equality with royalty unknown to the seventeenth-century French peasant. Indeed, in France at that time, food was frequently scarce. It is not surprising that the Quebecois' diet was rich in meat, poultry, and fish and that regional dishes were made with these ingredients.

Although maintaining their French heritage, the Quebecois incorporated ingredients and dishes from other cultures. From the beginning, the French had close ties with aboriginal peoples whose culture dictated that they share game and fish with their friends. The Native Peoples showed them the edible wild flora and fauna, and the French were quick to incorporate wild game, berries, and maple sugar into their diet. It should be noted that corn, beans, and squash had already been introduced into France before Quebec was colonized, and potatoes are thought to have been introduced by the British. American Loyalists and British immigrants after 1755 also influenced Quebec cookery; the French especially liked sweet British desserts, many of them made with molasses. Cultural influences continue today as with the Middle Eastern innovation *mechoui*, a popular party at which a whole animal is barbecued, usually wild game like buffalo or wild boar. Quebec cities, like other Canadian centers, have a multicultural character. This is especially true of Montreal, where there are more French-speaking immigrants than in other major Canadian cities: Haitians, Lebanese, and Vietnamese have all influenced Quebec's cookery, particularly in their family-owned restaurants and their ingredients in small grocery stores. Moreover, Montreal's population contains a mix of people speaking a multitude of languages who have contributed their foodways to the cultural mix of this city.

Quebec's cuisine is a highly regional one. The Institut de Tourisme et d'Hôtellerie du Québec has identified at least seventeen gastronomical regions within the province and has searched out more than 30,000 regional recipes. In the Gaspé, for instance, salt is used liberally and salmon layered with pastry is their version of *cipâte*. People from the Lac Saint-Jean area are called "*les Bluets*" (blueberries), and these berries are made into *grandpères* (dumplings cooked in blueberry sauce) or a blueberry *cipaille*. Gourgane beans brought from Europe are unique to this area and are often made into *soupe aux gourganes*, a filling bean, barley, and vegetable potage.

Today, young Quebec-trained chefs search out local ingredients, experiment with them, and to some extent are turning to France for inspiration. Artisanal breads, soft cheeses, goat cheeses, Normandy-style apple cider, local wines, organically grown vegetables, white asparagus, fresh herbs (especially summer savory), wild mushrooms, rabbits, caribou, and wild game birds are some of the ingredients finding their way onto the Quebec table. The Quebec diet is changing but the accent remains distinctly French Quebec.

Ontario: A Dynamic Cuisine

The French and then the British and, shortly thereafter, American Loyalist immigrants had close contact with members of the Iroquoian tribes. From these original farming inhabitants, the immigrants learned how to plant corn, beans, squash, Jerusalem artichokes, and sunflowers, and to tap the maple trees for their sweet sugar. In the early days of settlement, wild game and fresh fish from the streams and the many lakes in Ontario were plentiful. The French left little impact upon Ontario's cuisine, but the English foodways became dominant: their style of eating and especially their love of sweets, roasted beef and pork, cooked root vegetables, white bread, and tea. One of the first tasks the settlers had was to build grist mills to grind wheat for their cakes and breads. They found the farmland in southern Ontario to be fertile, and most of the crops from their homelands flourished. Dairy herds were established, which led in the nineteenth century to a significant trade in cheddar cheese with England and the popularity of this cheese in Ontario.

There were two influential groups who came north with the Loyalists at the end of the eighteenth century. The Iroquois under the leadership of Joseph Brant settled near Brandford to form the Six Nations. An agricultural people, they grew the "Three Sisters"—corn, beans, and squash—and reinforced the growth and use of these crops in Ontario. The other group was the Pennsylvania German Mennonites who took up farming in the Waterloo area. When the Ontario Mennonites chose their food preparations from the Pennsylvania German recipe repertoire, a difference appeared. While the recipes they loved best were still distinctly Mennonite, the choices of foods changed. In Ontario, they are known for summer sausages, *Nusschinken* (cool-smoked ham), smoked pork chops, *Koch Käse* (a runny cooked whey cheese flavored with caraway seed, smeared on bread with apple butter), shoofly pie made with maple syrup, Dutch apple pie, doughnuts, and mint tea.

Cabin au sucre

Where the sugar maples grow in Quebec, there will be "sugar shacks." From the beginning of settlement, colonists tapped the clear maple sap to produce sugar for the year's use as a sweetener. "Spiles," originally wooden tubes with sharpened ends and now metal tubes with hooks for buckets or tubing, were placed in holes drilled into the sugar maple trees. When the nights were cold and days warm, the sap flowed. In the old days, horses hauled tubs of the clear liquid to a covered shed where the sap was boiled down day and night. It took thirty to forty buckets of sap to produce one bucket of golden maple syrup. Men and boys stayed for weeks in the bush tending the fires and watching the syrup so that it would not burn. Today, when one drives through Quebec in the early spring before the snow melts, buckets adorning maple trees and smoke billowing from the bush are a common sight. From this, today's *cabin au sucre,* or sugar shack, has become a Quebec feature that anyone can enjoy. City folk today flock to the *cabins au sucre* to feast on maple-drenched dishes, to dance, and to drink. Outdoors, children are treated to *la tire*, syrup boiled down to a taffy and hardened on snow, and horses draw wagons of fun-seekers into the bush to view the miles of plastic tubing collecting the clear sap—Quebec "gold."

In the nineteenth century, southern Ontario was the terminus of the "underground railroad," offering shelter to American blacks escaping slavery. They brought Southern American cookery to Ontario. Irish, Scots, English, and other groups streamed into Ontario during this century, reinforcing British cuisine. Rutabagas (called turnips) were standard winter fare. Steamed carrot pudding became a Christmas tradition. China tea cups were given to brides, and the prescribed wedding cake was a dark fruit cake.

Some ethnic groups entering Ontario in the nineteenth and twentieth centuries formed communities around Ontario: the Poles in Wilno, the Portuguese in Strathroy, the Italians in Guelph, the Scots in the Renfrew valley near Ottawa, the Finns in Thunder Bay, and Ukrainians and Eastern Europeans in Hamilton. This is not to say that myriad cultural groups are not found in these areas; the point is that in these areas, the home cuisine and the language of these settlers was maintained.

Coming primarily from politically troubled parts of the world, approximately 175,000 immigrants annually enter Canada. Of these, about half locate in Ontario, the majority moving into the Toronto area. Immediately after World War II came Italians, Eastern Europeans, British war brides, and many others. In the 1970s, after Canada's newly entrenched multicultural policy, immigrants streamed in from Hong Kong, Vietnam, Somalia, Ethiopia, Croatia, Serbia, India, Sri Lanka, the Middle East, and other countries. Ontario had long served up a meat, potato, and root vegetable table, but the influx of new people and their culinary traditions meant a developing and rapidly changing gastronomy in Ontario, led by Toronto.

Toronto, the most culturally diverse city in Canada, is a reflection of Canadian multiculturalism in the makeup of its population and in its cuisine. There are five Chinatowns in the Toronto area, most recently settled by affluent Chinese from Hong Kong, and Chinese restaurants represent every region in China. Upscale restaurants serve Italian, Portuguese, Greek, Indian, Lebanese, Caribbean, and American cuisine, but the neighborhood dining spots are the best places to find the comfort food of nearly every nation in the world and at a reasonable price.

As a result of this diversity, Ontario is somewhat fragmented in its cuisine, but people in Ontario pride themselves on a receptivity to the flavors of the world. Hoisin sauce, *garam masala*, *baba ghanoush*, phyllo pastry, flat breads, *tzatziki*, pierogies, rice and beans, Jamaican meat patties, and espresso are, if not daily fare, part of Ontario's food repertoire.

The Prairies: Bread and Beef

Traveling west through the provinces of Manitoba, Saskatchewan, and Alberta, seemingly endless fields of wheat dominate the landscape. The wheat belt runs through all three prairie provinces, and wheat is an important economic export. Canadian cuisine has been affected by this bountiful crop since it was first planted on the Prairies in the last half of the nineteenth century. Canadians have a history of baking. In 1913 Five Roses Flour Company published a cookbook of recipes collected from women across Canada. By 1915 this book was found in 950,000 or nearly half of the homes in Canada. In addition to bread and pastry flours, durum wheat that is made into semolina flour for making pastas is grown here.

Prairie history, however, was not one of farming. Native Americans who dominated the plains lived primarily on buffalo, which they preserved by drying and mixing it with buffalo fat and berries, usually Saskatoon berries, and storing the mixture, known as pemmican, in containers made of buffalo skin. French and Scottish voyagers of the fur trade were provisioned with pemmican by Native People, and early settlers relied upon it. When overhunting led to the demise of the huge buffalo herds, beef took its place. A favored method of beef cookery is grilling, and some cook it outdoors year round. For community barbecues, a hole is dug with a backhoe large enough for several cords of wood and an entire beef animal. After twelve hours of underground cooking, the beef is sliced and served with baked beans, fresh breads, salads, pickles and relishes, pies and cakes. Calgary, the home of the Canadian cowboy, glorifies the chuck wagon at "stampede," the annual rodeo. Chuck wagon races are an awaited event; the wagons dash pell-mell around a circle and at the finish line the cowboy "cook" must be the first to light the campfire. Chuck wagon expressions humorously included "baked wind pills" (baked beans), "CPR (Canadian Pacific Railroad) strawberries" (prunes), "dough-gods" (dumplings), "paperweights" (hot biscuits), and "yesterday, today and forever" (hash).

Until the 1950s, British settlers strongly influenced prairie cuisine. Stews, roast beef with Yorkshire pudding, and cakes named after British royalty (Prince of Wales, Prince Albert, King George and King Edward cakes) were popular. Today, Alberta is dotted with English tea houses, in as unlikely locations as a grain elevator.

While British cookery dominated the great wave of immigration (over a million) in the early part of the twentieth century, immigrant groups did not sacrifice their culinary traditions. Russian Mennonites settling in Manitoba, Icelandic immigrants in Grimli, Manitoba, Hutterites in Alberta, and the French who came early in settlement, particularly in Winnipeg, continued to cook their favorite recipes, as had their families before them.

Ukrainians, however, influenced prairie cookery. From the time they arrived at the end of the nineteenth century, they brought with them a tradition of wheat farming and cuisine. Mothers taught daughters the ancient art of making traditional breads and pysanky. They introduced *varenyky* or pierogies (flour-based rounds of dough stuffed with a unique Canadian potato and cheddar cheese mixture), stuffed cabbage rolls, *psyrizhky* (baked stuffed buns), and *paska* (Easter bread).

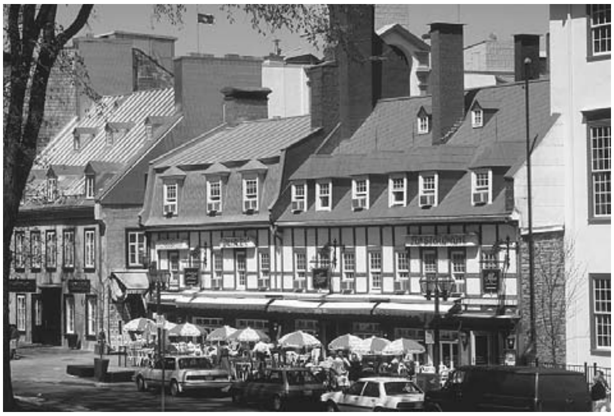
Newer immigration waves have made their mark on Prairie cuisine, particularly in the cities. In Winnipeg there is the largest Philippine population outside of that country. West Indian *roti* shops, Middle Eastern foods, and other ethnic foods add to the culinary flavors of Winnipeg, Edmonton, Saskatoon, and Calgary.

British Columbia: Aboriginal, English, Chinese, and California Fusion

Because of settlement patterns in British Columbia, Canada's westernmost province, its cuisine is different from the rest of Canada. The aboriginal people included many bands of North Coastal and Interior Coastal Peoples living in small villages along the Pacific Ocean and in the interior mountainous areas. By the 1860s there was a genteel English colony on Vancouver Island enjoying garden parties and afternoon tea. Chinese laborers arrived in the last half of the nineteenth century, and in addition to opening restaurants, frequently became cooks in English homes. In the twentieth century, the Californian free-spirited cookery spread up the coast, espousing the use of fresh local ingredients and healthy cooking, including vegetarianism. Many other cultural groups added to this mix but the dominant cuisine is Aboriginal, English, Chinese, and Californian.

As the cuisine in British Columbia developed, locally grown or harvested ingredients from land and sea respectively were adopted by all groups and each modified them according to their backgrounds. The Pacific harvest focuses on salmon: coho, chinook, pink, chum, and red sockeye salmon. Halibut, black cod, lingcod, tuna, rockfish, and eulachon are also favored fish. Shellfish include crabs (especially Dungeness) oysters, scallops, shrimp, prawns, abalone, and many varieties of clams. Agricultural areas in the beginning were developed in the Fraser River delta, supplying produce for Victoria and Chinese vegetables for early Chinese immigrants. Further inland, microclimates characterize the agricultural areas of the Okanagan and Similkimen Valleys, the fruit-growing regions of British Columbia. This climate is ideal for viticulture, and some grapes left on the vine until January are made into Eiswein. Soapberries, thimbleberries, salmonberries, huckleberries, and many other berries are harvested from the wild, as are pine mushrooms growing in evergreen forests.

The first inhabitants who influenced British Columbian cookery were the North Coast Native Peoples. Salmon was and continues to be their primary foodstuff: it is baked, poached, barbecued, and smoked. Family smokehouses are common in the coastal villages. Women also preserve salmon by canning for times when it is not in season. Eulachon oil and herring eggs are prized foods. Eulachon, a small oily fish (also called "candle fish" because when dried it can be lighted), can be eaten fried or baked, but is prized more for its oil, used as a dip for foods and as a seasoning. Spruce boughs are placed in the ocean water and become a spawning site for herring. The branches are harvested with the eggs still clinging to them and are then dried. It is not uncommon to see these boughs drying on the sides of houses. Roots were gathered in the past but are not as commonly used today with the exception of roasted camas bulbs. Indian ice cream is made by whipping the indigenous soapberries into a froth. These local ingredients still dominate aboriginal cooking, particularly since food must be brought to many native villages by ferry. However, the overall cuisine of the Native Peoples has been affected by Canadian culinary culture and their daily menus are as likely to include pizza, burgers, donuts and coffee, stews, pies and cakes as that of any other Canadian. But they value their distinct culinary traditions.



French Canada is noted for its distinctive cookery, and the Old City of Quebec has capitalized on food tourism. Shown here is the Auberge du Tresor, a restaurant and hotel in the historic part of the city. © Wolfgang Kaehler/CORBIS.

Victoria on Vancouver Island, more than any other Canadian city, has a decidedly English character. Afternoon tea is still a tradition, and locally brewed ales can be found at English-style pubs. In the warm climate (by Canadian standards), growers around Victoria are able to successfully harvest such fruits as kiwi and figs. Their small farms are often organic, and herbs are grown year-round.

Vancouver, the largest city in British Columbia, although multicultural, has a character all its own. Here there are English, Chinese, Pacific Coast Native, Italian, and Japanese, as well as Californian influences. The Chinese influence is strongest in Vancouver. The Chinese community demands fresh produce and fish—evident in Vancouver food stores. Chinese vegetables such as *gai lohn* have long been grown in the Fraser River delta. Live fish and shellfish from the Pacific are kept in tanks (goeduck clams, Dungeness crabs, and rockfish). Recent wealthy immigrants from Hong Kong created a demand for imported Chinese foods and medicines such as ginseng (grown commercially in British Columbia and Ontario), dried abalone, shark's fin, and bird's nest.

Young, well-trained chefs are combining this cooking in various adaptations, creating a fusion cuisine. These young people revere local ingredients, ethnic ideas and styles, organically grown foods, herbs, edible flowers, whole grains, and enjoy the good life.

The North: Finding Food for Survival

Canada's agricultural belt as well as its population is concentrated in approximately the lower one-third of its land mass. The "North" includes the territories of the Yukon, the Northwest Territories, and the newest territory, Nunavut. For purposes of describing the regional cuisines of Canada, the forest land south of the tundra and north of the agricultural belt are also included, as are parts of the Prairie provinces, Ontario, Quebec and Labrador.

Indigenous ingredients distinguish the cuisine of northern Canada from other regions. Because food supplies are difficult to transport, there is more of an emphasis upon local foods than in southern Canada.

Caribou, muskoxen, moose, deer, ptarmigan, and arctic char are hunted or fished. Today aboriginal people supply wild game to restaurants and the luxury market, particularly caribou, muskoxen, and arctic char. Migratory ducks and geese provide variety to the larder in the fall. Berries grow profusely—blueberries, partridge berries, cranberries, and black currants are made into pies, preserves, jellies, and sauces. These foods all have local habitats—not all are found in every part of Canada's north.

The aboriginal population comprises about two-thirds of the northern population. Before European settlement, the Inuit occupied the Arctic, that is, the tundra beyond the tree line that encompasses the northern third of Canada's land mass. The aboriginal tribes of the Mackenzie and Yukon River basins and the Northern Cree occupy the northern wooded areas. Before contact with Europeans, these Peoples of the First Nations were self-sufficient and lived seasonally, either following herds of caribou or moving from place to place where food could be found. Their diet was rich in protein, with plant materials making up an estimated five percent of their food. This diet was healthy and supplied all their nutritional needs. In the twentieth century, attempts to assimilate Native Peoples into white society changed the native culture dramatically. Many were moved to permanent settlements (especially the Inuit) and were no longer able to resume their migratory food patterns. They began to live on foods that could be transported into their villages, usually by plane. These foods were much different from their traditional diet. Carbohydrates were introduced, particularly white flour and refined sugar. Manufactured foods like potato chips and soft drinks became popular, especially because the traditional pattern was to eat when hungry rather than at set mealtimes. Rich in fat and starch, these new foods were detrimental to the health of Native Peoples, leading to diabetes and other dietary diseases. While there is a trend among Native Peoples to return to their traditional diet, permanent settlements make this difficult.

The largest white settlements in the north are in the Yukon and Northwest Territories. Dawson and Whitehorse were settled during the gold rush, and Yellowknife was established as the capital of the Northwest Territories. The Yukon today has predominately British roots. The center of the gold rush beginning in 1897, Dawson drew miners, honky-tonk girls, and the Royal Canadian Mounted Police (RCMP). To prevent starvation, miners were required to pack in a year's supply of food before they were allowed into the territory. Provisions were basic and affected the cuisine of the territory: beans, flour, dried fruit, sugar, bacon, and tea were common items. Wild game supplemented their plain diets, but if they struck it rich they could buy luxury foods such as chocolate, champagne, and fresh eggs. Prospectors became known as "sour-doughs" because they craved white bread so much they baked it in their camps. Legend has it that they kept the yeast starter alive by carrying it in their armpits when traveling in the bitter cold.

Today procurement of food for the north still requires a great deal of planning. Winter is unpredictable, and even where there are logging trails or water access to northern communities, food supplies are sometimes delayed. Nearly any food can be shipped in by air, but that option is expensive. With modern communications with the rest of the world, there is demand for many more food products, especially in increasingly popular luxury fly-in hunting and fishing lodges. Overall, diets in the North are simpler than elsewhere, but definitely Canadian in style.

From coast to coast, diverse regional cuisines dominate Canadian cooking. Canadians today value their ethnic origins highly and take pride in preserving their culture, particularly their cuisine. Overlying these regional cuisines is a dominant North American influence, which is not surprising since there was American immigration into Canada early in its history, the language is understood by most Canadians, and the cultural influence of the media has brought trends and new foods to Canada. Canadians also take advantage of fruits and vegetables grown south of the border that lend variety to winter meals. One cannot say that there is a national cuisine, as there is in Mexico, but one must experience and enjoy the diverse regional cuisines of Canada, which together create a diversity of foodways that reflect Canadian society.

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Jo Marie Powers

CANADA.

NATIVE PEOPLES

There are over half a million Peoples of the First Nations scattered across Canada. Divided into more than 600 bands, nearly 60 percent live on reserves, the majority on the plains and the West Coast. Greatly differing in their background, culture, and traditional cuisine, the Peoples of the First Nations can be divided into cultural groupings, each with a distinct cuisine: the Woodland First Nations, the First Nations of Southeast Ontario, the Plains People, the Pacific Coastal Nations, the First Nations of the Plateau, and the First Nations of the Mackenzie and Yukon River basins. The Inuit, occupying one-third of the landmass in Canada, are another important aboriginal group with a different and distinct cuisine.

Inhabitants of Canada for thousands of years before European contact, the Native Peoples created markedly different cuisines from the raw ingredients available: local wildlife and indigenous plants. Although basic cooking methods varied from tribe to tribe, most peoples roasted food over hot coals and used the "stone-boiling" method of cookery. Food and water were placed in a wooden, bark, or skin container and hot rocks were dropped into the vessel to heat the water and cook the food. It was not surprising that iron kettles were highly prized when offered in trade by Europeans because they simplified this method of cookery. Salt was absent from their traditional food preparations as was frying food in fat. Both were introduced by Europeans along with new ingredients and preparations. Wheat flour was one of the first widely accepted foods and bannock became the traditional bread that spread to every tribe across Canada. New root vegetables such as carrots, onions, and turnips were readily added to their cooking pots for flavor and nourishment. It is thought that potatoes, brought to Europe from Peru by the Spaniards, were carried to Canada by Irish immigrants and these easy-to-grow tubers were quickly accepted in aboriginal communities. Refined, cheap sugar was a valued commodity and enjoyed in its many uses in sweet desserts and, later, in soft drinks. In the twentieth century, aboriginal people, like other North Americans, became enamored with manufactured foods including snack foods, rich in salt, fat, and sugar, and began to shop at their band or grocery stores for most of their food supplies. However, nutritional research has shown that their native diet was healthier than the new diet to which they were introduced. The incidence of diabetes and other dietary diseases is high among Native Peoples.

BANNOCK

Bannock is a bread universally loved and prepared in the homes of every aboriginal tribe in Canada. The Scottish fur traders are thought to have introduced this preparation. Folklore tells its probable origin. Scottish men, carrying a bag of flour in their canoe and not caring about amenities, made a well in the center of the flour, poured in water, and stirred it with their fingers to make a dough. Wrapped around a stick and roasted over the campfire, this bannock was shared with aboriginal guides.

Today bannock has many variations. Flour, a small amount of baking powder and salt, and sometimes a little fat, are placed in a large bowl and an indentation is made in the center. Buttermilk, milk, or water is poured in and the liquid is deftly and gently worked into the flour to form a soft dough. This is rolled out and cut into rounds and baked. The result is a tender, unleavened bread about two inches thick. It is also cooked in an ungreased skillet on top of the stove. When the bannock dough is fried in fat, it is called "fry bread" or "fried bread." In the out-of-doors, bannock is still baked over a campfire, either wrapped around a stick in the traditional manner or in a heavy iron skillet placed on hot coals. For variety, blueberries, saskatoon berries, or raisins are added to the dough before it is baked.

At powwows, bannock is a featured food. It is rolled into large rounds and deep-fried as a base for Indian tacos. This recipe first appeared on the powwow circuit between twenty and thirty years ago, and the fry bread base is topped with a seasoned bean or meat mixture, shredded cheese, chopped lettuce, and tomato. The fry bread can also be served hot with butter and honey.

After initial contact, Europeans attempted to assimilate the Peoples of the First Nations into white culture, most recently by taking children from their families and placing them in residential boarding schools. Children were taught English and ate the white people's diet, but the Peoples of the First Nations remembered their past. There is a strong force within their communities to prepare traditional foods, and, at the same time, to improve their diet. Young aboriginal chefs are making their mark on Canadian cuisine. Specifically trained in courses on aboriginal cuisine and native culture, these young people are putting native cuisine on Canadian menus.

Although diverse in their foods and foodways, there is a commonality that crosses from Nation to Nation, and that is a deep spiritual relationship with the land and the life forms that inhabit it. The Peoples of the First Nations have a great respect for all living things and believe that human beings participate in a world of interrelated spiritual forms. Moreover, toward the end of the twentieth century, aboriginal peoples across Canada began a concerted effort to control their lands and resources.

The Woodland Peoples

The Woodland Peoples include Mi'kmaq, Montagnais, Ojibway, Algonquin, Odawa, and Cree, the tribes who first met the French and formed alliances with them in the seventeenth century. Spread across the eastern provinces from Nova Scotia to Manitoba, they were hunting and gathering societies, migrating from place to place, following the seasonal movements of wild game animals. Moose, venison, beaver, rabbit, and caribou in the north were their quarry. Wild waterfowl and fish were also part of their diet, as well as berries that could be gathered. Wild game was prepared by the women, who either roasted the food or boiled it by dropping heated stones into water-filled bark containers.

Sharing food was part of their culture and many an early settler would not have survived had it not been for the native people who gave them part of the meat they hunted and taught them how to track game and use snowshoes. They introduced the French to maple sap, which they prized as a spring tonic and which could be boiled down to sugar. They showed them fiddleheads, the fronds of the ostrich fern, a gourmet delicacy in twentieth-century Canada. An important grain, part of the Ojibway diet, was wild rice, gathered in shallow bays by canoe. The Woodland Peoples no longer depend upon wild game, although hunting and trapping are still important.

The spiritual part of their culture remains integral to their life. For example, the Ojibway observe the seasons with festivals, beginning in the spring with the strawberry festival and the drinking of strawberry juice, giving thanks to their creator.

Peoples of Southeast Ontario

At the time of contact, the aboriginal people who were farmers in Canada lived in Ontario (members of the Iroquoian tribes), and there were occasional farming settlements in Quebec. Fifteen varieties of corn, sixty of beans, and six of squash, including pumpkins, were grown. Jerusalem artichokes and sunflowers were also cultivated. Maples were tapped in the spring and the sap boiled down to sugar, used sparingly as a sweetener and sold to early settlers. The most important of their crops were corn, beans, and squash, the "Three Sisters," which together provided a complete diet. Food was cooked by the women in pottery containers, which they made. Fish and meat were added for flavoring but were a small part of their diet. Three festivals were held to honor corn: the corn planting, the green corn, and the harvest festivals.

The largest band in Canada is the Six Nations of the Grand River Iroquois in Ohsweken, Ontario, who came north with British Loyalists in the late eighteenth century. Their ceremonies are held in a modern building resembling a long house in style. For traditional ceremonies families bring food, fragrant sweet grass is burned, and the food is blessed. Corn soup is served at ceremonies and in homes. To make this special soup, women begin preparing it in late summer, first slowly drying white flint corn kernels in the oven and then storing them in containers. The soup is made by simmering the dried corn with fresh pork, kidney beans, and a little salt. Corn soup is also served at the "Snow Snake" in the winter, a contest in which the men throw a javelin-like spear down an icy groove (the spear may travel almost 3,300 ft., close to 1,100 yds.).

The Plains Peoples

The Plains Peoples (Blackfoot, Blood, Peigan, Gros Ventre, Cree, Assiniboine, Sioux, and Sarcee [Tsuu T'ina]) followed buffalo migrations. Depending upon the tribe, after the slaughter the kidney, heart, or liver (all were considered sacred) was eaten first, raw. Animals were always slaughtered as needed, not for sport. Every bit of the buffalo was utilized for food, clothing, or shelter. The fresh meat was either roasted or cooked in a skin bag by the stone-boiling method. Jerky was prepared by sun-drying strips of meat, which were pounded almost into a powder and then mixed with buffalo fat and berries to make pemmican. Stored in a buffalo skin, it remained edible for years, and early European settlers and fur traders depended upon it. After the buffalo had all but disappeared, its meat was replaced by beef. Today, the Plains Peoples' favorite method of cooking beef is boiling it with potatoes, and the boiled meat is often served with pork cracklings. Tongue is a delicacy eaten during the Sun Dances. Kidneys, lightly grilled on the outside, are eaten by the Siksika of the Blackfoot. Intestines are stuffed with raisins, cooked, and eaten. Their tradition of not letting any part of the animal go to waste continues. Men of these tribes still consider themselves meat eaters and continue to hunt wild game for food and sport—deer, antelope, rabbits, and, near the Rockies, elk and mountain sheep, as well as other animals and birds.

The Pacific Coast First Nations

The Pacific Coast First Nations (Haida, Tsimshian, Nootka, Coast Salish, Kwakiutl, and Bella Coola) live on the coast of British Columbia. By the time Columbus had reached the Americas, these people had developed an elaborate social structure. They lived in semipermanent communities in homes built with cedar boards, had extensive trade networks, and had sufficient leisure time for artisan carvers to develop.

A unique feature of these people was the potlatch, an elaborate feast publicly declaring and legitimizing a change in state—birth, marriage, death, or inheritance of rights. The chief who gave the potlatch provided enormous quantities of food, served in intricately carved containers, and invited guests from other tribes were expected to consume food until they could eat no more. During the feast the chief gave away his possessions, and the more generous he was, the more powerful he was thought to be. The potlatch was outlawed from 1884 until 1951, but was still held in secret. Potlatches today are held for the same reasons as in the past, and the potlatch ceremonies—singing, drumming, dancing, and speechmaking—all reaffirm the community's cultural identity.

The planning for a potlatch may take several years. The community participates in preparing feast foods, which are a combination of their favorite traditional dishes and North American foods. Entire families attend the potlatch, including infants. Generally, two meals are served each day of the potlatch, a dinner and then a late supper break after midnight. Some of the traditional foods that are served include dried herring roe, grease from the eulachon (an anadromous marine food fish found along the north Pacific coast), seaweed soup with salmon eggs, and, always, salmon. These foods are accompanied by tossed salads, vegetables, pickles, bannock, and cakes. Speechmakers reiterate the "plentifulness of the food." Rituals are observed at the feast: elders and chiefs are served first, guests are considered rude if they refuse food during the meal, and all are invited to take food home. On the last night of the feast, boxes and boxes of goods are given to the guests. Today these gifts consist of a variety of goods such as mugs, glasses, housewares, T-shirts with the family crest, towels, and blankets. Valued foods such as dried herring eggs and eulachon grease are given to special guests, as are envelopes of money. The revitalized potlatch reinforces community cohesiveness and support for the leaders of the community.

The First Nations of the Plateau

The First Nations of the Plateau (Interior Salish, Kottenay Tribe, Chilcotin, Tahltan, Tagish, and Carrier Sekani) occupy the great valley between the Rocky Mountains and the coastal ranges in British Columbia. These peoples, along with the coastal Nations, were the most numerous of any aboriginal group before European contact. Within these cultural groups, staple foods varied from northern to southern British Columbia. In the central area, salmon, which spawned in the Fraser River, were the staple food, while in the north wild game, especially moose, deer, and caribou, was hunted. Researchers have identified more than 150 plants that were gathered and, in the southern area, supplied 50 percent of the calories consumed. Families or chiefs owned gathering areas and, although agriculture, per se, was not practiced, the grounds were tended and cared for so that plants would flourish and could be harvested annually. Roots were an important staple, especially Yellow Avalanche Lily, Spring Beauty tubers ("Indian Potato"), and bitterroot. Pit cooking was favored for cooking roots. A hole was dug, rocks added, a fire built to heat the rocks, and a protective layer of vegetable matter was placed over the coals. Foods were placed on top of this layer and carefully covered with more greenery and then with soil. Some water was added, and the whole cooked for hours. Wild berries, gathered by women, were eaten fresh or cooked and dried in wooden frames to make berry cakes, then stored for later use. These cakes were soaked and mixed with eulachon oil. The Interior Peoples had extensive trade with the Coastal Peoples and exchanged their roots, berries, and other goods for eulachon "grease," herring roe, and other goods. When potatoes, rice, flour, sugar, and other foods were introduced, they were readily accepted by the Interior Peoples. They still gather berries, root vegetables, and wild mushrooms. Their traditional foods are greatly valued even though many of their ancestral gathering grounds have been destroyed by cattle or development.

The First Nations of the Mackenzie and Yukon River Basins

Small in numbers, the twelve tribes of the Mackenzie and Yukon River basins occupy one-fourth of Canada's landmass. They include the Chipewyan, Beaver, Slave, Yellowknife, Dogrib, and Hare tribes. Their traditional hunting lands, located just below the tundra, provided sparse vegetation for game animals, so family units had their own hunting grounds. Seminomadic, they followed migratory animals such as caribou. Where available, they hunted moose, mountain sheep, wood buffalo, and bear. Hunting was often a winter activity that required snowshoes, and snares were set to trap game. Fish were important, caught either through the ice in the winter or by canoe after the ice broke up in the spring. Game was boiled in birch bark containers using the stone-boiling method. All of the Yukon tribes held memorial feasts for their dead on the first anniversary of their death. Today, hunting is still an important part of their life and snowmobiles have allowed them to have a wider range in their winter hunting territory. However, permanent settlements and the decrease in caribou herds in some parts of their territory have diminished the emphasis on game as their major food supply.

In the twenty-first century, Native Peoples eat much like other North Americans. They buy their foods from grocery or band stores, frequent fast-food restaurants and pizza parlors, get Chinese takeout, and drop into coffee and donut shops.

See also **American Indians**; **Arctic**; **Canada**; **Inuit**; **Potlatch**.

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Jo Marie Powers

CANCER. *See* **Health and Disease.**

CANDY AND CONFECTIONS. Candy is a collective name for sugary treats such as fudge, taffy, bright colored gumdrops, and boiled sugar. Originally, "sugar candy" meant sugar concentrated to the point that it formed a hard crystalline mass on cooling. The term (derived ultimately from a Sanskrit root, through Arabic *sukkar quandi*) was first recorded in English in the late fourteenth century; the word "candy" used alone appeared in the eighteenth century. The equivalent word in British English is "sweets." "Confection" is a word with a wider meaning. Sugar-based candy represents one category of confections (and is the sense mostly discussed here). Chocolate is another category (though the fillings of bars may be candy). The idea of a confection extends to pastry, cookies, and cakes. The trade of the confectioner, who is skilled in making delicate sweet things, links these different areas of expertise together.

Five hundred years ago, "confection" meant a mixture made to enhance health. Confection originally had the sense of 'something put together', and confections in the fourteenth century were medicinal preparations made from combinations of various drugs. It was very quickly discovered that "a spoonful of sugar makes the medicine go down," and sweetening agents were added to the medicines. "Confection" was being used to mean 'a preparation of spices, sugar, fruits, etc.' by the middle of the fifteenth century. Confectioners preserved fruit, made sugarplums, marzipan, cordials, and light cakes. Sugar was important in these: it was expensive, exotic, sweet, and considered to be a spice with health-giving qualities. It was used to decorate other foods. In the English-speaking world, sugar became steadily cheaper through the eighteenth and nineteenth centuries. Chocolate candies were known in the late 1600s but only became common when large-scale production developed at the end of the nineteenth century. Pastry making (*patisserie* in French) became a specialty divorced from sugar-working. Candy-

CANDY CANES AND PULLED SUGAR

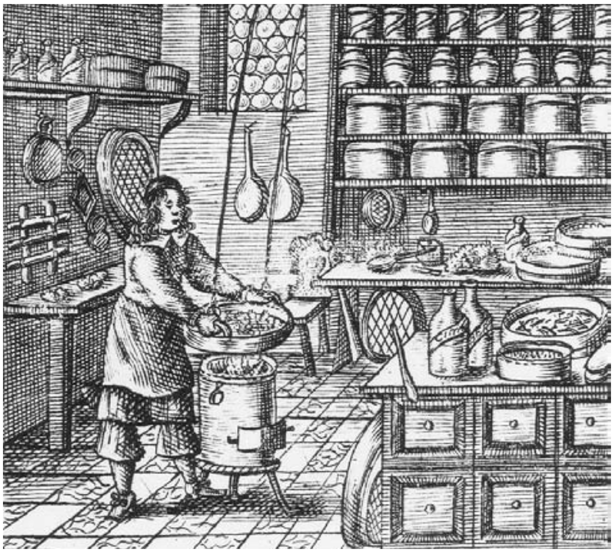
Striped candy canes, used for decorating the Christmas tree, are made by a technique known as pulling. For this, a concentrated hot sugar syrup is worked by stretching and folding, either by hand over an iron hook set in the wall or on a specially designed machine. After a short time, the sugar becomes opaque and white as pockets of air are folded into the mass and stretched. The basic lump of pulled sugar is made into a rough cylinder and decorated lengthwise with stripes and patterns made from colored boiled sugar (usually red). Then the mass is pulled out again (often by spinning on a machine) into long thin pieces. This process extends the sugar into thin ropes with decoration running through the whole length. Once the required diameter, usually about half an inch, is reached, the ropes are cut into shorter sticks. Candy canes are given an extra flourish by bending the top to give a shepherd's crook shape. Pulling is known in many other countries. In Britain it is used for "seaside rock," sold as a souvenir in seaside resorts. This is a sugar stick with letters or patterns running the length. In Sweden it makes the traditional mint-flavored *polkagrisar.*

Pulling is also used to make a more friable textured candy. The best-known example is probably Edinburgh rock, sold in the Scottish capital. For this, the sugar syrup is boiled to a lower temperature, and the sugar is allowed to grain after the candy is shaped. Similar confections include cinnamon-flavored *kaneel-brokken* (The Netherlands) and *peinir schekeri* (Turkey). Pulled sugar has an ancient and obscure origin. A description of the process is given in the *Kitab-al-Tabikh,* a collection of recipes written down in thirteenth-century Baghdad, but, as with other candy techniques, the skill was probably developed at a much earlier date somewhere farther east and transmitted westward with sugar cane and the knowledge of refining sugar itself.

making also became an industry, helped by glucose (from corn syrup), and cheap penny candies emerged as the most obvious sugar confections.

Special uses of the word "candy," such as sugar candy, rock candy, and candied fruit, hint at the history of confections. Sugar candy is a hard mass of tiny crystals. It is now seldom made (although fudge is a softer version, and maple candy can be considered a special type). To make rock candy, large sugar crystals are allowed to grow slowly on sticks suspended in syrup. Candied (or crystallized) fruit is preserved by soaking in syrup. Concentration is gradually increased until it is strong enough to prevent decay. This was formerly an important preservation method for fruit, stems, and roots, including medicinal items such as lettuce stems and marshmallow roots. These techniques and other candies such as candy canes and jelly beans were brought to North America by European settlers. They can be traced back through the Middle Ages to traditions of sugar-working transmitted westward from the Byzantine and Islamic worlds.

Modern chemistry shows that early candy recipes exploit special properties of ordinary white crystal sugar (known chemically as sucrose) when boiled as syrup. This skill of sugar-boiling is of fundamental importance to the confectioner. First, the crystals are dissolved in water and brought to the boil. Although water boils at 100°C, sucrose does not melt until it reaches a temperature of around 160°C. As weak syrup boils, it becomes more concentrated, and the temperature rises above 100°C. More water evaporates. This increases the sugar concentration, which raises the temperature further, so that more water boils off and the syrup becomes more concentrated until it is entirely molten sugar. The basis for candy-making lies in cooking the syrup to varying temperatures—relatively low for chewy candies, higher for hard candy. These are measured on a special thermometer or by observed "stages" such as the "ball" test used when making fudge.



The interior of a confectionery shop showing a confectioner making candied comfits. From Balthasar Schnurr's *Kunst- und Wunderbüchlein* (Frankfurt, 1615). ROUGHWOOD COLLECTION.

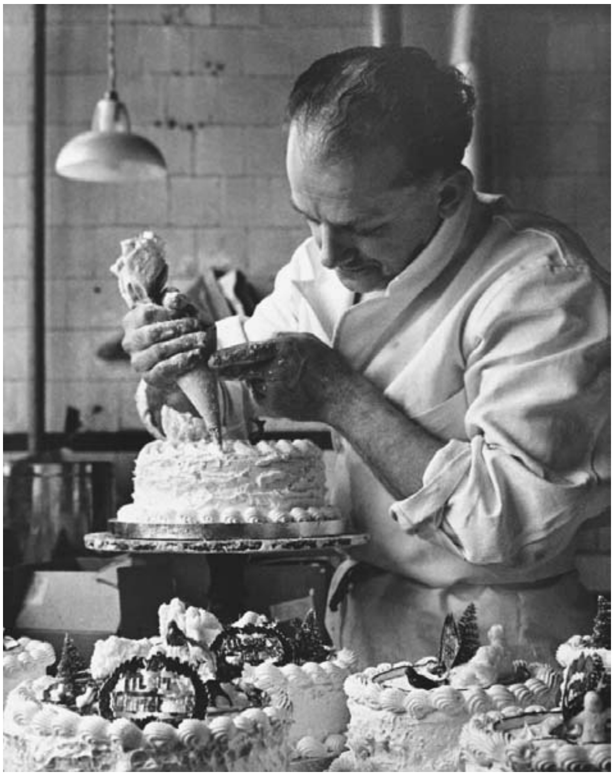
HALLOWEEN

Halloween in North America is celebrated by the custom of "trick or treat," in which collecting candy plays a vital part. The use of the colors orange and black and the images used on the packaging add to the general theme of witches, ghouls, and pumpkins. The festival of Hallowe'en, or "All Hallows Eve," has its roots in the Christian celebrations of All Saints and All Souls on November first and second; scholars believe this date was originally a pagan festival of the dead that was taken over by the church. Yellow- and orange-striped candy corn (first devised in the 1880s) recalls the idea of harvest, also important at this time of the year.

In Mexico, the Day of the Dead features a particularly vibrant and lavish selection of human and animal figures and skulls made from hard sugar candy or sugar paste sold at local fairs. These appear to have arisen from a fusion of European techniques of sugar-working, Christianity, and elements of native tradition.

In Europe, Halloween and All Saints have some special associations with candy. In southern Europe, All Saints is remembered as a special time when people visit the graves of relatives, and perhaps eat one special seasonal confection, for instance the Spanish *huesos de santo* (almond candy rolls filled with sweetened egg yolk). One place in which many candies are traditional to this date is Sicily. Here, marzipan fruit, *torrone,* and *cubiata* (the latter two local versions of nut or sesame brittle) are sold in special fairs together with *pupi di cena*—statuettes made of hard sugar candy with gaudy foil decorations. These figures recall a general Renaissance tradition, now mostly forgotten elsewhere to the east of the Atlantic, of decorating banquet tables with sugar models.

In the United Kingdom, toffee was traditionally made around the beginning of November, but All Souls traditions to do with candy or other special foods had almost disappeared by the twentieth century. However, the American trick or treat custom has recently been discovered by British children, and candies aimed specifically at this market now appear in the shops.



The art of confectionery is divided into a number of specialized professions, one of them cake decorating. Cake decorations are mostly sugar or sugar-based, and it takes an expert hand to achieve the fine points of piping and design. This confectioner in Knightsbridge, London, is putting the final touches on a Christmas cake in 1958. © HULTON-DEUTSCH COLLECTION/CORBIS.

Another part of the story of candies lies in the chemical structure of sucrose. This consists of two smaller sugar molecules, glucose and fructose, linked together. Dissolved in syrup, the links between the smaller molecules break, giving a mixture of sucrose, glucose, and fructose in water. The original candy was syrup boiled to a temperature of about 115°C, and then stirred, poured into a mold, and cooled. Stirring encourages the mixture to grain: the glucose and fructose bond again as sucrose, and crystals form, giving a hard texture. This is now used only for a few special items such as some of the figures made for the Mexican Day of the Dead and English Kendal Mint Cake. But the same basic technique gives the solid-yet-melt-in-the-mouth textures of fudge, penuche, New Orleans pralines, peppermint patties, and fondant. In these candies, the industry uses numerous technical devices to control crystal size, giving very small crystals and a creamy texture. Careful control of temperature and "seeding" syrups with preprepared crystals of the desired size are two methods.

Syrups boiled to 154°C and cooled quickly remain transparent and glassy and are the basis of hard, clear candies such as fruit drops and golden barley sugar sticks. Confectioners knew that acid from fruit juice helped to keep clear candies translucent, and in the nineteenth century, they discovered that newly available ingredients, such as tartaric acid (from grapes) or glucose (in corn syrup) were more reliable. These "doctors" alter the chemistry of the syrup so that the relative proportions of glucose and fructose are unequal, inhibiting graining and encouraging a clear candy. Glucose, used to control texture in most industrially produced candies, is a vital ingredient in modern confectionery. Sugar syrups boiled to high temperatures can also be used for pulling, a method for such favorites as peppermint sticks and candy canes.

A third category of candies, which includes jelly beans, red-hots, and M&Ms, is made by panning in a special revolving drum like a large concrete mixer. This is a low-temperature process, using weak syrups cooked to only a few degrees above 100°C. Nuts (especially almonds), seeds (such as caraway or aniseed), and pellets of chocolate or fruit paste are coated with small amounts of syrup and tumbled until the sugar has dried on their surface. Eventually this builds up in thin layers to make a shell. Jelly beans as now made originated in the late nineteenth century but older recipes used bits of fruit paste. The Italian name for candies such as sugar almonds is *confetti*, and a tradition of throwing handfuls of these during festivities is commemorated in the paper confetti thrown at weddings.

Other ingredients add flavor, color, and texture to candies. Sugar paste is a mixture of confectioner's sugar and soaked gum arabic or tragacanth. Through the centuries, this was valued for modeling flowers and figures and is still popular for cake decoration. It is also an excellent vehicle for medicines and perfumes. Pastes were made up containing strong drugs such as opium or fragrances such as violet to sweeten the breath. Lifesavers and English Polo Mints echo this tradition, although high pressure is now used to compress the sugar.

Fruit confections often rely on pectin for their jellied texture. Gelatin and plant-derived gums provide alternatives in candies such as gum drops and pastilles. Chewing gum was devised in the late nineteenth century as a sweetened confection based on chicle, an elastic latex derived from a Mexican tree. Foundations for the success of this were laid in the 1890s by a dynamic young salesman named William Wrigley. Flour gives a characteristic chewy toughness to licorice candies, and cornstarch is used in Turkish delight (replacing the wheat-derived starches originally employed).

Almonds are used in many confections. Ground with sugar, they make marzipan. In caramelized sugar, they make brittle, although peanuts have become a more usual base for this candy. Almonds are also combined with sugar that has been boiled with egg whites to make French nougat and its relatives *turron*, *torrone*, and numerous other Mediterranean and Middle Eastern variations. Divinity, a softer version of this, developed in the southern United States. Egg whites gave the spongy texture to early marshmallow recipes; gum or gelatin are now used.

Milk, butter, and cream provide delicious textures and flavors in caramels, butterscotch, and toffee. The ancestor of these seems to have been taffy, unrefined sugar boiled with butter and then pulled. It was made in both England and North America in the nineteenth century, but the traditions have diverged on opposite sides of the Atlantic. In England, taffy has been forgotten, and modern toffee is brittle, hard, and brown. In America, taffy has developed into soft, multicolored salt-water taffy. Chewy caramels, boiled with milk, probably developed from the taffy tradition in the eastern United States. Milk is also important in confections from other cultures. Thick condensed milk is the *dulce de leche* of Hispanic cultures. Similar preparations provide the basis for many Indian and Bangladeshi confections including fudge-like *barfi* and cake-like *gulab jamun.*

The principal contribution that candies and confections make to the diet is concentrated energy. Consumption of candy is high in North America and Europe. According to the National Confectioner's Association, total U.S. consumption hovered around 7 billion pounds per annum for candy and 3.3 billion pounds for chocolate during the late 1990s. Debates continue over the relationship between confections and health problems such as diabetes and heart disease. The consensus is that too much sugar, whatever the source, is bad for the human body. The relationship of sugar and candy to dental cavities is direct and has been noticed for centuries; a visitor to the court of Elizabeth I in England observed that her teeth were black and attributed it to eating too much sugar.

The complex history of candies and confections has seen them go from being expensive luxuries to something consumed every day by everybody. Much of this is due to cheap sugar and industrial production methods. Despite this, they are still considered treats, valued for decorative qualities as well as their intrinsic sweetness. They retain strong links with celebrations such as weddings, christenings, Christmas, and Easter in many countries.

See also **Chocolate; Christmas; Day of the Dead; Desserts; Easter; Feasts, Festivals and Fasts; Halloween; Sugar and Sweeteners; Syrups.**

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CANNIBALISM. There is certainly no shortage of information on cannibalism. A search at any good library will net twenty to thirty books on the topic, and, at the time this encyclopedia went to press, the World Wide Web contained no fewer than 850 sites. Books on the topic range from popular surveys by Askenasy (1994) to anthropological treatments by Brown and Tuzin (1983), Goldman (1999), and Petrinovich (2000) to anthropological critique by Arens (1979) to postcolonial and literary critique by Barker and others (1998). A superficial examination of post–World War II films lists a variety of both serious and humorous treatments of cannibalism, many of them first-rate (*Fires on the Plain* [Japan, 1959], *Soylent Green* [U.S., 1973], *Survive!* [Mexico, 1976], *Eating Raoul* [U.S., 1982], *Silence of the Lambs* [U.S., 1991], *Delicatessen* [France, 1991], *The Cook, the Thief, His Wife, and Her Lover* [1993/1989, France/Netherlands.], *Alive* [U.S., 1993]). The fact that cannibalism is a powerful taboo in most human societies undeniably contributes to our fascination with tales about organisms eating conspecifics (others of the same species), especially humans.

THE GREEKS

The ancient Greeks' fears of cannibalism were reflected in the writings of Homer and others. For example, the Titan god Kronos ate his sons Hades and Poseidon and tried to eat Zeus in the fear that they would supplant him. Zeus, the future leader of the Olympian gods, forced his father to disgorge Hades and Poseidon. In another story, the curse on the House of Atreus was brought about by a deceptive form of endocannibalism. Atreus and Thyestes were brothers. In a series of deceptions, Atreus, having killed his own son without knowing who he was, exacted revenge against his brother, Thyestes, by killing Thyestes' own sons and serving them to him at a feast. A final example is in the tale of Odysseus' return from Troy to Ithaca. He stopped at an island in search of food and stumbled on the cave of Polyphemus, a Cyclops. Odysseus escaped from Polyphemus, but not before the Cyclops had devoured a number of his men.

The practice of human cannibalism is highly variable and can be defined in a number of ways: (1) Endocannibalism is the consumption of deceased individuals who live within the group, such as kin and friends. (This pattern was common in New Guinea as an act of veneration.) (2) Exocannibalism is the consumption of outsiders as an act to gain strength or demonstrate power over the vanquished, who had usually been murdered. (3) Starvation or survival cannibalism is the consumption during actual or perceived starvation. (This is well documented in numerous historical sources.) (4) Gastronomic cannibalism is nonfunerary, nonstarvation cannibalism, that is, routine cannibalism for food. (This is not well documented.) (5) Medicinal cannibalism is the consumption of human tissues such as blood, powdered bone, or dried tissue for medicinal purposes. (6) Sadistic cannibalism is the killing and eating of individuals out of sadistic or psychopathological motives. (There is considerable evidence for this pattern of cannibalism.) In exocannibalism, gastronomic cannibalism, and sadistic cannibalism, the victims are murdered before being eaten; in endocannibalism, starvation cannibalism, and medicinal cannibalism, they are not.

Cannibalism in Nonhuman Animals

Cannibalism occurs in a wide variety of invertebrate and vertebrate species and includes: infanticide, mating and courtship, competitive encounters, eating the old, and eating eggs. Among nonhuman organisms, cannibalism may be either ecological or social. Ecological factors include a limited food supply or the recovery of reproductive investment when food is scarce for infant survival; social factors include competition for reproductive resources or food resources. A general principle is that older individuals usually consume younger ones or eggs; it is relatively rare for adults to eat other adults. Elgar and Crespi (1992) define cannibalism in nonhuman organisms only in cases where an individual is killed (rather than dying a natural death) before being eaten.

JACK AND THE BEANSTALK

This rhyme from "Jack and the Beanstalk" illustrates an example of threatened cannibalism in a children's story. Numerous nursery rhymes and fairy tales include cannibalism as part of the theme. Another example is "Hansel and Gretel."

Fe, Fi, Fo, Fum.
I smell the blood of an Englishman.
Be he alive or be he dead,
I'll grind his bones to make my bread.

In a comprehensive survey of cannibalism in primates in the wild, Hiraiwa-Hasegawa (1992) observed only five species in this practice: *Cercopithecus ascanius* (redtail monkey), *Papio cynocepharus cynocephalus* (baboon), *Macaca fuscata* (Japanese macaque), *Gorilla gorilla beringei* (mountain gorilla), and *Pan troglodytes* (common chimpanzee). In each episode observed, infants were eaten after being killed, and this custom appeared to serve a nutritional (therefore, ecological rather than social) purpose in animals who ordinarily consumed meat as a part of their diets. Chimpanzees, our closest evolutionary relatives, have the highest rates of cannibalism among nonhuman primates; chimpanzees also have the highest rates of predation (of red colobus monkeys) among nonhuman primates.

Cannibalism in History and Prehistory

Identification of cannibalism in the distant past is, according to Tim White (1992), based on very specific indicators in fossilized or unfossilized human bones: (1) similar butchering techniques for human and animal remains; (2) similar patterns of long bone breakage (for marrow extraction); (3) identical patterns of processing and discarding after use; and (4) evidence of cooking (White, 1992). Based on these criteria, there is good evidence for cannibalism from the southwestern United States; New Guinea, Fiji, and other sites in the Pacific; and Europe; there is limited evidence at other sites around the world. Ann Gibbons (1997) has reported that very early paleoanthropological specimens dating back hundreds of thousands of years are increasingly being identified as showing signs of cannibalism.

There is abundant evidence from historical accounts of cannibalism in the Caribbean (the term was defined for Carib Indians; the Spanish word *Canibales* is a form of the ethnic name *Carib*) and in Spanish accounts of Mesoamerican ritual sacrifices and cannibalism. Many historical accounts have been challenged within the past few decades because most information was derived from enemies of the groups identified as "cannibals," where the term was used to denigrate the other group. Also, during periods of exploration from the sixteenth century onward, Europeans were likely to accept the identification of "cannibal" in a group that was thought to be "savage" and "primitive." Hence, there is probably some exaggeration in the historical literature.

A storm of controversy has arisen over new evidence for cannibalism in Anasazi populations of the southwestern United States from the period between 900 and 1200 C.E. White (1992) and the Turners (1999) have identified skeletal remains from a number of populations that lived in the Four Corners area that show clear signs of persistent and regular cannibalism (White, 1992; Turner and Turner, 1999). The controversy has been fueled by the traditional view of these peoples as peaceful and nonviolent and the belief that, if cannibalism did exist, it resulted from periodic famine and hunger, which must have commonly struck prehistoric peoples of the arid Southwest. A new image of these peoples, under the purported cultural influence of Mesoamerican traditions of violence from the south, is one of human sacrifice, cannibalism, and social pathology—quite different from the earlier view.

Cannibalism and Survival

Some of the best-documented examples of cannibalism have been based on the conditions that take place during widespread famines and on accounts of shipwrecked, marooned, or stranded groups of people who have gone for long periods without food. Two of the best-documented of many cases are the pioneer Donner party's isolation in the Sierra Nevada Mountains in the fall and winter of 1846–1847, and the crash of the Uruguayan rugby team in the Chilean Andes in October 1972. In these and other well-documented cases, it is unquestionable that the food acquired by means of cannibalism enabled some individuals to survive rather than starving to death.

A more controversial issue is whether regular cannibalism in groups of people makes the difference between inadequate and adequate dietary intake. The Aztecs of Mexico practiced regular ritual sacrifice of captives and consumed the victims. Michael Harner (1977) and Marvin Harris (1977) argued that this food provided a protein-rich source of nutrients to a large Aztec population that was suffering from limited protein intake due to the absence of Native American domestic animals during pre-Hispanic times. This argument has been countered on the grounds that (1) population density was somewhat lower than estimated and (2) protein sources were available from a variety of plant and wild animal food that, when considered together, provided an adequate protein intake for most of the people.

Garn and Block (1970) argued that the meat yield from an average human body (50 kg) would only provide about 4.0 kg of protein, and that this would meet the daily minimum protein requirements of only sixty adults. However, Dornsteich and Morren (1974) presented a more convincing argument for New Guinea cannibalism in several highland populations. They noted that the consumption of human flesh by the Miyanmin people provided between 5 and 10 percent of the daily intake of protein, which was equivalent to or greater than the protein derived from domestic and feral pig consumption. This basic issue seems to relate to the primary motives that people have for consuming human flesh. It is probably not correct to state that some people practice cannibalism solely as a source of food. There are many other human motives for cannibalism. On the other hand, human tissue has the same nutritional value as any other mammalian tissue when it is eaten, whether by a human or nonhuman predator.

KURU

Kuru can be used as an example of how endocannibalism led to a disastrous epidemic of a degenerative encephalopathic disease, the discovery of a whole class of diseases called prion diseases, a Nobel Prize won by D. Carleton Gajdusek, and the beginning of our understanding of mad cow disease, which led to the mass destruction of livestock in the United Kingdom.

A popular account of the early discovery of kuru is given in a book by Michael Howell and Peter Ford (1985). The Fore people, who live in the central highlands of New Guinea and practiced a form of endocannibalism, were reported to have a disease that had a gradual onset (imbalance) but then progressed rapidly to an inability to stand or sit upright, dementia, and a general neurological deterioration that always ended in death. The Fore attributed the lethal disorder to sorcery, but Western officials believed the epidemic had natural causes, perhaps hysteria. Following work by Vincent Zigas, a district medical officer, and Carleton Gajdusek, a young American scientist, it was discovered that endocannibalism, as practiced by the Fore, contributed to the familial transmission of the infectious agent. By handling and consuming the incompletely cooked remains of the kuru victims, especially the highly infectious brain and nervous tissue, members of the family contracted the disease but did not show symptoms until many years later. The first connection with an animal disease was suggested in 1959 when a veterinary scientist suggested that kuru in humans seemed similar to symptoms of a disease called scrapie that was found in sheep. The most recent epidemic of a prion disease is mad cow disease (bovine spongiform encephalopathy), which is a livestock disease that has been transmitted to humans. This is the second example of a livestock prion disease that has somehow been transformed and become infectious in humans (the first is the probable transmission of scrapie to humans in kuru). Finally, the kuru epidemic in the Fore population was brought to a halt when the Australian government outlawed cannibalism in what is now Papua-New Guinea, and the practice slowly began to decline.

Cannibalism and Disease

The Fore tribe of the highlands of Papua New Guinea was investigated at length beginning in 1957 by D. Carleton Gajdusek, who won a Nobel prize in 1976 for his study of the neurological-degenerative disease kuru, which he determined was caused by human contact with infected human brain tissue. Kuru, Creutzfeldt-Jakob disease, and bovine spongiform encephalopathy are all transmissible spongiform encephalopathies (TSE) and were formerly believed to be caused by a slow virus infection; recent evidence indicates that they are conveyed by proteins called prions. Among the Fore, the principal pattern of contact with infected human tissue was during the mortuary preparation associated with endocannibalistic consumption of dead kin. In 1979 William Arens challenged Gajdusek's explanation for the spread of kuru on the grounds that there were no direct observations of cannibalism in the Fore people.

Whether cannibalism reflects pathological behavior depends on the circumstances of consumption. Starvation cannibalism appears to be tacitly condoned by Western societies, and other societies have sanctioned a variety of exocannibalistic practices. But perhaps the most abhorrent practice is that of sadistic or psychopathological murder and consumption of human tissue. Jeffrey Dahmer is a most recent example. A deranged young man who did not appear to be abnormal, he was arrested in Milwaukee in 1991 for the murder, dismemberment, and partial consumption of seventeen individuals. There are many other examples of such bizarre and pathological behavior in the literature.

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CANNING. *See* **Packaging and Canning.**

CARAMELIZATION.

Caramelization is the familiar browning of sugars through exposure to heat. The most common form of sugar—table sugar or sucrose—is a disaccharide, a combination of two monosaccharides: glucose and fructose. The two sugars can be easily separated using the enzyme invertase, which is essentially what bees do when they make honey from nectar. Fructose caramelizes more readily than glucose, so baked goods made from honey are generally a bit darker than those made with sucrose.

When sugar syrups are heated, they pass through several distinct stages, each having characteristics that are very useful to confectioners. Different sugars reach these stages at varying temperatures. The following table is for sucrose:

Caramelization of sugar begins around 310°F. When it reaches the light caramel stage (at 356°F for sucrose), many complex chemical reactions change simple sugars into a host of different flavoring compounds. Scissions (the breaking of long molecular chains into shorter segments), rearrangements of molecular components, and subsequent reactions between the resulting new compounds all occur in rapid succession. One of the compounds created during caramelization is biacetyl ($C_4H_6O_2$), which has a warm buttery scent, but there are also traces of as many as one hundred sweet, sour, and bitter compounds. The complexity of the resulting mixture makes the flavor of butterscotch more interesting than the mere sweetness of sugar. Of course, a number of yellow and brown water-soluble polymers are also produced, which accounts for caramel's coloration. These polymers are often used as colorants in commercial food products, from colas to soy sauce, and even in the variety of pumpernickel known as "black bread."

TABLE 1

Stages in the caramelization of sugar

Stage	Temperature	Characteristics and uses
All water evaporated	212˚F	Sugar is melted and impurities rise to the surface.
Small Thread	215˚F	No color; cools soft; no flavor change. Used in buttercream frostings.
Large Thread	219˚F	No color; cools soft; no flavor change. Used in preserves.
Small Ball	230–240˚F	No color; cools semisoft; no flavor change. Used in cream candy fillings, Italian meringue, fondants, fudge, and marshmallows.
Large Ball	246–252˚F	No color; cools firm; no flavor change. Used in soft caramels.
Light Crack	264˚F	No color; cools firm; no flavor change. Used in taffy.
Hard Crack	300–331˚F	No color; cools hard; no flavor change. Used in butterscotch and hard candies.
Extrahard Crack	334˚F	Slight color; shatters like glass when cooled; no flavor change. Used in nut brittles and hard candies.
Light Caramel	356˚F	Pale amber to golden brown; rich flavor.
Medium Caramel	356–370˚F	Golden brown to chestnut brown; rich flavor.
Dark Caramel	370–400˚F	Very dark and bitter; smells burned. May be used for coloring, but has little sweetness left.
Black Jack	410˚F	Known to Carême as “monkey’s blood.” At this point, the sugar begins to breaks down to pure carbon.

Many cooks assume that all the browning done in the kitchen is the result of caramelization, and it is common to see recipes that describe the “caramelization” of seared meats. However, that browning is actually the result of another set of chemical processes known, collectively, as the Maillard reaction. Maillard reactions are similar to caramelization, except that they involve the interaction of sugars and proteins—specifically, fructose, lactose, and one form of glucose with the amino acid lysine—at higher temperatures than those at which caramelization occurs. More complex carbohydrates, such as the starches found in flour, will also break down when heated into simpler sugars that can interact with the protein. That is one of the reasons that meats are often dusted with flour or cornstarch before searing. Since the Maillard reaction begins with a greater variety of chemical compounds than is required for caramelization, the resulting chemical complexity is greater. These reactions account for the wonderfully savory browning of baked breads, roasted coffee beans, and some cooked meats. If one considers the three differing flavor and aroma profiles of beef when raw, boiled, or roasted, the satisfyingly complex flavor produced by the Maillard reactions in the roasted meat is immediately apparent.

Crème caramel, dulce de leche, and similar desserts owe their flavor and color to both caramelization and the Maillard reaction. It the case of flan, the sauce for the custard is actually a thin coating of hard caramelized sugar used to line the mold before the custard is cooked—the caramel dissolves in water expressed from the cooked custard. In crème brûlée, the caramel topping remains crisp because it is browned à la minute under a broiler or small hand-held torch. Soft “caramel” candies are usually milk-based products that are merely flavored with caramel (but not brittle as true caramel would be).

Caramelization and Maillard reactions require temperatures that cannot be reached when water is present (the boiling point of water limits the cooking temperature to 212°F or less). Caramelization starts around 310°F, Maillard reactions even higher. When the sap of maple trees is boiled to make syrup, caramelization takes place even in the presence of water—because, while the average temperature is below 310°F, the temperature where the liquid is in contact with the hot metal of the evaporating pan is high enough for caramelization to occur. Similarly, the surfaces of roasted meats become dehydrated during cooking, allowing Maillard browning to take place while the interior remains moist.

These reactions (along with similar effects caused by enzymatic processes) can sometimes lead to undesirable browning. For example, when fruit preserves are prepared, the bright color of the ripe fruit must be maintained. Ascorbic or citric acids interfere with enzymatic browning, so they are typically added to low-acid fruits. Similarly, sulfur dioxide prevents the low-temperature Maillard reactions that often occur when carbohydrates and amino acids are present in high concentrations. Sultanas, or golden raisins, are merely raisins in which natural browning reactions have been prevented by sulfur dioxide.

See also **Candy and Confections; Carême; Dessert; Processing of Food; Sugar and Sweeteners; Syrups.**

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CARBOHYDRATES. Plants manufacture and store carbohydrates as their main source of energy through photosynthesis. Once consumed, these organic compounds can be digested, absorbed, and metabolized, supplying humans or animals with energy. Carbohydrates provide roughly half of the total caloric intake of the average human diet. These calories may be used immediately for energy metabolism or may be transformed and stored as glycogen or fat to be used as an energy source as demanded. Dietary carbohydrates are comprised of a wide array of compounds ranging from the simple one- or two-unit sugars to the long chain starches, glycogen and cellulose. Carbohydrates can be classified as monosaccharides, di- and oligosaccharides, and polysaccharides.

TABLE 1

Carbohydrate classification

Classification	*Number of sugar units***	*Examples*
Monosaccharides	1	Glucose, galactose, fructose
Disaccharides	2	Sucrose, lactose, maltose
Oligosaccharides	2–10	Includes the disaccharides
Polysaccharides	> 10	Glycogen, starch, cellulose

**A "sugar unit" is one monosaccharide—each unit is not necessarily the same monosaccharide. For example, sucrose consists of one glucose unit and one fructose unit.

Monosaccharides, often referred to as simple sugars, are the simplest form of carbohydrates and are seldom found free in nature. The three that can be absorbed by the human body include glucose, galactose, and fructose. Glucose is the most abundant of the monosaccharides and the most important nutritionally. It is the repeating monosaccharide unit in starch, glycogen, and cellulose, and is found in all edible disaccharides.

Oligosaccharides are short chains of monosaccharide units that are joined by glycosidic bonds. They generally have between two to ten units, with the disaccharides, those chains containing two units, being the most abundant. The most common disaccharides include:

Sucrose (from table, cane, and beet sugars), consisting of glucose and fructose
Lactose (from milk sugar), consisting of glucose and galactose
Maltose (from malt sugar), consisting of two glucose units

Polysaccharides are long chains of monosaccharide units. The major polysaccharides include the digestible forms (glycogen and starch) and nondigestible forms (cellulose, hemicellulose, lignin, pectin, and gums).

Starch is the most common digestible polysaccharide found in plants. It can be found in two forms—amylose and amylopectin. Amylose is a linear, unbranched molecule that is bound solely by a-1,4 glycosidic bonds. Amylopectin, which makes up the greatest percent of the total starch content, is branched with a-1,6 bonds at the branch points.

Glycogen is the major storage form of carbohydrates in animals, found primarily in the liver and skeletal muscle. When energy intake exceeds energy expenditure, excess calories from fat, protein, and carbohydrate can be used to form glycogen. It is made up of repeating glucose units and is highly branched. During times of fasting or in between meals, these chains can be broken down to single glucose units and used as an energy source for the body. Although found in animal tissue, animal products do not contain large amounts of glycogen because it is depleted at the time of slaughter due to stress hormones.

Cellulose is the major component of cell walls in plants. Just as starch and glycogen, it too is made up of repeating glucose molecules. However, the glycosidic bonds connecting the units are b-1,4. These bonds are resistant to mammalian digestive enzymes rendering cellulose, and other substances containing these bonds, indigestible. Thus, cellulose is not considered to be a significant source of energy for the body. However, as a fiber, it is important for intestinal bacteria.

Since cellulose is a major part of the plant cell wall, it also encases some of the starch, preventing the digestive enzymes from reaching it and decreasing the digestibility of some raw foods such as potatoes and grains. Cooking causes the granules to swell and also softens and ruptures the cellulose wall, allowing the starch to be digested.

Dietary Fiber

Fiber can be classified as soluble and insoluble. Soluble fiber, which includes pectin and gums, dissolves in water to form a gel in the digestive tract. This increases the time the food is in the small intestine, thus increasing the chance of nutrients being absorbed. It is believed that soluble fiber plays a role in lowering blood LDL cholesterol. This could be due to the binding and increased excretion of fat and bile acid (a derivative of cholesterol) or other mechanisms not yet understood. Bacteria in the bowel can use fiber as a food source. These bacteria can degrade the fiber and release some components that can then be absorbed and used by the body. The increased nutrition for the bacteria can increase microbial growth, which can then lead to increased stool bulk, with little of the fiber actually found in the stool.

Insoluble fiber, including cellulose, hemicellulose, and lignin (a noncarbohydrate component of the cell wall that is often included as dietary fiber), absorbs water, thereby increasing the bulk and volume of the stool. It helps to speed the movement through the intestinal tract, preventing constipation, and is prescribed in the treatment of irritable bowel syndrome. It has also been shown that insoluble fibers bind fat-soluble carcinogens and remove them from the gastrointestinal tract, helping to decrease cancer risk.

Refined and processed foods have not only most of the fiber removed, but along with it many of the vitamins, minerals, and phytochemicals (chemicals found in plants believed to contain protective properties) that contribute to the health benefits of whole grain foods. The federal government's Dietary Guidelines for Americans encourage individuals to include whole grain foods in their diet to ensure adequate fiber to promote proper bowel function, as well as to receive other added health benefits.

Digestion, Absorption, and Transportation

In order for carbohydrates to be absorbed by the intestinal mucosal cells, they must first be converted into monosaccharides. The digestive process begins in the mouth with salivary a-amylase that partially breaks down starch by hydrolyzing some of the a-1,4 bonds. However, the digestion that takes place here is of little significance since food remains in the mouth for only a brief period, although this may differ depending on chewing time. The enzyme continues to work for a short time in the stomach until the pH is lowered due to hydrochloric acid that inhibits the enzyme.

TABLE 2

Examples of carbohydrate food sources

Monosaccharides

Glucose	Fructose	Galactose
Fruit Vegetables Honey	High-fructose corn syrup Honey Fruit	Milk Milk products

Disaccharides

Sucrose	Lactose	Maltose
Table sugar Maple sugar Fruit Vegetables Honey	Milk Milk products	Beer Malt liquor

Polysaccharides

Starch (rye, oats, wheat, rice, potatoes, legumes, cereals, bread)

Dietary Fiber

Soluble

Pectin	Gums
Fruits (apples, berries) Jams and jellies (additive)	Oats, barley Ice cream (additive) Legumes

Insoluble

Cellulose	Hemicellulose	Lignin
Whole wheat foods Bran Leafy vegetables	Whole grains	Fruit Seeds Bran, wheat Vegetables

STARCH

Starch from plants makes up about half of our dietary carbohydrates. Starch molecules can aggregate to form granules that differ by size and shape depending on the source of the starch, for example, corn, potato, and manioc. Although there is no difference in the nutritional value between the starches since all cooked starches are broken down in the body into glucose molecules, they do differ by characteristics such as solubility, flavor, and thickening power. Because of these characteristics, starch is often removed from the source to use commercially. For example, the starch can be removed from tubers such as potatoes and manioc (also known as cassava) through a wet milling process, or in the case of manioc, through leaching and drying. The potato starch is often used as a thickener or instead of cornstarch in recipes, while manioc is best known as tapioca.

The bulk of carbohydrate digestion occurs in the small intestine by pancreatic a-amylase. The pH of the small intestines is increased due to the addition of bicarbonate and bile, allowing the enzyme activity to occur. Specific disaccharidases located on the intestinal mucosal cells help to further break down the carbohydrates into the monosaccharides: glucose, fructose, and galactose.

Once the carbohydrates have been broken down, the monosaccharides can be absorbed by the mucosal cells. Glucose and galactose enter by active transport, which requires energy as well as specific receptors and carriers. Fructose is absorbed by facilitated diffusion. Like active transport, facilitated diffusion requires a specific carrier, but instead of needing energy, it relies on the low levels of fructose inside the cell to "pull" the fructose inside. Once transported through the intestinal wall, the monosaccharides enter the blood through the capillaries and are carried to the portal circulation and then to the liver.

Metabolism of Carbohydrates

The liver is the major site of galactose and fructose metabolism, where they are taken up, converted to glucose derivatives, and either stored as liver glycogen or used for energy immediately when needed. Although glucose is metabolized extensively in the liver, unlike galactose and fructose, it is also passed into the blood supply to be used by other tissues. Tissues like skeletal muscle and adipose tissue depend on insulin for glucose uptake, whereas the brain and liver do not. This dependence on insulin becomes a problem for diabetics who either cannot make insulin

(IDDM) or are resistent to insulin (NIDDM). For individuals left untreated, dietary carbohydrates cause glucose levels to rise, resulting in hyperglycemia, which will lead to serious consequences if steps are not taken to correct it.

Once in the tissues, the fate of glucose depends on the energy demands of the body. Glucose can be metabolized through the glycolysis pathway to pyruvate where it is either converted to lactate or completely oxidized to CO_2, H_2O, and energy. Liver and skeletal muscle can convert excess glucose to glycogen through a pathway known as glycogenesis. The glycogen is stored after meals to be used as an energy source when energy demands are higher than intake. At this time the glycogen is broken down into individual glucose units, a process known as glycogenolysis, and the glucose can be metabolized further. Excess carbohydrates also can be used as a substrate for fat synthesis.

Carbohydrates are an essential part of a healthy diet. They provide an easily available energy source, are an important vehicle for micronutrients and phytochemicals, help to maintain adequate blood glucose, and are important in maintaining the integrity and function of the gastrointestinal tract. Table 2 contains examples of foods that contain the various types of carbohydrates.

See also **Digestion**; **Fiber, Dietary**; **Starch**.

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CARDIOVASCULAR DISEASES. *See* **Health and Disease.**

CARÊME, MARIE ANTOINE.

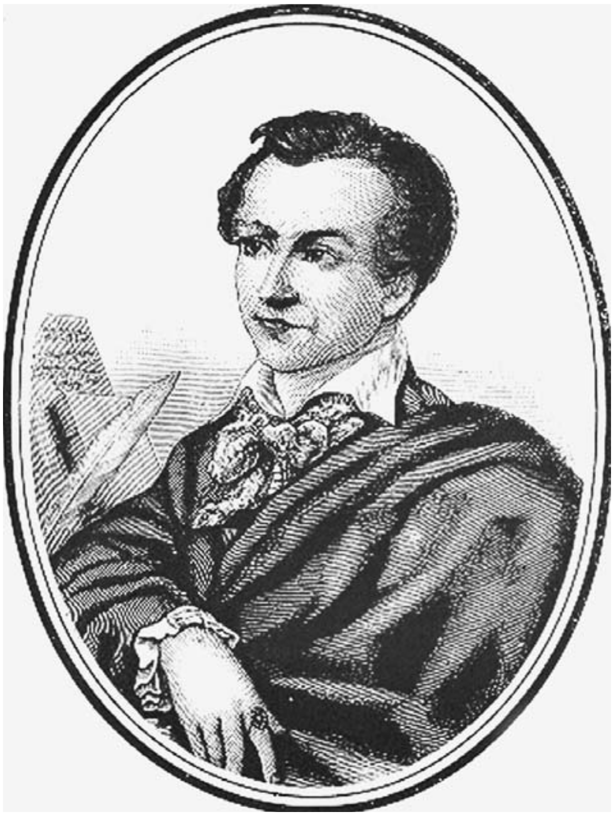
Marie Antoine Carême was born into a working class family in Paris in 1784. When he died in 1833, he was recognized as the greatest chef of his time, and his name was familiar to the rich and famous throughout Europe.

Carême's colleagues, and the public at large, first discovered his talents with the publication of *Le Pâtissier royal parisien* in 1815. It was only the third French treatise devoted entirely to French pastry, following *Le Pâtissier françois* (1653) and *La Pâtisserie de santé* (1790). Carême's approach to pastry was innovative in more than one way. Not only did he perfect and diversify the uses of now classic preparations, such as *génoise* and *biscuit* (sponge cakes) or cream puff pastry, but appears to be the first to give recipes for *fromage bavarois* (pastry cream lightened with whipped cream and stiffened with gelatin) and its elegant derivative, the *Charlotte russe*.

In addition to presenting a far greater number of preparations than his predecessors, *Le Pâtissier royal parisien* was also one of the first to include a profusion of engraved plates throughout. Until then, French cookbooks contained very few illustrations, and when they did, they were almost exclusively devoted to table settings, some of which, nevertheless, included instructions for building very elaborate centerpieces for dessert tables. Carême's engravings, on the other hand, were for finished dishes. To the modern eye, they look less like pictures of food than elaborate architectural constructions: temples, helmets, waterfalls, all made of cooked sugar, almond paste, nougatine, and so on, to serve not only as centerpieces, but also as presentation pedestals for his elaborate pâtés and desserts. For Carême, the way food was served was as important as the way it tasted. He criticizes the way his predecessors seasoned and served "mountains of food," and he even attacks the size and shape of the china they employed.

In his great work on cookery, *L'art de la cuisine française au XIXe siècle* (1847), Carême carries his love of extravagant decoration to new heights for savory dishes, as well, standing cutlets and poultry on end and presenting them in a circle, turban style, or sticking whole fish and roasts with a wide array of decorative skewers garnished with truffles, crayfish, and mushrooms. More important, he entirely revamps the art of cookery itself, arguing, among other things, for a cuisine based on "velvety" sauces, rather than the thin, watery sauces favored in the past and for developing a series of basic preparations (brown and white sauces, court-bouillons, forcemeats, etc.) that would become the building blocks of classic French cuisine upon which entire families of preparations could be constructed by combining them or changing the main ingredient or a flavoring.

Despite all of his modernism, Carême preferred the monumental *service à la française*—in which all the dishes of a given course were placed on the table at once—to the newly-introduced *service à la russe*, in which they were kept hot in the kitchen, then served sequentially from platters passed by waiters. "Certainly this method of serving is conducive to good eating," he wrote, "but our ser-



Portrait of Marie Antoine Carême, from a nineteenth-century wood engraving. ROUGHWOOD COLLECTION.

vice *à la française* is more elegant and lavish." His influence on French cuisine was enormous, and succeeding generations of chefs continued in the paths he had traced. It was not until 1903, when Auguste Escoffier published his *Guide Culinaire*, that Carême's authority was finally challenged, but his name is revered to this day as a great master whose contributions irrevocably shaped the course of French cuisine.

See also **France,** *subentries on* **Food and Cuisine in France** *and* **Tradition and Change in French Cuisine.**

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Mary Hyman
Philip Hyman

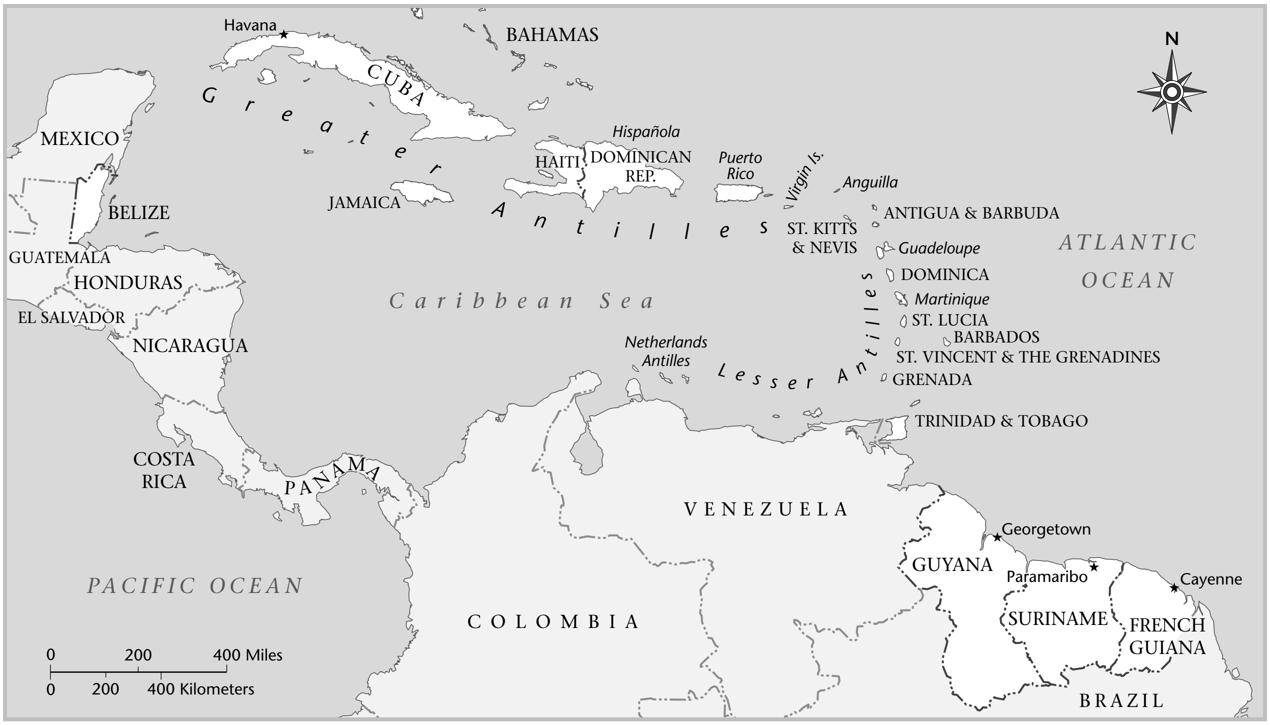
CARIBBEAN. The Caribbean is generally thought to include the Greater and Lesser Antilles in the Caribbean Sea, as well as the mainland French Guiana, Guyana (formerly colonial British Guiana), and Suriname (formerly Dutch Guiana) in South America, and the Central American nation of Belize (formerly British Honduras). It is a geographic nexus between Old and New Worlds, and as such has been global since its inception as a region. Boasting no distinguishable population of direct pre-Columbian descendants apart from a small Carib community in Dominica, its inhabitants are otherwise composed of a highly diverse ethnic and cultural mix of descendants from the Americas, Africa, Europe, and Asia.

Spain was the initial colonizer of the entire Caribbean, but contiguous Spanish settlement in the Caribbean was limited largely to Puerto Rico, the Dominican Republic, and Cuba. Still, one should talk of the Caribbean as a region distinct from Latin America. The Spanish Caribbean islands have been shaped by experiences similar to those of their non-Spanish neighbors. While their cultural connections to Latin America are apparent—in language, culture generally, and perhaps in political philosophy—their Caribbean experience of slavery, plantation agriculture, and the rise of peasantries accord more with the Antilles. It is food (sugar in particular, but also coffee, cocoa, citrus, spices, and bananas), and not language that culturally unifies the Caribbean as a region historically.

Caribbean food, like the people who have come to inhabit the region, is not homogeneous, nor can we accurately talk about an indigenous diet without accounting for the effects of the Columbian conquest of the Americas. There were indigenous American food plants and tobacco, but there were also scores of new cultivars, from Africa, Europe, and Asia, as well as domesticated animals, which played a major role in the constitution of the region after 1492. But these two categories were not, however, isomorphic with the categories of domestically consumed and exported categories of post-conquest Caribbean food products. Instead, there are two categories of Caribbean food that better account for its history as a region. One encompasses those products that are responsible for constituting the region through a transatlantic system of trade. These products shape the way in which the region is defined by European and North American tastes. The other includes products grown as a direct response to the rigidities of this global system through culturally elaborated alternative systems of production, exchange, and consumption.

Repopulating the Region: Foundations of Exploration and Imperialism

Before the seventeenth century, the rights of Spain and Portugal to have colonial monopolies were established by several papal decrees issued in the fifteenth century. *Inter Coetera* of Pope Calixte III in 1456 gave Portugal the right to colonize lands "discovered" while circumnavi-


Havana
BAHAMAS
CUBA
Greater Antilles
MEXICO
BELIZE
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
JAMAICA
Hispañola
HAITI
DOMINICAN REP.
Puerto Rico
Virgin Is.
Anguilla
ANTIGUA & BARBUDA
ST. KITTS & NEVIS
Guadeloupe
DOMINICA
Martinique
ST. LUCIA
BARBADOS
ST. VINCENT & THE GRENADINES
GRENADA
TRINIDAD & TOBAGO
Lesser Antilles
Netherlands Antilles
Caribbean Sea
ATLANTIC OCEAN
PACIFIC OCEAN
VENEZUELA
COLOMBIA
GUYANA
Georgetown
Paramaribo
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gating Africa on South Asian exploration. Later bulls, for instance *Inter Coetera II* of Alexander VI in 1493, affirmed Spanish rights to colonization west of the Azores. Colonization rights, as conveyed by God's earthly representative, were in effect divided hemispherically. The 1493 Tordesillas Treaty, for instance, recognized Portuguese colonization rights up to 270 leagues west of the Azores, thus establishing Brazil as Portuguese but the rest of what is now regarded as the Caribbean and Latin America as Spanish (Mudimbe, 1995).

A common denominator in Spanish and Portuguese colonization should be noted. *Rominus Pontifex*, a papal bull of Nicolas V in 1454, is explicit that the central mission of colonization was proselytization. Non-Christians could be dispossessed of their lands under the doctrine of *terra nullius* (no man's land) or even killed for resisting conversion to Christianity. In fact, as Valentin Mudimbe has documented well in his study of these papal instruments, "if [colonial subjects] failed to accept the 'truth' and, politically, to become 'colonized,' it was not only legal but also an act of faith and a religious duty for the colonizers to kill the natives" (Mudimbe, 1995, p. 61). The grounding of New World colonization by the Spanish in such a religious dictum is responsible in part for the violent character of transatlantic contact, both in the Caribbean region and in mainland Latin America. Disease (particularly smallpox), genocide, and enslavement eliminated most of the indigenous populations of the larger settled islands by the end of the sixteenth century. Beginning in the seventeenth century, settlements by other European nations had a similar effect on the smaller islands of the Lesser Antilles. Today, only the small eastern Caribbean island of Dominica boasts any bona fide "Carib" Indian population, amounting to no more than two thousand persons.

Spanish settlements had been established, mainly on the islands of Hispaniola and Cuba. A production system using Amerindian slave labor was attempted, but after subsequent failures, some slaves were imported from Africa. Still, within seventy-five years, these settlements had become largely peasant-oriented and insular. Spain had turned its attention to the mainland of Latin America, pursuing a policy of resource (particularly gold) extraction. In the early seventeenth century, various European nations began to challenge Spain's monopoly on colonization in the Americas on the grounds that many of the islands claimed by Spain were not, nor had they ever been, occupied by Spain. British, French, Dutch, Danish, and Swedish explorers began to settle the smaller islands of the Lesser Antilles. Though the colonizers differed, there was one common trait on these newly settled lands—the plantation.

The Sweet Taste of Colonialism

Columbus's inadvertent happening onto the Americas in 1492 is responsible for a shift of Europe's center from thalassic (focused on the Mediterranean Sea) to oceanic (focused particularly on the Atlantic) (Mintz 1991, p. 112). McNeill has noted the impact of this shift on Europe:

> The principal historical impact of the American food crops, I suggest, was that they undergirded Europe's rise to world dominion between the eighteenth and

> twentieth centuries. No other continent of the Old World profited so greatly. That was because Europe's climate, and especially its comparatively abundant rainfall, fitted the needs of the American food crops better than anywhere else, except China; and in China rice was so productive that the new crops had less to offer than potatoes and maize did in Europe" (McNeill, 1991, p. 52).

The Peruvian potato, for instance, was extraordinarily important to Europe, as it produced four times the caloric intake of rye bread. Potatoes never replaced grain completely: they do not store nearly as well as grain. But the efficient use of acreage is credited with population booms in Germany and Russia and the quick adoption of industry each experienced.

The constitution of an Atlantic epicenter is reflected not merely in the exchange of commodities between the Old and New Worlds. It is defined by the manner in which the demands made by Europe's growing populations were accommodated. Taste is essentially what defined the Caribbean as a region. The Caribbean provided a hospitable climate for the cultivation of sugar cane, particularly on the flatter, drier islands of the Antilles and coastal South America. The Spanish had initially developed sugar cane production in Cuba in the seventeenth century (Ortiz, 1947) but had not taken an interest in the mass production of the product. British colonization in the sixteenth century began to exploit sugar cane production using existing regional techniques, as well as methods learned from the Dutch occupation of Brazilian sugar estates. French interest in sugar production quickly followed and was equally influential by the eighteenth century. What was most significant about sugar was not the growing pancolonial interest in the cultivation of another New World commodity, but its rapid transformation from a luxury item to a sweet, tempting product demanded by a growing European working class: "…as sugar became cheaper and more plentiful, its potency as a symbol of power declined while its potency as a source of profit gradually increased" (Mintz, 1985, p. 95).

Production of sugar in the Caribbean multiplied to keep up with metropolitan demand. The need for a cheap source of physical labor led to the forced relocation of at least five million African slaves to the Caribbean during this same period. Revolts, slave maroonage (flight from plantations followed by the establishment of communities in remote terrains), and other forms of resistance both on the slave ships and in the colonies did little to slow European expansion of the sugar industry. In fact, at the time that Western Europe began to industrialize in the late eighteenth century, the importation of slaves to the Caribbean, particularly to the French colony of Saint-Domingue on the western third of the island of Hispaniola, was at its highest. Saint-Domingue was so valuable a colony to the French that at the Treaty of Paris they ceded their entire claim to Eastern Canada (now Quebec) in exchange for retaining it, Martinique, and Guadeloupe. During a protracted conflict of 1791 to 1803 in this colony, which in 1804 would be declared the republic of Haiti by revolting slaves, France and England both endured enormous military losses. France lost nineteen generals, including Leclerc, the husband of Napoleon's own sister Pauline, in the conflict. The "unthinkability" of losing the Haitian Revolution helps explain the silence on the subject in West European and American historiography (Trouillot, 1995). It was the profitability of Caribbean sugar colonies that had shaped the military and economic might of Europe generally and of France and England in particular.

Following the loss of Saint-Domingue, France retracted its New World interests, selling its remaining North American claims to the newly formed United States under the Louisiana Purchase in 1803. Britain's interest in sugar cane production declined along with global prices in the late nineteenth century, as beet sugar production proved more profitable. Prior to its contraction, however, the British employed a number of labor management devices aimed at reducing the costs of labor on their plantations. Between the end of apprenticeship in 1838 and 1917, about 500,000 East Indians were brought, mainly as indentured laborers, into the Caribbean (Williams, 1970, p. 348). The cultural influence is particularly strong where the concentrations of Indians were highest, in Trinidad and Guyana. Chinese laborers were brought, particularly to Cuba. Javanese were brought to Surinam, and African indentured servants to the French West Indies as well.

By the mid-nineteenth century, Cuba emerged as the dominant sugar producer in the Americas. Cuban reintegration into sugar production had begun following the British occupation of Havana in 1762 and the concomitant massive importation of slave labor into Cuba by enterprising merchants. Sugar production in Cuba essentially demonstrates an adaptation of the plantation system to a transition from mercantilist to capitalist interests in the New World. American merchant interests in the Cuban sugar industry developed throughout the nineteenth century and serve to explain, in part, American military intervention in the Cuban-Spanish War in 1898.

American military and financial involvement in Cuba thereafter typifies the manner in which foreign tastes shape the Caribbean's definition as an area in the twenty-first century. Rather than merely serving to satiate the European taste for sugar, the region has been used to satisfy new tastes: for sun, sex, and sin. The elimination of tropical diseases from the Caribbean by the early twentieth century, coupled with the devastation of Europe during World War I, made the Caribbean an attractive tourist destination. Casinos, brothels, and beaches were set up specifically to pander to North American and European interests.

A foreign traveler to the Caribbean is likely to come into contact with a broad range of dishes professing to be authentic in character. Most food produced for tourists reflects the particular tradition of transatlantic shipping from which these contemporary relations emerge: imported goods today compared to the dry provisions of the colonial period; Bacardi, yet another imported rum consumed over locally produced brands. Even the origins of the Daiquirí come from a drink that was consumed on slave ships to prevent scurvy: it was the name of the place where soldiers from the United States first tasted it (Ortiz, 1947, p. 25). As much as Europe's addiction to sugar defined the Caribbean culturally as a region from the seventeenth to the nineteenth centuries, so too does this new addiction affect it today. Even the concept of a Caribbean nation itself must endure the hungers of North American college students on spring breaks, en route to a "Bacardi Nation" that has petitioned for United Nations membership (Cohen, 1998).

Biting Back: Local Food Economies

Perhaps the most contentious debate among contemporary scholars of the Caribbean concerns the origins of the region's cultural influences. Many argue that African cultural influences define the region culturally (Herskovits, 1990; Brathwaite, 1993). Others have suggested the rigidities of the colonial system were so severe as to preclude the survival of any culture (Frazier, 1966). But one thing can be said about the Caribbean over any other region of the world. The Caribbean embodies all of the elements of what we today might call globalization: rapidity and movement of labor and capital; the amalgamation and negotiation of diverse and worldly cultural influences; and integral development of technology and communications. This, however, should not imply that the region is more culturally manufactured than other regions of the world, or that the late establishment of formal national or regional identities (beginning with the failed West Indies Federation from 1958–1962) is reflected in a lack of cultural distinctiveness. A few scholars have correctly noted that the Caribbean is best defined culturally through processes negotiated by its own inhabitants, and not determined by the mere movement of one or another traits from Europe, or Africa or Asia, to the region (Mintz and Price, 1992; Scott, 1991).

Inasmuch as the plantation system sought to define its inserted inhabitants in the Caribbean region as a monolithically defined production matrix, there were responses in the production, exchange, and consumption of food. Plantation owners were required by the late seventeenth century to provide rations to their slaves, but these tended to be inadequate. Slaves responded by establishing their own provision grounds adjacent to the plantations, on which they grew a wide range of products, not only for their own consumption but for sale as well (Mintz, 1978a; Mintz, 1978b; Gaspar, 1991; Mintz, 1995). So important were these provision grounds that some even revolted to keep them. The 1831 abolition of the Sunday market for the barter and exchange of slave-produced goods in Antigua sparked uprisings and the burning of several plantations (Gaspar, 1991). During the early years of the Haitian Revolution, "the leaders of the rebellion did not ask for an abstractly couched 'freedom.' Rather, their most sweeping demands included three days a week to work on their own gardens and the elimination of the whip" (Trouillot, 1995, p. 103).

Often the surplus of these gardens was sold in slave markets, some reaching off-island destinations. Though the available historical record seems unwilling to acknowledge the fact, slaves were, in a strict sense internationally mobile. Market women ("hucksters" in the Eastern Caribbean, "higglers" in Jamaica, "Madan Sara" in Haiti) would traffic agricultural products both in local markets and to other islands in the region, either individually or through third parties. An eighteenth-century soldier's diary establishes that nonproduce, even manufactured items—including textiles, "syrup beer and a country drink called mawbey" (Aytoun, 1984, p. 28)—are being exchanged in local markets in the small Eastern Caribbean island of Dominica by these market women, and legitimated through the payment of an often hefty fee to their owners. The ability of the market women to meet this fee (rumored to be as much as a dollar and a half a week—an immense sum by the standards of the day) in cash payments suggests that slave markets were significantly broader than the historical record has typically suggested. Dry goods such as rice, wheat flour, beans, corn, and salted meats we know were imported, both from Europe and the United States, except during interruptions caused by the American Revolution. Similarly, a number of agricultural products were being cultivated on provision grounds: "ground provisions" (tubers, including yams, potatoes, dasheen, tannia, eddoes), citrus, bananas and plantains, breadfruit, cassava (the flour of which is used to make farina), and various herbs, used as a spice, for medicinal purposes, and in Obeah, Voudun, and other Afro-Caribbean religious ceremonies, particularly as a poison against slavemasters and in rebellions.

Until emerging national governments established and enforced customs regulations in the 1960s, the regional circulation of agricultural produce and dry provisions remained primarily a locally constituted economy. Ascendant merchants and entrepreneurs following emancipation began to formalize the importation of dry and canned goods in particular. Local agricultural products continue to have symbolic meanings that reflect the historic articulation of ground provision production with the transatlantic plantation system. In islands where certain agricultural products are abundant, it is not uncommon to see surpluses of certain products—bananas and breadfruit are common in the Eastern Caribbean for instance—given away rather than sold. Land, no matter how small in area, has enormous meaning "as a symbol of personhood, prestige, security, and freedom for descendants of former slaves in the face of plantation-engendered land scarcity" (Besson, 1987, p.15). The South Asian and Far

Eastern contemporary cultural and cuisine influences—for instance in the curry dishes, such as the *roti* associated with Trinidad, Guyana, and Jamaica but abundant through the Caribbean—are in fact the result of colonial responses to labor shortages on plantations following emancipation. British emancipation implemented a four-year period of apprenticeship designed to reorient slaves to wage labor. Yet freed slaves continued to demonstrate a stronger desire to work provision grounds.

An interesting case in which the attachment to provision grounds and transatlantic production intersect involves the emergence of the Eastern Caribbean banana economies from the 1950s onward. Bananas, produced mainly in Dominica, St. Lucia, St. Vincent and The Grenadines, and Grenada, were under exclusive license for sale to Britain during this period. Farmers, most of whom were cultivating plots of no more than a few acres, were required to produce exclusively for sale in British supermarkets in exchange for guaranteed markets. Trouillot has noted the reluctance of Dominican banana farmers to diversify their production cycles because of the symbolic qualities that bananas impart: "We can always eat our fig" was the response. While still green, bananas are a starch, and thus an excellent carbohydrate source. Green bananas (or "fig") are frequently used in local Caribbean cooking, as a porridge, used with other ground provisions in a stew (*bouyon*), or even used in certain festive cooking dishes, for instance in *sankouche* (with salted codfish, Creole, and curry seasonings). Bananas require about nine months to come to fruition, and the comparisons to a child's gestation period are sometimes invoked in the care of banana plants.

Gobbling Globalization and Globalization Gobbled

Despite an ideological commitment to local produce, and the proactivity of some small-scale producers, Caribbean tastes are hardly defined by some kind of peasant ethic or veneration of local products. Tubers, once key carbohydrates in the Caribbean diet, are declining in importance. And while even the most prototypical of Caribbean dishes have always to some extent been the product of a Creolization (blending) of locally grown products with imported items such as salted codfish, rice, and flour, imported items, particularly canned items, are gaining as status symbols. Former Jamaican Prime Minister Michael Manley once lamented: "How can we build agriculture if our middle class believes it will surely rot if it can't buy tin mushrooms from abroad?" (Manley, 1988, p. 37). Monetary remittances from Caribbean persons living and working in more lucrative wage employment in Europe, Canada, and the United States has a long tradition in the Caribbean, and has been responsible for infusing cash into these economies. More recently, the remittance of actual packaged food products is becoming more prevalent (Palacio, 1991).

The retention of land, particularly for agricultural purposes, by small-scale producers and plantations alike, continues to be under threat, not just by hurricanes, agricultural diseases, and declining prices for many agricultural products, but by a growing nonagricultural sector. Plantations have declined in importance through most of the Caribbean during the last century, and, accordingly, many former estates have been sold off. Supplementing one's wages on a plantation with the maintenance of a provision garden has thus become increasingly difficult. Golf courses, mining expeditions, and hotel development not only acquire or degrade land, but draw Caribbeans into low-paying service-sector wage positions, making them "a stranger in we own land" (Pattullo, 1996). As labor has gradually been drawn out of the agricultural sector, and land for gardens is increasingly abandoned, sold, or not maintained, many Caribbean people have become increasingly reliant on wages in a highly volatile and unstable service sector to buy these packaged, imported food items.

Local cuisine in some ways has become increasingly foreignized, not merely by the inclusion of foreign products in Caribbean diets, which has always occurred in varying degrees, but through substantial changes in the ways in which Caribbean fare is internationally recognized. Foreign investment interests increasingly appropriate local cuisine for commercial purposes. Hotels throughout the Caribbean are notorious for hiring European chefs to cook "authentic" Caribbean dishes, which are often flashy reinterpretations or fusions of Caribbean fare—*accras* (fried codfish) are marked up as much as ten times in price in foreign owned restaurants for the mere addition of tartar sauce. And the local dishes historically consumed by Caribbean people are likewise affected by these changes. Fried chicken is now ubiquitous, so much so that Kentucky Fried Chicken is the only franchise on many of the more sparsely populated islands. The longest lines in any Caribbean capital will be at the fast-food chains. Locally, Ovaltine has far more cachet than the Blue Mountain Coffee of Jamaica sought by upper-class American consumers. And apart from national celebrations in which folk recipes predominate, most celebrations throughout the Caribbean are overcome by, as some complain, "rum and coke and smoke," the smoke being from the barbecue.

Despite the dramatic changes to Caribbean food through the postwar period of modernization and international development, local responses to these changes continue to be informed by an ongoing process of Creolization. Foreign phenomena continue to be incorporated into local dishes. *Peleau* (a specifically Creole dish, but ostensibly the same rice and beans–based dish found throughout the Caribbean) was once regarded in the Eastern Caribbean as a dish that usually included fish. Declining fishery production and the rapid growth of frozen chicken imports have changed the content but not the underlying Caribbean form. Caribbean food has established its distinctiveness historically by creatively and strategically incorporating diverse elements into a localized answer to the rigidities imposed by foreign consumer demands.

See also **Africa**; **Banana and Plantain**; **Central America**; **France**; **Fruit**; **Iberian Peninsula**; **Potato**; **South America; United States: African American Foodways**.

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Jeffrey W. Mantz

CASSAVA. Cassava, or manioc (*Manihot esculenta*), is a root crop native to tropical America that is now consumed by millions of people throughout the tropics, and is used in food preparation in many industrialized processes. Although it is not well known outside the tropics, cassava now accounts for about 30 percent of the world production of roots and tubers. It is an exceptional producer of carbohydrates and a plant better able to tolerate seasonal drought than other major food crops.

Plant Biology

The cassava plant is a perennial woody shrub that grows from about one to three meters in height. The leaves are palmate (hand-shaped) and dark green in color. The cone-shaped roots are starch storage organs covered with a papery bark and a pink to white cortex. The flesh ranges from bright white to soft yellow. Over five thousand varieties of cassava are known, each of which has its own distinctive qualities and is adapted to different environmental conditions.

The cassava plant is hardy and better able to tolerate drought and poor soil conditions than most other food plants. It can grow in extremely poor, acidic soils because it forms a symbiotic association with soil fungi (mycorrhizae). It is also one of the most productive food plants in terms of carbohydrate production per unit of land, and unequalled in its ability to recover when foliage is lost or damaged by diseases or pests.

The cassava plant is somewhat unusual, and even infamous, because both the roots and leaves can be toxic to consume. The toxicity of cassava is due to the presence of cyanogenic glucosides (compounds of cyanide and glucose) which liberate hydrogen cyanide (HCN)), a potent toxin, when the plant tissue is damaged. Cyanogenic glucosides are found throughout the plant and in all varieties of cassava. Varieties referred to as "sweet," or low-cyanide, have low levels of cyanogenic glucosides in the flesh of the root and can be peeled and cooked like other root vegetables. Those referred to as "bitter," or high-cyanide, have higher levels of cyanogenic glucosides throughout the root (peel and flesh) and require more extensive processing before they are safe to consume. A number of different processing techniques are used (grating, fermenting, sun drying), all of which serve to damage the plant tissue and hence cause the liberation and volitalization of HCN. The potential toxicity of cassava foods depends on the effectiveness of processing and preparation techniques; high-cyanide roots can be processed to remove all most all traces of cyanide-containing compounds. Many farmers prefer to cultivate the high-cyanide varieties for reasons that are not entirely clear.

History

Cassava was domesticated sometime in the distant past, maybe five thousand years ago. Exactly where is not known, but the current consensus is that domestication took place somewhere in Central or South America, perhaps along the southern border of Brazil, where wild relatives of cassava are currently found.

Cassava was the staple crop of the Amerindians of South America when the Portuguese arrived in 1500 just south of what is known as Bahia, Brazil. The Amerindians living in the area were the Tupinamba, who relied on cassava as a dietary staple, processing it into bread and meal using techniques similar to those still used by Amerindians in the twenty-first century.

When the Portuguese began to import slaves from Africa in about 1550, they used cassava in the form of meal (farinha) to provision their ships and began cultivating cassava at their stations along the coast of West Africa soon afterward. From their stations near the mouth of the Congo River, cassava diffused to all of central Africa. The Portuguese were also responsible for introducing cassava to East Africa, Madagascar, India, Ceylon, Malaya, and Indonesia by the 1700s.

Cassava was probably first introduced into Asia during Spanish occupation of the Philippines and was distributed throughout tropical Asia by the beginning of the nineteenth century. Expansion of cassava cultivation was pushed by colonial administrators who saw cassava as a famine reserve (especially the Dutch in Java, and the British in India), and as an export commodity (Malaya and Java in the 1850s).

Procurement and Production

Cassava is typically grown by small-scale farmers using traditional methods, and farming on marginal lands not well suited to other crops. It is propagated by planting stakes cut from the woody stems of mature plants. These plantings require adequate moisture during the first two to three months, but after that they are relatively drought resistant. Cassava roots mature to harvestable size in six to twelve months depending on variety and ecological conditions, and can be harvested at any time in the following two years, a harvest window that provides farmers an unusual degree of flexibility. To harvest the plants, farmers typically cut off the top three-quarters of the plant, and then pull up the roots and separate them from one another. Mechanical harvesting is still relatively rare.

Because fresh cassava roots deteriorate rapidly (within three to four days) after harvesting, they are usually consumed immediately or processed into a form that has better storage characteristics. Fresh roots (low-cyanide) destined for distant markets can be sealed in wax, packaged in plastic bags, or frozen to prevent deterioration. Leaves can be harvested at any stage of the growth of the plant, but typically only the youngest leaves are picked. The leaves deteriorate rapidly after harvesting and so are generally cooked the same day.

Cassava Foods

Cassava roots are prepared into an amazing variety of foods. Traditional preparation techniques vary by region, and by ethnic group within a given region.

South America. For Amerindians, the most common ways of preparing high-cyanide cassava were as a bread (*casabe*, *cazabe*, *beiju*), a roasted granular meal (*fariña*, farinha), and as a beer (*chicha*). In the northwest Amazon the bread is a large, thick (one inch or more) flat bread made by peeling and grating the roots, and then sieving the grated mash with water to separate the liquids and starch from the more fibrous portion. The starch is allowed to settle, and the liquids decanted off the top, then boiled to make a drink (*manicuera*). The starch and fibrous portion of the roots are stored separately and allowed to ferment for forty-eight hours before being dewatered, and then recombined and baked on a large clay griddle. In Venezuela and Guyana the bread is a thinner, hardtack-like bread made without the starch extraction step.

Farinha is made by soaking the roots of yellow-fleshed, high-cyanide varieties in water until they ferment. The roots are then peeled, grated, mixed with fresh grated roots and the mixture allowed to ferment for a week or more. The mash is then dewatered, sprinkled onto a hot griddle, and roasted while being stirred. The resulting product is a dry granular meal that can be stored almost indefinitely. It is most commonly consumed as *chive*, a drink that is made by putting a handful of meal in water and swirling to mix. Well-made meal can expand five times in volume and results in a full feeling.

Cassava bread being baked on a stone griddle at Dritabiki, Suriname. The bread, which is drying in the sun in the foreground, is paper-thin and brittle when eaten. Among the Djuka peoples of Suriname, the bread is crumbled to make a dried cereal called *kwak*. © ADAM WOOLFITT/CORBIS.

Chicha, a mildly alcoholic beer, is made from both low-cyanide and high-cyanide cassava. With low-cyanide varieties it is prepared by peeling, cooking, and mashing the roots, then adding water and some masticated roots and allowing the mixture to ferment. With high-cyanide varieties it is prepared from *manicuera* (the cooked juices) and a very thin bread, some of which is masticated, and other cooked roots or tubers.

In the national cuisines of South America, low-cyanide cassava is used as a vegetable (boiled, or boiled and fried). In Brazil, farinha is part of a number of traditional dishes, and in Colombia several breads are made with the fermented starch of high-cyanide cassava.

Africa. Cassava is the second most important food crop in sub-Saharan Africa. The majority of the cassava-based foods made in Africa rely on fermentation in one form or another. Two common products are *gari*, a granular meal similar to farinha, and *fufu*, a sticky dough made by pounding cooked or fermented roots into a paste. Other products include *chikwange* or *baton de manioc*, a steamed/boiled paste made from soaked roots, and *lafun*, a flour made from soaked roots.

Asia. Cassava roots are prepared in most Asian countries by boiling, baking, and frying. Another widespread practice is to peel, slice, and sun dry the roots and then grind them into a flour. The flour is then used to make porridge, or other traditional foods like *chappatis* and *dosas* (India), *bibingka* (Philippines), and a rice-like product called *landong* (Philippines). Commercially produced cassava starch is exported as tapioca.

South Pacific. Boiling and baking are the most common techniques for preparing cassava roots. On some islands cassava is also used to prepare *ma*, a traditional fermented product typically made from breadfruit.

North America and Europe. The pure starch, or tapioca, extracted from cassava roots is commercially available as a flour, flakes, or pellets (pearls) and is used to thicken a wide variety of food products such as sauces, gravies, pie fillings, pudding, and baby foods. The well-known dessert tapioca pudding is made with the pearls, which become gelatinous, semi-transparent balls in the finished product, affectionately referred to as "frog spawn" by British schoolchildren.

Relations to Human Biology

Fresh peeled cassava roots are rich in carbohydrate (30–35 percent), and low in protein (1–2 percent) and fat (less than 1 percent). They have nutritionally significant amounts of calcium (50 mg/100g), phosphorous (40 mg/100g) and vitamin C (25 mg/100g). The quality of the protein is relatively good, and the starch is highly digestible. Fresh cassava leaves are a good source of protein (23 percent), vitamins, and minerals.

The cyanide-generating potential of cassava roots and leaves has been of considerable concern. Although traditional methods of processing are effective in reducing cyanide content to innocuous levels, inadequate processing, as sometimes occurs during famine and periods of social upheaval, or the rush to market, can lead to health problems, particularly cyanide poisoning.

In South America there is no evidence of acute or chronic cyanide toxicity associated with cassava consumption by Amerindians for whom cassava is a traditional dietary staple, even though some groups rely on varieties of cassava with a very high cyanide content. In other parts of the world, however, cassava consumption has been associated with cyanide toxicity and other disorders. Acute cyanide poisonings are relatively rare, but can be fatal. The cases typically involve the consumption of raw or inadequately processed cassava. The symptoms are dizziness, headache, nausea, vomiting, and diarrhea.

In Africa, cassava-based diets have been associated with two neurological disorders: tropical ataxic neuropathy (TAN) and konzo. Both occur among the rural poor on diets largely restricted to high-cyanide cassava. TAN is a disease characterized by ataxia (muscular incoordination), reduced sensory perception, and deafness. The onset is slow and the course progressive, and it is found primarily in adults over the age of forty. Konzo is a disease characterized by the sudden onset of spastic paralysis in both legs, which results in a slightly spastic gait in mild cases and a complete inability to walk in severe cases. It primarily affects children and women under forty, and tends to occur in areas under conditions of famine or near-famine when people have nothing to eat but cassava and their nutritional status is poor. Both of these disorders are relatively rare given the millions of people on cassava-based diets in Africa.

The cyanide found in cassava-based diets is metabolically detoxified to thiocyanate and therefore cassava consumers have higher than normal levels of thiocyanate in body fluids. This is thought to be beneficial in areas of West Africa where sickle-cell anemia is present because thiocyanate inhibits the tendency of hemoglobin molecules to sickle. It is problematic in areas of Africa where the dietary iodine intake is low because thiocyante blocks iodine uptake by the thyroid gland. In these areas, cassava consumption is associated with iodine deficiency disorders including goiter, cretinism, mild mental disorders, and other related conditions.

Cassava as a Symbol of Identity

Important food plants like cassava tend to be powerful symbols of social and cultural identity. These symbolic associations can be clearly seen in South America.

For the native people like the Tukanoan, cassava is one of the most important and highly valued foods, and is consumed with meals and most snacks. They believe that cassava was the first food; it was planted by the first woman to make bread for the first man. They consider the extracted starch, *weta*, to be the purest, whitest, and more nourishing of foods. The term *weta* also means the essence of something. For non-Indian subsistence farmers in the Amazon, farinha is an essential component of everyday meals and snacks, as well as an ingredient in special dishes. People will go to considerable trouble and expense to obtain it from the market when home-produced supplies run out because cassava is part of the fabric of everyday life, and consuming it part of their identity. In contrast, for Brazil's urban elite, farinha is only occasionally consumed as part of certain traditional dishes, and the everyday consumption of farinha is seen as a marker of lower class status and poverty.

Global and Contemporary

Cassava now provides about 30 percent of worldwide production of roots and tubers, and is the staple crop of over 200 million people in Africa alone. World production increased more than four-fold in the last two decades of the twentieth century, with most of this increase being in Africa. Cassava is a crop with enormous potential to provide food energy, and a crop that will play a particularly important role in areas like Africa where the production of adequate food is a serious challenge.

It is also a crop that has received relatively little attention from researchers in comparison to the dominant food crops of the green revolution—wheat, rice, and maize. However, efforts are underway to rectify the situation, and find ways to capitalize on cassava's strengths (high productivity, tolerance of poor soils and low rainfall, and relatively good resistance to pests and disease) and to improve its major shortcomings (rapid postharvest deterioration), and address its cyanide content. The following areas are particularly promising:

1. The use of microbial biotechnologies (technologies that utilize organisms like fungi and bacteria) to improve production and the processing of traditional products and to develop new products. Cassava production depends on soil mycorrhiza (fungi), and processing technologies depend on a variety of fungi (*Aspergillus*, *Saccharomyces*, and others), and bacteria (mostly *Lactobacillus* and *Corynebacterium*) to reduce toxicity, improve storage qualities, and achieve the desired taste and texture of cassava foods.
2. The use of micropropagation (culturing of tiny masses of dividing cells) for the exchange of varieties. This is particularly important for cassava because the plant is traditionally propagated from vegetative stakes that can transmit disease.
3. The use of genetic biotechnology for inserting new genetic material (DNA) into cassava varieties in order to improve quality and disease resistance.

See also **Africa; Brazil; South America.**

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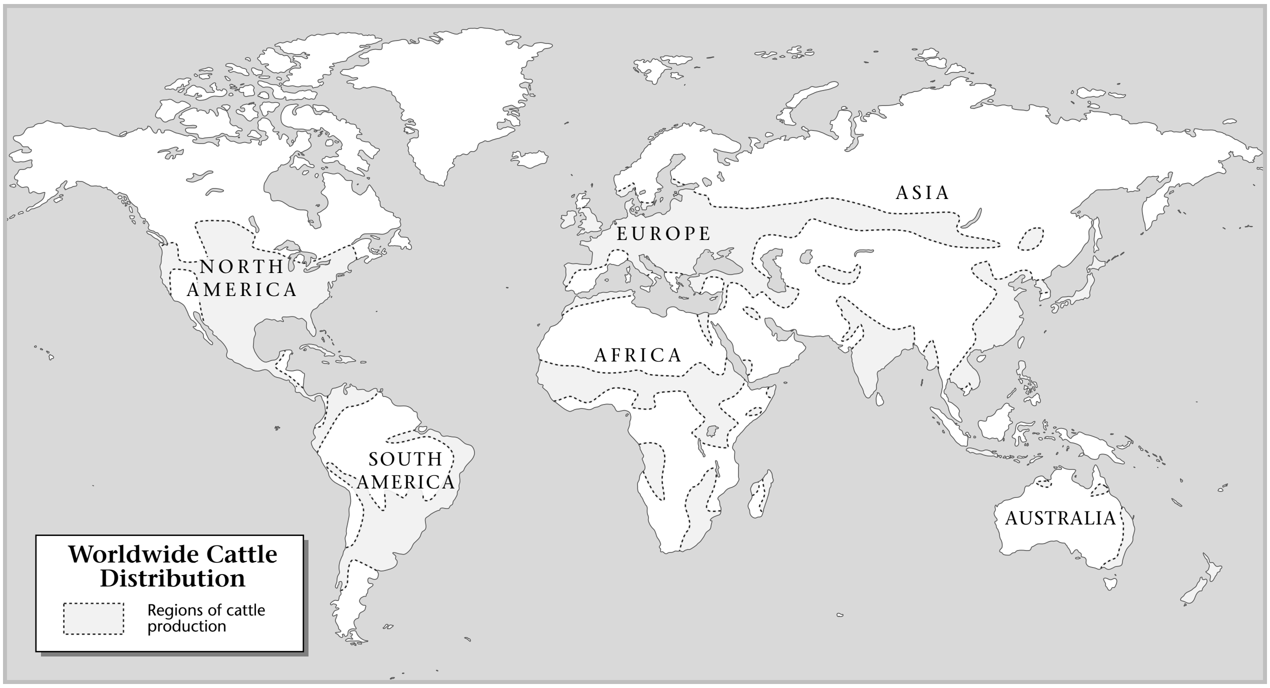
Darna L. Dufour

CATSUP. *See* **Condiments.**

CATTLE. The history of the domestication of cattle, their use as key elements of human survival systems, their biology, how and when they are currently raised, and how they are processed and marketed for consumption are all issues that help us understand beef as a part of different food systems. “Cattle” refers to live animals, including the young (calves), females before giving birth (heifers), females that have given birth (cows), fertile males (bulls), and castrated males (steers). Beef is the meat of all these animals while specialized terms for beef, such as veal (the meat of young, milk-fed calves), relate to food preferences in different cultures.

Beef is produced and consumed worldwide, and, like that of many commodities, its production is increasing. It is consumed not only as hamburgers, roasts, and steaks, but meat by-products including hides, horns, hoofs, intestines, and brains are used in a variety of products including: shampoo, marshmallows, ice cream, gelatin, cement, chalk, chewing gum, makeup, matches, margarine, and strings for musical instruments and tennis racquets. Beef is raised in three phases before it is processed: calves are raised on pasture and range land, as feeder cattle they feed on pasture, crop residue, and range land, and finally they go to feedlots, where they are fattened for slaughter. The slaughterhouse (packer) is also the disassembly plant, where the carcass is divided into “cuts.” Since the advent of boxed beef, most of the disassembly occurs at the plant itself, whereas previously sides of beef went to wholesale or retail butchers who divided it further. After slaughter, the commodity chain diverges. A portion goes directly to wholesalers, who distribute to institutional users or grocery stores, although grocery chains are increasingly linked directly to the packer. Another portion goes into further processing for sausages, bologna, hot dogs, and other processed meats, or is used for canned and frozen “heat and eat” meals. The carcass is rendered and the by-products are used in a wide variety of products. For example, hooves can be made into gelatin, hides into leather, bones and cartilage into bonemeal for plant nutrition, and intestines and some organs and other parts not usually used in meat markets go to pet food. Up until the mid-1980s, the



bones and nerves were ground into bone meal and fed as a supplement to cattle and other animals, until this practice was banned. Beef is increasingly consumed in restaurants, from steakhouses to fast food establishments. There is enormous variety in the use of all parts of the animal for delicacies prepared for home use and street food sale, from the stomach (tripe soup in many cultures) to the tail. Lower-quality beef and inferior parts are used in Japan in a simple dish called *nimono* as a kind of seasoning.

Biology

Description. Cattle are large ruminants of the family Bovidae and the genus *Bos*. Ruminants are mammals whose stomach has four parts—rumen, reticulum, omasum, and abomasums. The rumen provides a pouch where fibrous plant materials are broken down by bacteria so their nutrients can be digested. Because they are ruminants, cattle can digest plant materials that serve no other human use. As herbivores, they are selective eaters, but consume a variety of types of plants.

From the time of their original domestication, cattle were selectively chosen to meet multiple human needs, including providing traction and transportation, meat, and milk. Cattle have provided fuel for cooking and heating, plaster for walls, manure for gardens and fields, strings for musical instruments, and clothing—from hats to shoes. Originally valued for docility, cattle are increasingly bred to meet specific needs of those who raise them, process them, and eat them.

The systematic development of cattle breeding began as a part of the industrial revolution and the renaissance of British agriculture. The enclosure movement in England in the sixteenth century not only forced rural peasant farmers from the land to work in factories, but left privatized lands in the hands of a few landed gentry who could breed the stock they desired. Breed formation started with a useful local type that was then inbred until it showed uniformity. Breeds were then shown at livestock fairs that were part of the country lifestyle of the landed classes. Heredity was carefully recorded in herd books, and sires and mating were carefully controlled. Pure breed associations were formed. It was in this context, between 1750 and 1850, that the Angus, Hereford, and Shorthorn breeds were developed.

In other regions of Europe, inbreeding had produced uniform and locally adapted breeds, although specialization in rearing and feeding cattle for beef occurred long after it had in Great Britain. In the United States, interest in breeding began around the turn of the twentieth century (numbers had been important up to that point). In particular, Herefords were imported because they matured early, which allowed for the slaughter of yearlings rather than the four-year-olds prevalent at that time. In parts of France, five- to six-year-olds are still preferred for their flavor, particularly if they are fattened on grass.

In the course of seeking early maturing animals, many lines and traits have been lost. However, the introduction of new breeds has transformed the appearance—and probably the taste, nutritional qualities, and tenderness—of cattle in beef-exporting nations, particularly the United States and Canada.

Original extent. Cattle may have originated at about the same time in Europe, Asia, and Africa. Surviving relatives are present on all three continents. Seldom kept solely for beef production, cattle were beasts of burden as well as critical providers of milk and butter. They were only slaughtered when their ability to produce these ongoing products was reduced, at which point their hides, hooves, horns, bones, intestines, and other non-edible parts were valued as much as their meat, which generally supplemented that provided by wild game. Modern domestic cattle are believed to descend from *Bos taurus*, which includes European breeds such as Shorthorn and Jersey and *Bos indicus*, which includes Zebu breeds from South Asia and Africa. Cattle in much of the world were primarily used for traction for crop agriculture and for transportation.

Nutritional and nonnutritional constituents. Bovine flesh is called beef when the animal is mature and referred to as veal when it is a calf. Beef provides high levels of energy and protein. Proteins found in beef have a higher digestibility than most plant proteins and a wider range of amino acids. The bioavailability of important minerals (including calcium, phosphorous, iron, zinc, magnesium, and manganese) as well as vitamins (including thiamine, riboflavin, niacin, pyridoxine [B6], and B12) is high in beef. In many parts of the world, beef is viewed as the most fortified and most nutritious butcher's meat. High in iron, it can also be high in cholesterol and highly saturated fatty acids, as for many years cattle were bred for weight gain. Corn-fed cattle have higher levels of omega-6, which is a coagulant, in their meat. Grass-fed animals, in contrast, have much higher concentrations of omega-

TABLE 1

Characteristic	***Bos taurus***	***Bos indicus***
Ears	Short and erect	Long and drooping
Hump	Absent	Well-developed and fleshy
Skin	Relatively tight	Very loose
Hair	Long and thick	Fine and short
Horns	Short and turned down or hornless	Long and turned up
Call	Bellow	Grunt
Body	Wide through barrel and hindquarter	Narrower throughout
Temperament	Relatively docile	Nervous
Heat tolerance	Poor	Good
Birth weight	High	Low

These distinguishing characteristics have been combined and recombined in over a hundred different registered breeds.

3 fatty acids, which have anti-inflammatory properties and are anticoagulants. Too much omega-6 leads to clogged arteries, while omega-3 fatty acids do not. Fat content in general depends on the cut of beef, genetics, and the feeding of the animal prior to slaughter.

History

Domestication. Among early transhumant populations, which moved seasonally to find food, herds of hoofed mammals that were the ancestors of our current breeds moved with them. Initially roaming to find grass as seasons changed, cattle were later driven to provide a constant source of fuel and milk. As human life became more sedentary, cattle were an important part of the move to agriculture, providing traction for plowing in many sites in the Old World. In the New World, cattle were introduced with European colonization.

Historical diffusion and trade. Cattle husbandry was a part of Roman culture and spread with the Roman Empire. Norman conquerors brought beef-eating to the British Isles, although cattle were already serving many other functions for farm households. Cattle culture was an early part of complex social organization, often representing wealth. For example, the Celts based their wealth on cattle prior to 1066. In fact, in a number of languages the root word for cattle and for money is the same. In parts of Africa, wealth is judged by number of cattle, and dowries are paid in cattle.

South American grasslands did not have large ruminants before the Spanish and Portuguese introduced cattle to the grasslands from Argentina and Chile to Mexico and the southern part of what is now the United States. Raised on large *estancias*, *faezendas*, or *haciendas*, they were valued primarily for their hides, hooves, and horns, which could be exported to Europe. The owners of the large estates employed *vaqueros*, *gauchos*, or cowboys to undertake the day-to-day care of the cattle and to drive them to the appropriate place for shipping or slaughter. Thus, cattle imported to the New World from Spain were primarily beef cattle, the famous long-horns, tough for eating but resilient, and able to utilize the meager feed available in the dry plains of the central North American continent.

Australia and New Zealand grasslands were the last to have cattle introduced. The first cattle, black Africander, arrived in 1788 and Zebu cattle arrived from India in 1795, followed by English breeds. While settlers introduced cattle, it was large companies that exploited the great potential of the early cattle industry in Australia. The early cattle were driven to follow forage and water availability and then to slaughter. Wire fencing in the 1860s and bore wells and the railway book in the 1880s allowed for the establishment of permanent cattle stations. With the first shipment of frozen beef to England in 1879, the cattle industry became export-oriented.

Europeans who came to the North American continent and the Antipodes (New Zealand and Australia) brought their livestock with them. There was much genetic diversity in the livestock that arrived with migrants from different rural areas of Europe. The cattle from northern Europe tended to be triple-purpose cattle—for traction, milk, and meat—and they tended to be either family cows or small herds of beef raised on family farms outside population settlements.

The coming of the railroad transformed cattle production in North and South America, allowing both livestock and sides of beef to travel further faster. Beef was produced primarily in the plain states. Cattle drives to railheads gave rise to the myths of the cowboy. Railroads transported the cattle to population centers, where they could be butchered nearer to the consumer. The wide dispersal of cattle and their seasonal migrations was gradually cut back as the plains were fenced and other forms of agriculture competed with cattle for the land.

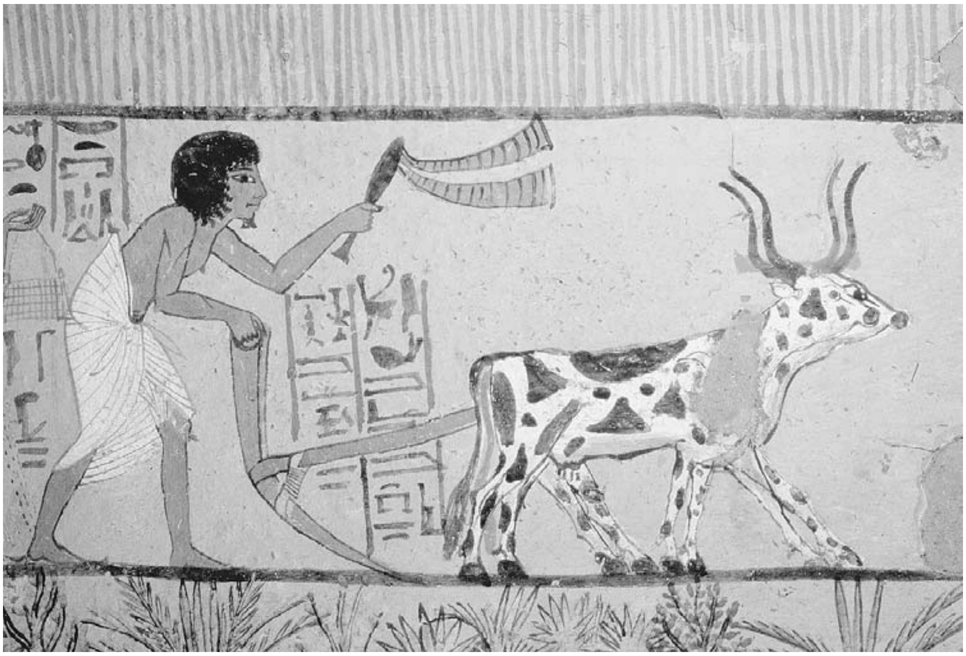
Yet even in the east, the ability of ruminants to convert plant materials of all kinds into food meant that land unfit for agriculture, because it was too steep or too poorly drained, was used for grazing cattle. As farmers moved into the plains in the 1830s and 1840s, before the lands of the majority of states like Iowa and Illinois were drained for agriculture, cattle were an important part of the farming mix using land that was unfit for cultivation or homesites. As soil was drained, however, less land was used for pasture, and more was used for crops.

Cattle were still the cheapest way of shipping the course grains, particularly corn. Meadows changed to pasture, and then were drained and became cropland. The farmers who moved to these reclaimed areas were almost all commercial rather than subsistence. As cities grew, the demand for meat increased.

James Whitaker argues that "through a combination of availability of railroads, type of land tenure, cost of drainage, and price of beef in the 1880s and early 1890s," many of the states shifted to producing cash grains rather than fat cattle (1975, p. 14). Mechanization in particular helped bring about this change, as did the ability to open up the prairie with chisel plows.

During the nineteenth century, cow/calf operations and fattening cattle were further differentiated. By 1819, cattle feeders from Indiana, Ohio, and Kentucky were traveling as far west as Missouri and Oklahoma in search of young animals to take home for fattening on corn in preparation for the overland drive to the eastern markets. But some cattle producers believed they could raise cattle *and* corn more cheaply in Iowa and Illinois than in Ohio or Kentucky. Those cattle were driven to eastern markets or shipped south to New Orleans on the Mississippi.

Those who first drove feeder cattle east to fatten brought the cattle-feeding pattern to Iowa and Illinois when they returned to settle after seeing the advantages



Detail of a fresco from a tomb in the Valley of the Kings, Egypt. Dating from 1306 to 1209 B.C.E., this scene shows a man and his wife (she is following him) plowing fields with cattle. In some cultures, cattle were far more valuable as draught animals than as food. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

of cheap prairie grass and corn. Until the Civil War, these cattle went primarily to the eastern markets.

Farmers had to go greater distances to find the feeder cattle they needed to fatten for market. Cow/calf operations, which thrived on smaller farm units, encouraged settlement. Large-scale operators gathered their herds from farmers who felt that feeding cattle was not profitable with less than two dozen head (Whitaker, 1975, p. 22). Thus, small operators produced the calves, while larger operations fed them out and fattened them.

After the Civil War, feeders again returned to Texas and the plains. The increasing use of the western range as a source of feeder cattle brought significant changes to the cattle feeding industry in the Corn Belt. There were two available feeding strategies: 1) purchase cheap western cattle, feed them for a year, and then sell for a small profit margin per animal hoping to make money on the large volume of sales; or 2) pursue a low-volume business of better quality of cattle bringing a larger profit per head. Improved cattle provided a way to get the most profit out of good grass and good corn while not robbing the land of its fertility as the cattle recycled the nutrients they consumed.

Those who followed the second strategy were more interested in improved beef breeds. Farmers were slow to improve their herds, but those who did generally profited from it. Because cow/calf operations were a small part of many farms, breed and pasture improvements were not quickly or widely adopted.

By the end of the 1850s, cattle were being fattened in Iowa and Illinois rather than being calved and weaned and driven east to be fattened. In the years after 1865, technological advances contributed to the continued growth and expansion in the beef industry. Illinois and Iowa became leading producers of corn-fattened cattle and Chicago became one of the world's leading cattle markets. The organization and expansion of a central market in Chicago was a result of the new railroad network, the concentration of meat packers in Chicago, the development of refrigeration facilities, the reorganization of retail meat marketing, and growth of the export trade in live and dressed beef. Demand for dressed beef increased, and the Corn Belt states met that demand with the combined production of cattle and corn.

The Civil War and the railroads brought centralization of market facilities, as increased receipts of livestock created chaos in handling transactions between several markets in the city. Formation of the Union Stockyards in 1865 was critical to bringing order out of chaos and in concentrating power. Demands of the new end market, created by the expansion of the railroads, gave rise to the dressed beef industry and the major packers who controlled it.

Although the technology existed before the Civil War, it was only in the late 1860s that refrigeration was effectively used to prevent the early spoilage of fresh meat, lengthening the time and distance from point of slaughter that fresh beef could be consumed. At first, consumers distrusted the quality of meat shipped hundreds of miles after being slaughtered; but, because dressed beef was sufficiently cheaper than local butcher stock, people were willing to try it.

The Swift Company was critical in moving this conversion forward. Swift and other companies fought with the railroad about whether dressed beef could be shipped at the same rate as live cattle. The invention of the hermetically sealed tin meant that corn-fattened cattle from Illinois and Iowa could be packed and shipped to domestic and foreign markets.

Soon after the Civil War, in the early 1870s, Chicago packers replaced packing pickled beef in barrels with canning. A court ruling that invalidated patented claims on the canning process triggered the expansion of canned meat. Western beef tended to be canned, as the quality was inferior to the corn-fed beef of the Midwest.

The great expansion of the market through technological and marketing changes in the dress beef trade created large vertically organized Chicago-based corporations. These corporations controlled, for the most part, both the wholesale and retail domestic markets for beef products. Known as the "big five," Armour & Company, Patrick Cudahy, Nelson Morris, Swift & Company, and Wilson & Company frequently acted together in buying cattle in the Union Stockyards and dividing retail trade among themselves. They also set prices and attempted to eliminate some of the less profitable aspects of competition.

As these companies were expanding rapidly due to the sharp increase in demand, they were pressed for cash and, thus, worked hard to lower both the price of labor in the packing plants and the cattle they purchased. To compound the problem of vertical integration and monopoly, a number of the packers went into the cattle feeding business.

By 1900 the concentration, if not the ownership of packing plants, had become decentralized. The major leading packing centers, with the same packers owning most of the capacity, were located in Chicago, Kansas City, Omaha, East St. Louis, and St. Joseph. There were lesser centers in Des Moines, Sioux City, St. Paul, and Fort Worth. The packers had so revolutionized the meat trade that butchers in some circles in the 1920s claimed that "not a retail butcher has made a fair profit and a living in the last ten years" because of packer branch houses (Whitaker, 1975, p. 54).

A major transformation of beef packing, which had previously been located near consumers and the transportation centers of larger cities, occurred with the founding of Iowa Beef Packing in Denison, Iowa, later renamed IBP. To lower buying costs, shorten transportation distances, and eliminate intermediaries, IBP put its plants near large feed lots, which tended to be located near sources of feed grains and away from large population centers.

Work on the plant floor was organized to require less skilled and less experienced workers. Thus wages could be considerably lower than in Chicago, Kansas City, or even Des Moines. Focusing on primal cuts, they became know as "kill and chill" plants, shipping to meat processors all the specialty items that were once part of traditional packing plants. Hot dogs, sausages, processed meats, and even hamburger were shipped to other sites for further elaboration and additional value. That also kept work standard and wages low compared to the plants that were closing in the Midwest.

In 1967, IBP perfected an innovation that dramatically changed the industry—boxed beef. Instead of shipping beef to customers in whole carcass form, as the industry had done for years, IBP mastered a process in which the packer breaks down the carcass into smaller portions. These cuts are then vacuum-packed and shipped out in boxes. While boxed beef was initially sold to the hotel, restaurant, and institutional trade, they soon shipped it to retail groceries as well.

Through this "butcher friendly" concept, it became possible to eliminate more than 250 pounds of fat, bones, and trimmings, which were of very little value to the retail and food service customer. Boxed meat improved quality, provided easier merchandising at the retail level, improved shelf life, and saved energy, transportation, and labor costs. This major innovation in beef processing came with the 1967 opening of a boxed beef operation at IBP's new Dakota City plant complex. It was the first large-scale beef processing plant in the nation. Dakota City also became the new location of the company's headquarters.

The advent of boxed beef changed the structure and geography of the entire meat industry. Now, instead of shipping carcasses, the packing plants cut the beef down into wholesale pieces and vacuum packed them into boxes. This greatly reduced the amount of work for wholesale butchers and also decreased the amount of space needed for shipping. In the 1970s, fuel and transportation costs were at an all-time high in constant dollar terms. Boxed beef allowed the packer to add more value to the product at the plant, to reduce transaction costs in shipping, and it reduced labor costs for urban retail grocery chains. It also reduced the power of grocery store cutters, as the retooling of the plants in rural areas reduced the power of the workers on the floor. Stores were able to bypass the skilled labor union members for meatpacking and distribution by hiring low-skilled workers to do repetitive tasks that were relatively quickly learned; turnover was high due to poor working conditions but labor was plentiful as long as unemployment was relatively high or there was a plentiful supply of immigrant workers. That strategy that linked new technology to new workers lowered costs and pushed the balance of power in the industry in favor of the packers and the grocery chain and against cattle growers and packing plant workers.

Procurement

Husbandry. Calves are generally conceived either through artificial insemination (increasingly the case in developed countries) or by bulls, in the case of larger herds, or borrowed for the occasion for smaller herds. Calves are raised on grassland or rangeland with their mothers until weaned, then usually sold to a stocker feeder who will bring them up to around nine hundred to a thousand pounds on rangeland, pasture, or crop residues. Prior to slaughter, cattle often enter a feedlot, where they are fed high-protein feed and fattened.

Artificial insemination (AI) is little used in cow/calf operations in the western half of the United States. Most herds depend on bulls. One bull for each twenty to thirty cows is usually recommended. The biggest deterrent to using AI is the extra labor needed to detect cows in heat on open range and then to confine them for individual insemination. The problem was partially overcome with the approval for use of hormonal materials that can be injected to synchronize estrus. More than half of an entire cowherd may be bred successfully during a single day by a skilled inseminator using AI and estrus stimulation.

Birthing difficulties are one of the most costly problems in calf production. As a result, American ranchers typically breed their heifers to Longhorns in order to get low birthweight calves—but this results in substandard beef.

Cow/calf producers normally rely on grazing. Nutrients obtained through grazing are usually less costly than those provided through harvested forages, grains, or other processed feeds. In addition, the dispersion of cattle grazing helps to minimize other problems, such as disease epidemics. Lowering the risk of disease decreases production costs and also reduces the need for labor. The western United States dry native range, on which agricultural operations are minimal, provides an overwhelming share of the grazing. The area necessary to support a cow depends on the amount of rainfall—the less the rainfall, the more acres required to support each head of livestock.

The stocker feeder generally uses pasture and rangeland as well as crop residues for feeding. The cattle still harvest most of their own food. Increasingly, stocker feeders are using rotational grazing (particularly in Australia and New Zealand), which helps them raise more cattle better on less land and keep the land in better condition.

There is a disjunction between the cow/calf operator or stock feeders and the feedlots/packers, which results in a very fragmented commodity chain with a great deal of distrust between the stages. The first two stages manage the resource. The last two stages manage the market.

While much of the world prefers grass-finished beef, the United States and Canada have focused on corn-fattened beef. Grain farmers who raised cattle on their uncultivable land fed their cattle using their own grains. While farm feedlots were dominant through the 1960s, changes in the tax laws in the 1970s made investment in "agricultural" enterprises extremely profitable. Capital moved into stand-alone feedlots, first from rural professionals, then from their urban kin and friends, and finally from corporations. The relocation of the feedlots, in turn, impacted corn production. As the large feed lots moved to more arid areas, where waste management was easier and population less dense, demand for corn increased. Beef fattening became more concentrated and shifted west.

The use of cattle as draught animals has declined considerably since the introduction of tractors, but in rural Romania it is still a common sight. This team of bullocks is at work in fall plowing in the village of Hobbitza. © Adam Woolfitt/CORBIS.

Biological and mechanical technology worked together to standardize beef production in order to maximize packer convenience. Packing plants demanded uniform-sized carcasses to maintain the speed of the disassembly line. Adjusting the height of the chain that carried the carcass around the plant was time consuming. At the same time, hormones were being introduced to increase rate of growth and improve feed conversion. While there is some evidence that the injection or implanting of hormones or steroids may toughen the meat and affect flavor, it does add extra weight. Animals were slaughtered at the same age and much higher weights, in essence increasing the supply of beef.

Slaughter and processing. Traditionally, small farmers around the world raised cattle from calf to slaughter (although in many parts of Africa, as in North and South America, beef cattle were not herded by their owners). Once the productivity of the animal had declined or feed supply became scarce, it was either slaughtered for home consumption or taken to an *abattoir* or butcher to be slaughtered, disassembled, and sold.

The division of labor between cow/calf operations, stock feeder operations, and fattening operations was established in the early part of the twentieth century. By that time, the industry had taken on its current form—very centralized packing operations with close ties to wholesale and retail distributors linked to feedlots, feeders, and cow/calf operations. Industrial concentration increases as the animals grow older. There are a great many cow-calf operations, slightly fewer stock feeder operations for the weaned calves, many fewer feedlots, many fewer packers, and a decreasing number of wholesalers, now mostly linked to retail chains.

Before World War II, retail stores bought quarters and sides of beef and cut them into "primal cuts" and retail cuts. After the war, consolidation of the retail grocery industry proceeded very rapidly, as local butcher shops and single-store operations were closed. One of the major ways supermarkets had of increasing profits was decreasing labor costs. Self-service, which required less labor to gather customer orders, now included meats, replacing the butcher who had previously cut and wrapped meat to each customer's specific request. Supermarket corporations particularly welcomed the central processing of meat, which allowed them to reduce the number of meat cutters who were their highest paid workers. Box beef was an innovation that met the needs of supermarket chains, as net profits declined between 1967 and 1974 to 0.8 percent, 60 percent of their previous level, and real wages grew over 7.5 percent per year, or 50 percent faster than before (Walsh, 1991, p. 452). Thus the retail part of the beef industry was ready for packaging innovation. That innovation, boxed beef, impacted the geography as well as the structure of the meat-packing industry by moving beef processing from urban centers, where, as a mature industry, it was highly unionized, to rural areas near feedlots and sources of grain, particularly corn. As these areas were sparsely populated, it was necessary to recruit a labor force, and new migrants from Asia (particularly Southeast Asia), Latin America (particularly Mexico), and Africa (particularly Somalia) moved to the rural packing plants to take the jobs.

Storage. Consumers prefer fresh beef to frozen beef. Yet beef has a relatively high spoilage rate. Spoilage is averted by keeping bacterial counts low, which is accomplished through plant cleanliness, careful slaughter procedures that prevent *E. coli* from the intestines from coming into contact with the carcass as it goes to be disassembled, and keeping temperatures low so that the bacteria multiply at low rates. Reducing the oxidation of the meat after aging, that is, minimizing contact with oxygen in the atmosphere, is also a factor. Refrigerated cars and trailer trucks help reduce spoilage, as does consuming the meat shortly after it is produced and slaughtered. Irradiation of beef is now highly promoted by the industry to increase shelf life, but meat processors have been reluctant to introduce this procedure because of consumer concerns related to its impact on beef quality and safety.

Aging the carcass adds tenderness and flavor, but adds cost in terms of storage space and time in inventory. After slaughter and initial disassembly, beef is moved within the packing plant to a refrigerated room kept at a temperature between 34°F and 38°F. This cools the meat and firms it prior to shipment. The meat is generally kept refrigerated for 24 to 36 hours. Fresh beef can be held for several weeks at this temperature, and prime beef is sometimes held for five or six weeks long to "age" it. Fresh chilled beef must be shipped in specially refrigerated cars and ships in order to arrive in good condition.

Distribution. There is increasing vertical integration between the international companies who own the packing plants and retail grocery chains. While beef has traditionally gone through a series of brokers and wholesalers, the links in the commodity chain have been reduced for a number of major grocery chains such as Walmart. This vertical integration has been coupled with an increase in branded beef for supermarket sales, which was unheard of in the early 1990s. Restaurant chains are also forming tighter linkages with packers and even feedlots, stock feeders and cow/calf operators, as consumer demand for particular qualities in appearance and taste, as well as how an animal is raised, become more important.

Changes in the means of procurement over time. Carcasses are graded for quality, which is assumed to be related to taste and tenderness. The price paid by the packing house depends in part on the grade the carcass receives and that day's demand for the different grades. Different nations have their own grading standards. Grading standards change over time, but relatively slowly. In part, that is because each stage of the system defines quality differently.

Despite increasing concentration in feeding and packing, the beef cattle industry is disjointed and dispersed because of its dispersed resource base. There are over one million cow-calf herds in the United States, down 2 percent between 1996 and 1997. The average cowherd consists of fifty cows. Thirty percent of calves come from 700,000 herds, averaging fifteen heads of cattle. Sixty percent of cattle end up in 215 different feedlots. This dispersed base funnels through the auction markets, which still play a dominant role in the cattle industry, into gross economies of scale in the form of feedlots and packing. The cattle industry is a scavenger industry, in that its nutrient fuel base varies widely and ranges extensively, and includes grass, crop residue, and wheat that otherwise might not be used for commercial purposes. And there are difficulties in linking the different parts of the value chain when one part is based on managing the available resources (cow-calf operations and feeder cattle operations) and another is based on responding to market timing (feed lots and packers).

American beef exports have increased from less than one percent of production in the 1970s to around 9 percent by 2000. In general, imported beef competes with U.S. dairy cull cows in the production of hamburger. Imports have averaged 9 to 11 percent of beef consumed in the United States since the mid-1980s, with the level in any year depending on the phase in the American cattle cycle. For example, at the peak of the cattle cycle in 1996, less than 8 percent of the beef consumed in the United States was imported, compared to over 11 percent in 2000.

Preparation and Consumption

Preparation. Beef can be preserved and prepared in many ways. Early preservation involved salt: meat was salted and dried or placed in a brine of salt water. Beef is still salted and dried in many parts of the world, providing portability and flexibility in storage and consumption. The dried beef can be eaten dry or reconstituted in sauces. Prior to the advent of canning, corned beef was shipped across continents to feed armies stationed abroad. But with the advent of the canning process, corned beef could be more easily shipped and stored for a wide range of purposes. Relatively large pieces of fresh beef are preferred in Europe, Australia and New Zealand, and the Americas. In Asia and Africa, beef is eaten more often, but in smaller quantities than in the West. In some cultures, beef is a condiment, served in highly flavored sauces with grains and legumes.

Different cultures have different ways of cutting beef and defining beef quality. In France, where hormone injections and implants are illegal, male cattle are not castrated until they gain full size. The preferred animal is older, slow growing, grass-fed, and the meat is darker in color. In North America, animals are killed younger, grow faster through the use of hormones and nutrient-rich feeding, and the meat is lighter in color in the meat case. These cuts of beef are often grilled (requiring marbling) or fried. Groups of European origin also bake and boil various cuts of beef. Braising, simmering, roasting, broiling, soups, and stews are other ways that specific cuts of beef are made palatable. Beef is also eaten raw, chopped fine for beefsteak tartare and beefsteak *à l'americaine.* Beef is often cooked with alcoholic beverages, such as beer and wine, to tenderize it and add flavor.

The introduction of European genetics led to four modern Japanese breeds that are known as *wagyu.* They are valued because of their wonderful taste and extreme tenderness. The meat is thinly sliced and placed in boiling water along with a variety of vegetables, resembling a traditional method for cooking fish and vegetables for *shabu-shabu* and *sukiyaki*. High marbling is required to maintain its tenderness during the boiling process. Beef in served in many cultures with a wide variety of root crops and vegetables

Types of beef. Almost all parts of the animal are used as food. Western cookbooks include recipes for brains, blood, heart, kidneys, liver, lights (lungs), sweetbreads (thymus gland), tongue, and tripe (the lining of the third stomach), which are particularly used in regional cooking. In addition, beef heads were made into head cheese and the feet used in soups in many cultures. Use of these less desirable cuts came from peasant households, who invented delicious but labor-intensive ways to utilize the parts rejected by the upper classes.

Consumption

Traditions. Because of the multiple functions of cattle and their breeding potential to increase wealth, many societies in Asia and the Pacific developed strong taboos against killing cows or healthy bulls. Only worn-out work animals, barren cows, and unwanted calves were sold for slaughter or consumed within the household. Thus many of the ways of cooking beef involved long, slow cooking.

Many cultures around the world consume beef. Its consumption is permitted by all major religions of the world except Hinduism, although Buddhism discourages the eating of the meat of four-legged animals, including beef. For many years, in India, which had a very high cattle population (and even higher if one counts water buffalo), it was illegal to kill cattle, and slaughter of buffalo was highly restricted. Japan only revoked the ban against eating meat in 1882, soon after the Meiji Restoration. Shinto also had strong norms against showing of blood. Thus butchers cut the beef very thinly. Christianity views eating meat, particularly beef, as highly desirable and a sign of self-indulgence. Thus the giving up of meat during holy seasons, such as Lent, and on Fridays becomes a symbol of sacrifice, replicating that of Christ for the world.

Generally, beef is a meat for the wealthy. Nations that are large producers of beef also tend to eat very large pieces of beef relatively often. As nations' fortunes rise and fall, so does their per capita beef consumption. For example, the economic slowdown of the 1980s decreased Peruvian beef consumption, and the economic problems at the end of the twentieth and the beginning of the twenty-first century have reduced the traditionally high consumption of beef in Argentina.

Nourishment

While beef provides important nutrients, particularly iron and key amino acids, it is also a source of fat and cholesterol, although the concentration varies, depending on the cut of beef and how the animal was raised.

Symbolism

Ritualism and traditions. Cattle worship was widespread in the cattle cults of the Mediterranean basin. The crescent of the cow horns was seen as imbued with the life-giving power of the crescent moon. Cows, in particular, figure as symbols of fertility in parts of Asia and Africa.

Cattle are viewed as sacred in the Hindu tradition. Beef is not consumed, nor are cattle unduly constrained.

But the by-products of cattle form an important part of peasant survival strategies in many rural areas. Their manure provides building materials, fuel, and fertilizer, and the animals themselves provide traction to raise the grains and pulses that are the staples of the South Asian diet. The prohibition against killing cattle ensures that even in times of hunger, the means to produce the following year will be in place.

Cattle have a paramount and pervasive symbolic value in many parts of East Africa, where they represent social status as well as wealth. As a result, the supply of cattle exceeds the demand for their meat, milk, hides, traction, or other uses to which they are put. In particular, the use of cattle for meat and hides or their sale for cash reduces the status of the head of household. More recently, the size of cattle corrals has proven to be an excellent proxy for the household wealth and status in communities in much of Africa. Cattle have critical symbolic importance in ritual, dance, marriage, and other aspects of social relations. For example, in many cultures the marriage contract calls for the payment of bride price to compensate for the loss of the services of the young woman to her parents. This is often negotiated in terms of number of cattle, delivered in installments: at marriage, the birth of the first child, and at the birth of the second child, at which time the marriage process is seen to be complete.

Global and Contemporary Issues

Commercialization. Over 48 million metric tons of beef were consumed globally in 2000, an increase of slightly over a million-and-a-half tons since 1995. Beef production worldwide exceeded consumption in 2000 by over a million metric tons, a pattern of overproduction that has marked the end of the twentieth and the beginning of the twenty-first century.

Generally, beef consumption increases with a rise in middle class incomes. The Argentina consumes the most beef per capita, followed by the United States, Australia, and Canada. The United States consumes the largest total amount of beef annually (around 12 million metric tons a year), followed by the European Union, the People's Republic of China, and Brazil. Canada, Mexico, Colombia, Argentina, and the Russian Federation are also major beef consumers.

Between 1995 and 2000, beef consumption increased 49 percent in India and 32 percent in the People's Republic of China. In contrast, during the same period it declined 28 percent in the Russian Federation and 19 percent in Poland. It did not decline further in the Russian Federation because of beef that came in the form of food aid. Unlike Europe, the United States does not have a direct subsidy program for beef, although it often steps in as a buyer to help keep market prices up. That beef is exported as food aid, and used domestically for school lunches and at military bases.

The United States trades an increasing amount of dressed beef internationally. The U.S. had a cattle inventory of 99.5 million head in January of 1998 (USDA/NASS, 1998), compared to a world cattle inventory of 1,323.3 billion head (FAO, 1998). While the numbers of American cattle rise and fall in approximately 18-year cycles, with numbers increasing with each cycle, world cattle numbers have shown a general increase since 1961. The current cycle peaked in 1996. With the large herd destruction in Europe in 2001 due to animal diseases, the herd shrink will increase.

Australia exports the most beef, followed closely by the United States, which is the second largest international beef exporter (primarily high quality beef) and the largest beef importer (primarily low quality beef to be made into hamburger). The United States consistently imports more beef than it exports. Japan is the second largest importer of beef. Between 1995 and 2000, beef exports increased the most in Canada and Brazil, followed by India and Uruguay. China and Australia decreased beef exports during this period, perhaps related to the increased consumption in both those countries. Mexico's beef imports increased over five times during the six-year period, as its economy gained a solid footing. However, imports dropped in many countries during that time period. In South Africa, decreasing imports was coupled by increased production. But in both Poland and the Russian Federation, both imports and production dropped substantially.

Consumption patterns. Beef is increasingly consumed in institutions and restaurants rather than at home, following the trend of most foods. Many cuts of beef require long cooking times, whereas restaurants tend to offer quick cooking cuts such as hamburger and steaks. Condiments and sauces give the meat flavors once provided by long cooking with herbs and spices. A variety of tenderizers are used to substitute for lack of aging, unreliable genetic origins, and short cooking times.

Beef is often eaten in the form of hamburgers, as the whole place and pace of eating changes in America and other places of the world. Where the ritual of family dining continues, beef often has an honored place, but the shift of women's work from the home to the factory and office has reduced that practice. Beef for home consumption is increasingly ground beef, with a growing market in packaged foods that can augment the ground beef and give it a homemade gourmet patina.

Beef that has been prepared to be carried out or home delivered, particularly as pepperoni or hamburger pizza, is increasingly popular, not only among the young but among working couples who would like to eat at home but have no time to cook. Increasingly, work place cafeterias are providing after work take-home meals for company or agency employees.

Institutions serve beef often, including in school lunchrooms (increasingly through franchisers, including fast food purveyors), hospitals, nursing homes, and prisons. There are fewer dietary restrictions on beef than pork among ethnic groups, increasing its utility in many institutional settings.

While beef has long been part of ready-to-eat soups and entrées, there are increasing attempts to make beef easier to cook and tastier—perhaps in response to the use of less tasty, less tender, quick-maturing breeds and hormone use to speed growth in the United States, where, unlike in Europe and Japan, early maturity is preferred over taste and tenderness. (However, the USDA firmly states that hormone-raised beef is extremely tasty and tender.) Beef is thus available at retail in stir-fry or fajita slices that have been marinated in a wide array of herbs, spices, and tenderizers. This cuts cooking time and gives a wider menu variety to the working chef and eater.

Types of consumption. Cattle and calf meat is consumed directly as meals and snacks, and its by-products are used in a wide number of foods, from gelatin to ice cream. In the United States, direct per capita beef consumption declined from 81.7 pounds to 63.8 pounds in 1997. More recent data suggests that U.S. beef consumption is increasing from the low in the years 1992–1996 of 63.5 pounds, in part in response to economic expansion.

Issues surrounding consumption. Cattle have proven to be a source of conflict at all stages of their production and consumption. On rangelands and pasture, there is great concern about: 1) overgrazing and its negative impact on biodiversity, soil quality, and hydrology; and 2) contamination of streams when cattle are allowed to freely wander in them. While research and practical experience have shown that cattle can enhance grassland and rangeland, that is often not the case, and cattlemen and women are generally extremely suspicious of environmental constraints, since they are seen as potentially infringing on the rights of the cattle operators to use their land and the land they rent (whether from the government or from their neighbors) as they see fit.

Cattle raising has been the cause of a great deal of deforestation in tropical areas of the world. Settlers clear land, selling valuable timber to transnational companies. The newly cleared soils are planted with fast-growing pasture that often is relatively impervious to water, increasing runoff. Cattle are grazed for the low end of the beef market, ending up in fast food outlets in developed countries.

In Europe and increasingly in America, there is concern about how cattle are raised and treated. There is growing concern about the stress animals undergo in large feedlots, which some believe affects the taste of the meat. Modern packing plants have tried to decrease stress at the time of slaughter to reduce the adrenalin in the muscle tissues, which toughens the meat and gives it an off-putting flavor. Concern for animal welfare is coupled with health and environmental concerns surrounding large feedlots and packing plants.

Europe does not allow injection or implantation of hormones, which is a standard practice of most producers in the United States. In fact, stocker feeders inject their cattle with hormones on penalty of not being able to sell them to a feedlot. If the cattle are not injected in the neck, meat quality will be negatively impacted around the site of injection, which is often easiest to administer into the prime cuts. Hormones increase the rate of growth and nutrient utilization, but increasing evidence suggests that they negatively impact meat taste and tenderness. They are also viewed as a health hazard in Europe, as well as having a negative impact on animal health, as the use of these steroids puts additional stress on the animal. As a result, Europe banned American beef produced with artificial hormones in 1989, which has resulted in a continuing trade battle.

Mad cow disease (bovine spongiform encephalopathies, or BSE) has been linked to the fatal Creutzfeldt-Jakob Disease (CJD) through human consumption of meat from cattle with the prion disease. It is thought to be transmitted from one animal to another through the consumption of bone meal from sick but undiagnosed cattle or sheep and from animals to humans by eating meat that contains prions transferred by the nervous system. Thus the brains and the meat that is in contact with the spinal column are particularly suspect. In parts of Europe, the sale of meat on the bone has been forbidden. As a result, beef consumption has dropped precipitously and exports have been banned altogether.

Foot and mouth disease outbreaks can cripple production and exports, as occurred in Britain, Argentina, and Europe in 2001. In contrast to BSE, foot and mouth disease is not transferable to humans, but it is easily passed among hooved species and greatly reduces the productivity in infected cattle herds. Increased globalization of the food system may be related to both outbreaks.

See also **Ecology and Food**; **Goat**; **Mammals**; **Meat**; **Pig**; **Sheep**; **United States: Midwest.**

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Cornelia Butler Flora

CAULIFLOWER. *See* **Cabbage and Crucifer Plants.**

CENTRAL AMERICA. Central America is an isthmus, or land bridge, that unites the two continents of North and South America. It consists of seven countries: Belize, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, and Panama. Except for Belize, all of these countries were first settled by the Spanish in the early 1500s and remained part of the Spanish colonial empire until they revolted for independence in 1821. The culinary history of the three-hundred-year colonial period has not been studied as thoroughly as it has in Mexico or in South America, in part because many documents relating to the area are housed in Spain rather than in local archives. Furthermore, while Central America attempted to unite politically following independence, that effort eventually failed. This political fragmentation has left a distinctive imprint on the culinary profile of the region. In spite of this, however, there are certain unifying features.

Common Features

Geographically, the countries have a great abundance of volcanoes. This has had an important influence on the cuisine because the volcanoes have fertilized the soil with mineral nutrients that have made this one of the richest areas of biodiversity in the world. The gold the Spanish conquistadors had hoped to find was made up for by an exquisite natural beauty and an abundance of unusual food plants, both cultivated and wild. Due to this rich soil, the region has become a center of coffee production.

Another unifying feature is the composition of the people themselves. The population of Central America consists mainly of four groups: mestizos, a mixture of Spanish and native peoples and the largest group; small pockets of indigenous populations; Africans; and people of unmixed European descent sometimes referred to as Creoles. Throughout much of the region, African populations are concentrated along the Atlantic coastline, while mestizos populate the Pacific side. The central area of the isthmus is home to a lush rainforest sparsely populated by small groups of indigenous tribes.

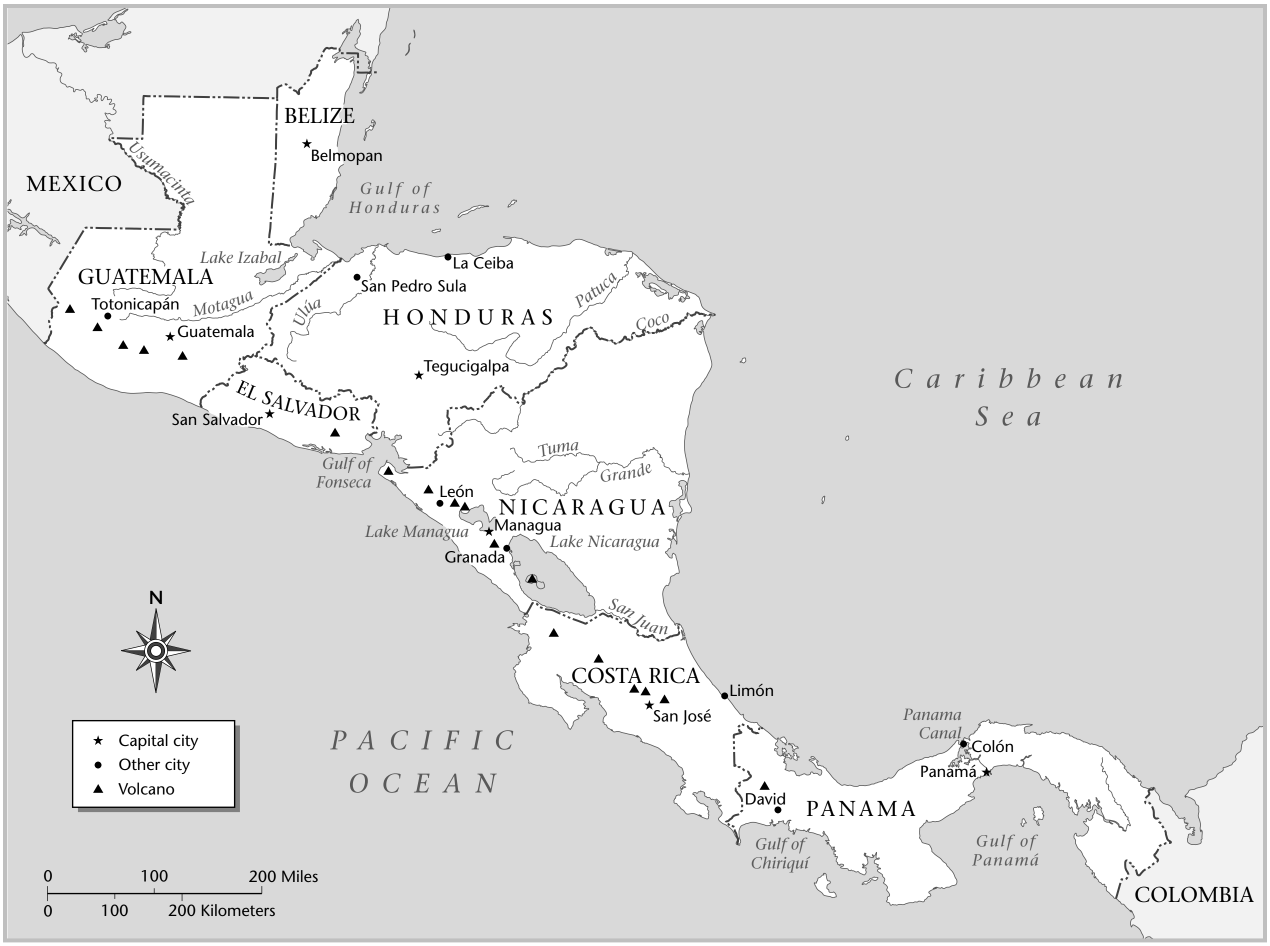
The African population descends mainly from runaway slaves who escaped from Jamaica and neighboring Caribbean islands. They have preserved a dialect of English infused with African vocabulary. This group has made Central America more diverse in language as well as in cookery, since its cooks have blended together African and indigenous food preferences. One of the typical ingredients is coconut: shredded coconut, coconut milk, or coconut oil. Except for smaller indigenous tribes like the Miskitos of central Nicaragua, coconut is not widely favored by the other ethnic groups.

In terms of cookery, the mestizos have mixed traditional indigenous dishes, mainly preparations of Mayan origin, with old Spanish prototypes, but in some instances the two cooking traditions have been kept separate. The smaller indigenous tribes still remaining in Central America rely mainly on hunting and gathering and have not influenced the cookery as much as larger groups, such as the Mayans.

One of the characteristics of all Central American cooking is the use of fresh ingredients, from fresh meats and vegetables, to tortillas and breads made to order, even dairy products prepared the same day. The markets abound with the sweet aromas of tropical fruits and vegetables displayed in an endless sea of colors. The market is especially important as a stage for lively social exchange, and since the cooking traditions of Central America are mostly oral rather than based on cookbooks, recipe discussions in the marketplace serve as a major conduit for ideas and the comparison of family cooking preferences.

Oral tradition is a key to understanding Central American cookery: most recipes are handed down from generation to generation by word of mouth. In middle- or upper-class families, it is customary to have an in-house cook, but someone in the family is assigned the task of teaching the cook the way a dish should be prepared. Special instruction and attention are required for dishes that have been handed down within the family and are usually prepared only on special occasions. Although the choice of recipe ingredients may vary within each country and family, there are still quite a few standard national dishes that have been maintained over a long period of time and have not undergone much variation. Outside the region, little is known about the cookery of Central America because many of the key recipes are not written down, except perhaps in a small number of local cookbooks of very recent date.

Beef is an important meat in Central American cooking because of the large number of cattle ranches, which


MEXICO
BELIZE
Belmopan
Usumacinta
Gulf of Honduras
Lake Izabal
GUATEMALA
Totonicapán
Motagua
Guatemala
Ulúa
La Ceiba
San Pedro Sula
HONDURAS
Patuca
Coco
Tegucigalpa
Caribbean Sea
EL SALVADOR
San Salvador
Gulf of Fonseca
Tuma
Grande
León
NICARAGUA
Managua
Lake Managua
Lake Nicaragua
Granada
San Juan
N
COSTA RICA
Limón
San José
Panama Canal
Colón
Panamá
PACIFIC OCEAN
★ Capital city
● Other city
▲ Volcano
David
PANAMA
Gulf of Chiriquí
Gulf of Panamá
COLOMBIA
0 100 200 Miles
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provide beef both for local consumption and for export. The flavor of Central American beef is very different from that of the beef of North and South America, in part because the animals are grass-fed and thus leaner, but also because the Criollo breed of cattle is itself quite distinctive. The flavor and texture of its meat more closely resemble veal than beef.

It was customary for a middle- or upper-class family to have beef at least once a day, especially in Nicaragua. New dietary trends have changed a few old traditions so that now people mindful of their health are eating less red meat, yet beef is still a luxury for the poor. For those who prefer to eat less red meat, beans are a common substitute. Beans are said to be one of the staple foods of the poor, but they are very popular among all social classes. Once boiled, the beans may be sautéed with onions, sweet peppers, garlic, salt and pepper, and some of the cooking broth may be added. The result is a simple yet tasty dish. A common preparation consisting of beans, boiled plantains, and cheese forms a one-pot vegetarian meal that is nutritionally balanced as well as pleasing to the palate. Many of the most popular dishes of the region are studies in simplicity, since light food is a welcome reprieve in the hot climate.

Contrary to popular belief, Central American cookery is not spicy, except in Guatemala where the chili pepper plays an important role as a spice. Elsewhere, chili pepper is an optional ingredient, except in some dishes where it is considered critical, but one is always given the option to choose between something spicy or not. At most meals, a bowl of hot sauce or a salsa consisting of a mixture of tomatoes, garlic, onions, and sweet and hot peppers marinated in lime juice provides added spice and flavor for many dishes. There are many other variations of salsas containing chili peppers, such as *encurtido*, a mixture of chopped vegetables pickled in vinegar with hot peppers. In this case, the spicy vinegar brings out a variety of subtle flavors in the dishes eaten with it. Most meat preparations are marinated in a mixture of black pepper and sour orange or lime juice, giving them a cleaner and more complex taste. The sour juice is important in tenderizing, flavoring, and sterilizing the meat.

The annatto is another important ingredient in the cookery of this region. Annatto is the seed of an indigenous tree (*Bixa orellana*), better known in other parts of the world for coloring cheese; it is this ingredient that dyes the cheese orange or yellow. The cultural importance of annatto dates back to pre-Columbian times when it was used for special rituals. The Mayas and other indigenous populations employed it as body paint during religious ceremonies, and also for coloring pottery, for monetary purposes, and for flavoring certain foods. Known as *achiote* in Central America, the seeds are ground and mixed together into a paste of black pepper, salt, and vinegar that is then diluted in either sour orange juice or lime juice and used to marinate or preserve meat. Historically, *achiote* was used to preserve meats from spoiling in the tropical heat. Today, *achiote* creates a delicious marinade for grilled meats. It seems to have little taste as a raw paste, but when heated, it undergoes a chemical change that releases a complex array of flavors. While *achiote* lengthens cooking times, it also prevents meats from scorching or drying out while they are being grilled.

Rice is a key element in every Central American meal and is one of the important culinary contributions from Spanish cookery. After careful rinsing, rice is usually sautéed in oil with onions until toasted; water is then added, with a little salt to taste. Toasting causes the grains to remain fluffy, and the onions impart a subtle aroma and flavor that complements many entrees. In fact, Central Americans commonly judge the abilities of cooks based on the fluffiness of their rice, for it is said that if one masters the art of cooking rice, one has mastered the art of cooking.

There are numerous rice dishes in the region that are similar to Spanish paellas, such as *arroz a la Valenciana* in Nicaragua. This consists of a mixture of chicken, pork, shrimp, and sausage cooked together with rice and vegetables. *Arroz con pollo* is another popular dish served throughout the region from Guatemala to Panama. Although the recipe varies, the essential mixture and texture is common, consisting of chicken and vegetables cooked together in a stew; rice is then added. This recipe has much more broth than the Nicaraguan *arroz a la Valenciana*, and *achiote* is added as the substitute for saffron.

Throughout Central America, maize is doubtless the single most important culinary element in all of the regional cookeries. Maize was so important to the indigenous peoples before the arrival of Columbus that in Mayan mythology man and woman were created from two maize kernels. It was seen as a life-giving element and it has greatly influenced the cookery of Central America. The tortilla, made from maize flour and water, is usually present in at least one daily meal. It is traditionally eaten while still warm and accompanied by several types of salty cheese. There are people who specialize in making tortillas and can shape the dough between their hands in a matter of seconds, until it reaches a circumference of approximately 10 inches (25 centimeters). The tortillas are then placed on a hot griddle, lightly scorched, and rushed to the table while still steaming.

Maize is also the ingredient for many refreshing drinks and is fermented to create an alcoholic drink known as *chicha*, which can also be consumed before full fermentation takes place. This old indigenous beverage has changed very little over time, except that now sugar is used as a sweetener rather than honey. *Chicha* is a generic term used by the early conquistadors to describe any alcoholic beverage in the New World, but there are actually many variations of *chicha* throughout Latin America.

Atole is another drink made from maize that is mainly a feature of Guatemalan cuisine, but is present throughout Central America under many local variations. It is a filling, high-energy drink that can be either sweet or salty. *Atole*, typically served hot or warm, has a thick consistency and can be made from a wide variety of ingredients, the most common being milk, sugar, ground maize kernels, cinnamon, and cloves. In Nicaragua, *atole* vendors always seem to show up after a heavy afternoon rainstorm, making sure everyone warms up by drinking plenty of the beverage. It is especially popular in the cool mountainous areas of the region.

Tamales made from maize are popular throughout the isthmus and are prepared in a variety of ways, depending on the local cultures. Each country has a special variation of tamales, but aside from the different ingredients, they are always wrapped in either cornhusks or plantain leaves and steamed or boiled. Tamales can be eaten on any occasion, but in some countries, such as El Salvador, Costa Rica, and Panama, they are generally prepared for holidays. Traditionally, they are consumed during the Christmas season or at Easter. They can also range in size from dainty handheld appetizers to large main-course dishes. The most common forms consist of ground dried maize or the raw mashed kernels shaped into a thick, rectangular dough that is filled with different vegetables or meats, or simply sweetened with sugar. They are then wrapped in leaves and boiled or steamed.

Just as there are variations in ingredients, there are also variations in nomenclature. For example, in El Salvador, *tamales rellenos* are similar to the Honduran and Nicaraguan *nacatamales.* In both Honduras and Nicaragua, there are tamales (boiled in corn husks) and *nacatamales* (boiled in plantain leaves), which vary from one another in their fillings. *Nacatamales* are difficult to prepare not only because of the complexity of the ingredients, but also because of the length of time they take to cook. In Nicaragua, there are people who specialize in making them since they are always in demand for parties or for traditional Sunday brunch.

Another way of using ground maize is as a thickener for stews or for giving a distinctive flavoring to certain dishes. Ground maize can also be toasted and used to flour meats or fish for deep frying. Water and sugar can be added to toasted maize to make *pinolillo*, a chocolate-like drink that is filling yet refreshing. In Honduras, *pinolillo* is also prepared with a touch of ground chocolate, thus giving it a more complex taste.

Central America is a paradise for natural fruit drinks, since it has a seemingly endless variety of fruits that can be mixed together to produce deliciously healthy and refreshing beverages. One can find a natural fruit juice stand on almost every street corner on hot, sunny days. Many Central Americans take a break before lunch and sit for a few minutes under the shade of a tree to cool off and relax with a tall glass of *refresco*, literally "refreshing," with plenty of ice. The best drinks are made with ripe fruits, so that there is no need for sugar. These fruits can also be used for creating an enormous variety of sorbets, which are popular on hot, humid afternoons.

The plantain plays a much more important role in Central American cuisine than the potato. It is more or less a staple vegetable, and green or ripe plantains can be prepared in a number of ways. Although the plant is not native to the continent, it adapted very quickly to the climate and soil of this tropical region. Its leaves are used in wrapping foods, such as tamales and *nacatamales*, for grilling, and sometimes as eating utensils. The plantain leaves give the food a subtle yet rich flavor, and, when grilling fish, keep it from scorching and impart flavor to the meat. It is said that Nicaraguan *vigorón* is not authentic unless it is served on the plantain leaf, which functions as a plate. When the leaf is folded, some of the juice is released into the food, perhaps giving it its "authentic" flavor. The old colonial Nicaraguan city of Granada is well known for its *vigorón*, consisting of boiled yuca (cassava), a sour and spicy shredded cabbage salad, and crunchy pork rinds.

Another way of cooking the unripe plantain is to cut the fruit into paper-thin strips and fry them at a high temperature, thus making them crunchy yet not oily. This is a popular way of preparing plantains throughout Central America. They can also be grilled or boiled in water and accompanied by a salty cheese. The ripe plantains can also be boiled and baked with cinnamon, cloves, and cheese, resulting in a tasty dessert sweetened by the vegetable's own natural sugars.

As a general rule, the indigenous peoples of Central America were originally vegetarian, eating meat only on special occasions and cooking with little or no oils or fats. The European method of frying and cooking with animal fat quickly changed the native cuisine, but it also made room for a new and inventive style of cooking. Besides the better-known meats such as pork, beef, chicken, and fish, other animal meats are also part of Central American cookery. The *gibnut* or paca, a large rodent that feeds mainly on wild nuts, is consumed in Belize. The *cusuco* (*Dasypus novemcinctus*), a species of armadillo, is eaten in several countries, but it is most popular in El Salvador, where it is mainly a feature of rural cookery. This meat is marinated in lime juice, then grilled, following the same method used for cooking iguana.

Central Americans have developed a special breed of cattle to withstand the hot, humid climate. This herd is grazing near Tegucigalpa, Honduras. PHOTOEDIT. REPRODUCED BY PERMISSION.

Iguana is eaten throughout the region, but, again, it is mainly consumed by country people. The iguana is known to have a rich flavor because it feeds on fruits, and it is especially fond of papaya, which gives the meat a tender texture and sweet flavor. Many people consider the meat an aphrodisiac, and it can also be boiled in soup, an old home remedy for strengthening those who are sick. Furthermore, iguana was an important meat substitute during the colonial period, since the Catholic Church declared it a type of fish for consumption on meatless days. There are numerous methods of cooking iguana, but those who eat it generally prefer it grilled.

Guatemala

Guatemala was once part of the heartland of Mayan civilization. The Mayan imprint on modern Guatemala's culinary riches is present in its numerous traditional dishes, especially those with corn as the predominant ingredient. The country is well-known for the great variety of its *atoles*. One of these *is atole de arroz*, a sweet beverage with corn, rice, cinnamon, sugar, and chocolate as ingredients. In the cool and mountainous area of Totonicapán, there is an unusual (and probably very old) *atole* made with beans, salt, and ground chili pepper.

Recados, pastelike mixtures, are important in Guatemala and are used for marinating meats or as condiments to bring out complex flavors in cooked dishes. The most common of these is *recado colorado*, which uses ground annatto as a base mixed with garlic, black pepper, cumin, and other ingredients depending on the local recipe. Of all Central American countries, Guatemala is the only one that uses the chili pepper almost as an essential part of its cuisine. Peppers are used as a condiment, or as a main dish such as *chiles rellenos* (stuffed peppers). The chilies are first fire-roasted, next filled with a traditional mixture of pork and beef, onions, tomatoes, cabbage, and herbs. They are then dipped in a batter, covered with breadcrumbs and fried, blending indigenous and European methods of food preparation.

Belize

Located to the east of Guatemala, Belize is a country with a large native-born population of African descent. Formerly a British colony, it attracted immigrants from other parts of the Caribbean due to an extensive lumbering industry. It is also the only Central American country where English is the official language. In the western part of the country, the food is similar to that of Guatemala because of the border they share. This cuisine is a blend of Spanish and Mayan influences, yet the coconut is an important ingredient because of the predominating African influence.

One of the local delicacies is conch soup in which the meat from the giant conch, a mollusk, is cooked with okra, green plantains, onions, lime juice, chili peppers, and coconut until it acquires a thick consistency. Belizeans are as proud of their conch soup as they are of their popular stewed beans with pork or beef. Stew beans are prepared by boiling meat with the beans, onions, coconut milk, herbs, and spices (depending on personal tastes); they are served with rice. *Garnaches* and *salbutes* are common dishes and can be served either as a main meal or as appetizers. These are thin, crispy deep-fried tortillas served with beans, cheese, and cabbage on top and may also be accompanied with chicken. In May, the cashew festival, which evolved out of the English May Day celebration, takes place. This festivity includes plenty of food and live music, as well as locally made cashew wine.

Honduras

Honduras has a diverse cuisine that shares many similarities with that of Nicaragua, its neighbor to the south, including the influence of African-Caribbean culture. An outstanding Honduran dish is the popular *sopa de caracol*, or conch soup. In this recipe, fresh carrots, chayote, chickpeas, celery, onions, plantains, and baby corn are sauteéd in butter and added to a clear broth flavored with *culantro*, a native herb similar in flavor to cilantro, but stronger-tasting. Coconut is then added to the broth along with some milk, the conch meat, achiote, and parsley as the garnish. The result is a flavorful soup with an African-Caribbean touch.

Capirotadas, commonly eaten during Lent, are small dumplings made from maize flour and water, filled with cheese, and then lightly fried until brown. The dumplings are subsequently added to a vegetable broth and enjoyed as a main meal. Another variation is to add syrup cooked with cinnamon and cloves, which is then served on the dumplings, creating a tasty yet simple dessert. *Pinole*, a slightly coarse, ground maize, is used as a thickener in dishes such as *gallina en pinol* and *iguana en pinol.* In both recipes—the first made with chicken or (preferably) hen and the second with iguana—toasted maize gives the meat a light nutty taste that complements the mixture of meat, herbs, broth, and vegetables.

El Salvador

El Salvador is the smallest Central American country and the only one without an Atlantic coastline. The cuisine of El Salvador is popular throughout the isthmus because of its famous *pupusas.* Although there are similar variations of these tortillas in most Latin American countries, El Salvador has gained recognition for having what are generally considered the best recipes. *Pupusas* are basically tortilla dumplings filled with either cheese, small pieces of *chicharrón* (pork rinds), a mixture of both, or beans. The dumplings are then covered with *curtidos*, a combination of cabbage, shredded carrots, and chilies infused in vinegar.

Nicaragua

Nicaragua is the largest country in Central America, and until the 1970s it was also the wealthiest. Its cuisine varies greatly from region to region, from old Spanish dishes such as *relleno*, *salpicón*, or *indio viejo*, to more indigenous preparations like *nacatamales. Relleno* literally means "stuffing" and in its original Old World form was probably used for stuffed fowl or empanadas. Like many Spanish dishes of medieval origin, it uses ingredients now associated with desserts: dried fruit, milk, nutmeg, sugar, and shredded bread as a thickener. Along with these ingredients, pork, olives, finely diced carrots, onions, mustard, capers, and vinegar or wine are blended into the mix. The result is a sweet and sour dish in which the diverse ingredients seem to come together harmoniously. Due to long, slow cooking and hours of constant stirring, this dish is so time-consuming to make that it is only eaten once a year, during the Christmas holidays. The large outlay of expensive ingredients, many of which must be imported, once set this dish apart as a class symbol of the old ruling families of the country during the colonial period, but today *relleno* has assumed the character of a national icon, especially to expatriate Nicaraguans.

Another dish of Spanish origin is *salpicón*, which is thought to have come to Nicaragua during the 1500s. The basic concept involves making a complete meal out of the basics for soup. It begins with beef boiled with an assortment of vegetables, most importantly ripe plantains. The meat is then taken out of its broth and finely chopped

The market at Chichicastango, Guatemala, is rich in local produce and in colorful native costumes. © TIBOR BOGNAR/CORBIS. CENTRAL EUROPE

with onions, sweet peppers, bitter orange juice, salt, and pepper. The boiled plantain is mashed, having already given the soup a subtle sweet flavor, and is then used as the dough for making empanadas. The empanadas are filled with the chopped beef and cooked rice that is to accompany the meal. A complete dinner is thus created by using as many ingredients as possible with little waste.

Indio viejo is similar to *salpicón* in that beef is boiled to create soup, but different in that the meat is then shredded and cooked again in its own broth with maize flour, spearmint, tomatoes, and, depending on family, recipes, *achiote*. The result is a complementary blend of Old World and indigenous flavors. *Nacatamales* also blend the Old World with the New, but the basic recipe has indigenous roots. Best described as fairly large dumplings made from maize flour, they are filled with capers, potatoes, onions, prunes, meat (pork, chicken, or turkey) marinated in *achiote*, tomatoes, and chilies. The dumplings are then wrapped in plantain leaves and boiled in water for several hours until all the ingredients are fully cooked. *Nacatamales* are usually enjoyed as Sunday brunch with strong black coffee.

Costa Rica

Costa Rica is well-known worldwide for its natural beauty and perhaps also for its excellent coffee. Ecotourism has helped the country's economy, but it has also greatly changed the local food culture. Aside from the more popular Americanized fast-food restaurants that are now common, the true cuisine of the Costa Rican people is the one prepared at home. Without a doubt, most Costa Ricans crave the popular *gallo pinto*, a mixture of white rice and beans cooked with a variety of fresh herbs and vegetables, creating a tasty meal of its own. This dish is eaten in most parts of the country at least once a day.

Olla de carne is another popular recipe that blends together a variety of vegetables and beef. This one-pot dish consists of squash, corn, yuca, ayote, and potatoes cooked together with beef in its broth, creating a very hearty stew. Round pieces of lightly mashed green plantains, known as *patacones*, are served during most meals and act as a substitute for the now ubiquitous french fries. During the Christmas holidays, Costa Ricans enjoy elaborate tamales, very similar to the Nicaraguan *nacatamales* in the variety of ingredients used as well as in the manner of preparation.

Panama

Panama is a country defined largely by the Panama Canal, which has created a trading link between the Atlantic and the Pacific. During pre-Columbian times, the country was a center of older civilizations that specialized in gold craftsmanship, using native animals as models for their works of art. Panama's culinary connection to this indigenous past was largely severed during the colonial period, when the region was part of what is now Colombia.

Created by the United States during the early 1900s, Panama and its canal attracted many immigrants seeking employment and new opportunities. This migration shaped modern Panamanian culture because of the large numbers of black laborers arriving from English-speaking islands in the Caribbean. The result was a blending of the local mestizo cuisine with that of the newly arrived immigrants. Panamanians keep their traditional cuisine alive at home, but they assimilated many African elements, especially the use of coconut as a main ingredient.

One example of the strong African influence is the popularity of *fufu*, particularly along the northern Atlantic coast of the country. Elsewhere in Latin America, *fufu* is a dumpling made of plantains or yams, but in Panama the term is applied to the entire stew. It is composed of a coconut milk base, boiled plantains, chilies, yuca, yams, and fried fish added at the end. *Saos* is yet another African-influenced dish adapted from the Jamaican kitchen. It consists of boiled calf's or pig's feet marinated in plenty of lime juice, onions, chilies, salt, and pepper.

In spite of the prevalence of these African influences, most Panamanians identify their national cookery with indigenous and Spanish preparations, especially *sancocho*, which is treated as a national culinary symbol. This dish consists of chicken cooked with vegetables, including yuca, corn, plantains, chayote, and potatoes, served with rice on the side. Panamanians seek relief from the midmorning heat by enjoying the popular and refreshing beverage known as *chicheme*, which resembles *atole* because it is a maize-based beverage blended with sugar and cinnamon. Before lunch time, Panamanians like to enjoy a drink of *chicheme* with the tasty *carimoñolas*. These lightly fried dumplings consisting of boiled mashed yuca filled with ground beef, sweet peppers, tomatoes, and herbs can be eaten either as appetizers or as a main course.

See also **Banana and Plantain; Caribbean; Iberian Peninsula; Inca Empire; Maize; Mexico; Mexico and Central America, Pre-Columbian; South America**.

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Enrique Balladares-Castellón

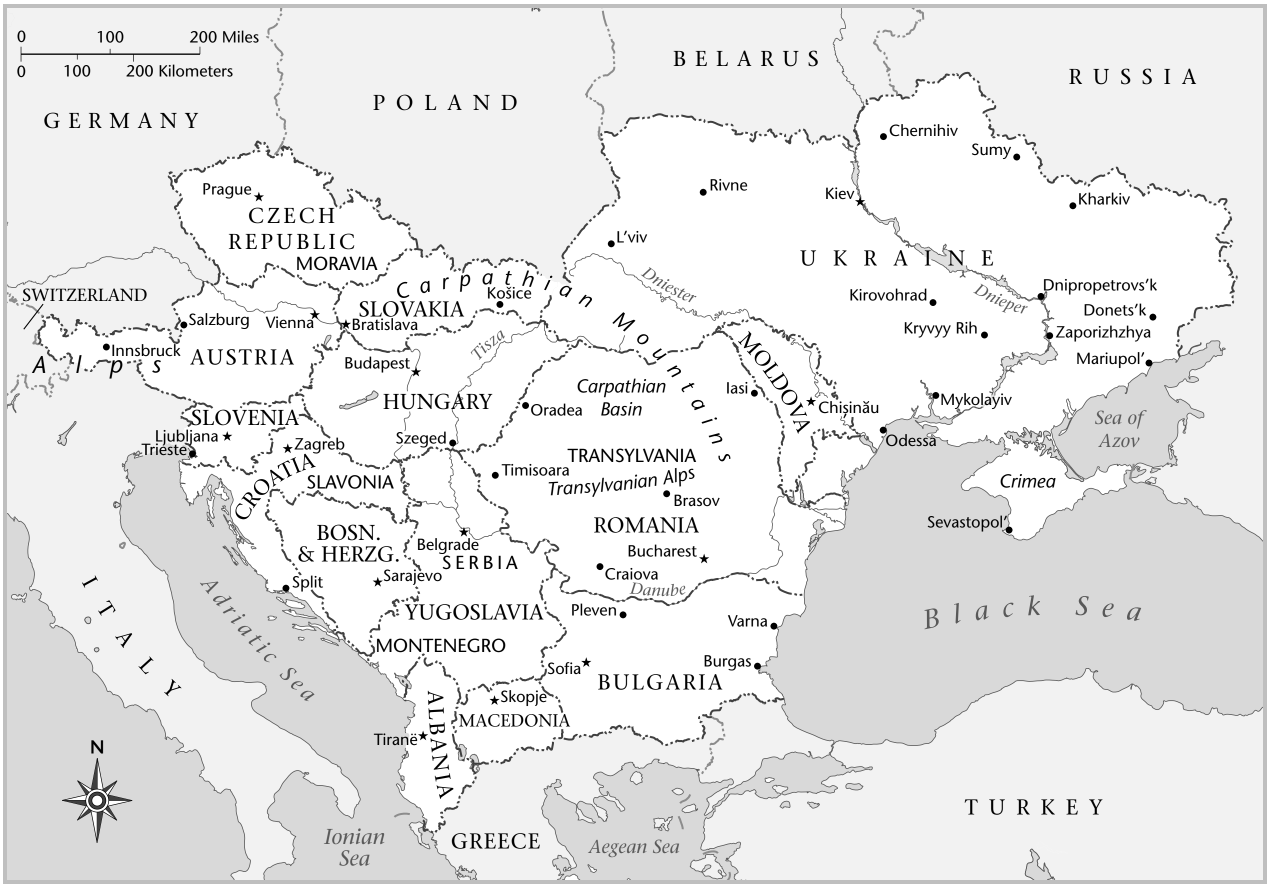
CENTRAL ASIA. *See* **Asia, Central.**

CENTRAL EUROPE.

For the purposes of this encyclopedia, Central Europe will be defined as the Czech Republic, Slovakia, Hungary, Romania, and Poland, although technically Austria and Germany played a critical role in the cultural development of the region. All of these countries were at one time completely or partly incorporated into the Prussian or Austro-Hungarian Empires and therefore shared in the transcultural culinary exchanges during the eighteenth and nineteenth centuries. Central Europe is a region represented by huge ethnic diversities, a complicated political history, and a wide range of microclimates, from Poland's cold Baltic winters in the north to the mild Black Sea climate of coastal Romania in the south.

From a geographic standpoint, most of the region is drained by the Danube River. The Carpathian Mountains form a natural barrier, cutting off Poland to the north and Romania to the east. The Transylvanian Alps in central Romania divide the region even further, and the Wallachian Plain stretches south across the Danube into Bulgaria. Hungary occupies a vast windy plain roughly corresponding to the ancient Roman province of Pannonia. The southernmost parts of this region were once under the political domination of the Byzantine Empire. This was followed by nearly five hundred years of Ottoman Turk influence.

The Czech Republic's kingdoms of Bohemia, Hungary, and Poland were all at one time major political and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Dnipropetrovs'k
Kirovohrad
Donets'k
Kryvyy Rih
Zaporizhzhya
Mariupol'
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MORAVIA
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Odessa
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Oradea
SLOVENIA
Ljubljana
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Zagreb
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Crimea
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Belgrade
SERBIA
ROMANIA
Bucharest
Craiova
Danube
Split
Sarajevo
ITALY
Adriatic Sea
YUGOSLAVIA
Pleven
Varna
Black Sea
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cultural forces as well. The traditional foods of these three kingdoms were gradually incorporated into the court cuisine of the Austrian Empire, so by the nineteenth century they had become "Viennese." The Wiener schnitzel (Viennese veal cutlet) would never have been possible without Hungarian beef; the famous *Kolatschen* (custard-filled pastries) of the Vienna coffeehouses would never have existed without the ancient *kolace* of Bohemia. As a political coequal to Austria, Hungary evolved a distinctive cuisine of its own inspired by nationalistic themes. Since Slovakia and Romanian Transylvania were once part of the Hungarian Kingdom, they experienced Hungarian influences most, but, by the same token, they gave back to Hungarian cookery added regional nuances and many specialized dishes.

While all of these countries were once unified in some manner under Austro-Hungarian rule, that unity disintegrated with the fall of the empire in 1918, after which they became independent states. At the close of World War II, and under the coercion of the occupying Soviet forces, all of the Central European nations were brought into the Soviet empire and remained within that cultural and political sphere until the fall of communism in 1989. Each of these nations became independent again with an earnest desire to rediscover the culinary past that was largely ignored for almost forty-five years. However, the communist governments of all the Central European countries took considerable interest in ethnographic research and established many open-air museums and research institutes where rural life could be studied. While the motivation was political, the end result was a body of valuable archival materials much better organized than in some Western countries.

If there is a common theme to this discussion, it would be that linguistic and religious boundaries of Central Europe do not coincide with political boundaries. There are large minority populations in each country, and before the mass expulsion of Jews during World War II and of Germans at the end of the war, the diversity of minority populations was even greater than in the twenty-first century. This diversity created a patchwork quilt of foodways and local cookeries, all of which must be considered when viewing the region from a historical perspective. Yet regardless of the ethnic diversity, there are certain universal foods common to all the Central European cuisines. These include sour cream, dried mushrooms, poppy seeds, sauerkraut, horseradish, and smoked bacon. Bacon and bacon drippings provide one of the distinctive flavors of this region. On a par with this is the generous use of dill.

During the nineteenth century, movements for national independence turned toward rural peasant culture to find a national cultural identity, and certain traditional peasant dishes became symbols of national styles of cooking. Hungarian *gulyás* (goulash) is a classic example. Originally it was a stew prepared by cattle drovers, herders whose occupation was essentially the same as the gaucho of Argentina and the cowboy of the American West. Their unfettered lifestyle and distinctive eating habits became a symbol of Hungarian identity; thus, the food they ate was elevated to a national icon.

This process occurred in all of the Central European countries and was in many respects random since it overlooked the fact that there were numerous ethnic groups who did not aspire to form states of their own, among them the Jews, Armenians, and gypsies. While the Central European Jews belong to the Ashkenazim, their traditional food culture represents elements of Spanish Sephardic traditions combined with South German flour-based dishes and such Slavic features as borscht or *blinz*.

Periodization of Culinary History

The food culture of Central Europe may be broken down into historical periods corresponding with the rest of Europe, although, in general, development has lagged behind western Europe. The medieval period lasted until about 1500, followed by a period of political upheaval and consolidation from 1500 to 1680. Ottoman invasions occupied the political stage, and the countryside experienced vast destruction and loss of populations. The era from 1680 to 1850 may be viewed as one of reconstruction and political reorganization under the Habsburg monarchy. Political unification brought with it cultural repression and an institutionalizing of German as the lingua franca of the region. In the 1780s all Jews living within the Austrian Empire were forced to Germanize their names. German became such a dominant language that in some regions, such as Bohemia, it nearly replaced the local tongue.

The foods and foodways of medieval Central Europe represent an area of research largely unexplored by scholarship, in part due to the lack of surviving records. Maria Dembińska's pioneering work on medieval Poland (1963) has pointed the way for similar studies of Bohemia and Hungary, but published research is limited. In spite of this, some generalities can be made. The kingdoms of Bohemia and Hungary were powerful in the early Middle Ages, and Bohemia in particular became the epicenter for many culinary influences in the region. Likewise, the Danube River served as a conduit for new foods and dishes emanating from Byzantium. The strudel, the cucumber, and red beets moved into Central Europe by this route. The lack of written records has been addressed through medieval archeology, especially since World War II.

Meal Systems in Central Europe

The medieval meal systems of Central Europe are key to understanding meal systems of the region, even in the twenty-first century. Traces of the medieval two-meal system (a light meal in the morning about 9:00 A.M. and an evening meal about 5:00 P.M.) still survive in parts of Central Europe, and this eating pattern defines the type of foods consumed. During the summer half of the year (from spring plowing to fall plowing), field workers eat three times a day, but during the winter they revert to the medieval two-meal system. In grain-growing regions, the first meal eaten in the early hours of the day was generally bread with lard or cottage cheese, since it was easy to transport. A midday meal of hot cooked food was brought to the field hands during their break. In the crescent-shaped mountainous zone surrounding the Carpathian Basin as well as in the Carpathian areas of the Ukraine and Transylvania (Romania), the morning meal was a hot cooked dish, such as Romanian *mamaliga* (cornmeal mush). The midday meal consisted of remnants from the morning, while a cooked evening meal was eaten at home. It was also a general custom to eat from a common bowl. Until the late nineteenth century, children normally stood to eat at the dinner table, and men and boys ate separately from women and girls. Once children reached the age of puberty, they were given a place to sit at the farmhouse table in accordance with their status in the family. For example, younger boys of lesser rank sat lower down the table than their older brothers, who had first choice of the food after their father.

Another unifying feature of Central European cookery is the widespread use of gruels made from hulled, whole, or cracked grains. The grits can also be made from lentils, peas, fava beans, and in more recent times from New World beans. All levels of Central European society ate grits, but the proportion varied. Wealthier people consumed more meat, while the poorest individuals subsisted on an essentially vegetarian diet. In medieval Poland the inevitable gruel for king and peasant alike was millet. In modern-day Romania it is *mamaliga* made from maize. Rice has never played a significant role in the cookery and has always been associated with luxury foods and urban cuisine. Only the Bulgarians grew rice on a large scale, mostly for provisioning the Ottoman army. Rice did not become integrated into Bulgarian food culture until the eighteenth century.

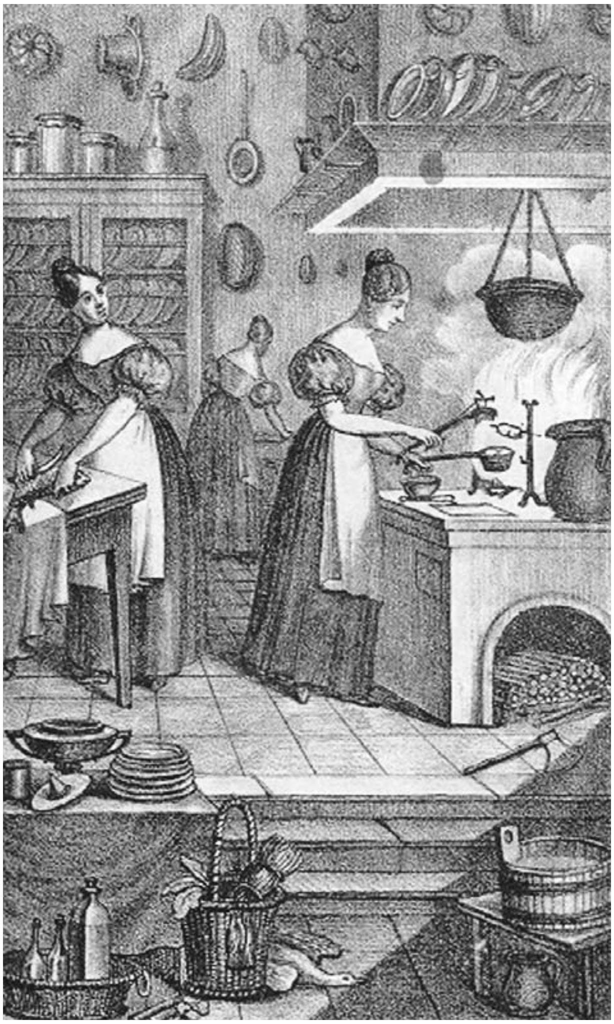
Along with grain-based gruels, bread soup was another universal food throughout the region. This is a dish of medieval origin in which pieces of bread are soaked in hot broth, then puréed, or the broth is simply poured over a slice of bread. Nearly every country in Central Europe possesses a long list of local variations on this theme. More elegant preparations replaced the bread with roux, flour fried in lard or bacon drippings. A close relative of this soup was a dish made from small balls or crumbs of dough produced by rubbing the dough against a sieve or grater. The dough was then boiled in water, milk, meat stock, or vegetable puree until thick. The most typical dish of this kind prepared in Hungary is called *tarhonya*, a term borrowed from Turkish in the eighteenth century.

During the Middle Ages it was called *vágott étek*, *vagdalt étek*, and *gombóta*, terms all referring to the shape of the dough or to the action of rubbing the flour. In mountainous areas of Slovakia, Poland, and Romania, this dish is made with buckwheat flour.

The introduction of maize via the Balkans was perhaps the most important addition to the gruel-based diet of the countryside. In most areas it was first introduced as a fodder crop, but poor farmers in mountainous areas soon adopted it as a foodstuff since it was much easier to grow than wheat. The most common method of preparing it was in the form of mush, but it was also used as a filling in sausages, as dumplings mixed with meat or vegetables, and as a stuffing in steamed cabbage leaves. The mush is known as *mamaliga* in Romania and *puliszka* in Hungary.

Shifts in Taste Preferences

In terms of general taste preferences, there have been a number of important shifts in Central European diets. Pickled vegetables (especially cabbage and root crops), vinegar preparations, and sour milk are found everywhere, especially in areas where beer is the most common beverage. The sweet-and-sour or tart and spicy foods preserved in peasant cuisine began to disappear in urban cookery during the eighteenth century in favor of more neutral tastes. This shift occurred directionally from west to east and from the upper classes to the lower ones. Sugar at one time represented a prestige food consumed only by the aristocracy and rich merchants, and it reached peasant cookery only in the nineteenth century. The preference for food highly spiced with black pepper shifted in the late eighteenth century to a widespread use of paprika. This shift began in the lower Balkans and emanated out of Bulgaria, where New World peppers had been introduced in the 1600s. The Bulgarians have always been the market gardeners of Central Europe, and it was through them that many new foods, such as beans, maize, and tomatoes, were disseminated into the Slavic regions.



The idealized kitchen of the Austro-Hungarian Empire. Frontispiece from the 1833 Polish adaptation of Franz Zelena's *Wiener Kochbuch* (Viennese Cookbook), first published in Vienna in 1828. ROUGHWOOD COLLECTION.

Drinking Habits

Central Europe can be divided into three large zones according to the predominant drinking habits. The northeastern region, including the Czech Republic and Poland in particular, are beer-drinking countries. In the northwest, brandy and spirits predominate, while the southern area is largely wine-drinking. The centers of wine production lie in Slovakia, Hungary, and Romania. The Romans introduced viticulture into these countries, and many grape varietals are peculiar to central Europe, among them the famous Tokay of Hungary.

Among the nonalcoholic beverages, buttermilk, whey, and a light beer made with birch sap (*Betula pendata*) were popular in many parts of the region, as were herbal teas, especially medicinal teas made with Saint-John's-wort. Coffee drinking spread from the Balkans due to Turkish influence. Coffee is consumed with milk as an early morning beverage or is taken black after meals. The peasants first served it at the beginning of feasts and weddings and only later incorporated it into their everyday diet.

Poland

Poland's culinary history did not begin in 1364 with the famous Congress of Kings held in the ancient capital city of Cracow, but it was during that event that Poland's distinctive cuisine was showcased to the world. The host of this gathering, which included hundreds of nobles and several thousand retainers, was King Casimir III, who had positioned the kingdom as a world power and who was himself a connoisseur of Italian cooking. Present at this congress was Peter I de Lusignan of Cyprus, who brought

Poppy seeds are used extensively in Central European cooking. During the Middle Ages poppy seeds were associated with fasting dishes, but today they are enjoyed in traditional cakes like the one shown here. PHOTO BY ANDRÉ BARANOWSKI.

with him Byzantine cooks, a troupe of gypsy musicians, and eating habits of the East. The culinary watershed of this event has not been studied in great detail, but after that, Polish dishes are mentioned frequently in cookery books of the 1400s and 1500s as one of the recognized "national" styles of cooking. Elements of Poland's medieval cuisine have also been preserved in the countryside, as the Polish ethnographer Zofia Szromba-Rysowa has pointed out in her study of village foodways *Przy wspólnym stole* (At the common table, 1988).

Poland's culinary identity may be divided into four broad regional styles: the cuisine of the mountainous south; the cookery of the Baltic coastal region; the foods of the east, principally dishes emanating from Lithuania and Russia; and the classic cookery of the great estates and urban restaurants. The influence of Germany was also pervasive, especially in the period before 1700. The first cookbook written in Polish, the *Kuchmistrzostwo* of 1532, was a translation of a popular German cookbook called the *Kuchenmeisterei* that first appeared at Nürnberg in 1485. The first truly Polish cookbook was published at Cracow in 1682 by Stanislaw Czerniecki under the Latin title *Compendium Fercolorum.* Czerniecki was a petty noble who served as royal secretary to King Jan III Sobieski. Parallel to the German influence was the Yiddish-speaking Jewish community, one of the largest in Europe.

When the elector of Saxony ascended the Polish throne in the early eighteenth century, he brought with him French cooks. This blend of French and Polish themes in the court cuisine of the country helped to create the Polish cookery that has survived into the twenty-first century. Poland's haute cuisine has always differed from that of other European nations in that it has drawn its inspiration from the peasantry and recreated these foods not only as symbols of Polishness but also as a political reminder that Poland's most ancient monarchs and noble families were themselves the children of peasants. These dishes include *bigos* (a game stew); the baba cake; *sauce polonaise* (a sauce originally served with boiled pike); and a host of sausages (the Polish word *kielbasa* simply means 'sausage'), the most famous of which are *kielbasa krakowsaka (*pressed ham sausage), *kasza gryczana* (buckwheat kasha), and pierogi, the Polish equivalent of Spanish empanadas. Polish beer and vodka are also well-known outside the country.

The Czech Republic

Although small in size, the Czech Republic is one of the wealthiest and most industrialized of the Central European countries. It is also blessed with a rich culinary history tracing back to the early Middle Ages. The country consists of two major regions, Bohemia and Moravia, each with its distinct local cooking style. The capital, Prague, is situated on the Vlatava River, which flows north into Germany. This geographic link brought the city and its culinary culture in constant contact with German Saxony and the Baltic port city of Stettin at the mouth of the Oder. However, due to its political domination by Austria, Prague became a melding place for many exotic culinary ideas and the location of a number of well-known cooking schools and restaurants. Prior to World War I, the company of Bohuslav and Vydra was internationally known for its culinary equipment, especially gingerbread and pastry supplies. In the area of pastry, the Czech Republic is perhaps best known as the home of the layer cake (torte) and *koláce* (sweet buns with a variety of fillings). Both terms evolved from Latin.

Other important culinary centers in the country are Karlovy Vary (the former Karlsbad), which was a famous spa resort during the Austro-Hungarian Empire, and Plzen (Pilsen). Plzen is a scenic town noted for its Pilsner beer. Until 1945 the town was situated in the heartland of the Sudeten German region. After the expulsion of the Germans, the Czechs continued the famous brewery and maintained an international standard for high-quality brewing.

As a counterpoint to the heavy Germanization of the country under the Austrians, Bohemia produced Magdalena Dobromila Rettigová (1785–1845), a cookbook writer whose recipes were widely circulated in Czech and

Polish family in Upper Silesia enjoying a dessert course of traditional homemade cakes and fruit wines. Photo by André Baranowski.

were translated into German. Rettigová also wrote juvenile literary fiction that championed the national language. She was followed by Božena Němcová (1820–1862), whose semiautobiographical novel *The Grandmother* (1855) described the foods and daily life of Bohemia and offers a detailed look into the mind-set of a culture besieged by foreign and mostly Germanizing influences with a long list of foods the author considered typical of Czech culture. Some of this nostalgia for the past is present in Marie Rosická's *Bohemian-American Cook Book* first published in Omaha, Nebraska, in 1915. In print off and on since its first appearance, the book is an important culinary link to the homeland for Czech immigrants in the United States.

Slovakia

While Slovakia speaks the same language as the Czech Republic, it has experienced a different history. The ancient capital city of Pressburg (now Bratislava) on the Danube has oriented the country southward, and for much of its history Slovakia was a territory of the kingdom of Hungary. Like Hungary, Slovakia is a wine-growing region, thus it forms a cultural line of demarcation between the beer-drinking Slavs to the north and the wine-drinking central Europeans to the south. The country's wines are mostly white, consisting of Pinot Gris (Rulandske to Slovakians), Sylvaner, and a few others. The main wine-growing area centers around Modra, north of Bratislava.

Slovakia is also a country where fish play an important role in the diet, especially trout and carp. During the Middle Ages, Slovakian towns along the Danube were involved in an extensive fish-pickling industry, once critical to the Roman Catholic dietary calendar. Since it lay on trade routes with Poland and Bohemia, Slovakia also served as a conduit for culinary ideas flowing out of

Hungary and the Ottoman Empire. Maize is significant in the diet, and Hungarian *gulyás* is prepared in myriad ways. The Carpathian Rocombole garlic, popular among American growers, came from the eastern part of this country.

Hungary

Most food historians do not realize that Marcus Rumpolt, the author of *Ein New Kochbuch* (1581), was Hungarian by birth, not German. While his cookbook is viewed as a classic of German Renaissance printing, a number of the recipes incorporated in the book are Hungarian. The book was also translated into Hungarian. Rumpolt is just one example of the pervasive influence Hungary has had on the cookery of Central Europe. On the international level, Hungarian cookery is perhaps the best-known of all the cuisines of Central Europe, and so are its wines.

Hungary experienced the fate of being a great medieval power, only to suffer defeat and invasion by the Ottoman Turks. The medieval kings of Hungary enjoyed a long association with Italy, especially southern Italy and Sicily, thus Hungarian cookery early developed a distinctiveness best characterized as a blend of Slavic and Mediterranean Europe. The Turkish occupation of the country devastated it, and not until the 1680s were the Turks driven back, after their defeat at Buda. Through dynastic marriage, the kingdom of Hungary became part of the Habsburg Empire, but Turkish influences lingered and blended with local culinary traditions, coffee drinking among them. However, Austrian rule meant that both upper-class and middle-class cooking became heavily Germanized. Many of the foods associated with Hungarian cuisine came from the countryside, among them *pörkölt* casseroles, *guylás*, *palacsubták* (a type of pancake), and *Liptó* cheese made with goat milk.

In contrast to this, Budapest became a great center for pastry baking, in part due to the proximity of wheat-growing districts and constant contact with the Viennese court. Two of the best-known nineteenth-century cafés were Gerbaud's in Pest and Russwurm's in Buda, but the most famous of all was run by József Dobos, whose Dobos Torte is found in every cookbook devoted to elaborate cakes.

Nothing about Hungarian cuisine, however, is better known than paprika. Introduced in the eighteenth century from Bulgaria, paprika gradually made such inroads into Hungarian cookery that it became a defining element. The Hungarians have also become the unrivaled masters in pepper breeding, so in any given farm market it is possible to see vast quantities of unusually shaped peppers, both sweet and hot, piled in heaps or hanging in endless strings among braids of garlic and other local produce. Hungarians enjoy peppers with every meal, even at breakfast. One popular breakfast dish consists of hot peppers stuffed with bacon drippings. The peppers are sliced and eaten on rye bread.

Romania

Romania's borders have moved considerably throughout history. The western part of the country was once the Principality of Transylvania and part of the Austro-Hungarian Empire. It is difficult for a country that speaks a romance language to look west toward Vienna for culinary inspiration when it has the Black Sea lapping at its feet. This mixture of Slav and Latin, of Orientalism and self-conscious Francophilia, characterized the flowering of Romanian haute cuisine during the interwar period. It was the product of literati, and it was decidedly sybaritic.

This is not the Romanian cookery of modern cookbooks, yet in reality there are probably two distinct Romanian cookeries, one created exclusively in the restaurants, an important aspect of Romanian social life, and the simpler foods made at home. Much unites both of these cookeries with the Mediterranean and the Near East. Spit-roasted meats, stuffed vegetables, rice pilafs, an abundance of eggplants, and a good array of local red and white wines all work together to give the food a peculiarly Romanian character. Food is often served *mezze* fashion, in an array of small dishes, and there is a widespread preference for hot pepper.

Mamaliga, Romanian polenta, is well-known and has already been mentioned, but not as well-known are Romanian *ghiveci* (a dish resembling ratatouille), *mititei* sausages (garlic-flavored beef sausages), carp's roe paste (*icre*), sour winter soups, and *sarmale* (stuffed cabbage leaves). In Transylvania the cookery changes due to the presence of a large German minority that settled there in the Middle Ages and to an even larger Hungarian community. Both of these groups have distinctive local cuisines that have had an important influence on Slovakia and Hungary to the west.

See also **Germany, Austria, Switzerland**; **Judaism**; **Middle Ages, European**; **Sausage**; **Stew**.

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Kara Kuti

CEREAL GRAINS AND PSEUDO-CEREALS.

Cereals and pseudo-cereals are the primary carbohydrate supply for the world's human population. Nearly half of the annual cereal production is used for human food. Cereals also serve as the primary food for dairy and draft animals, poultry, and wild birds, and are the main ingredient in the production of alcohol. The primary cereals include wheat, rice, corn, sorghum, millets, oats, barley, and triticale. Wheat and rice provide nearly 50 percent of the world's food energy. Millet is a term that refers to small-seeded grain and has been applied to many unrelated species. The primary millet involved in world trade is proso millet, which is grown mostly in northern China. Foxtail millet and pearl millet, totally unrelated species, are also widely grown for grain on subsistence farms in Asia and Africa, respectively. Three other unrelated millets—finger, brown-top, and Japanese—are locally important cereals on subsistence farms throughout the world. Pseudo-cereals include amaranth and buckwheat.

Defining Cereals and Pseudo-Cereals

Cereals are members of the grass family (Gramineae) that are grown for their edible starchy seeds. Pseudo-cereals are grown for the same purpose, but are not members of the grass family. Since they are grouped based on use rather than the biology of the plant, this aspect will be considered separately. Initial development of cereal plants involves seminal roots that vary from three to eight in number. They arise directly from the hypocotyl. Further plant development includes the development of a second set of roots which are permanent and arise from the point just a little below the surface of the ground. These roots are fibrous rather than tap and are noted for their ability to control soil erosion through an extensive network of root hairs. They extend outward and downward in all directions from the crown, providing the primary nutrition for the plants.

Cereals are identified by alternate two-ranked leaves that are frequently formed near the ground. The leaves are composed of a sheath that encloses the stem (culm) and is split down the side opposite the blade. Identification of vegetative plants is usually based on the shape and size of the ligule, which is an appendage extending upward at the juncture of the sheath and the blade, and on the presence or absence of hairs in this region. The stems are composed of nodes and internodes that elongate to varying degrees as the crop matures. The nodes associated with leaf blades are the most apparent and are identified as the swelling in the stems. Nodes lower on the plant have the potential to develop additional stems, which are frequently referred to as tillers. The grain is produced on a spikelet that varies significantly from corn to wheat to millet in size, shape, and appearance.

The cereals and pseudo-cereals are essentially a starchy crop. However, they may contain significant quantities of protein and oil, and it is frequently these constituents that determine suitability for a specific end use. Structurally the seeds are composed of three main parts including the endosperm, embryo, and seed coat. The endosperm is the primary starch storage portion but also contains some protein. The embryo is the oil storage portion, high in protein and minerals. The seed coat, also called pericarp or bran, consists mainly of cellulose and hemicellulose with some protein and lignin. Relative proportions of the three components vary among the different cereals with the embryo of "small grains" such as wheat and barley making up less than 4 percent of the total seed, while in corn it averages 12 percent. There is also large variation from variety to variety.

Buckwheat and amaranth are two of the most widely used pseudo-cereals, but their production is dwarfed by the true cereals. Buckwheat is in the Polygonaceae family and amaranth is in the Amaranthaceae family. Neither has been the primary energy source for large regions, but both have played significant roles in food use. They both have a tap root rather than a fibrous root system and have two cotyledons rather than one as is true for the grasses. The root system consists of a tap root (central or primary root) that extends downward to a considerable distance. This root is thicker and stouter than the lateral roots that arise from it. The lateral roots may be divided several times. The tap root first penetrates the soil for some distance, forming no laterals. Laterals are then formed, beginning at the upper portion of the tap root. Buckwheat and amaranth are herbaceous, erect growing annuals. Under ordinary conditions buckwheat attains a height similar to wheat. Amaranth is typically twice the height of wheat, but there are some dwarf varieties that seldom grow taller than four feet. Both plants adjust themselves very efficiently to surroundings, such as fertility of soil and rate of seeding, by sending out branches from the main stem. The buckwheat kernel is in the form of an achene, being a single seed enclosed in an indehiscent pericarp that fits tightly around the seed. The achene is three-angled, the angles being acute, and has the form of a pyramid with the base rounded. The hull or pericarp varies from silver gray to brown or black in color and is hard and thick, with the surface polished and shining. It separates readily from the mealy endosperm. The relatively large embryo is central, dividing the soft, white endosperm into two parts, the cotyledons being broad. The surrounding testa is membranous and light yellowish-green in color.

Buckwheat groats, called kasha, are sold in whole and granulated form. Kasha can be baked, boiled, or steamed to serve as an alternative to rice and potatoes. Buckwheat flours have been used extensively in pancake mixes as well as in various breads. The Japanese mill buckwheat groats into flour for use in the production of soba noodles, a major part of the Japanese diet. Buckwheat flour is the primary ingredient in such European dishes as polenta and Zganci.

Reliance of the world population on one or more of the cereal grains as a primary food material is not just happenstance. They contain the main food essentials for the human and animal body, although they are deficient in vitamins and may be low in particular amino acid portions of the protein. Pseudo-cereals frequently have a unique amino acid profile and can be used to supplement cereals for a more balanced amino acid diet. Starch, the primary constituent of cereal grains, breaks down in the digestive tract into simpler and more easily digested sugars to supply the body with its primary source of energy. While varying in oil percentage, the oil plays a significant role in total energy supply in the diet and some varieties have been selected with amounts adequate for processing and selling as vegetable oil.

While rich in thiamine, riboflavin, niacin, and pantothenic acid, the cereals do not meet all of the vitamin and mineral requirements for food or feed. Frequently foods and feeds that are used to supplement these needs are considered more important than the cereals themselves, but as a proportion of total food and feed consumed, none come close. The role of fiber in the diet has recently been studied extensively and has altered somewhat the thought on the value of the seed coat, which contains the highest portion. This portion is also high in vitamins and minerals and many recipes have been altered to include higher proportions of whole grain or bran to take advantage of the health benefits.

Cereals and pseudo-cereals are not often used as human food without some preparation to convert them to a more edible and digestible form. Modern processing methods utilize grains to produce everything from tortillas to macaroni, as well as breakfast food, flour, bread, and vegetable spreads.

Origins of Cereals

The origins of some cereals are obscure. More than one had its cultural beginning before recorded history. The development of cereal grains, probably more than any other factor, permitted the earliest tribes to change from nomadic life to full or partial agricultural subsistence. They provided more food with less effort than did any other crop. They were important for their ability to provide subsistence and security of subsistence over time. Cereals can be easily stored to provide food between harvests. Their role in reducing the time spent by people in hunting and gathering allowed humankind to develop other pursuits.

The various cereals probably developed in different parts of the world. Corn is likely the only cereal native to the Americas, while wheat and barley may have been cultivated first in the Fertile Crescent area of the Middle East. The pseudo-cereal amaranth is also native to the Americas, and the earliest identification of amaranth as a grain comes from archaeological digs at a cave in Tehaucan, Puebla, Mexico, where seeds of *Amaranthus cruentus* were dated as six thousand years old. Aztec writings are the first recorded indication of its use and mention collection of large quantities of amaranth along with corn and beans in annual tribute to the ruling class. Although the origin of proso millet has not been ascertained, it is one of the first cultivated cereals, most likely prior to wheat. Proso millet has been known for many thousands of years in eastern Asia including China, India, and Russia. The genus *Setaria* is widely distributed in warm and temperate areas. Foxtail millet, the most widely grown food of this genus, is one of the world's oldest cultivated crops. Its planting was mentioned in Chinese records as early as 2700 B.C.E. Foxtail was the most important plant food in the Neolithic culture in China, and its domestication and cultivation constituted the earliest identifiable manifestation of this culture, the beginning of which has been estimated at over four thousand years ago. Buckwheat is native to temperate east Asia, where it was grown in China before 1000 C.E.

Modern Cereal Production

Development of mechanization for planting, harvesting, shipping, and processing of cereals during the first half of the twentieth century led to the greatest advancement in cereal production since the dawn of history. Practically all labor involved in modern cereal production involves mechanized operation. Mechanization—along with improvements in weed, disease, and insect control, improved nutrient management, and variety improvements—increased production potential and led to the Green Revolution in the second half of the twentieth century. Today, one farmer typically provides cereals that feed more than one hundred people. The average yield per unit of land of cereals has increased by more than 50 percent in the last fifty years. Increases in corn and rice have been more dramatic than those of the other cereals, but all have shown steady improvements. The dramatic yield improvements in corn have led to a production area increase in corn at the expense of oats, millet, rye, and barley. Especially in China, millet production has been pushed to more marginal areas with the best land being dedicated to corn and rice, with higher yield potential.

The sickle or reaping hook was used for cutting cereals during the Stone Age. In biblical times the blades were made of bronze or iron. Steel sickles were made in the nineteenth century. The sickle is still a part of harvesting in many developing countries. Typically a man with a sickle can cut, bind, and shock an acre of grain in around forty hours. A scythe was more common in the Roman Empire and areas of the Orient. With attached cradle frames, harvesting time was cut to twenty hours per acre. In the first century of the common era, Pliny the Elder described a grain stripper that was pushed by oxen and used by inhabitants of Gaul. Between 1775 and 1840 reapers were developed in Europe and the United States, but this was quickly replaced by combines by 1950. The combine not only replaced the reaper, but also replaced the thresher that was developed in the latter half of the nineteenth century. Before then, grain had been flailed out by hand or threshed by treading out the grain under the feet of people or livestock. With a flail a man can thresh seven or eight bushels per day. A form of threshing machine still used in Asia and Africa consists of stone-studded planks, stone rollers, or metal disks on a shaft drawn by animals over the grain stalks that are spread on a threshing floor. Today, modern combines cut, thresh, and clean more than one hundred acres per day.

The mechanical corn picker was not developed until World War II and replaced the age-old tradition of husking by hand from the standing stalk. If the stalks were being harvested for forage, some cut them by hand and placed them in shocks to cure. Today the corn picker has been replaced by the modern combine used on other small grains with only modifications of the header.

Storage and Transportation

Compared with many other crops, cereals and pseudo-cereals are extremely amenable to storage. The moisture content at harvest is typically below 15 percent and their composition and seed coats are such that deterioration is slow. Seasonal harvest with a continuous demand means that storage between harvests is required. Under typical conditions this need can be met easily; with care, storage for many years without serious loss of quality is possible. Storage during times of surplus is a part of human history, and with benefits of modern technology, cool dry conditions can be maintained and storage can be successful for extended periods of time. There are, however, problems with storage, including excessive moisture content at the time of storage, excessive temperature, microbial, insect, and arachnid infestation, rodent and bird predation, mechanical damage, and biochemical deterioration. The latter is especially important for cereals and pseudo-cereals with higher than normal oil content because the oil becomes rancid over time.

The distribution system for cereals is frequently criticized as there is a surplus of production and yet hungry people around the world. However, the infrastructure that moves cereals by truck, train, barge, and ship is one of the most complex and efficient systems in the world. It is estimated that rail shipments from Kansas and Nebraska—the heart of winter wheat production—to the Pacific Coast, or a combination of truck and barge shipments to the Gulf Coast, cost less than $0.50 per bushel, including less than $0.15 for transportation from the field to a local destination, and that loading on a ship and delivering to a handling facility in Southeast Asia or Africa adds only $0.50 per bushel. Getting from one village of the developing world to the next can double the total value of the wheat.

Processing

Cereals are processed in many ways, but the methods are broadly grouped into wet milling, dry milling, oil processing, fermentation, and feed processing. Characteristic features of milling processes include separation of the endosperm from the embryo and seed coat, and reduction of the endosperm into flour or grits. Milling schemes are classified as wet or dry, but this is a relative classification because water is used in almost all separations. Few generalizations can be made about cereal milling. For example, most rice is milled in two stages to remove the husk and then the bran, however, some is milled into flour. There are dry milling processes that change the shape and size of cereal. Fractions produced by this step are frequently separated in another step. An additional milling process can be completed by changing the temperature or water content. Unlike dry milling, which primarily just fractionates, wet milling is a maceration process in which physical and chemical changes occur in the basic constituents: starch, protein, and cell wall material. The objective is complete dissociation of the endosperm cell contents with the release of the starch granules from the protein network. Processing has taken a huge step from Stone Age grinding stones for dry milling to soaking processes to remove starch, described by Cato in the second century B.C.E., to modern milling and extrusion processes. Milling processes today are almost entirely based on meeting end product specifications by the most efficient means possible with almost all steps controlled mechanically and electronically.

The other primary processing method is production of alcohol from cereal grains through a fermentation process. This two-step process includes the conversion of starch to soluble sugars by amylolytic enzymes, followed by the conversion of the sugars into alcohol. In the first step the enzymes may be derived from the grain itself (malting), from other organisms present or added as extracts. The malting process has also been used for the production of some breakfast foods. It is comprised of a controlled germination during which enzymes capable of catalyzing hydrolysis of starch are produced. The fermentation process results in the development of alcoholic drinks, including beer and sake. Further processing by evaporating and condensing increases the alcohol content and produces whiskey, scotch, bourbon, and neutral spirits, including those used for production of fuel. Today production of gasohol ranks as one of the largest uses of corn following its use as animal feed. The by-products of fermentation are primarily used as livestock feed.

The number of foods prepared from a base of cereals is the largest of all food crops. Cereal grains are largely interchangeable for different uses and are, therefore, mutually competitive. They can substitute for one another in a number of food and nonfood uses. In their use as feeds they are almost completely interchangeable. That allows more latitude within which available grain supplies can satisfy a series of demands.

As raw materials in major processing industries, however, grains are not always so interchangeable. Technology of a particular process often requires a specific combination of chemical and physical characteristics in the raw material, which can be met fully by only one type of grain. This has been extended to variety specificity for many products and has led to the development of identity-preserved marketing systems that are quite distinct from the bulk transportation systems discussed earlier. Some predict that with greater use of biotechnology for adding trait specificity, the identity-preserved marketing systems may become increasingly important.

Cereal uses for food are largely defined by cultural context, but with the greater global movement of people, there is now a greater dispersion of foods. For example, rice-based products are now a common food item in places with no rice production. The same is true of amaranth.

The Aztecs used amaranth, which they called *huautli*, in a beverage, a sauce, for a type of tortilla, and for various medical uses. Popped or ground amaranth often was mixed with honey or other sweet, sticky plant materials, and then shaped into a variety of figures and shapes that were used in celebrations and religious ceremonies. Unlike most cereals, amaranth leaves are used as a vegetable, similar to spinach, and certain types have been selected almost exclusively for their leaf production. Most commercial production of amaranth is for types selected primarily for grain or forage production.

Both cereals and pseudo-cereals have a long history of use as forage crops for livestock. The small grains have been used extensively for hay, grazing, green-chop (fresh fodder harvested and used as cattle feed), and silage. Foxtail millet, pearl millet, and some other millets are perhaps better known for their forage use than for their grain production. Corn and sorghum are utilized extensively for silage. Almost all stover of all cereals and pseudo-cereals has potential utilization by livestock even though it may require supplementation with higher-protein feeds. Prior to the soft dough stage, when the kernel is still immature and has not yet hardened, most cereals meet or exceed nutrient requirements of livestock. Cereal forages are used as supplemental feed for cow and calf herds, support major elements of the stocker cattle industry, and have potential to produce finished beef. Cereal improvement programs, while directed at improved seed production, have improved disease resistance, stress resistance, insect resistance, and general adaptability to specific climates. This has led to significant improvements in consistency and quantity of forage production as well.

Cereal silage is an important part of the dairy industry. Corn silage alone makes up over 40 percent of the value of the forage fed to dairy cows in the United States. Corn silage is noted for its palatability, consistent quality, high yields, and energy content compared with alternative forages. The cost of production tends to be lower for corn silage than for most other forages, but this is partially offset by the large transportation costs of relatively wet material. Transportation costs have largely limited use to livestock production near the field from which the silage was harvested.

While the cereals and pseudo-cereals are primarily known as a source of energy, they have played important roles in other ways throughout history. Cereal sprouts have long been known for their cleansing properties and are a common part of health food stores. Amaranth and buckwheat have been evaluated extensively for their vitamin E, B_1, and B_2 activity in reducing arteriosclerosis. Oats and buckwheat are recognized as cholesterol-lowering foods. The pseudo-cereals have a different amino acid composition than the cereals and when combined in the diet produce a much more ideal amino acid balance.

Perhaps because of their importance in meeting daily sustenance and perhaps for other reasons, the cereals have been a symbol of human life and culture throughout recorded history. Amaranth played a major role in pagan rituals. Wheat and wheat harvesting are a part of world symbolism from the flags of major countries to churches and cemeteries. So much emphasis was placed on grain production by Roman peoples that the protection of grain was the primary concern of Ceres, one of the powerful Roman goddesses. The name cereal was derived from this association. With the huge supply of human energy coming from a few major cereals, and a few minor cereals in some regions, one of the big concerns for the world population is the risk of a major crop failure. This possibility has received increasing attention as selection and major gene improvements have narrowed the genetic base within crops to a few major varieties. It is particularly important that the diversity within major crops is conserved effectively, available for use, and managed wisely.

See also **Barley**; **Bread**; **Cereals, Cold**; **Horticulture**; **Maize**; **Mexico and Central America, Pre-Columbian**; **Pastry**; **Porridge**; **Rice**; **Rome and the Roman Empire**; **Wheat**.

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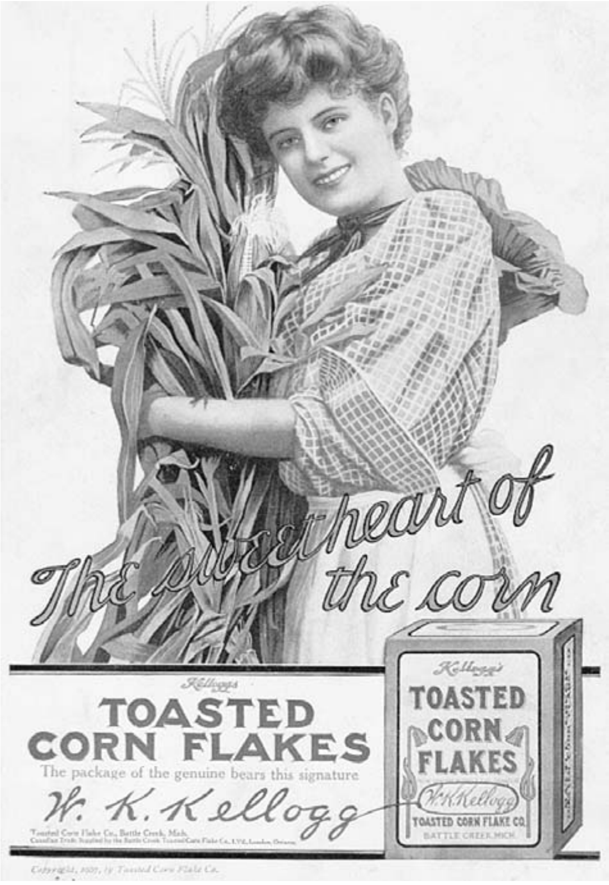
David D. Baltensperger

CEREALS, COLD. Cold cereal has been a favorite breakfast of millions of Americans for several generations. Ready-to-eat cold cereal started as a healthy snack in the early 1900s. By the twenty-first century more than 2.7 million pounds of cold cereal were consumed by children and adults each year in the United States.

Cold cereal makes a quick, nutritious, low-cost, and portable breakfast. Ready-to-eat cereal products supply important nutrients. When combined with low-fat milk, cold cereal makes a meal that is high in protein and low in cholesterol and fat. Milk and grains compliment each other nutritionally since they are from different food groups. Most cereals are fortified with at least 25 percent of the daily recommended intake of essential vitamins and minerals and may provide up to twenty-six grams of fiber per cup of cereal.



Fresh corn and a pretty face are used to promote Kellogg's new breakfast cereal in this 1907 advertisement. COURTESY OF JANET CAMERON.

Hot, cooked grains started long ago, but cold, ready-to-eat cereals were not available until Will Keith Kellogg and his physician brother John Harvey Kellogg began experimenting with flaked wheat in the early 1900s in Battle Creek, Michigan. While John Harvey Kellogg sought a nutritious food for his patients, Will Keith Kellogg recognized the sales potential of the crunchy, flaked grains that offered taste and convenience. Based on their experiments, Will Keith Kellogg founded the Battle Creek Toasted Corn Flake Company, later renamed the W. K. Kellogg Company. He is credited with transforming American breakfast habits and pioneering the mass advertising campaign in the United States. Competition among cereal manufacturers spurred marketing creativity. Cheerios, developed and marketed in 1941 as Cheerioats, supplied World War II soldiers with Yank Paks, special one-ounce packages available to the military. Cheerios also sponsored the *Lone Ranger* radio and

Most cold breakfast cereals are eaten with milk, but the addition of fresh fruits, nuts, or raisins is also popular. © ARTHUR BECK/CORBIS.

television shows during the 1940s and 1950s and featured premiums, such as deputy badges.

Cold cereal has gone through many changes since the Kellogg brothers' time. Most cereals are made from one grain or a combination of several grains, including wheat, corn, rice, oats, and barley. Ready-to-eat cereals fall into three main categories: whole grain, enriched, or restored. Whole grain cereals include the bran, germ, and endosperm—parts of the grain or "seed"—and the nutrients they naturally contain. Enriched cereals contain grains supplemented with vitamins and minerals above the level found in them naturally. For example, most grains are low in vitamin D, so enriched cereals have added vitamin D to meet the body's requirement. Restored cereals contain whole or refined grains plus nutrients that were lost during processing, such as B vitamins and iron. Some cereal manufacturers add 100 percent of the recommended daily value of nutrients; most add just 25 percent.

Experts disagree on the value of cold cereal. Some nutritionists feel that unfortified, natural whole grains are healthier than prepared cereals made from fortified, refined grains. Others argue that consumers are likely to eat more of the sweet-flavored cereals and therefore will eat sufficient quantities to meet dietary requirements. But cold cereals have more than vitamins and minerals. Fiber is an important part of whole grains and of the human diet. Cereal ingredients such as oats, wheat, and psyllium, contain fiber and help reduce the risk of heart disease. Scientific research indicates that a diet including wheat bran may help reduce the risk of colon cancer.

Cereal boxes note that "diets rich in whole grains and other plant foods and low in total fat, saturated fat, and cholesterol, may help reduce the risk of heart disease." When shopping for cold cereal, read the nutrition facts on the box. Most nutritionists agree that the best cold cereal contains one or more whole grains, no partially hydrogenated oils, no added sugar, no added salt, and plenty of fiber (at least 3 grams of fiber per 100 calories or 3 to 5 grams of fiber per 1-ounce serving). Some cereal makers add BHT or other artificial ingredients to preserve flavors. Other companies avoid artificial ingredients and depend instead on heat processing at low temperatures or the addition of oil to preserve cereal quality.

Responding to customer concerns, cold cereals are likely to begin to include more plant-derived ingredients, such as cornstarch or herbal blends. Cornstarch helps keep cereal flakes crunchy in milk and helps hold together clusters of fruit, nuts, and grains. Some consumers want their breakfast cereal to supply herbal extracts, such as gingerroot, elderberries, or green tea, as well as whole grains. Look for nontraditional cereal grains, such as triticale, spelt, kamut, quinoa, flax, and soybeans. Sprouted grains offer a sweet, maltlike flavor. Substitutes for refined sugar include honey and fruit-juice concentrates; however, these ingredients add sugar, too. Cereals have also become more portable for on-the-go consumers without the time for a sit-down breakfast.

See also **Breakfast; Cereal Grains and Pseudo-Cereals; Kellogg, John Harvey; Wheat: Wheat as a Food.**

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Patricia S. Michalak

CHEESE.

Cheese, which has been described as "milk's leap toward immortality," can be more dispassionately defined as a product of milk fermentation. Yet part of our fascination with cheese may come from the sheer number and diversity of cheeses worldwide. They number into the thousands, although an exact count is difficult, as cheeses are notoriously difficult to classify. A classification of cheese only in terms of bacteriological processes neglects the symbolism of ancient mythologies, regional pride, and artistic ingenuity that are embedded in this, one of the simplest and most complicated of foods. The mythology of cheese is shared by disparate groups: the Greeks gods and mortals, the conquerors and conquered of the Roman Empire, a delighted Napoleon and the waitress who first served him Camembert. The legends are compelling, but not as much as the product itself.

History

The beginnings of cheesemaking are unknown, but it has been generally reasoned that the knowledge of how to turn milk into cheese closely followed upon the domestication of lactating animals. Some of the earliest archaeological evidence of cheesemaking comes from the Fertile Crescent, where animals were domesticated around 8000 B.C.E. A Sumerian relief (c. 3500–2800 B.C.E.) portrays cattle and dairying practice. Pots that had likely contained cheese were discovered in the tomb of Horus-aha, the second king of the Egyptian First Dynasty (c. 3000–2800 B.C.E.). And perforated bowls (c. 3000–1000 B.C.E.) made from pottery or rushes have been found in more than one European location. These bowls were designed to drain the liquid whey from the solid curds.

Cheesemaking was an efficient means of preserving an extremely perishable food (milk) from the spoiling effects of the Near East climate. The art and science of cheesemaking spread into Europe, and quickly became a regular part of the diet and a symbol of strength in ancient Greece, where Olympians trained on diets of cheese. Polyphemus, the brutal Cyclops of Homer's *Odyssey*, milks his animals amid the racks of cheese in his cave, while Odysseus watches quietly nearby. According to Greek mythology, the knowledge of cheesemaking was a gift to mortals by the gods of Mount Olympus. Roman soldiers carried cheese rations with them as the Roman Empire grew, though cheesemaking was highly developed in the Celtic parts of Europe. The Feast of Imbolc (2 February) was a celebration of the approach of spring: the new lambs and the milk of the ewes represented the changing seasons and were honored as a first sign of spring.

Artisanal cheesemaking might have been lost after the fall of the Roman Empire if not for the Christian monasteries. The monks not only preserved cultural traditions during the Dark Ages, but spent much time reworking and improving cheese recipes. Their creations, among them French Munster and Epoisses, are still referred to as "monastery" or "trappist cheeses."

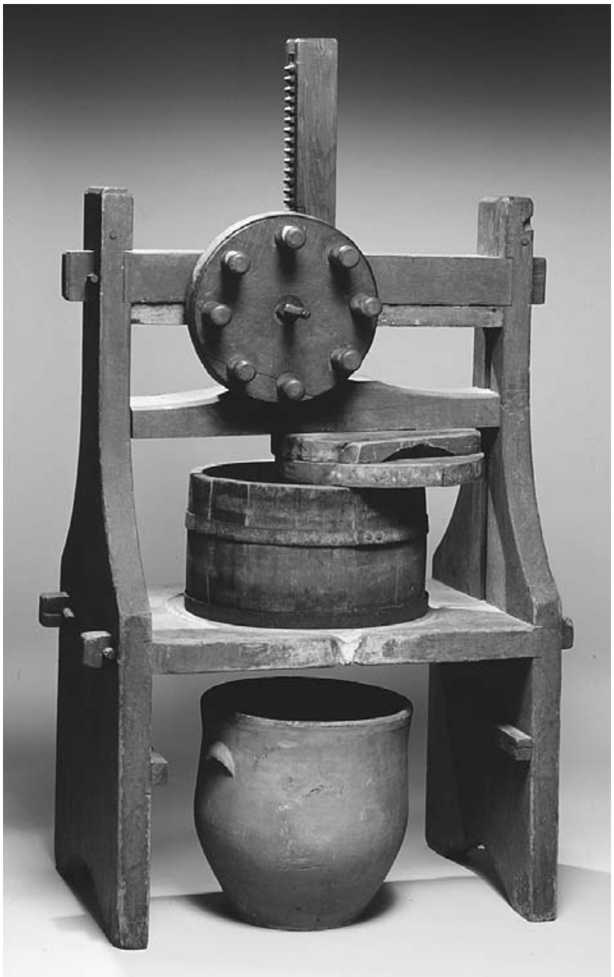
In the following centuries, cheesemaking grew as an art and industry. The first commercial cheese factory in the United States was established in Rome, New York, in 1851. Innovations like the kind of cream cheese popularly known as Philadelphia Cream Cheese and pasteurizing whole cheese (patented in the United States by James Kraft in 1916) followed. Almost a century of pasteurized process cheese sales in the United States and abroad have demonstrated their popularity, but a growing number of cheesemakers and cheese-eaters are committing to the preservation and production of artisanal (made by hand) and farmstead (made from the animals of a farm on that farm) cheeses. Several books about specialty cheeses have been published in the last few years, and wider selections of domestic and imported cheeses are available in supermarket, and restaurants.

Milk

When confronted by the vast number of cheeses, the different shapes, colors and aromas at a well-stocked cheese counter, it is astonishing to remember that all these endless varieties come from only one basic ingredient. Although a cheesemaker makes many decisions throughout the cheesemaking process that will affect the finished product, the first step is always to select the raw material, milk.

Cheese can be made from any animal that produces milk: cow, sheep, goat, camel, mare, buffalo, or yak. With the exception of Italy's mozzarella *di bufala*, made from the milk of herds of water-buffalo, cheeses in the Western world are typically made from the milk of cows, goats, and sheep. Of the three animals, sheep produce the lowest volume of milk, but because it is so much higher in fat and protein content than either goat's or cow's milk, less of it is needed to make cheese. On average, ten pounds of cow's or goat's milk or about half that amount of sheep's milk is required to make one pound of cheese. In contrast to the rich, concentrated flavor of sheep's milk, goat's milk is slightly sweet and fresh-tasting; cow's milk is the lightest of the three. The milk of individual breeds of the same species also has a unique flavor profile. Consequently, the laws governing many name-controlled cheeses specify the breed of animal from which the milk is to come. Cheesemakers have the further choice of how to use the milk they collect: full fat, partly skimmed, or with extra cream added.

Free-grazing animals feast on a bounty of wild grasses, flowers, and other vegetation during the warmer months. This gives their milk a complexity of flavor that is easily distinguishable from the milk of grain-fed animals in winter. Some cheesemakers insist that they can



Red-painted cheese press, Connecticut, ca. 1835. Tulip poplar and oak. The press creates a wheel of cheese inside the tub, while excess whey drips from the drain into an earthenware pot. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

perceive slight flavor adjustments daily—as the animals move from one pasture to another.

Pasteurization

Milk used for cheese may or may not be pasteurized. Pasteurization is a process of heating milk that destroys most of the naturally present bacteria (see Cheese Safety below). Current U.S. law requires that cheeses be pasteurized or, if made from unpasteurized milk, aged for at least sixty days at 35°F before sale for consumption. Milk may be pasteurized in one of two ways: by heating it to 161°F for fifteen seconds, or by heating it to 145°F for thirty minutes (the latter method is sometimes called "heat treatment"). These laws apply to both domestically produced and imported cheeses. When cheese is made from unpasteurized milk, it is frequently referred to as "raw milk" cheese, connoting that the milk has not been "cooked." Most cheesemakers believe that the brilliant nuances of flavor found in raw milk, with its naturally present "good" bacteria, simply cannot be duplicated in a pasteurized milk cheese, though some well-respected cheeses, including British Stilton, are made only from pasteurized milk.

The Principles of Cheesemaking

An oft-repeated legend has it that the first cheesemaker fell into the role by accident. A nomadic tribesman prepared for a long desert journey, he carried a bag made from the dried stomach of a young sheep and filled with milk. As he walked steadily under the relentless sun, the milk began to curdle. Noting that this "fresh cheese" had a pleasant taste and did not spoil as easily as milk, the nomad later drained off the whey and salted the curds to enhance these qualities. The cheesemaking tradition had begun.

While modern cheesemaking techniques are more refined and recipes have become standardized, the basic principles remain the same now as when the (possibly apocryphal) nomad of cheese legend opened his sheep's stomach bag (which supplied the coagulating rennet), warmed by the sun and agitated by his rhythmic trek.

The Steps of Cheesemaking

There are as many recipes for cheese as there are cheeses, but all of them follow some combination of these steps.

Acidification: souring the milk. The milk is gently warmed to encourage the growth of lactic acid bacteria, Streptococci and Lactobacilli. These bacteria feed on the milk sugar lactose, changing it to lactic acid. As the acidity rises, the solids in the milk (casein protein, fat, some vitamins and minerals) clump together, forming curds in the watery whey (milk is approximately 85 percent water). This is the first step for making all cheeses; in ancient times, cheeses were most likely the result of leaving pots of milk to sour naturally in the sun, affected by bacteria in the air. Some cheesemakers still wait for these process to begin with free, airborne lactic acid bacteria, but most use a starter culture. Starters are widely available commercially, but cheesemakers can also use a bit of the previous day's milk (unless it is pasteurized)—the same principle as with a sourdough bread starter.

Renneting: coagulating the curd. Cheesemaking has been referred to as "controlled spoiling" because of the need to efficiently form curds before undesirable bacteria cause the milk to become rancid. The enzyme rennin, traditionally removed from the stomach lining of a young animal (usually the same species of animal that supplied the milk), hastens and completes the curdling process. The renneting property of some plants has been recognized nearly since the dawn of cheesemaking; these vegetable rennets are the traditional agents in several cheeses. Other vegetarian rennets, made from a yeast or fungus, are also used today.

The curd is left to "set," forming a network of protein that traps the other milk solids inside. As the solids bind more tightly together, they begin to push out the liquid whey, a process the cheesemaker may continue by cutting, cooking, and pressing. The whey is sometimes used to make cheese as well (Italian ricotta and Cypriot hallumi are two examples), but usually it is discarded.

Treating the curds. After renneting, cheese recipes diverge. Some soft cheeses, like fresh goat's milk cheese, are gently transferred to molds. The curd's own weight will continue to press out whey. These cheeses might be labeled "hand ladled" to indicate that they were created using this time-consuming method. The Greeks called the molds that held the curds *formos*, which became the root for cheese in Italy (*formaggio*) and France (*fromage*). Our English word "cheese" has its root in the Latin *caseus*, which became *Käse* in German and *queso* in Spanish.

In contrast to the light touch required for soft cheeses, which derive their creamy texture from a higher water content, the curds for other cheeses are sliced and chopped, by hand or machine, to release more whey. The smaller the curds are cut, the firmer the resulting cheese. Cheddar and some other cheeses undergo a unique process called "cheddaring," which results in its firm, flaky texture. Blocks of curd are stacked, turned, and restacked to press out as much whey as possible. Then the dry curds are milled, ground into tiny pieces, and packed into molds.

Some hard cheeses are "cooked," that is, the curds are reheated during processing. This causes the curds to release even more whey and alters the texture of the cheese. Examples of cooked cheeses include Emmentaler, Appenzeller, and Gruyère.

Preparation for aging: salting, molding, and pressing. Cheeses can be salted in four different ways. For some cheeses, the salt is stirred directly into the curd. A second method involves rubbing or sprinkling dry salt onto the rind of a cheese. This helps to form the rind, protecting the inside of the cheese from ripening too quickly. Some large cheeses are soaked in a pool of brine. The fourth option is to wash the surface of the cheese with a brine solution. In the case of washed-rind cheeses, the salt does not protect the cheese from bacteria—it invites them. The cheeses must be regularly rubbed with water, brine, or alcohol to encourage the growth of the bacteria that give them their sticky orange rinds and distinctive aroma.

Cheese is then transferred, if it has not been already, to a mold where the final cheese will take shape. The whey of soft cheeses drips through the holes in their molds, pressed out by the cheese's weight. Other, firmer cheeses are pressed by hand or machine to extract the last bits of whey.

Ripening. During the ripening or aging stage, the cheesemaker cares for the cheese at a precise temperature and humidity level until it is ready to eat; this can range anywhere from a few weeks for a soft-ripened cheese to a few years for a wheel of Parmigiano-Reggiano. Depending on the variety, ripening cheeses need to be turned to equally distribute the butterfat and brushed to maintain the rind quality.

Name-controlled Cheeses

Before the 1951 Stresa Convention in Stresa, Italy, it was impossible for traditional, regional cheesemakers to protect their products from inauthentic forgeries. The delegates to this international conference accomplished two goals: they created a uniform definition of "cheese" to facilitate international trade, and protected by law the names and origins of a select group of treasured traditional cheeses. Protected cheeses fall into two categories. A few cheeses, including France's Roquefort and Switzerland's Sbrinz, are given absolute protection—the cheese cannot be made outside of its designated region. A second group of cheeses may be produced in nontraditional areas, but must be clearly labeled with its region of origin. Camembert produced in the United States is a good example of this second group.

"Name-controlled" cheeses must meet stringent laws that go beyond the international standards for processing and safety. The departments and associations that supervise these cheeses differ from country to country (and from cheese to cheese), but generally emphasize the unique, regional quality of the cheese. In Switzerland, for example, cheeses must be native to the area in which they are made. France has the most specific cheese production laws of any country. The Appellation d'Origine Contrôlée (AOC) designation indicates that a cheesemaker has complied with regulations that include the type and breed of animal from which the milk comes, location of production of both milk and cheese, production techniques (including pasteurization), the final composition of the cheese (its fat and moisture content, for example), and the physical and sensory attributes of the cheese, which include its shape, size, and of course, flavor. Spain, Portugal, Italy, and Great Britain are also home to name-controlled cheeses.

The effort to control cheese quality through government standards of identity can be related to similar efforts with wine. Purchasing a French cheese with the AOC designation on the label does not necessarily guarantee quality, however. Subtle differences between individual producers, milk quality, or aging time and conditions can make the difference between a great cheese and a not-so-great one.

Classifying Cheese

As Pierre Androuët asserts in his fundamental text *Guide du Fromage* (Guide to Cheese), a cheese should simply be what it is—its appearance, aroma, texture, and flavor

Traditional baskets for straining cheese curds. Cyprus, 20th century. Myrtle twigs. The use of myrtle for cheese strainers dates to classical antiquity. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

should be characteristic of the variety to which it belongs. But how does one determinate a cheese's "type"? There are innumerable cheeses, and no single, standardized method for grouping them; rather, authorities employ different classification systems.

General characteristics, such as the type of milk (or whey) used or the country of origin, provide a starting point for discussing broad topics; for example, the relative unpopularity of sheep's milk cheese in the United States compared to European countries, or the social implications of cheese consumption in England as opposed to France. More specific classifications—the moisture content of the cheese (hard, semi-hard, soft, or fresh), whether it was made from pasteurized or unpasteurized milk, or the length of aging—may serve scientific inquiries concerned with bacterial development rates in different cheeses.

When cheese is classified by "type," it is grouped by similar characteristics like taste, smell, and appearance. The rind type and the method of production are often used as determining factors. Steven Jenkins describes eight different cheese "families" (including processed cheese) (*Cheese Primer*, pp. 11–13). These very common categories may help when choosing a cheese at the cheese counter, but a particular cheese may fit into more than one category, or not seem to fit in any.

Fresh cheese. After the formation of curds, the cheese (and also, sometimes, the whey) is usually transferred to plastic tubs and covered. The cheeses are eaten fresh, not ripened, and do not have a rind. Cottage cheese, cream cheese, and feta—a pickled cheese—are some common examples of fresh cheeses. Sometimes fresh Mozzarella is also included in this category because it does not form a rind, but this is problematic because Mozzarella curds are heated and stretched.

Bloomy rind cheeses. Also called simply "soft ripened cheese," this category includes cheeses like French Camembert and Brie, which are covered with velvety white molds that ripen the cheese from the outside in.

Washed-rind cheese. These orange, sticky, stinky cheeses are rubbed with a water, brine, or alcohol solution to invite the growth of ripening bacteria and molds on their rinds. Examples include the French Livarot (nicknamed "The Colonel" because it is ringed with raffia stripes) and Alsatian Munster.

Natural rind cheese. These cheeses are self-sufficient, naturally forming their rinds from air contact. Surface-molded goat cheeses and British Stilton are good examples. British farmhouse cheeses are sometimes included in the natural rind category because their permeable cheesecloth wrapping allows them to develop a thick protective rind. Likewise, Parmigiano-Reggiano and other cheeses are helped to form a rind that still develops largely from air contact.

Blue-veined cheese. To allow the growth of their distinctive bluish or greenish interior molds, these cheeses are never pressed. They are typically injected with a mold strain, and then pierced to expose the insides to air. They may be wrapped in foil like Italian Gorgonzola or form natural rinds like British Stilton.

Uncooked, pressed cheese. This is a category defined by processing type. These cheeses are pressed to remove whey, but are not cooked (see Treating the Curds).

Cooked, pressed cheese. Cheeses such as Swiss Emmental (sometimes Emmentaler) and Gruyère are cooked and pressed in the processes described above.

Processed cheese. There is another type of cheese that, because of its overwhelming presence in supermarket refrigerator cases, should not be overlooked. Pasteurized processed cheese is created by heating and mixing a blend of natural cheeses and emulsifiers. These cheeses—American cheese certainly being the best-known in the United States—can retain their flavor and texture qualities in a much broader range of temperature and moisture conditions than can natural cheeses, and for a longer period of time. They are also easy to use in a variety of dishes, and are typically less expensive than natural cheeses. Because the entire product, not just the milk, is pasteurized, and because processed cheeses are often vacuum-packaged, they are uniformly and consistently safe. The nutrient content of processed cheese remains very close to that of natural cheese, although the sodium content may be higher. All of these characteristics make them popular choices not only in the United States but in other countries as well.

Processed cheese food and cheese spread both contain natural cheese and emulsifying agents, but add other ingredients like whey, skim milk, milk powders, or water that raise the moisture content of the product. This causes them to melt or spread more easily. There are also imitation cheese products that contain little or no milk protein. Soy cheese is one example of an imitation cheese product.

Nutritional Value

The fat content of cheese is noted on its package as a certain percent butterfat. This can be misleading, however, because the fat content is evaluated as a percentage of the solids in the cheese (fat-in-dry-matter), not the overall weight of the cheese. Even a very hard, aged cheese like Parmigiano-Reggiano contains a significant amount of water, about 30 percent. As a cheese ages, it loses moisture, and the fat percentage relative to weight increases, though the fat-in-dry-matter remains the same. Soft cheeses typically have a high fat-in-dry-matter percentage, but they also contain more water than hard cheeses; their overall fat percentage is much lower, as much as half, the fat-in-dry-matter percentage.

Cheese's greatest nutritional advantage is its high protein content and the digestibility of that protein. In addition, cheese is a valuable source of vitamin A, vitamin B2, and vitamin B12, and the minerals calcium and phosphorus.

People who suffer from lactose intolerance often believe that they must forego cheese altogether. In fact, many cheeses (especially aged, hard cheeses like Parmigiano-Reggiano) contain very little or no lactose, as the lactose is expelled along with the whey. The small amounts of remaining lactose are mostly converted into lactic acid during the aging process.

Cheese Safety

Cheese has been cited as the vehicle for several bacterial outbreaks—defined as an illness from a common source that affects two or more people. Organisms communicated to humans through cheese have included Salmonella, *Listeria monocytogenes*, *Brucella melitensis*, and *Escherichia coli* (including *E. coli* O157). Nearly all of these bacteria are destroyed during the pasteurization process. Raw milk cheeses seem to have been the cause of reported outbreaks more often than pasteurized cheeses. In the interest of public safety, the United States requires that milk for cheesemaking be pasteurized or that the cheese be aged for sixty days. However, recent concerns about the effectiveness of pasteurization, coupled with alarm and confusion over animal disease outbreaks like mad cow disease and hoof-and-mouth disease (which do not affect milk safety) have prompted scientists and government officials to reevaluate the current policy.

A close review of the reported outbreaks reveals that current laws are probably adequate to prevent cheese-borne illnesses, provided that they are strictly enforced and the starting quality of the milk is high. Reports and studies of cheese-borne outbreaks often include "unpasteurized" and "improperly pasteurized" cheese in the same category, implying that milk that has not completed the pasteurization process is of the same quality as raw milk. Traditional cheesemakers would argue that this is not the case. When milk is intended for pasteurization, its initial bacterial quality need not be as high as that of raw milk, as all bacteria will be destroyed in the pasteurization process. However, if the pasteurization process were ever to fail, or if, as some researchers have hypothesized, pasteurization is not effective against all bacteria, milk of low initial bacterial quality increases the risk of cheese-borne illness. Cheesemakers who use raw milk, on the other hand, must take special care to keep it free of dangerous bacteria.

Few outbreaks have been caused by unpasteurized dairy products in which there was not at least one flaw in the production process. Curds from unpasteurized milk have been mislabeled as pasteurized, raw milk cheeses have been sold before the minimum required aging time, and fresh, unpasteurized Mexican soft cheese has been illegally imported and sold. All of the above cases involved raw milk cheeses, demonstrating the danger that can be associated with that product. Yet, they also show that the existing standards governing raw milk cheese could have prevented the outbreaks, if they had been carefully followed.

Bacterial levels in raw milk will always be higher than in properly pasteurized milk, even when the greatest of care is taken. Aging a cheese for at least sixty days has long been thought to neutralize harmful bacteria, but this may not be true for all types of cheeses and all types of bacteria. Certain groups of people, those with weakened immune systems or special concerns, should not consume raw milk products, particularly soft and semi-soft cheeses. A consumer choosing a raw milk cheese needs to do so fully aware of the possible risks. New labeling requirements could help make sure that people are informed of the risks and the pleasures when they purchase cheese.

See also **Dairy Products**; **France; Italy; Wine**.

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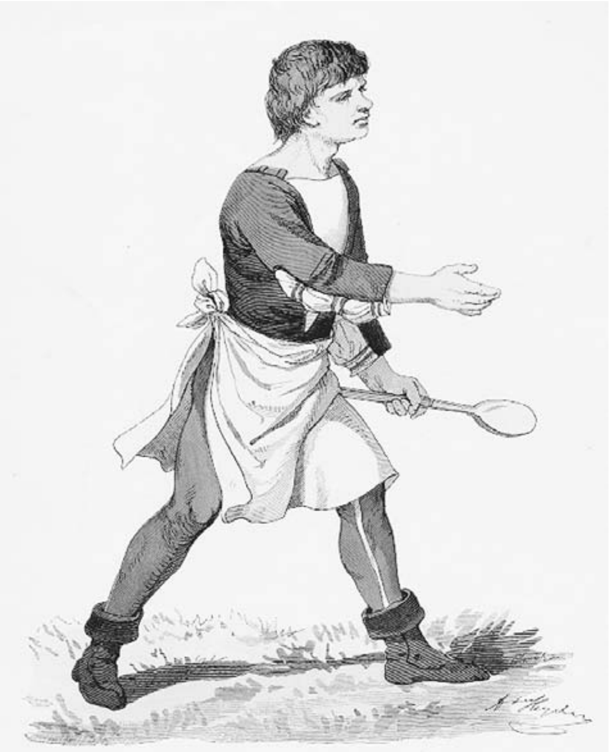
Sara Firebaugh

CHEF, THE. This entry focuses on the emergence of the *chef de cuisine* with the rise of restaurants in the public sphere. Until recently, well-known chefs working in restaurants in Britain and the United States were French or French-trained (for example, Alexis Soyer at the Reform Club in London and Charle Elme Francatelli at Delmonico's in New York City). Japan and China did not have fine dining-style restaurants or the western-style kitchen organization until more recently. African Americans were usually cooks, primarily in domestic settings or as caterers.

The role of "chef" emerged initially from the homes of European nobility, beginning as early as the medieval period. In these grand estates, kitchens were large and populated with numerous workers whose jobs were to help the nobility execute the large, complex banquets important to the maintenance of social position and power during this period. These banquets were about excess, elaborately decorated fish, fowl, and game on platters, dramatic interludes, and massive goblets of wine. As Europe entered the early modern period (1500s and 1600s), the link between social power and social display began to revolve more around exhibits of refinement. Civility and elegance took precedence over excess. The table increasingly became a site for such assertions, hence the kitchen also became more important.

The position of "chef," which comes from *chef de cuisine*, or chief of the kitchen, signifies the highest-ranking worker in a grand hierarchy. Initially he was in charge of running the kitchen, and, like the butler, reported in turn to the head of the household. In twentieth-century parlance, the "chef" traditionally has been a department head. *Chefs de cuisine* were part of the guild system, which regulated artisan practices in France until the French Revolution. Guilds controlled apprentices, the only means available for acquiring training in artisanal crafts and becoming an established craftsperson. Guilds also supervised aspects of production. In France up until the nineteenth century, *maître queux*, or master cooks in noble houses, were treated under a separate set of guild statutes. *Cuisiniers* and *traiteurs*, who worked alongside the urban streets, were considered another corporate



Drawing by Franz Freiherr von Lipperheide (1835–1906) showing the type of clothing worn by court cooks during the 1400s. From a hand-colored print published in Berlin in 1884. ROUGHWOOD COLLECTION.

group. Only after the revolution did these two groups meld, eventually leading to the identification of the *chef de cuisine* or head of any large establishment, public or private.

Without question, the most dramatic shift in both identity and practice for the chef was the move from the private to the public sphere as the primary locale for plying the trade. Up until the middle of the eighteenth century, all those with the title *chef de cuisine* worked for the nobility. With increased urbanization, the decline of the monarchical state, and the rise of bourgeois city life, the tables turned on the appropriate sites for asserting social rank. Power shifted to the new domain of the restaurant as fine dining became available to a new social class. *Chefs de cuisine* came to oversee these kitchens. An example is Antoine Beauvilliers, who worked for numerous noble houses but eventually moved to Paris, opened an early fine dining restaurant, La Grande Taverne de Londres, and wrote a cookbook, *L'Art du cuisinier* (1814). The shift from the private to the public sphere took years to complete. Auguste Escoffier, who worked from the 1860s to the 1930s, was the first renowned *chef de cuisine* who trained or worked only in public restaurants.

No evidence exists that women were ever appointed *chefs de cuisine* in any kitchen setting before well into the twentieth century. From the medieval period women worked as domestic cooks throughout Europe, but their roles were clearly defined as servants. In the move from private to public sphere, women were left behind to work in smaller, nonprofessional venues.

Chefs de cuisine historically came from France or were trained under French chefs due to the importance of the French court as the seat of "civility" and "culture" for European courtly life, more generally beginning in the early modern period. French haute cuisine symbolized, along with porcelain dishes, ornate silverware, and table decorations, and other French artisanal products, the heights of refinement. Throughout Europe a courtly banquet displaying these items revealed the sophistication and social status of the noble hosts. French chefs were hired to work for the nobility throughout Europe, including the Russian tsar and the king and queen of Britain among others.

French *chefs de cuisine* capitalized on the powerful reputation of French haute cuisine. By the 1600s they began to simultaneously promote and codify their cuisine with the publication of cookbooks, for example Pierre François de La Varenne's *Le Cuisinier français* (1651), which he dedicated to his noble patron, the Marquis d'Uxelles. Antonin Carême, another *chef de cuisine* who worked in various noble households, created *Le Cuisinier parisien, ou, l'art de la cuisine française au dix-neuvième siècle* (1828), heralded by many as the first cookbook to document the modern approach to French haute cuisine, an approach that focused on refined sauces, extremely elaborate set pieces, and an integrated system of skills and methods. By the late nineteenth century, the ever growing popularity of French chefs both inside and outside of France, the increasingly literate bourgeoisie, and greater possibilities for printing books meant that many chefs, including Urbain Dubois, Georges-Auguste Escoffier, and Jules Gouffe, wrote cookbooks in which they advocated for their mastery of French haute cuisine and its importance in the culinary pantheon. *Chefs de cuisine* managed large kitchens, but they also advocated for a certain culinary sensibility and approach. This approach was disseminated to all the apprentices and cooks working in their kitchens.

Apprenticeship was traditionally the primary means of training cooks. Only after a minimum three-year apprenticeship could a young boy, who generally began his apprenticeship between the ages of ten and thirteen, be called a "cook." The early years were usually spent cleaning vegetables, scrubbing copper pots, and generally obeying the orders of the cooks, *sauciers*, *poissoniers*, *sous chefs*, and *chefs de cuisine*, all higher up in the hierarchy of kitchen work. After completing an apprenticeship, a young journeyman cook could stay in the establishment where he was trained or search for work elsewhere. The arduous and long journey to becoming a *chef de cuisine* was not over; years went by before an aspiring cook could hope to become a chef.

Even though the official guild system was abolished after the French Revolution, until the 1870s all culinary training continued to occur within the confines of work establishments. As the culture of work changed in France and in Europe more generally, cooks and chefs began to reconsider this approach. The industrialization of many artisanal production forms on one hand and the increasingly elite status of certain occupations (engineer, pharmacist, doctor) on the other began to concern those involved in the food and beverage trades. Artisanal training was beginning to shift from the workplace to schools supported by the state. The elite alimentary craftspeople, the *chefs de cuisine*, decided the culinary training system needed to change. From 1870 through 1900 a dedicated group of French chefs worked to create a professional culinary school to replace the traditional apprenticeship program. Unfortunately their efforts did not succeed due to much resistance by those in charge of establishments used to the free labor of apprentices and the general belief in the apprenticeship model. Thus in the food trades the link between formal schooling and professional training did not occur until well into the twentieth century. Vocational schools designed to train cooks eventually capable of achieving the status of *chef de cuisine* were founded in Europe and North America by the 1930s and 1940s and throughout the world by the 1960s. However, apprenticeship was the dominant mode of culinary education for entry into professional kitchens through the late twentieth century.

The lineage of the French remained powerful in the organization of work in professional kitchens in the twentieth century. Such dominance is seen in the types of food prepared, the organization of the kitchen, and the identity and training of the head chefs running the kitchen. The imprint of the French on public fine dining meant that the *chef de cuisine* position retained the flavor of that culture.

As the modern restaurant became more a part of the economic culture, however, *chefs de cuisine* were as often found outside the kitchen, promoting their restaurants, dealing with customers, and reading and responding to profit and loss statements. The traditional tasks of overseeing menu and recipe development and supervising the production of food as it goes out of the kitchen into the restaurant remained a vital part of their job descriptions but did not encompass them totally. In larger, more corporate environments, such as hotels, chain restaurants, and college food services, the title *chef de cuisine* was often replaced with "executive chef." Managing a professional kitchen revolves around a corporate-style identity as much as or more than any cultural or culinary allegiance.

After the 1990s the identity and practice of the *chef de cuisine* began to shift even more, particularly in the United States and England. Chefs have gone from anonymous blue-collar workers sweating without much acclaim in big, hot kitchens to celebrities with their own cooking shows, product lines, and cookbooks and memoirs. Much like aspiring stars in the movie industry, aspiring cooks go into the profession because they hope to be famous one day. Why has fame come to the once lowly cook and chef? There are many possible answers, but one would have to be the decline of domestic cooking resulting from the increased number of women entering the work force since around 1970. Another answer may be found in the tremendous increase in disposable income for a certain segment of the urban population, which, combined with less cooking at home, has made going to restaurants a combination of high theater and spectator sport. Meanwhile, the expectation that the most powerful and high-ranking people working in public kitchens should be French or at least French-trained began to dissipate. The chef can come from anywhere and creates food that is indebted to but not dominated by French haute cuisine. The *chef de cuisine* has become a citizen of the globe and a respected professional.

See also **Carême, Marie Antoine; Escoffier, Georges-Auguste; France; Kitchens, Restaurant; La Varenne, Pierre François de; Places of Consumption; Restaurants.**

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Amy B. Trubek

CHEMICAL CONTAMINANTS. *See* **Additives; Environment; Food Safety; Toxins, Unnatural, and Food Safety; Water: Safety of Water.**

CHICKEN SOUP.

Since prehistoric times, chickens have been mainly kept for their eggs. However, capons and old tough chickens were boiled by a wide variety of groups in Asia, Polynesia, Africa, and Europe. Boiling permitted the fuller use of chicken parts, such as bones, giblets, feet, neck, and pinions. Consumption of the liquid expanded the quantity of food available, added variety to the diet, and extracted nutritional components that otherwise would have been lost.

Broth was considered a restorative in the ancient world. Chicken broth's special identification with health may have been due to the humoral system of medicine. According to the theory, broth had qualities that eased digestion. As thin foods were believed to be easier to digest, broths were specifically recommended for the sick. Also, the color of chicken soup was similar to the human complexion and was consequently considered nourishing. Whatever the cause of the original belief, it survived into the Middle Ages: Chicken broth was commonly believed to be healthful throughout the Mediterranean and Western Europe. Moslems were particularly taken with chicken broth, as were the Jews. For instance, the classical Persian philosopher and physician Avicenna (980–1037) and the Jewish rabbi, physician, and philosopher Maimonides (1135–1204) regarded chicken soup as beneficial for the ill. This belief survived in Western culinary traditions, particularly those of Jews in Eastern Europe. Jews boiled chickens on Friday. The water in which the chicken was boiled was converted into soup and consumed during the week. Added to the broth were other ingredients, such as carrots, onions, celery, parsnips, kreplach, noodles, and matzoh balls. It was offered to those who were ill as a restorative.

Recipes for using chickens in soups were present in cookery manuscripts and were published in early printed cookbooks, such as Platina's *On Right Pleasure and Good Health* (1470), which contains a recipe that recommends chicken broth for the old and infirm. Chickens were employed in soup-making in England from the earliest days, and soup recipes containing chicken were regularly published as medical prescriptions.

Europeans introduced chickens into the Americas, and chickens were used in soup-making from the sixteenth century onwards. In the United States, recipes for soups containing chicken were published since 1824. However, the actual term "chicken soup" was not commonly used until the late nineteenth century. American manufacturers produced and promoted various commercial chicken soups, the most common of which was chicken noodle soup.

Today, chicken soup is particularly associated with Jewish cookery and is popularly known as the "Jewish penicillin." In 1993 Jack Canfield and Mark Victor Hansen compiled a book titled *Chicken Soup for the Soul*, which built on chicken soup's healthy reputation and set in motion the publications of dozens of "chicken soup" books, including the first cookbooks solely focused on making chicken soup. Some scientific evidence has surfaced to support the belief in the healthful qualities of chicken soup: In addition to protein and vitamins, recent research has suggested that chicken soup does have a naturally occurring peptide that has positive influence on health.

See also **Poultry; Soup; Stew.**

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Andrew F. Smith

CHILD, JULIA. Possibly more than any other person, from the 1960s onward, Julia Child (1912–) revolutionized American attitudes toward cooking and eating by embodying two principles: cooks are made, not born, and the pleasure of food comes first. With the supreme confidence of a born clown who grew to six-foot-two, she turned America on to food by entertaining her audience as well as instructing them, making her an icon of the American spirit of energy and good humor. Combining the skills of a highly organized engineer with those of a slapstick comedian, she brought all of America into her home kitchen, through the doubled media of books and television, to wish them *"bon appétit."*

Born Julia McWilliams in Pasadena, California, to a family who had their own cook, Child did not set foot in a kitchen until she married at thirty-four. A graduate of

> "If I can make a soufflé rise, so can you."
>
> —Julia Child, in *The New Yorker*, 13 October 1997, p. 91
>
> "No matter what happens in the kitchen, never apologize."
>
> —Julia Child, in Fitch, *Appetite for Life*, p. 142
>
> "It's a shame to be caught up in something that doesn't absolutely make you tremble with joy!"
>
> —Julia Child, in Fitch, *Appetite for Life*, p. 480

Julia Child has become an icon of modern American cooking. She is shown here holding a bowl of tomatoes. COURTESY OF AP/WIDE WORLD PHOTOS.

Smith College and a veteran of World War II, she wed a fellow member of the Office of Strategic Services (OSS) whom she had met in Ceylon, Paul Child, who loved art, good living, and good food. When her husband was assigned to the Paris office of the United States Information Service in 1948, Child quickly enrolled in the *Cordon Bleu* school of cooking. There she joined with Louisette Bertholle and Simone Beck to found *l'École des Trois Gourmandes* (the school of the three gourmets). The first volume of *Mastering the Art of French Cooking* appeared in 1961. The second volume, coauthored by Child and Beck, followed in 1970. Together, the encyclopedic volumes introduced "the servantless American cook" to the classic techniques and terminology of French bourgeois cooking translated into American terms and American kitchens.

While the success of the first volume was phenomenal, it was but a prelude to Child's success as a television performer in 1962, in which her infectious enthusiasm and natural clowning were simultaneously embraced and parodied. She followed *The French Chef* series for Boston's public station WGBH, from 1963 to 1973, by eight more series over the next decades, where she often served as interlocutor to guest chefs. Usually a series such as *In Julia's Kitchen with Master Chefs* was followed by a book of similar title, so that her publishing output was as prolific as her broadcasting. To date she has published eleven volumes.

Like James Beard, Child linked America's East to West, with houses in both Cambridge, Massachusetts, and Santa Barbara, California. She was among the first to establish an American food community with a national educative mission and proselytized universities to recognize gastronomic studies as part of a liberal arts curriculum. With California winemakers Robert Mondavi and Richard Graff, she founded the American Institute of Wine and Food in 1981 and helped transform the International Association of Cooking Professionals (IACP) into a comprehensive trade organization.

Her personal generosity and breadth of spirit brought amateurs together with professionals and made her a goodwill ambassador, not just between America and France, where the Childs built a house in Provence, but also internationally. She has fulfilled in her own life her admonition in her first book to "above all, have a good time." By taking what she called the "lah-de-dah" out of French cooking, she has made the pleasures of food available to ordinary Americans everywhere.

See also **Beard, James; Chef; Cookbooks; Fisher, M. F. K.; Gastronomy; Wine**.

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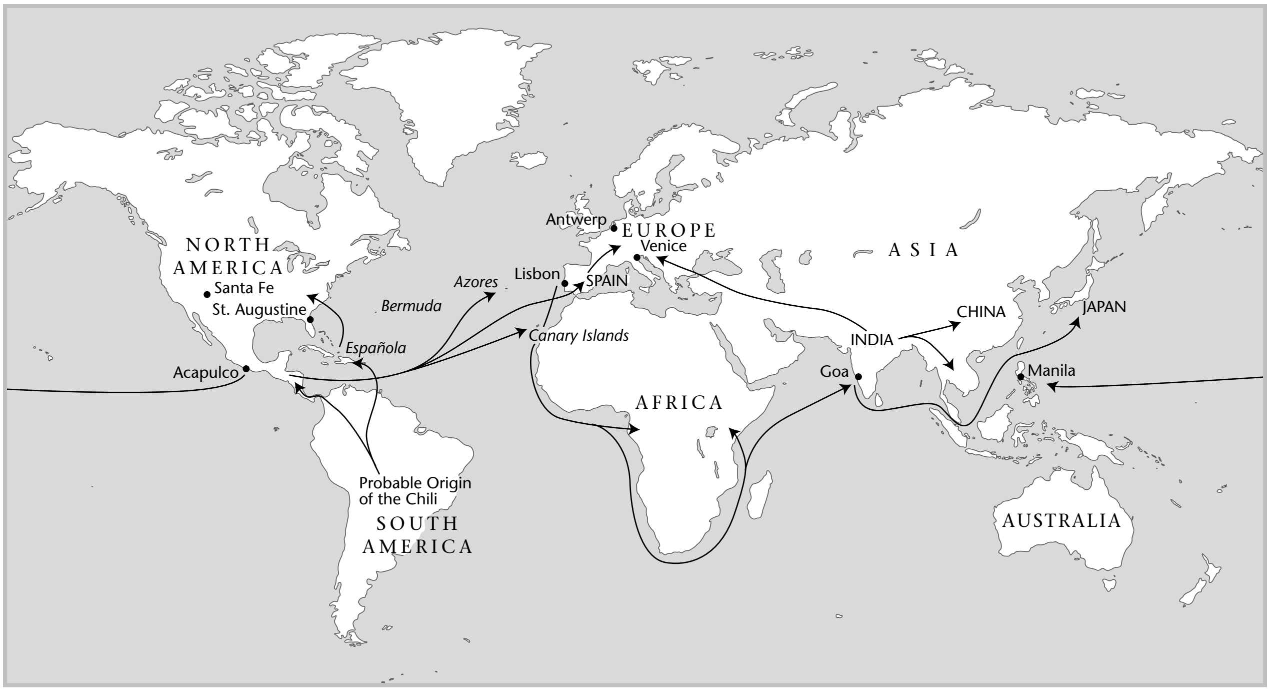
Betty Fussell

CHILI PEPPERS.

Chili peppers (genus *Capsicum*) can be eaten fresh or dried, raw or cooked, alone or mixed with other foods. They add zest to any food—meat, poultry, seafood, starch, vegetable, fruit—whether eaten by themselves or as an ingredient in a prepared dish. Peppers are the most popular spice and condiment in the world. They are consumed daily by one-quarter of the world's population, and the rate of consumption is growing. Nonpungent or sweet peppers are also consumed as a vegetable, but are the less popular spice. All capsicums were pungent before being domesticated by prehistoric New World peoples and before the breeding of nonpungent (sweet) types. Peppers, both pungent and nonpungent, are the fruit of perennial shrubs that were unknown outside the tropical and subtropical regions of the Western Hemisphere before 1493, when Christopher Columbus returned from the first of his voyages in search of a western route to the East Indies. Although he did not reach those exotic spice lands as he had proposed, his return to Spain with examples of a new pungent spice



discovered during his first voyage to the eastern coast of the Caribbean island of Española (Dominican Republic and Republic of Haiti) is well documented in his journal. Today capsicums are not only consumed as a spice, condiment, and vegetable; they also have many other uses—as coloring agents, in landscape design, as ornamental objects, in decorative design—and have great potential in the field of medicine.

Nutrition

Nutritionally, capsicums are a superior food. They are an excellent source of the B vitamins, are superior to citrus as a source of vitamin C when eaten raw, and they contain more vitamin A than any other food plant by weight. Vitamin A increases as the fruit matures and dries but is not affected by exposure to oxygen, while the production of vitamin C in peppers diminishes with maturity and drying and is, as in all plant foods, destroyed by exposure to oxygen. Capsicums also contain significant amounts of magnesium, iron, thiamine, riboflavin, and niacin. Even though chili peppers are not usually eaten in large quantities, small amounts are important where traditional diets provide only marginal amounts of vitamins. However, ripe nonpungent varieties, such as bell peppers, can be eaten as painlessly as an apple while providing more food value.

Capsaicin: The Pungent Principle

A unique group of mouth-warming, amide-type alkaloids containing a small vanilloid structural component known as capsaicin act directly on the pain receptors of the mouth and throat to produce the burning sensation associated with peppers. This vanilloid element is also present in pungent spices such as ginger and black pepper. Birds and a few other creatures such as snails or frogs do not have neuroreceptors for pungent vanilloid compounds and thus capsaicin does not cause them pain.

V. S. Govindarajan (1985) has suggested "pungency" as the proper term for the perception of the hot or burning sensation humans have in response to such foods rather than to others. Consequently, the response to chili peppers should be defined as pungent rather than hot, stinging, irritating, sharp, caustic, acrid, biting, burning, and spicy. He also suggests that pungency be given the status of a gustatory characteristic of food, as are sweet, sour, bitter, saline, astringent, or alkaline.

The vanillyl amide compounds or capsaicinoids in *Capsicum* are predominantly capsaicin (C 69 percent), dihydrodcapsaicin (DHC 22 percent), nordihydrocapsaicin (NDHC 7 percent), homocapsaicin (HC 1 percent), and homodihydrocapsaicin (HDHC 1 percent). Several more analogues of these in trace amounts bring the number to ten (Masada et al., 1971; Treace and Evans, 1983). The primary heat contributors are C and DHC, but the delayed action of HDHC is the most irritating and difficult to quell. These compounds form a pungent group, of which capsaicin is the most important. Two of these five capsaicinoids cause the sensation of "rapid bite" at the back of the palate and the throat, while the others cause a long, low-intensity bite on the tongue and midpalate.

Most of the organs secreting these pungent alkaloids are localized in the fruit's placenta, to which the seeds are attached, along with the dissepiment (veins or crosswalls). The seeds contain only a low concentration

CHILI, CHILLI, CHILE, OR PIMENTO?

Columbus believed that he had arrived in the Orient when he landed on the islands of the Caribbean Sea. He was so convinced of this that he called the islands the Indies, the natives were labeled Indians, and to the confusion of all who came after him, the pungent spice they ate was named *pimiento* after the completely unrelated black pepper—*pimienta*—that he sought. The indigenous Arawaks, his Indians, called the fruit *axí* (pronounced "aah hee") that was transliterated in Spanish to *ají (ajé* or *agí*).

Today the pungent varieties are still called *ají* in the Dominican Republic (formerly Española) and a few other places in the Caribbean and much of South America. In the Andean area the ancient words *uchu* and *huayca* are used for capsicums by some Amerindian groups. In Spain American peppers are called *pimiento* or *pimientón* (depending on the size) after *pimienta* or black pepper from India. However, the Spanish names did not stay with the plant through Europe; it is called *peperone* in Italy, *piment* in France, and *paprika* by the Slavic peoples in the Balkans.

In 1519 when the Spaniards arrived in Mexico, the Nahuatl-speaking natives called their fiery fruit *chilli*. The main interest of the initial Iberian explorers was conquest, then gold and silver; chilies and other plants were of little concern to them. Fifty years later a different type of Spaniard arrived. Dr. Francisco Hernandez, physician to the King of Spain, was the first European to collect plants in the Americas. Hernandez lived in Mexico from 1570 to 1577, and when he returned to Spain, he produced four books on the natural history of the plants and animals he had found in New Spain. He heard the Nahuatl speakers pronouncing the name of their pungent native spice "chee yee." Consequently, when he wrote about that plant, he gave the Nahuatl word a Spanish spelling, using the double *ll* to reproduce the "y" sound he had heard the natives make. The Nahuatl stem *chil-* refers to the chili plant. It also means 'red.' To the generic word "chilli" the term that described the particular chili cultivar was added (e.g., *tonalchilli* for a chili of the sun or summer, *chiltecpin* for a flea chili, etc.). At some point the Spanish speakers in Mexico changed the original Hernandez spelling to *chile*. Today, that word refers to both pungent and sweet types of chilies and is used Nahuatl-style combined with a descriptive adjective, such as *chile colorado* (for a red chili) or *chile poblano* (for a Pueblo chili). Confusingly, the same Mexican variety can have different names in different geographic regions, in various stages of maturity, or in the dried state.

In Portuguese *pimenta* is used for capsicums and qualifies the various types—*pimenta-da-caiena*, cayenne pepper; *pimenta-da-malagueta*, red pepper; *pimenta-do-reino*, black pepper; *pimenta-da-jamaica*, allspice; while *pimentão* is pimento, red pepper, or just pepper. *Ají* and *chile* are not found in a Portuguese dictionary, nor did Portuguese settlers or explorers carry these words with them in their travels.

The Dutch and English were probably responsible for introducing the current capsicum names to the eastern part of the Old World because in Australia, India, Indonesia, and Southeast Asia in general, *chilli* (spelled *chillies* or sometimes *chilly*) is used by English speakers for the pungent types, while the mild ones are called capsicums. Each Far Eastern language has its own word for chilies—*prik* in Thai and *mirch* in Hindi, to name but two.

The most confusion with regard to spelling exists in the United States, especially in California and the Southwest. Here, one finds both the anglicized spelling *chili* (*chilies*) and the Spanish spelling *chile* (*chiles*) used by some for the pungent fruits of the *Capsicum* plant, while "chili" is also used as a short form of *chili con carne*, a variously concocted mixture of meat and chilies. *The Oxford English Dictionary* offers *chilli* as the primary spelling, calling *chile* and *chili* variants. *Webster's New International Dictionary* prefers *chili*, followed by the Spanish *chile* and the Nahuatl *chilli*. *Chilli* remains the spelling most used by English-speaking people throughout the world.

For the sake of clarity and consistency, it would help if capsicums or peppers were used when speaking of the fruit of the *Capsicum* in general, both sweet and pungent; chilli or chilli pepper for the pungent types; chili for the spicy meat dish; and pimento for the sweet, thick-fleshed, heart-shaped red capsicum. *Chile* (in italics) should refer to a native Mexican cultivar or, in its not italicized form, it should refer to the long green or red variety from New Mexico or California. Whenever possible, the name of the specific fruit type, group, or cultivar name should be used.

of capsaicin resulting from this contact. The amount of capsaicin in a pepper is influenced by the growing conditions of the plant and the age of the fruit and is possibly variety-specific. The amount of capsaicin will increase under dry, stressful conditions. About the eleventh day after the fruit sets, the capsaicin content begins to increase, becoming detectable when the fruit is about four weeks old and peaking just before maturity, then dropping somewhat as it ripens (Govindarajan, 1985). Sun-drying generally reduces the capsaicin content, but when the fruits are air-dried with minimum exposure to sunlight, the highest retention occurs.

Capsaicin has virtually no odor or flavor, making it hard to detect by chemical tests, but a drop of a solution containing one part in 100,000 causes a persistent burning on the tongue. Although capsaicin is eight times more pungent than the piperine in black pepper, it only obstructs the perception of sour and bitter; it does not impair the discernment of other gustatory characteristics of food, as does black pepper. Eating capsaicin also causes gustatory sweating. The neck, face, and front of the chest sweat as a reflexive response to the burning in the mouth. Capsaicin activates the digestive systems by acting as an irritant to the oral and gastrointestinal membranes. That is a desirable irritation because it increases the flow of saliva and gastric acids. Very little capsaicin is absorbed as it passes through the digestive tract, an uncomfortable consequence of which is "jaloproctitis," or burning defecation.

Ingesting capsaicin by eating chilies not only increases the flow of saliva and gastric secretions but also stimulates the appetite. These functions work together to aid the digestion of food. The increased saliva helps ease the passage of food through the mouth to the stomach where it is mixed with the activated gastric juice. These functions play an important role in the lives of people whose daily diet is principally starch-based (Solanke, 1973).

Although capsaicin is not water-soluble, the addition of a small amount of chlorine or ammonia will ionize the capsaicin compound, changing it into a soluble salt. The same solution can be used to rinse capsaicin from the skin. When handling more than one or two chili pods, one should wear rubber or plastic gloves and/or keep a bowl of water with chlorine handy so that hands and skin can be rinsed immediately. Capsaicin can be quite painful if it comes into contact with the eyes, nose, or any other orifice. Capsaicin is soluble in alcohol, as are many organic compounds. Oral burning can be relieved by lipoproteins such as the casein found in milk and yogurt. The capsaicin is removed by casein in a manner similar to the action of a detergent, thereby breaking the bond it had formed with the pain receptors in the mouth (Henken, 1991). It is the casein, not the fat found in milk products, which relieves the burning; therefore, butter and cheese do not have the same effect as milk and yogurt.

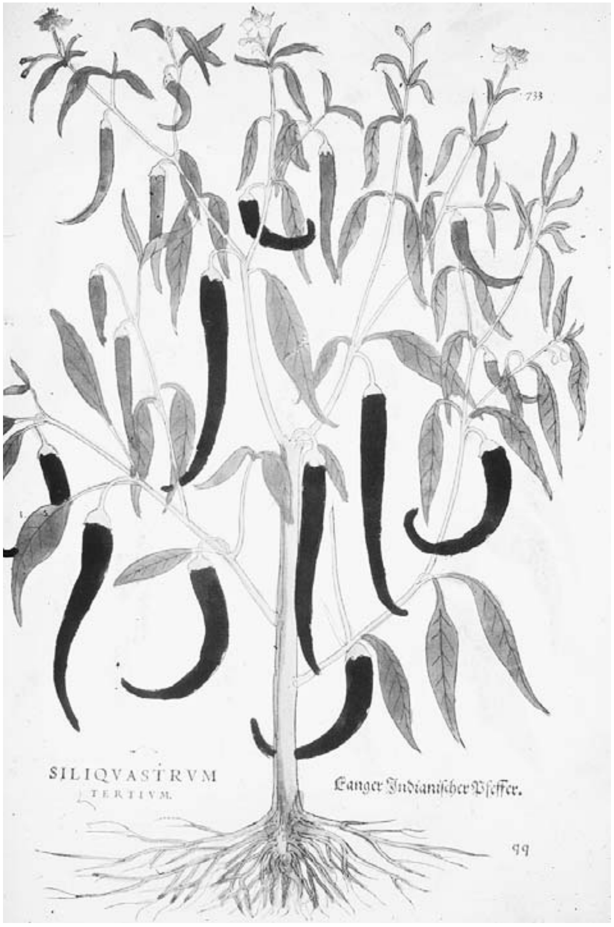
Chili peppers are an icon food for the American Southwest. This bundle of pods is drying in the sun near Santa Fe, New Mexico. © LOIS ELLEN FRANK/CORBIS.

Studies of the relationship of capsaicin to substance P, a neuropeptide that sends the message of pain to the brain, suggest that capsaicin can deplete nerves of their supply of substance P, thereby preventing the transmission of these pain signals (Rozin, 1990). Thus, capsiacin is being used to treat the pain associated with shingles, rheumatoid arthritis, and phantom-limb pain. Importantly, capsaicin may prove to be a non-habit-forming alternative to the addictive drugs used to control pain. It does not act on other sensory receptors such as those for taste and smell, but is specific to pain receptors. Medical researchers are finding this specificity to be a valuable aid in their studies.

Aroma, Flavor, and Color

The carotenoid pigments responsible for the color in capsicums make peppers commercially important worldwide as natural dyes in food and drug products. Red capsanthin is the most important pigment. All capsicums will change color as they mature from green to other hues—red, brown, yellow, orange, purple, and ripe green.

The flavor compound of capsicums is located in the outer wall (pericarp): very little flavor is found in the placenta and crosswall, and essentially none in the seeds. Color and flavor go hand in hand because the flavoring principle appears to be associated with the carotenoid pigment: strong color and strong flavor are linked. Two Latin American species, *Capsicum pubescens* (rocoto) and *C. chinense* (habanero), are more aromatic and have a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One of the first European depictions of peppers appeared in Leonhard Fuchs's *New Kreüterbuch* [New Herbal] published at Basel, Switzerland, in 1543. This plate from Fuchs shows the pepper now commonly known as Cayenne. ROUGHWOOD COLLECTION.

decidedly different flavor than those of the more commonly consumed *C. annuum* var. *annuum*.

Smell and taste are separate perceptions. Several aroma compounds produce the fragrance. The taste buds on the tongue can discern certain flavors at dilutions up to one part in two million, but odors can be detected at a dilution of one part in one billion. The more delicate flavors of foods are recognized as aromas in the nasal cavity adjacent to the mouth. Sensory cells with this function are much more discerning than the tongue.

Origin

It is difficult to determine where *Capsicum* originated because the genus is still not fully understood (Eshbaugh, 1980, 1993). If the genus is defined as limited to taxa-producing pungent capsaicin, the center of diversity occurs in an area from present-day Bolivia to southwestern Brazil. However, if it is redescribed to include other nonpungent taxa, a second center of diversity would center in Mesoamerica (Eshbaugh, 1993). It is certain, nevertheless, that the first ancestor of all domesticates originated in South America.

There are indications that the better-known *Capsicum annuum* originally was domesticated in Mesoamerica, and the next best well-known, *C. chinense*, originated in tropical northern Amazonia. The two less familiar species, *Capsicum pubescens* and *C. baccatum*, are more commonplace in the Andean and central regions of South America. The first two species were introduced to the Europeans after Columbus's voyages to the New World, while the other two species were not encountered until later, only recently becoming known outside their South American homeland.

The tropical perennial capsicum spread rapidly around the Old World tropics after 1492. Chili pepper has since become the dominant spice and condiment in the tropical and subtropical areas known as the "pepper belt," and in temperate regions sweet peppers are an important green vegetable and are grown as an annual. Concentrated breeding studies have produced *Capsicum* varieties that can be cultivated in environments quite different from their original tropical home and modern forms of transportation have made peppers of all fruit types available worldwide.

History

In his journal Columbus faithfully recorded his sighting of a new pungent, red-fruited plant that he called pepper, and he brought back specimens to Spain, marking the beginning of the history of capsicums for the people of the Old World (Anghiera, 1964; Morison, 1963). However, the pungent fruits were not originally discovered by Columbus. When nonagricultural Mongoloid peoples from northeastern Asia, who had begun migrating across the Bering Strait during the last Ice Age, reached the subtropical and tropical zones of their new homeland in the Western Hemisphere, they found capsicums widespread, having been carried by their natural dispersal agents, principally birds, from their nuclear area in southeastern Bolivia or southwestern Brazil to other regions (Pickersgill, 1984). Prehistoric plant remains and depictions of chilies on artifacts provide archaeological evidence of the use and probable cultivation of wild capsicums as early as 5000 B.C.E. It has also been shown that native Americans had domesticated (genetically altered) at least four species by the time of Columbus's discovery (Heiser, 1976; MacNeish, 1967). No other species have been domesticated since that time.

When Columbus arrived in the West Indies, he found at least two species of capsicums being cultivated by the Arawaks, agriculturists who had migrated north from their homeland in northeastern South America to the Caribbean Islands during a twelve-hundred-year period beginning about 1000 B.C.E. (Anghiera, 1964; Watts, 1987). Those migrants had traveled by way of present-day Trinidad and the lesser Antilles, bringing with them a tropical capsicum that had been domesticated in their homeland. They also brought the word "*ají*"—by which the plant was, and still is, known in the West Indies and throughout its native South American habitat (Heiser, 1969). Later a second species that had been domesticated in Mesoamerica probably came over different trade routes to the West Indies along with other Mesoamerican food plants—maize, beans, and squash (Sauer, 1966). However, *chilli*, the native Nahuatl name for the endemic Mesoamerican pepper plant, did not travel with it. It was that later arrival, a more climatically adaptable pepper than its earlier South American relative, which was introduced by Columbus to the Old World (Andrews 1993, 2000).

The new American plants from the tropical West Indies were not suited to the climate and day length of the Iberian Peninsula and other parts of Europe and the Mediterranean. Twenty-nine years later the conquest of Mexico, followed by that of Peru, revealed plants that were more climatically suitable to cultivation in temperate Europe and the Middle East. Within fifty years of the first arrival of capsicum peppers on the Iberian Peninsula and on islands such as Cape Verde, the Canaries, Madeira, and the Azores, American chili peppers were being grown on African coasts and in India, monsoon Asia, southwestern China, the Middle East, the Balkans, central Europe, and Italy. In 1542 Leonhart Fuchs, a German, was the first to describe and illustrate several types of peppers, which at the time were considered to be natives of India. It was not the Spaniards but the Portuguese who were responsible for the early diffusion of New World food plants to Africa, India, and the Far East, abetted by local shipping and traders following long-used trade routes. These mariners and merchants enabled the spread of the new American plants throughout the Old World with great rapidity (Boxer, 1969a).

PLANTING PEPPERS

Pepper seed should not be planted directly into the soil outdoors; they are best transplanted. Start the seed in a greenhouse, in flats, or in hotbeds at least six weeks before the first frost-free date. Sow them as thinly as possible on a sterile medium and cover no deeper than the thickness of the seed. Water carefully from the top so as not to dislodge the seed. From the time of sowing until transplanting and well started, never permit the seed or seedlings to dry or wilt. Germination will require twelve to twenty-one days at a constant temperature of 70ºF (21°C) for *Capsicum annuum* var. *annuum,* but longer for the other species. When four or more true leaves are well formed, transplant the seedlings into containers or flats containing equal parts peat, sand, and loam. Grow them at 70ºF (21°C). After the plants attain a height of 12 to 15 centimeters and all danger of frost is past, transplant them deeply in friable soil that is not below 55ºF (13°C). Space the plants 12 inches apart in rows 15 inches apart. Add a cup of water to each transplant and cover with a hot cap; irrigate immediately. Full sun and a well-drained soil are necessities. Peppers are a warm-season crop that grows better in a moderate climate, one that is not so cold as to cause freezing or too hot to set fruit. If night temperatures rise above 80ºF (27°C), the plant will not bloom. The optimum temperature for good yield is between 65ºF (18.5ºC) and 80ºF (26.5°C) during fruit setting (Andrews, 1993).

The Route from the New World

The dispersal of capsicum is not as well documented as that of plants such as maize (corn), tobacco, sweet potatoes, manioc (cassava), beans, and tomatoes. However, it is highly probably that capsicums followed the same trade route as the "three sisters"—corn, beans, and squash. The four plants have been closely associated throughout history.

In 1494 the pope's Treaty of Tordesillas divided the world on a line extending around the globe at a point 370 leagues west of the Cape Verde Islands. The Spanish were granted everything discovered west of the line and the Portuguese everything to the east of it. This arrangement persisted until the Dutch, followed by other European nations, challenged this monopoly at the end of the sixteenth century. Although the Portuguese were not active in the Spanish Caribbean until after 1509, when they brought the first slaves from Africa, they had acquired American maize by some yet unexplained means—perhaps in Galicia, Madeira, or the Canaries—before 1500, and were growing it on the west coast of Africa from where it was introduced to the Cape Verde Islands in 1502 (Jefferys, 1975). From early Portuguese "factories" in Africa and/or the eastern Atlantic Islands, the American food plants went to the east coast of Africa and India on the annual voyages of the *Nao da Goa* and other trading ships traveling between Lisbon and Goa on the Malabar Coast of western India (Boxer, 1984). As evidence of their coming from that African area, they were called "ginnie" (Guinea) peppers.

The natives of Africa and India, who were long-accustomed to pungent seasonings such as the African melegueta pepper (*Afromomum melegueta*), a member of the ginger tribe, Indian black pepper (*Piper nigrum*), and ginger (*Zingiber officinale*), readily accepted the fiery new spice. The Old World tropics provided an acceptable climate for the New World spice. The plants produced by the abundant, easily stored seed were much easier to

There are thousands of varieties of peppers. Shown here are several heirloom specimens, including Bull's Nose, Yellow Cayenne, and Chile Azul de Guinea. PHOTO BY L. WILBUR ZIMMERMAN. ROUGHWOOD SEED COLLECTION.

cultivate than native spices, making capsicums an inexpensive addition to the daily diet. Along the Malabar Coast of India, three varieties of capsicums were being grown and exported within fifty years of Columbus's discovery of the New World (Purseglove, 1963).

Once established in India, chili pepper became part of spice shipments from the Far East along the new Portuguese route around Africa to Europe, over the ancient trade routes to Europe via the Middle East, and also on existing routes to monsoon Asia (Lobelius, 1576). The Portuguese also brought chilies to Southeast Asia and Japan. Once established in these areas, birds carried pepper seed from island to island and to humanly inaccessible inland areas.

In southwestern China, American foods were known by the middle of that century, having been transported over the ancient caravan routes from the Ganges River across Burma and across western China into India and the Middle East (Ho, 1995). This is evidenced by the fact that today the cuisines of southwestern Szechuan and Hunan use more chili peppers than any other area in China.

After the Spanish conquest of the West Indies, Mexico, Mesoamerica, and Peru, trade with the new colonies was very limited (Braudel, 1976). Once Mexico was subjugated and opened for colonization, the Spaniards virtually deserted the West Indies for the North American continent, leaving the islands inhabited primarily by African slaves brought there by the Portuguese. By that time, the indigenous peoples of those islands were essentially extinct. For the first fifty years following the New World's discovery, the Spanish rulers were more interested in problems within the Habsburg Empire than in their new acquisitions and, as a consequence, Spanish trade with the New World came to a standstill (Watts, 1987). During this period Portuguese and other European opportunists entered the Caribbean and established trading footholds.

In 1492, after ousting the Moors from Spain following their seven-hundred-year occupation, the Spaniards established dominance over the western Mediterranean while the Ottoman Turks succeeded in seizing control of northern Africa, Egypt, Arabia, the Balkans, the Middle East, and the eastern Mediterranean Sea. At that time, for all practical purposes, the Mediterranean was two separate trading spheres divided by Italy, Malta, and Sicily with little or no trade or contact between the western Mediterranean and the Ottoman Empire (Braudel, 1976). This is an important consideration in the history of the diffusion of American peppers and other economic plants.

Venice was the center of the spice and oriental trade for central Europe, and Venetian merchants depended on the Ottoman Turks to supply them with goods from the Asia. The Muslim Arab and Gujurati traders received supplies from Portuguese ports on the west coast of India and Hormuz at the mouth of the Persian Gulf. Goods introduced to central Europe were taken to Antwerp and from there to the rest of Europe. Antwerp, the major European shipping port, also received goods from the Far

East, and from the Portuguese sources via India, Africa, and Lisbon. From these trading routes chili peppers came to be known in Italy by 1535 (Fernández de Oviedo, 1535), Germany by 1542 (Fuchs, 1543), England before 1538 (Turner, 1965), the Balkans before 1569 (Halasz, 1963), and in Moravia by 1585 (L'escluse, 1611). It was only in the Balkans and Turkey that chili peppers were used to any extent until the Napoleonic blockade cut off the supply of spices to Western Europe. Without their usual supply of spices, Europeans turned to Balkan paprika (chili pepper) as a substitute.

Most Europeans had grown capsicums only as ornamentals and believed that peppers were native to India and the Far East until the mid-nineteenth century when botanist Alphonse de Candolle produced convincing linguistic evidence for the American origin of the genus *Capsicum* (Candolle, 1852).

It was only after capsicums had become established in Asia, the Middle East, and Europe that the Spaniards played any part in the movement of New World plants to places other than Spain, Italy, and perhaps Western Europe. The Pacific Ocean route of the Spanish Manila-Acapulco *galleon* was established in 1565 and operated for 250 years (Schurz, 1939). This ship was a major means for transferring plants as well as trade goods between Mexico and the Far East. At approximately the same time the Spanish colonies of Saint Augustine, Florida, and Santa Fe, New Mexico, were founded. Those first European settlements in the present-day United States initiated Caribbean and Mexican trade with Florida and the Southwest, respectively, forty years before other northern Europeans began colonizing the east coast of North America. The first peppers to enter an English colony were sent to Virgina in 1621 by the governor of the Bermuda Islands.

Condiment, Spice, and Vegetable

At the time of World War II, one-fourth of the world's population, primarily in the pantropical belt and Korea, ate capsicums daily. Since that time the consumption of peppers as a spice, condiment, and vegetable has grown annually and is no longer limited to the tropical and subtropical areas. Some of the more common food products made with chilies are curry powder, cayenne pepper, crushed red pepper, dried whole peppers, chili powder, paprika, pepper sauce, pickled and processed peppers, pimento, and *salsa picante*. In 1992 *salsa picante*, a bottled sauce of Mexican origin made with a base of chilies, onions, and tomatoes, overtook tomato catsup as the top selling condiment in the United States.

Throughout the world capsicums are used as a source of color/pigment not only for commercial products such as cheese, sausage, salad dressings, and meat products, but also for drugs and cosmetics. Dried red peppers are added to hen feed to ensure yellow egg yolks and in caged bird feed to enhance the natural color of plumage.

The use of capsicums goes beyond that of a comestible. The florist and landscape industries have found their ornamental qualities to be of considerable value. The multihued, variform fruits of the attractive podded plant have become popular decorative motifs, not only in the Southwest but throughout the country. They can be found on chinaware, glasses, fabrics, in flower arrangements, as Christmas tree lights and ornaments, on men's neckties, even as hummingbird feeders, to name but a few.

Ritual, Folklore, and Magic Uses

The medical profession has discovered that certain folk medical practices employing chilies, many of which are prehistoric in origin, have merit and are being used by modern physicians to treat arthritis, shingles, toothache, and other types of pain. Research in this area continues. Solanaceous plants, which include capsicums, potatoes, datura, belladona, tobacco, and tomatoes, have long been used in charms, rituals, magic, ceremonies, divination, therapeutical practices, and other customs. Pre-Columbian Indian medicine men used peppers mixed with other substances for such ailments as coughs, poor digestion, ear infection, sore throat, injuries to the tongue, and to expedite childbirth.

The shape of most chili pepper pods, and their pungency/heat and redness have led them to be associated with male sexuality. In some cultures, eating chili peppers is thought to arouse passions, while in others people abstain from eating them in particular places or under certain conditions. Ancients used them in warfare and as torture or punishment and, even today, they are used as a repellent to ward off human or animal aggressors.

Diagnostic Descriptions

The Solanaceae, which includes such plants as potatoes, tomatoes, eggplant, petunias, and tobacco, is the family of which the genus *Capsicum* is a member. Currently, the genus consists of at least twenty-five species, four of which have been domesticated, and two others are cultivated extensively. The flowers, not the fruits, are the definitive feature of the genus. Although many of these are consumed by humans, it is those six species belonging to three separate genetic lineages that are of concern to human nutrition:

- *Capsicum pubescens* (first mentioned by Ruiz and Pavon, 1797). This domesticated species is the most distinctive in the genus. The flowers have comparatively large purple corollas (sometimes white infused with purple), which are solitary and erect at each node. The wavy, dark brownish-black seeds in the fruit, and those blossoms are unique among the capsicums. This extremely pungent chili, called *rocoto*, was domesticated in the Andean region of South America and is yet virtually unknown in other parts of the world. Its cultural requirements are cool, free-growing conditions and a long growing season.

SELECTION, PREPARATION, AND SERVING

Capsicums are a fruit that is used like a vegetable. Any type of pepper can be gathered when it is green, but when fully mature it is red, orange, yellow, purple, or brown. The two compounds that produce the pungency and flavor do not develop immediately, but increase gradually with maturity. As a consequence, immature fruits are less pungent and less flavorful than mature ones. A *chipotle*, or fully dried ripe red jalapeño is much more pungent than the green jalapeño, and a mature red bell pepper is much sweeter and flavorful than a green one. Until recently, the consumer had to settle for green rather than ripe fruit because the latter did not ship or store well. Better, faster shipping and storage facilities are changing that so that one may savor the flavor of a fully ripe pepper. Except for green bell peppers, capsicums are a seasonal crop, and the best selection will be available in the summer and fall. The most desirable fruits are those with glossy, smooth skin that is firm to the touch.

Peppers are best stored in the refrigerator. They may be kept there for weeks only if the fresh pods are dried with a clean cloth, and placed in an airtight container or a tightly sealed heavy zip-lock plastic bag. It is important to remove as much of the oxygen as possible before placing the tightly closed container in the refrigerator. Each time the container is opened, the unused pods must be dried and air removed before resealing. Once a week the peppers should be removed from the refrigerator and allowed to return to room temperature, then wiped dry, returned to the container, and sealed. If they cannot be stored this way, it is best to freeze them and then use them for cooking. If they are to be kept out of the refrigerator or if there is no time to withdraw the air, they should be placed in a paper container. If they are put in an air-filled plastic bag, they will rapidly spoil.

Dried peppers will keep almost indefinitely if properly stored. They should be kept in tightly closed jars or heavy plastic bags in a dry, cool place, preferably the refrigerator or freezer. Freezing the dried peppers before storing will kill any insect larvae and eggs. The peppers should be monitored for insects or mildew.

Before peppers are used in a favorite recipe, they must be washed, stemmed, veined, and seeded. Some cooks prefer to remove the skin but this is only necessary when using tough skinned *poblanos* or the New Mexican chile and any of its varieties. The large bell types, ethnic peppers (*Cubanelle,* Italian), pimentos, and others of these types should be parboiled or blanched for 2 to 3 minutes before being used whole for stuffing or filling, if the filling is not to be cooked in the pepper shell. Remove them from the heat immediately and plunge them into iced water to stop the cooking process. Small chilies need only to be washed, stemmed, seeded, and veined without skinning. Usually, if a recipe calls for a pepper to be roasted or blistered, it is not only to remove the skin, but also because the charred flavor is desirable.

Frozen peppers can be used for seasoning and cooking or as stuffed peppers; they are too soft for salads. If the skins are left on before freezing, most of the nutritive values is retained. When freezing pungent chilies, parboiling before freezing will prevent capsaicin loss. Dry small chilies and spread on a pan before freezing. When frozen hard, remove from the pan and immediately place them in a dry plastic bag. Return to freezer. Open bag and pick out a few as needed, being careful to prevent the thawing of those remaining in the bag. Return to freezer.

Peppers can be sun-dried, oven-dried, smoked, or dehydrated, but none of these methods are very practical for the modern home cook who is pressed for time. Sun-drying is an ancient method best adapted to arid climates, but is not feasible in humid areas. It takes several days in a dry, sunny locale. Oven-drying is a tedious process requiring the peppers to remain in a 140°F oven for up to 24 hours. Smoking is another method of artificially drying peppers that is seldom used in the United States. It is the procedure by which jalapeños are slowly dried and imparted with a smoky flavor to become *chipotles*. Dehydration is drying with heat from a man-made source. This process is not only faster, but also produces a much better product than the other methods.

The dried product can be placed in a processor or blender and flaked or powdered. The ground product will keep better once refrigerated. Whole pods may be used in recipes that require a long cooking time and a large amount of water such as those for soups or stews.

Many widely available and popular cookbooks provide directions and recipes for preparing and serving capsicums.

There are no sweet varieties. The fruit deteriorates rapidly because of its fleshy nature; consequently, it does not store or travel well. The best-known cultivars are *rocoto*, *locoto*, *manzana*, and *chile caballo*.

- *Capsicum baccatum* var. *pendulum* (mentioned in the work of Willdenow, 1808; Eshbaugh, 1968). It has an easily recognized flower with a cream-colored corolla marked with greenish-gold blotches near the base of each petal and anthers that are whitish yellow to brownish and is solitary at each node. An elongate fruit with cream-colored seeds is most typical. It is indigenous to the lowlands and mid-elevations of Bolivia and neighboring areas. In much of South America, where all pungent peppers are called *ají*, *C. baccatum* is the "Andean *ají*" (Ruskin, 1989). Little known beyond South America until now, it is being discovered by pepper fans. Only this species and the common annual pepper have nonpungent cultivars. The best-known cultivars are Andean *ají*, *cusqueno*, *puca-uchu*, *ají limon*, and *datil.*

- *Capsicum annuum* var. *annuum* (first mentioned by Linnaeus, 1753). The flowers with white corollas and purple anthers are solitary at each node (occasionally two or more). The variform fruit usually has firm flesh and straw-colored seeds. A multitude of pungent and nonpungent cultivars of this Mesoamerican domesticate now dominate the worldwide commercial pepper market. A relationship between *C. annuum*, *C. chinense*, and *C. frutescens* has caused the three to be known as the *C. annuum* complex. This relationship creates a taxonomic predicament. Some authors still recognize the first two as distinct but tend to have difficulty determining where *C. frutescens* fits into the picture, if indeed it is a separate species. The best-known cultivars are bell, cayenne, jalapeño, serrano, pimento, *poblano*, New Mexican chile/Anaheim, and cherry.
- *Capsicum annum* var. *glabriscululm* (mentioned in the work of Dunal, 1852; Heiser and Pickersgill, 1975). It is a semiwild species known as bird pepper. Its distinct flavor and high pungency cause it to be avidly consumed throughout its natural range, which extends through the southernmost parts of the United States to Colombia. This highly variable, tiny, erect, usually red pepper is cultivated commercially in the area around Sonora, Mexico, and seems to be in the process of domestication. Birds also consume it avidly. These chilies, which have many vernacular names and almost as many synonyms (*C. aviculare* is the most common), sell for ten times the rate of cultivated green bell peppers. The best-known cultivars are *chiltepin*, *chilpequin*, *malaqueta*, and bird pepper.
- *Capsicum chinense* (first mentioned by Jacquin, 1776). Its flowers are always two or more small, white to greenish white corollas with purple anthers hanging at each node, often in clusters. The variform fruit has cream-colored seeds that tend to require a longer germination period than *C. annuum.* Its domestication occurred in the lowland jungle of the western Amazon River basin and had been carried to the islands of the Caribbean before 1492. It has diffused throughout the world but to a much lesser degree than *C. annuum*, probably because it does not store or dry well; however, it is becoming more widely appreciated by cooks and gardeners for its pungency, aroma, and unique flavor. Although this distinctive pepper is considered to be a part of the *C. annuum* complex, some authors question its position there. The best-known cultivars are *habanero*, West Indian hot, Scotch bonnet, *ají flor*, *rocotillo*, and red savina.
- *Capsicum frutescens* (first mentioned by Linnaeus, 1753). Some authors no longer consider this semiwild species of *Capsicum* to be sustainable. It has two or more small white to greenish white flowers with purple anthers at each node and was once considered to be a member of the *C. annuum* complex, which includes three white-flowered species thought to have a mutual ancestor—*C. chinense*, *C. frutescens*, and *C. annuum*. The small fruit with cream-colored seed is always erect, never sweet, and often two or more may occur at each node. The tabasco pepper, limited to the Western Hemisphere, is the only variety of this species known to have been cultivated commercially. Easily transported by birds, the tiny varieties of wild *C. frutescens* can be found throughout the world's tropical pepper belt. The cultivated varieties are closely controlled by the McIlhenny Company of New Iberia, Louisiana. The cultivars are tabasco, greenleaf tabasco, and select.

See also **Central America; Columbian Exchange; Folklore, Food in; Iberian Penisula; Herbs and Spices; Magic; Mexico; Mexico and Central America; South America; United States: Cajun Cooking.**

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Jean Andrews

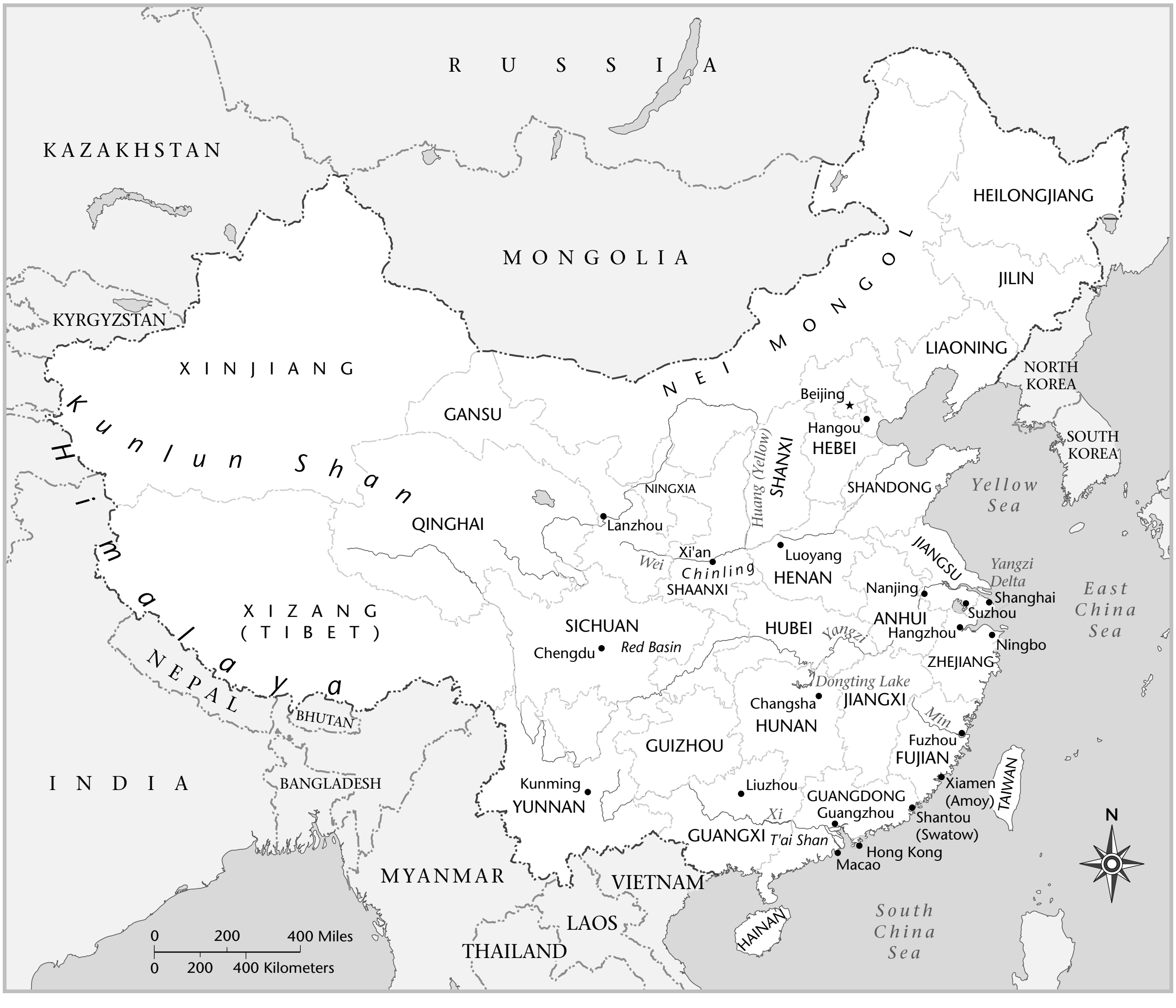
CHINA.

This entry includes six subentries:
Ancient and Dynastic China
Beijing (Peking) Cuisine
Fujian (Fukien) Cuisine
Guangzhou (Canton) Cuisine
Sichuan (Szechuan) Cuisine
Zhejiang (Chekiang) Cuisine

ANCIENT AND DYNASTIC CHINA

China's foodways began to take shape at the end of the last Ice Age. The glacial period was extremely cold and dry. As it broke, from 15,000 to 8000 B.C.E., conditions rapidly ameliorated. By 10,000 B.C.E., China was becoming warmer and wetter. Plant growth increased, making agricultural innovation more reasonable. As in the Near East at the same time, agriculture seems to have followed rapidly—stimulated, presumably, by increases in population, environmental productivity, trade, and communication.

Rice (*Oryza sativa*) was domesticated in the Yangzi Valley by 8000 B.C.E. By 5000–6000 B.C.E., it was abundant, and modern varieties had emerged: the long-grain "indica" types, the short-grain, tougher "japonicas," and probably the sticky rices. (These latter, miscalled "glutinous," are sticky because of a mutant form of the starch amylose.) Foxtail millet (*Setaria italica*) was domesticated farther north, by 6000 B.C.E. at the latest. It remained for millennia the staple of the areas too dry for rice agriculture. By 4000 B.C.E., it was joined by panic millet (*Panicum miliaceum*), which appeared about the same time in eastern Europe, having probably spread from China across central Asia. (The term "millet" refers to any small-seeded grain; several species of "millets" grow in China.) Foxtail millet is a more broadly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LAOS
THAILAND
VIETNAM
XIZANG (TIBET)
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GANSU
NEI MONGOL
HEILONGJIANG
JILIN
LIAONING
NORTH KOREA
SOUTH KOREA
Yellow Sea
East China Sea
South China Sea
Beijing
Hangou
HEBEI
Huang (Yellow)
SHANXI
SHANDONG
NINGXIA
Lanzhou
Xi'an
Wei
Chinling
SHAANXI
Luoyang
HENAN
JIANGSU
Yangzi Delta
Nanjing
Shanghai
Suzhou
ANHUI
Hangzhou
Ningbo
ZHEJIANG
SICHUAN
Chengdu
Red Basin
HUBEI
Yangzi
Dongting Lake
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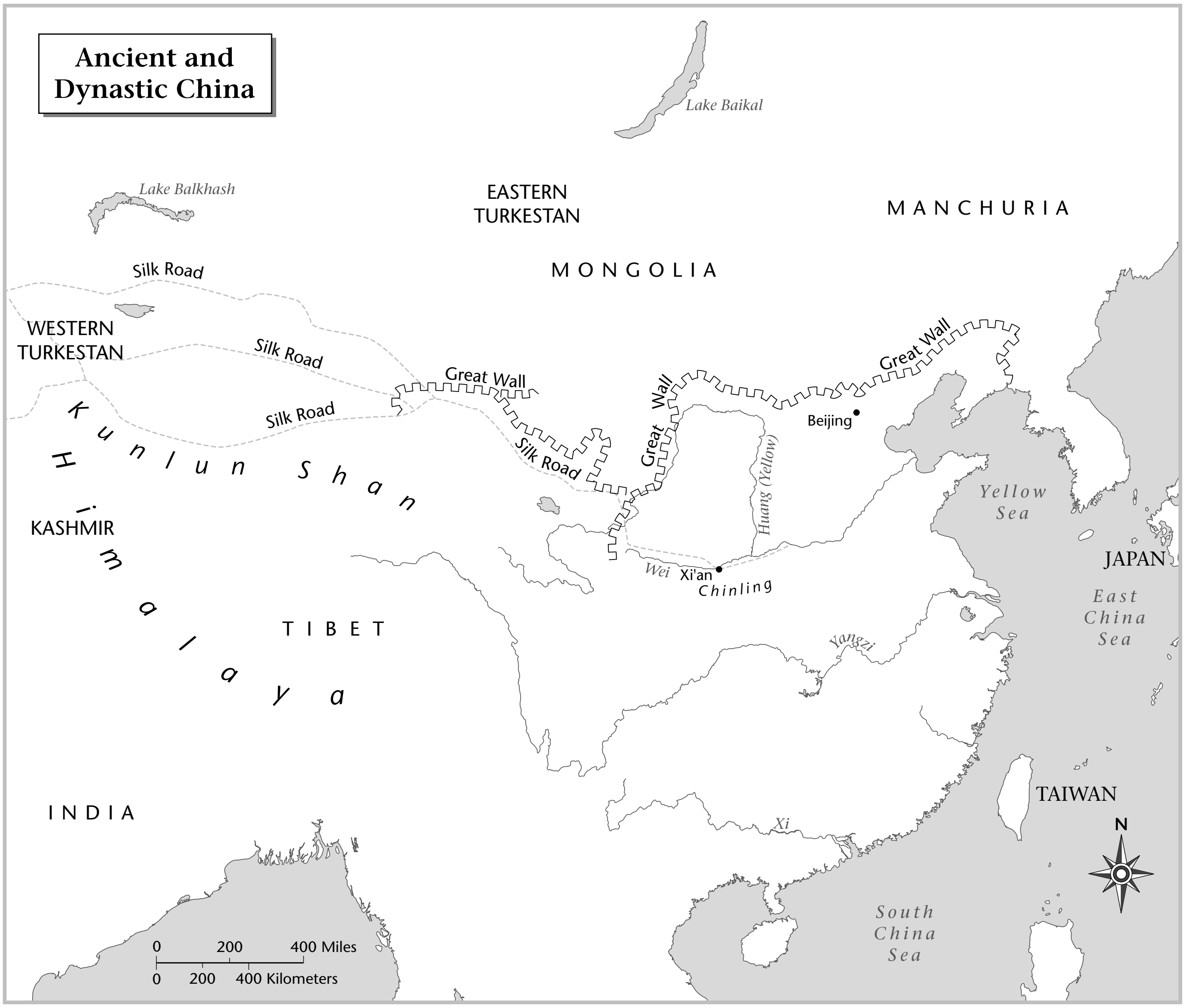
Ancient and Dynastic China

Lake Baikal
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MANCHURIA
MONGOLIA
Silk Road
WESTERN TURKESTAN
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Silk Road
Silk Road
Great Wall
Great Wall
Great Wall
Beijing
Kunlun Shan
Himalaya
KASHMIR
Huang (Yellow)
Yellow Sea
JAPAN
Wei
Xi'an
Chinling
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tolerant crop than rice, or indeed than almost any other grain staple. It grows best in hot summers (being a C4 plant) but is widely tolerant of different soils and water regimes. Rice, though less responsive to high heat (being a C3 plant), is an extremely efficient photosynthesizer, producing huge crops, even in cloudy conditions. C4 plants, as opposed to C3, have a metabolic pathway that allows more rapid growth in hot weather but less rapid growth in cool.

The earliest animal domestication reported so far is of pigs at Zengpiyan in Guangxi, a site dated to 7,600–9,000 years ago. The east Asian pig is the same species as, but a very different variety from, the Near Eastern one, and represents an independent domestication. Well before 6000 B.C.E., large villages with complex cultures and abundant domesticated rice occurred widely in the Yangzi Valley and elsewhere.

By 4000 B.C.E., chickens, pigs, sheep, dogs, and Chinese cabbages (*Brassica campestris*) were found widely. The chicken is native to southeast Asia and southern China. Its first archaeological occurrence, however, is in the north, near Xian; it may have once been native there (considerably older bones of wild chicken-like or pheasant-like birds have been found), or it could have been domesticated in the south and spread northward (Anderson, 1988). Sheep possibly were independently domesticated in China and in the Near East.

After this point, China's Neolithic cultures developed dramatically. Huge, rich, intensively agricultural sites are found throughout the modern eighteen provinces, as well as in neighboring areas. (China traditionally had eighteen provinces, today the eastern and southern parts of the country; China today has twenty-two provinces.) Agriculture spread rapidly into southeast Asia; Taiwan was settled by farmers, probably Austronesian-speakers ancestral to the modern "Taiwan aborigines," by 4000 B.C.E. The pig quickly became the dominant animal. By 3000 B.C.E., it was supplying 90 percent of the meat in the core areas, and it still supplies 90 percent of the meat in those areas today.

Meanwhile, wheat and barley spread across Asia from their domestication sites in the Fertile Crescent region of the Near East. By 5000 B.C.E. these grain crops were in Afghanistan. Their dates of arrival in China are obscure, but they were well established by 2000 B.C.E. Barley never became important, except in Tibet, but wheat was to revolutionize Chinese food in historic times, the period since 2000 B.C.E. Goats—a characteristic Near Eastern species, not found wild anywhere near China—appear about that time. Cattle, probably from the Near East, and water buffaloes, probably domesticated in or near the Yangzi Valley (and independently in India), may have been available by then, but their record is obscure. Finally, the horse, domesticated in the steppes of Ukraine and western Russia by 4500–4000 B.C.E., also reached China by about 2000 B.C.E. (the exact time being unclear).

All these introductions are related to the rise of civilization in China: the controversial “Xia dynasty” (c. 2200–1500 B.C.E.), whose existence is still sometimes debated, and the better-known Shang dynasty (c. 1500–1000 B.C.E.). These civilizations culminated a long-standing trend: the rich got richer, the poor poorer. The elite had great quantities of pork, grain, and wine, as well as other foods, while the ordinary people lived humbly on millet and coarse greens such as mallows (*Malva* spp.).

The origin of minor plant crops is poorly known. Sporadic finds of cultivated buckwheat are reported from very early archaeological levels in Japan, but are questionable. Certainly, buckwheat was cultivated in the centuries before the Common Era in China and Japan; it probably was domesticated in northwest China’s mountainous areas. A problem in interpreting China’s food history is the massive disturbance to most sites. Millennia of agriculture, rodent burrowing, tomb digging, flooding, and the like have scrambled the record. Thus, peanuts—a New World crop known to have been introduced to China in the sixteenth to seventeenth centuries—turn up in Han dynasty sites, probably thanks to seed-burying rodents. By 1500 B.C.E., written records are available, but the earliest of these mention only staple grains and animals.

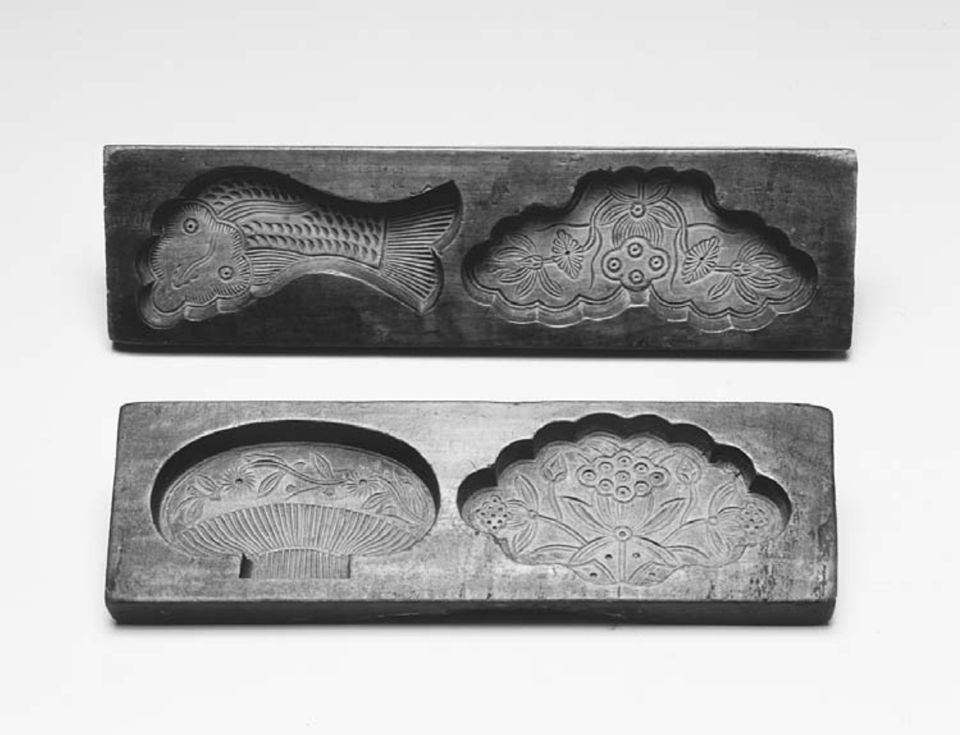
CHINESE NOODLES

Chinese noodle technology is complex. Wheat, rice, bean starch, and coarse grains are all used; wheat is most common. Noodles can be cut from a flat sheet of dough (as in Europe), extruded through a colander into boiling water, or pulled and stretched by hand. A specialty of north-central China is the swung noodle. A lump of dough is stretched out and then swung in a circle like a jump-rope; the dough stretches and gets thinner and thinner. It is folded back on itself and swung again and again. This takes a very skilled hand; otherwise the dough necks down and breaks. With skill, however, it allows ordinary wheat flour to produce a texture similar to the *al dente* texture of durum wheat pasta. (Durum wheat, the usual Italian pasta material, is virtually unknown in China.)

THE WOK

One characteristic Chinese cooking implement is the wok (a Cantonese word; the Putonghua is *guo*). This is a round-bottomed or parabolic pan, similar to the *kuali* of India and probably historically related to it. The wok was traditionally of cast iron, but is now usually aluminum. It first appears—so far as we know—in the Han Dynasty; pottery models of woks are found on the small pottery models of stoves that—along with other household-good models—accompanied the dead in tombs. The wok is made to fit into holes on the tops of the large clay stoves of traditional Chinese houses. Today it fits well over a gas ring. The wok is designed to heat rapidly to a very high temperature. Its rounded bottom allows heat to flow up rapidly along the sides. This allows stir-frying (*chao*), in which foods are cut into small, thin bits and stirred rapidly in smoking-hot oil. As items cook, the wok is shaken, often so violently that the contents fly up in the air—cooling them quickly so that they do not burn. The goal of stir-frying is to sear the outside of the food, while leaving the inside crisp or succulent. The wok, covered and set over lower heat, can also be used for slower cooking—steaming rice, even, though flat-bottomed cooking pots are usually used for that.

The history of plant domestication in China becomes brilliantly clear in the Zhou dynasty (ca. 1000 B.C.E.–221 B.C.E.). The *Book of Songs*, a collection of Zhou folk and court poetry, records dozens of plants. This work was edited in final form by Confucius himself, in the fifth century B.C.E.—according to historical records that we have no reason to doubt. Its 305 songs mention more plants than the whole of the Bible, as well as 88 animal species (some mythical). Coming from



Moon cake molds for Chinese New Year cakes. China, Ch'ing Dynasty (1644–1912), ca. 1800. Plum wood. The bat, fish, and fan motifs are symbols of good luck and prosperity. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

north China, the songs reflect a world dependent on millets. Wheat is mentioned in passing a few times. There were beans, cabbages, gourds, melons, and a huge host of vegetables and fruits. Pigs and chickens were the animals of daily use, but China was still rich in game and fish at the time.

CHOPSTICKS

Chopsticks are first mentioned in Zhou Dynasty texts. These small sticks, used to pick up pieces of food, probably go back to the very remote past. They have conditioned Chinese food preparation; foods are virtually always cut, or made, into pieces small enough to be easily manipulated with them. Routine use spread in early historic times to Korea, Japan, and Vietnam. The Chinese name is *kuaizi,* "little quick ones," whence the English name—"chop" being pidgin-English for "fast." See sidebar on page 386.

Soybeans enter the Chinese record in early Zhou, supplementing adzuki beans, which had been grown for centuries or millennia. Soybeans originated in far north China and Manchuria, and seem to have been domesticated by non-Han peoples there, possibly the bearers of the mysterious Hongshan civilization around 2000 B.C.E.

By this time, brewing was a major art form. Chinese *jiou*, translated "wine" but technically beer or ale, was invented long before the Shang dynasty. It was made from millet, and in the south (later, at least) it was made from rice. Shang wine vessels were of heroic proportions, and all sources agree that feasting went with heavy drinking. The histories allege that the last emperor of Xia was a debauchee who had a lake of wine and a forest of meat (i.e., a forest in which strips of meat were being wind-cured hanging from trees—a sight one could still see within living memory). This is generally taken as an exaggeration by Shang propagandists after Shang overthrew Xia. Be that as it may, heavy drinking was a part of Shang feasting, and is well documented for Zhou.

A major guide to foodways are the Zhou ritual books, the *Zhou Li* and *Li Ji*. These were compiled from damaged sources in the Han dynasty (206 B.C.E.–220 C.E.), but probably reflect Zhou reality as far as food is concerned. These sources confirm the importance of wine, mentioning many types, including herb-flavored ones. They also indicate that China, like other ancient civilizations, was deeply devoted to sacrificing animals and then eating them. Elites seem to have run through hecatombs of pigs, cattle, sheep, deer, and even horses. The trinity of pig, sheep, and cattle seems to have been dominant in sacrifice, indicating a possible indirect link with the Romans and their *suovetaurilia*. Chickens and ducks were not neglected. Old people were honored with rich, easily digestible, fatty cuts of meat, and the same favors were shown to the revered gods and ancestors. The *Li Ji* contains long passages on agriculture and on conservation.

In Han, new crops, notably grapes, came from West Asia. More important was the rise in food technology. Flour milling and oil production progressed dramatically. Bean curd and soy sauce production seem to have started about this time. (Fermented sauces were known in Zhou, but their exact nature is unclear.) Distilling of alcohol seems to have been invented in later Han. By Han, also, the idea of using food as medicine was established. The earliest surviving medical books from China are of Han date, and they have much to say about nutrition and diet therapy, always important in famine-torn China.

After Han, central Asian influences became very strong, and a flood of western foods entered China. The Silk Road, the great trade route across central Asia, linked East and West; its golden age stretched from Han through the Tang (621–960), Sung (960–1279), and Yuan (1279–1368). Persian bread, spinach, walnuts, broad beans, and even obscure herbs like fenugreek and cumin came to China, accompanied by Galenic medical concepts and Indian Buddhist foodways. Perhaps most important was the spectacular elaboration of wheat products. China, fed on millet mush and boiled rice until Han, became a land of noodles, breads, filled and unfilled dumplings, and countless other complex wheat preparations. Gradually, during this period, wheat replaced millet as the staple of the north.

The climax came in the Mongol Empire—China's Yuan Dynasty (1279–1368)—when the court in Beijing was serving dishes from Arabia, Persia, Turkistan, Kashmir, and indeed the whole Mongol-dominated world. Nomadic Mongol dishes, such as roast wolf, vied for place with Arabian delicacies such as rack of lamb marinated in saffron and rosewater (Buell and Anderson). Not until the twentieth century would the world again see such eclectic dining.

A nativistic reaction in the Ming dynasty (1368–1644) rehabilitated a Chinese food vastly more sophisticated and complex than that of Han or even Tang. The rise of an affluent middle class, especially in Sung, had led to the development of haute cuisine. Merchants and bureaucrats vied in feasting. Markets were well stocked; internal and external trade flourished. Broad regional styles had long been important—the meat-eating northwest contrasted with the fish-eating east and south, for instance—but now every city and many a town developed its own distinctive dishes and food specialties. Tea and distilled liquor had joined wine as common drinks, and gourmetship in tea and wine took extreme forms. Tea might be made, for instance, with water obtained from melting snow that fell on flowering-apricot blossoms; the carnation scent of the latter very delicately perfumed the tea. Nor were the less fortunate forgotten; a Ming prince, Zhu Xiao, compiled an excellent and thorough guide to famine foods in the early 1400s, and had it distributed to local governors throughout the country.

TOFU

Chinese food depends heavily on a wealth of soybean products. The soybean seems to have come from non-Chinese peoples in north China and to have been borrowed by the Chinese in the Zhou Dynasty. At first it was a low-class food, but soon cooks learned how to use it to advantage. Apparently the first gourmet use was in fermented thick sauces *(jiang)*, ancestral to Japanese *miso*. At some early point, brewed liquid soy sauce (*dou yu*) was invented, as well as the black-fermented soybeans popular in south China. These basic products have spawned a spectacularly diverse array of local ferment products, often using wheat flour, other bean species, vegetables, chilies, spices, or other ingredients. Soy ferments were often the only source of Vitamin B12, a necessary nutrient, in the diets of the poor. Bean curd (tofu, *doufu*) has long been said to have been invented in the Han Dynasty; there are no unequivocal references until much later, but recent evidence supports the Han date. Tofu is made by grinding soybeans with water, boiling the resulting milk, and then coagulating the boiled milk with calcium phosphate, alum, or some similar coagulant substance. The result is highly nutritious, and, if made with a calcium substance (as it almost always is), a very important calcium source. The oil and certain nutrition inhibitors go out with the waste water, leaving a low-calorie, high-nutrient product. It has served as the protein source of the poor through much of history. The skin that forms on the boiling milk, the lees, and other related products are all used, especially in vegetarian cuisine. With rising affluence, tofu consumption has declined in China—but risen explosively in the health-conscious western world. H. T. Huang provides a definitive history of soybean products in China. (See also Anderson, 1988.)

The most important food event of Ming, however, was the rise of sea trade, and especially the coming of contacts with the New World. Much of China, especially in the south, was not suitable for rice or wheat. Millet was at best a poor substitute. Suddenly, maize, white potatoes, and sweet potatoes appeared. Maize was common before 1600.

The great spread of New World crops came in the subsequent Qing dynasty (1644–1911). Sweet potatoes reached China by the late 1600s, and white potatoes by 1800. They continue to spread. Peanuts, tomatoes, chiles, guavas, and other New World crops revolutionized nutrition by introducing productive, easy-to-grow, nutrient-dense foods. Chilies, in particular, are extremely rich in vitamins and minerals; they, and the other New World crops, were critical in allowing the population explosion that has taken China from fifty million people in early Ming to today's 1.25 billion. Travelers in nineteenth-century China remarked on the availability and cheapness of a varied, nutritious diet.

Yet, China remained the "land of famine," in Walter Mallory's telling phrase. Deforestation and consequent flooding, overhunting, overfishing, and other environmental devastation led to disasters. Unfortunately, the pace of abuse greatly accelerated through the twentieth century (Brown; Edmonds).

See also **Japan; Korea; Noodle in Asia; Rice; Southeast Asia.**

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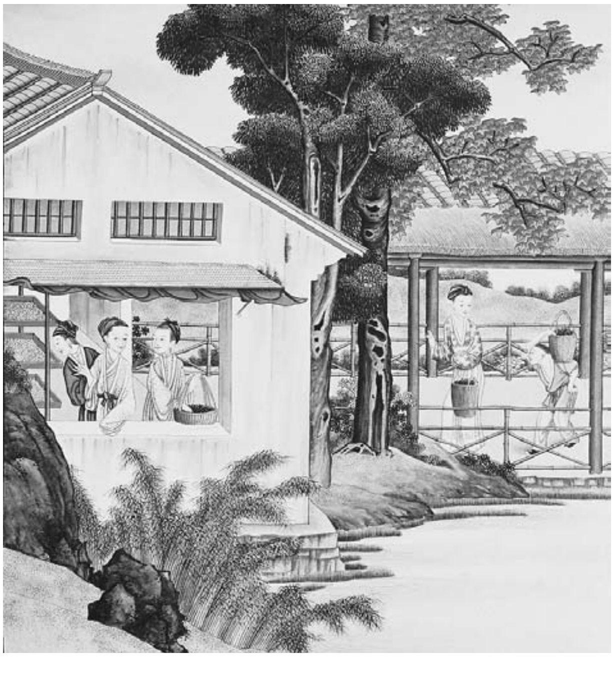
E. N. Anderson

BEIJING (PEKING) CUISINE

The cuisine of the city of Beijing is rooted in the broader tradition of north Chinese food. As the capital of China for most of the last eight hundred years, Beijing has been the beneficiary of two additional forces. First was the development of an imperial court cuisine perhaps unrivaled in the world. Second, as political center of China, Beijing has been a magnet for people from all over the world. Inevitably, they bring their foodways with them. The Mongols who established their court there in the Yuan dynasty brought barbaric delicacies such as wolves and swans, and today MacDonald's hamburgers are familiar.

Beijing occupies a dry, dusty region, oppressively hot in summer, bitterly cold and windy in winter. Nearby hills give relief from the summer heat, but there is no escape from winter's chill. Today, and even to some extent in the historic past, smoke and soot densely cover



Nineteenth-century print of daily life in China. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

the city, adding to the discomfort. The familiar foods of China's warmer, wetter regions, such as rice, fish, and subtropical fruits and vegetables, were rare luxuries until very recently.

Beijing's basic foodways can stand as exemplar for the north Chinese style of cooking. This style is found throughout northern China, with outstanding substyles in Shandong and Hebei as well as Beijing. It is China's simplest, and in the northwest—Shaanxi and Shanxi especially—it can become very simple indeed. These areas were, and in some areas still are, hunger zones, hard hit by famine. Often, only two meals a day are eaten, and coarse grains (maize, sorghum, buckwheat) are often important foods. Even so, they have their specialties, including Shanxi's outstanding vinegar.

North China produced very little rice until recently. Wheat and soybeans are staples. In early times, millets, especially foxtail millet (*Setaria italica*), were staples. Millet has now been almost entirely replaced by maize. This New World crop came north from southern China in the Qing dynasty, but was rare and unpopular. People correctly saw that millet was much more nourishing. In the twentieth century, however, vast increases in the productivity of maize have tipped the balance; foxtail millet has not benefited significantly from Green Revolution research. However, maize is still unpopular as a human food, and is largely fed to animals. Today rice is also produced well north of its historic range, and has become more familiar in the area. At the same time, the traditional oilseed, oil cabbage (rape cabbage), has been supplemented by sunflower, maize, and soybean. Vegetables, until recently, were also rather limited. In winter there was little beyond the Beijing cabbage—the cylindrical-headed form of Chinese cabbage, with pale leaves and greatly enlarged, crisp leaf bases. A conscious effort has recently been made to diversify winter vegetable availability. Melons were major fruits, especially the watermelon, extremely popular in summer for its cooling and diuretic qualities as well as its sweet taste. Their seeds were a popular snack, to the point that some varieties of watermelon were bred only for seeds, having many large seeds and very little flesh. In season, peaches and jujubes ("Chinese dates," *Zizyphus Ziziphus chinensis*) were common. Walnuts, lotus nuts, and other fruits and nuts were luxury items.

As in most of inland China, the pig was the main meat source, but beef and even lamb (or mutton) were frequent—the latter especially in Hui (Chinese Muslim) neighborhoods, which are extensive and are famous for their food. Chicken and duck were common, but the ordinary citizen saw them only at very special events.

Standard northern flavorings are ginger, sliced scallions, garlic, sesame oil, Chinese "wine," and soy sauce. Spices were traditionally quite rare. Coriander leaves

Lamb with Eggplant

Adapted by the Mongol court for Beijing use.

1 medium-sized eggplant
8 oz. lamb stew meat, with some fat
1 small onion, chopped fine
Dried mandarin-orange peel, 1–2 pieces (available in Chinese groceries as "dried orange peel")
1–2 cloves garlic
4 oz. yogurt
2 tsp crushed mint

Cut eggplant in half and remove central seedy part. Chop this, mix with lamb, onion, orange-peel, and stuff the eggplant. Steam or bake. Make a sauce: mash garlic, mix with yogurt. Put this over the eggplant and then sprinkle with the dried mint.

This is a version of a dish still common in Turkey and neighboring areas.

—Buell and Anderson, pp. 313-314

Carp with Ginger and Coriander

Here is a Chinese dish from the same source.

1 carp, about 2 lb.
Flour for dusting
Bean flour batter, enough to cover fish pieces
1 tsp ground coriander
Salt to taste
Vegetable oil
Fresh (sprouting) ginger
Cilantro (coriander leaves)
½ tsp turmeric (or safflower)
Radish slices

Scale the carp. Make a batter with the flour, bean flour, ground coriander, and salt. Batter the fish, let sit for an hour, and fry. Garnish with ginger (shaved), cilantro, turmeric (or safflower), and radish slices fried briefly. "Adjust flavors with onions" (apparently meaning: garnish with green scallions, slivered).

—Buell and Anderson, p. 308

How to Use Chopsticks

For Westerners accustomed to knives and forks, the proper handling of chopsticks is one of the most puzzling and awkward aspects of Chinese table etiquette. In the past, the way someone held chopsticks conveyed a great deal about his or her education and social class. Once mastered, chopsticks are much easier to use than knives and forks since the food is already cut up before it is served. These directions, illustrated by the accompanying drawings, describe the way to hold chopsticks in a manner generally acceptable throughout Asia.

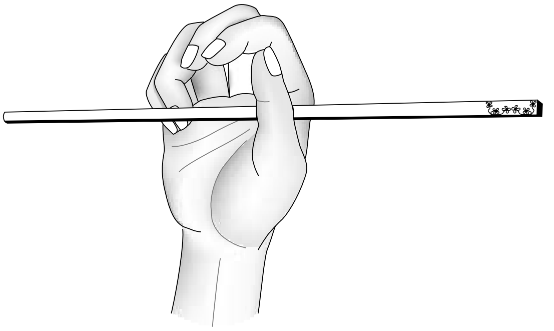
Step 1. Place a chopstick in the right hand between the thumb and index finger and rest it on the ring finger. The narrow end of the chopstick, the end used to pick up food, should point down. Slide the chopstick so that when it is held between the thumb and index finger about two-thirds of it is below the fingers.

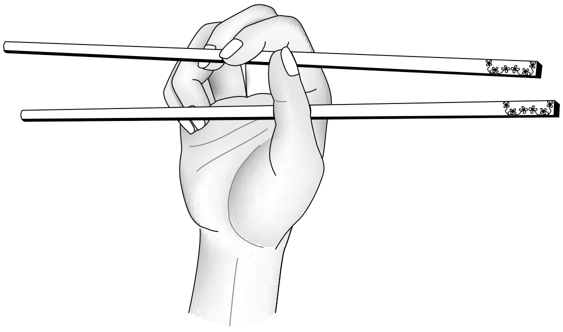
Step 2. Place the other chopstick between the index finger and thumb, with the narrow end resting on the third finger. Hold the chopsticks firmly.

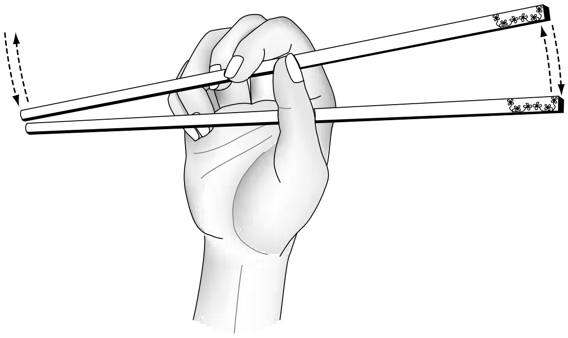
Step 3. Use the second chopstick to grasp food by pinching it against the first chopstick (which remains stationary). The tops of both chopsticks should be kept even so that they can be used like large tweezers. Never stab food with a chopstick.

Practice before going to an Asian restaurant. If there is an Asian store in your community, visit it to see what types of chopsticks are being sold. There are many styles, and some shapes are easier to use than others (square chopsticks are less likely to slip while smooth plastic ones can be difficult to hold in place). A true connoisseur will own several sets of beautifully ornamented chopsticks, which are kept in their own cases.

William Woys Weaver







(cilantro), introduced from the Near East in early medieval times, are a frequent flavoring or garnish.

The long, harsh winters forced the development of a sophisticated pickling and preserving industry. Pickled vegetables, sausages, dried meat, salted foods, and preserved fruits are important.

The court, of course, had far different fare. Exotic delicacies were the rule. Perhaps only the Mongols actually ate wolves. According to a more authentically Chinese tradition, the "eight delicacies" were served—the list is variable, but includes such things as camels' humps, apes' lips, and bears' paws, as well as various mythological animal parts. At least the bears' paws were in fact eaten; they are cooked long, into a gelatinous state. The appeal of such items is their rarity rather than their taste, but bears' paws are relished also by actual bear hunters in Siberia and north Canada. More prosaic but presumably much more common were rare species of mushrooms, bamboo shoots, and other vegetable foods, as well as complex and detailed preparations of ordinary animals such as chicken, duck, and fish. Dishes from the remote reaches of the empire, such as central Asia and Tibet, often graced the table, especially when dignitaries from those areas were being entertained. From southeast Asia came preservable exotica such as birds' nests (edible nests of swifts of the genus *Collocalia*) and sea cucumbers. Thus the court showed its cosmopolitan, world-ruling power as well as its hospitality. Many imperial recipes are preserved, and restaurants occasionally arise that re-create them.

History records that many emperors ignored the elaborate dishes and preferred simple fare. This is a formula, meant to indicate the virtue of the emperor; simplicity, indifference to vain show, and empathy with the ordinary people are virtues in all Chinese religious and philosophical traditions. However, the story is told circumstantially enough of some emperors to be apparent literal truth. In these cases, it stands as a telling comment on the quality of the formal service. Kenneth Lo, in *Peking Cooking*, records some imperial menus and other lore, including cutting remarks on the quality of the pompous feast fare. The last emperor, Aisin Gyoro Puyi, commented: “One big tasteless spread. All show and no flavour!” (1971, p. 24).

More usual fare—the fare of the vast majority, including, perhaps, those emperors—was based on wheat products. Noodles in soup, large steamed breads, and filled dumplings were staples. The large breads, usually chemically leavened, were called *mantou*, which means “barbarian heads.” Forms of this word are used from Korea to Greece; the word may actually be from an Altaic language, or it may be Chinese from the start. It used to refer to filled dumplings, and still does everywhere except in China, but at some obscure time the Chinese term came to refer to solid wheat loaves. Today, large filled dumplings (typically with leavened dough) are *paozi*. Smaller filled dumplings are *jiaozi*, a term limited to China, but denoting dumplings virtually identical to the *mantu* or *manti* of Korean, Turkic, and Greek kitchens. They are also clearly related to the *kreplachs*, *pelmeny*, and *vareniki* of eastern Europe, and to many other steamed or boiled dumplings of Eurasia. The complex history of these foods is still unclear.

The rich had rice congee: rice cooked in considerable water to make a thin porridge. The poor had an equivalent in porridge of millet, soybean meal, or wheat meal. Millet porridge, especially, was the most ancient foodstuff, having been prepared since earliest Neolithic times. It could be thick or thin. Often it was plain, but it could be flavored with sweet or savory ingredients. Cakes of coarse corn meal stood at the bottom of the prestige scale.

For centuries, Beijing has had countless eateries, from expensive and exclusive restaurants to food carts along the streets. Tea houses flourished everywhere, serving varying grades of tea along with snacks. These establishments varied from exclusive and refined, with the finest tea and foods, to rough stands for ordinary workers. They served as meeting houses, poor folks’ offices, and centers of political and social activity. Also common are food stalls and small, inexpensive restaurants selling noodles and dumplings. The food at these is consistently fresh and good, but not notably diverse.

Once chopsticks are mastered, it is easy to remove slippery dumplings from a large common bowl, as this family is doing in a Hong Kong restaurant. © Randy Faris/CORBIS.

As elsewhere in China, freshness is an ideal. Fish and poultry are sold alive whenever possible, and even larger animals may be. A new load of vegetables or fruit commands a high price, which may drop by the hour if the sun wilts the produce.

Ingredients in Chinese food are cut or otherwise prepared in bite sizes for ease in handling with chopsticks. Since earliest recorded times, eating large hunks of food was considered barbaric.

More ambitious restaurants have far more varied offerings. Traditionally, restaurants specialize in one type of cuisine. Some offer the dishes of a particular province or ethnic group. Others may focus on only one dish. Several classic Beijing dishes are so elaborate, and so popular, that restaurants focus solely on them.

The most famous such dish was, and is, Beijing duck. Ducks were domesticated in north China, and the most successful variety worldwide remains the “white Pekin” (or, more recently, its improved descendents). A proper Beijing duck is carefully raised from hatching onward. It is specially fed to give it the right amount and flavor of fat and meat. Killed at some three months of age, it is hung for a while, then inflated to separate the skin from the flesh. Preparation is simple: it is seasoned and roasted. As is true with ducks and with marinated pork slabs in much of China, Beijing duck is hung on a hook to roast, so that all sides are evenly cooked. Then the flesh and skin, cut up, are eaten rolled in small wheat pancakes, with fermented sauce (several variants are allowable) and slivered scallions. Some gourmets would eat only the skin, leaving the meat for servants.

Other dishes indicate the strength of Muslim and central Asian influence. Most pervasive are *shaobing*. These are small raised sesame breads, traditionally cooked Iranian style in a small *tandoor* oven. They are miniaturizations of Iranian *nan*, and seem to have been introduced in the Tang dynasty, when the Iranian court took refuge in China from the Arab armies that conquered Iran for Islam. Iranians were to be found on street corners everywhere in Xian (then Chang'an) selling these breads (see Schafer, 1963), which were soon nativized as Chinese fare. In Beijing today, they are often stuffed with meat that is slivered and then grilled or stir-fried. One such dish, of presumptive "barbarian" origin, is "Mongolian barbecue." This dish is not necessarily Mongolian in origin; it seems more likely a modern evolution from traditional Muslim Chinese dishes. It involves meat sliced very thin, drenched in a selection of piquant sauces, and grilled on a metal brazier over a high flame.

Another famous Muslim dish that has its specialty restaurants is lamb hot-pot. Chinese diners love to do their own cooking. Most often, this is done by dipping very thinly sliced ingredients into boiling stock at the table. The slices cook quickly, and flavor the stock, which is eaten as soup at the meal's end. Every province has its own versions of this hot-pot meal; Beijing's is based on lamb. The lamb has to be sliced evenly and very thinly. Chinese cooks spend years learning how to slice properly, and this dish provides a rigorous test of their accomplishments.

From farther afield come such dishes as the sweet-sour fish of Hebei. Made from fresh-water fish (usually species of carp), this is said to be China's best version of the dish. Shandong restaurants provide that province's superior dumplings and fish dishes.

In recent years, Beijing has added American fast foods to its diverse scene. Yan Yunxiang (1997) reports that McDonald's was, in the 1990s, the place to be seen—at least, many young people thought so. Young men would spend hours over a cup of coffee—all they could afford—simply to show they were sophisticated and cosmopolitan enough to be there. McDonald's, the symbol of bottom-scale eating in its native land, thus took on the prestige that, in that land, is reserved for exclusive Continental-style restaurants. More recently, Starbucks and other chains have been added to the youth scene.

See also **Japan; Noodle in Asia; Rice; Southeast Asia.**

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E. N. Anderson

FUJIAN (FUKIEN) CUISINE

The foods of southeast China are exceptionally diverse. Fujian, moist and both semitropical and tropical, is in that region and sixty-eight nautical miles across the straits from Taiwan. For those who divide Chinese food by compass points, Fujian, also spelled Fukien or Fu Chien, is distinctly eastern and has culinary similarities with nearby regions. Its foods are influenced by rivers, long coastlines, and interior rugged mountains, some reaching to the sea. This region, its landscape and its foods, is called *shan shui*, meaning mountain and water. It is one of China's five outstanding traditional cuisines, the others originating from the Guangzhou (Canton), Honan, Shandong, and Sichuan provinces. Fujianese foods are easily recognized: their rich stocks and sauces are used in a plethora of thin and thick soups. Two or three soups are commonly consumed at main meals and five or six at banquets. Many main ingredients are marinated in wine or the leftover red wine sediment called *lees* or *hung jiu*.

With a population of almost thirty million people and an area of forty-eight thousand square miles, the foods of Fujian—also called Min—are common wherever the Min or Wu dialects are spoken. They can be found in Fujian and in the southern Guangdung province in Shantou or Swatow, where many descendants of a well-known statesman exiled during the eighth century fled. This variation of Teochiu, Chiuchow (also spelled Chaochou and Chaozhou), is considered the finest cuisine. Concentrating on foods of the sea, it uses many seasonings, fish sauces, citrus marmalades, and satay-type sauce pastes. Every Fujianese food is loved locally, by those living on Hainan Island and by peoples in nearby areas. It is missed by more than 2.5 million Fujianese living overseas. Although popular throughout China, this cuisine is little known outside of the country.

The foods of Fujian are closely related to Taiwanese cuisine as many Fujianese fled there during several disruptive historical periods. This ancient cuisine, its origins predating 135 B.C.E. when the state of Min Yue was established in the Fujian province, has food roots in ancient Hakka migrants from northern provinces, aboriginal groups, and local Han peoples. With only 10 percent of its land arable, the remaining extensively cultivated areas grow a reasonable amount of rice, wheat, and sweet potatoes. They also grow fruits, soybeans, peanuts, and other oil seeds; people eat these agricultural products year-round, fruits included, because the region specializes in drying and preserving them. Sweet potatoes were not an important dietary component until they helped alleviate famine during Sung times (960–1280 C.E.) and again in the late 1500s. A shortage of rice propelled interest in this tuber, shredded and dubbed "sweet potato rice." Wheat foods also substituted for rice, and currently both are major dietary components in the region.

The sweet potatoes are roasted, boiled, and dried, used as snacks and meal components, and made into flour. Along with wheat, they are eaten in amounts equal to rice and used to make noodles, pancakes, dumpling skins, and other foods. Wheat and sweet potatoes are used to produce noodles in every imaginable shape. More are eaten here than in any other Chinese province; they are frequently served in soups when their solid content is finished. Noodles are also served plain, in stir-fried dishes and soups and stews, and transformed into batters. The latter is called "swallowskin" and is made from thin poured noodle batter. The batter, or *kuopien*, is cooked in a wok, and soup is added to it when a soft crust is formed. Swallowskins may also be served plain, have dried powdered pork or wine lees as ingredients, and can be used as wrappers for dumplings and fried foods. Some batters are made only of egg whites. These are called *kao li* and often have foods buried underneath.

Chou, better known also as *juk* or *congee*, is a popular southeastern breakfast-type rice soup. Other beloved Fujianese foods are fish balls, turtle meat, and a large variety of fungi including black or silver (white) cloud ears called *mo-er* or *yin-er*, respectively. Dishes are made with coagulated pig or chicken blood, with foods from local waters, and with chicken, pork, duck, and some goose. It is not uncommon in this province to be served a bird's nest or shark's fins as a main course, served as a thick stewlike soup. Many foods are cooked more slowly, fried with lard, and seasoned more liberally than in neighboring provinces. Soy sauce, with famous varieties made from local water, is employed sparingly in dishes, but large amounts are used in dipping sauces.

Contrary to practice in other provinces but similar to that in Guangzhou, tea is commonplace at meals. Grown in the north, it is preferred black, but more accurately called red for the color of the brew. The most popular variety is local; it is called *tit guan yin* or "Iron Goddess of Mercy." Local dishes are sweetened with sugar cane grown in the south, vegetables harvested wherever they can be grown, and animals raised where crops do not prosper.

Fujianese foods are typically served in three daily meals; they are easily recognized. Mornings start with rice soup and other small dishes or seasonings for the *juk*, two to three soups accompany other dishes at main meals, and five or six and an equal number of other dishes make up a banquet. Other than the breakfast *chou* or *juk*, soups may be clear, with contents, or thick and stewlike. Dipping sauces accompany other dishes, such as garlic crushed in a vinegar base if the main protein is poultry, or maltose if it is fried fish. Dishes and soups are based on complex stocks, maybe a sweet and sour sauce. Some are highly colored, many red from the marinade of red wine lees.

Fuzhou, also transliterated as Foochou or Foo Chow, was founded in 202 B.C.E. Meaning "happy city," this provincial capital on the Min River is blessed with more than a hundred different kinds of freshwater fish. It enjoys Fujianese and Fuzhou dishes cooked with fermented red wine lees, dumplings wrapped in swallow skin, noodles made with powdered pork, and meat and fish in one dish—sometimes one ball as in fish balls stuffed with meat in soup. Fermented fish sauces are used, as are different types of soy sauce, an influence from other southeastern countries that, in turn, were influenced by Fujian.

Xiamen, once called Amoy, is the second largest city in Fujian. Both are important up-river port cities sheltered from typhoons; they helped the province become a major maritime trading center. Known for their *popia*, Xiamenese people love this pancake. It is commonly filled with cooked meat and vegetables such as bean sprouts, garlic shoots, carrots, and bamboo shoots. Seaweed may also be added and the mixture flavored with hot mustard and/or plum sauce. Other popular dishes with roots in this city are stir-fried Xiamen noodles and Xiamen spring roll. Both are made with carrots, bean sprouts, peanuts, and grilled seaweed strips.

Well-known Fujianese dishes include diced and fried wine-marinated pork, steamed chicken in preserved tofu, drunken spare ribs, sweet and pungent litchi pork, deep-fried eel in wine lees, oyster omelet, stir-fried razor clams with ginger, hot and sour squid soup, duck tongue with white and black fungus, fried peanuts, and dried longan soup with lotus seeds. Also well known is *chi ping*, a Hainanese chicken-rice dish. Peace noodles are served everywhere on the first day of the first lunar month and eaten during *Ao Jiu* festival that same month. Another special dish is "Buddha Jumping Wall," a multiboiled thick casserole with shark's fins and ten other ingredients. Herbal soups are popular, too, and made with peony or rheumannia root, angelica (*sinensis*), star anise, wolfberry (*Lycium chinense* miller), cassia bark (*Cinnamonum aromaticum*), or a member of the prickly ash/fagara family (*Zanthoxylum avicennae*). In addition, they and other herbs are used as tonics, concentrates, and pastes.

Current literature divides China into many culinary regions, regional or provincial. Almost all include Fujianese food, whose essence may be found in its plethora of soups, sauces, vegetables, seafood, fruits, mushrooms, herbs, preserved fruits, and a special treat called "Tribute Candy." This after-dinner or snack sweet is a blend of baked peanuts ground into maltose or ground peanuts wrapped in a paperlike layer made from glutinous rice. Served with fresh fruit at the meal's end, it is enjoyed by everyone who adores sweet and tasty foods.

See also **Buddhism**; **Japan**; **Korea**; **Noodle in Asia; Rice**; **Southeast Asia**.

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Jacqueline M. Newman

GUANGZHOU (CANTON) CUISINE

Cantonese food has attracted a world following for its quality and variety. As to the former, a Chinese proverb says that one should "marry in Suzhou, live in Hangzhou, dine in Guangzhou, and die in Liuzhou," since these cities have, respectively, the prettiest girls, best views, best food, and best coffin woods. As to the variety, Chinese say that the Cantonese "eat everything with legs except a table, and everything with wings except an airplane."

Cantonese food is, broadly speaking, the food of Cantonese speakers. Cantonese is a separate language (though not dialect; there are, rather, several dialects of Cantonese) spoken throughout most of Guangdong province and well into Guangxi, and also by migrants who have radiated throughout the entire world. More narrowly, Cantonese food is the food that reaches its highest level of development in Guangzhou (the capital city of Guangdong) and in late-twentieth-century Hong Kong. The north parts of Guangdong are inhabited by Hakka and Teochiu people who speak other languages within the Chinese family; they have their own distinctive cuisines. Much of Guangxi, especially in the west and south, is inhabited by Zhuang and other Thai-speaking minority peoples, who also have their own cuisines. This leaves Cantonese food and language to some fifty million or more people.

This area is roughly coterminous with the part of China in which rice agriculture has always been most intensive. Lowland paddies produce up to three crops a year, and have since imperial times. Yields in the early twentieth century reached 2500 kg/ha. Today, with new varieties and intensive fertilizing, yields reach four or five times that figure. Nowhere else in China does rice so dominate the scene. Therefore, rice traditionally supplied some 90 percent of calories in the typical diet, and was the only true staple food. Other starchy foods—notably sweet potatoes and maize, since their seventeenth-century introduction from the New World—were mere famine backups.

In traditional times, a tightly integrated farming system developed, which combined this intensive rice agriculture with aquaculture, duck and pig rearing, and fruit and vegetable gardening. Every crop was fitted tightly into its place. For instance, ducks were taken by boat from field to field; they would be turned into a field when the crops were too old to be tempting food. Instead, they would eat the snails and insects, and leave fertilizer behind. Several species of fish were raised, each eating a different set of natural pond life-forms. Pigs and chickens were raised on leftovers and on items inedible to humans. Frogs and other wildlife were caught and eaten. What escaped the system and washed out to sea was cycled through shellfish and finfish. Nothing was lost and nothing was wasted. This system, along with related systems in southern Japan and central Java, was the most intensive and productive agriculture in the world before the rise of green revolution crops in the mid-twentieth century.

In coastal and delta areas, the most important animal protein is fish. Thousands of species of marine life occur and are utilized. Recently, overfishing has made aquaculture relatively more important. Away from the coast, pork is overwhelmingly the major meat, with poultry reserved for festive fare and other meats quite rare. Dogs, cats, and game animals are eaten, but not often. Soybean products, including bean curd, soy sauce, and fermented black beans (*tau si*), probably supplied more protein in the past than meat did. The most abundant vegetables are Chinese cabbages (many varieties) and the onion family (five species, in order of importance: onions, green onions, garlic, garlic chives, Chinese leeks). Also important are lettuce, tomatoes, potatoes (both white and sweet), taro, bamboo shoots, and dozens more. Condiments include vinegar, strong mustard (from *Brassica juncea)*, white pepper (not black), chili sauces, and, above all, soy sauce and its variants. Food is almost unthinkable without soy sauce. Rice by itself is not a meal, but rice with soy sauce is, and for the poor in earlier times it was, often the only meal of the day. Distinctively Cantonese, and a real marker of the cuisine, are *tau si*, soybeans boiled, salted, and fermented such that they turn black and acquire a strong meaty flavor.

Freshness, tenderness, and delicate subtle flavor are ideals. Relatively young animals and vegetables are preferred to old ones. Fresh items are always preferred. Not only are fish kept alive until wanted; they are preferred if kept alive in clean ocean water (rather than tanks), and they are sometimes taken at a dead run to the kitchen, so as not to lose a moment outside the water. Poultry was traditionally fed specially on high-quality foods. (Pigs, however, were fed on anything available.) The quality of the ingredients was once the most important dimension for evaluating food and restaurant quality. The goal of cooking was to preserve the essence of the fresh food item by cooking it quickly in a simple yet perfectly calculated way. Split-second timing was characteristic; a change in the sound of boiling or frying signified doneness, and the item was instantly whisked off the flame. Items are often briefly boiled before being stir-fried, so they would be tender in spite of quick frying.

Traditional food preparation includes salting and drying fish and vegetables. Small shrimps, salted and self-digested, produce a paste that is liked by some individuals. Pork sausages of various kinds are prepared; the most popular, *laap cheung*, traditionally includes rose-flavored alcohol. Unique to Cantonese cuisine is pork, roasted and marinated while hanging from forks in a tandoori-like clay oven. This dish is now usually baked in a more modern style, but retains the name *ch'a siu*, "fork-roasted."

A set of brown glazed soup pots reinforced with wire to prevent expansion and cracking. Pots of this kind are used all over China for making both stews and soups. Whole ducks or chickens can be placed inside the pots of larger size. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

The diet was based on rice eaten with a vast variety of vegetables and animals. The basic division in the diet was between *faan*, cooked rice, and *sung*, a word unique to Cantonese and referring to anything cooked to eat with or on the rice. Rice is regarded as the perfect food—indeed, a true "cultural superfood"; people feel they have not really eaten unless they have eaten it, and the standard Cantonese greeting around mealtime is "have you eaten rice yet?" (One always answers "yes," because if one says "no" the greeter is more or less duty bound to offer food. This custom harks back to the old days, when poverty was widespread and eating was by no means a regular thing.) Foods not eaten with rice are primarily mere snacks, sometimes called *siu sik*, "small eats." These include fruit, sweets, and the elaborate snacks called *tim sam*, "dot-the-hearts," which have evolved into the "dim sum" of global Chinese restaurants. The only substantial fare that does not involve rice are the noodle dishes, and even the noodles are sometimes made of rice—though wheat and wheat-and-egg noodles are commoner. Noodles are usually boiled in soup, or boiled and then stir-fried with vegetables and meat (the famous *ch'ao mien* or "chow mein").

The usual breakfast is tea with fried pastries and/or *juk* (congee), a small amount of rice boiled in a lot of water, producing a thin mush. It is eaten with peanuts, salt vegetables, soy sauce, or similar strong-flavored foods mixed in. Special occasions call for a long, lingering breakfast over tea and *tim sam*. This ritual, known as *yam* *ch'a* "drinking tea," has recently migrated to brunch or even lunch hour, and become a weekend fixture.

The main meal of the day can be at noon, midafternoon, or evening. It is based on a large amount of cooked rice. With this, typically, one finds a steamed dish and a stir-fried dish, and perhaps another steamed dish. Steamed fish and stir-fried vegetables would be a typical combination. It is common to prepare a four-dish meal in one pot by putting small saucers of raw foods on top of the rice, and simmering all in a closed pot; the other dishes steam while the rice boils. Almost invariably, there is soup, usually at the end of the meal. Water is known to be unsafe to drink unboiled; boiled water by itself is neither tasty nor nourishing. Tea is expensive. Soup, in contrast, is known to extract the nutrient values of foods, and can be made from tough vegetables and other economical items. It is thus the preferred way to take liquid.

The other meal (lunch or casual supper) will normally be noodles in soup, or a similar substantial but unassuming dish.

Banquets involve large amounts of meat and fish, and little or no rice. Whole fish and other impressive seafoods are usually the most expensive and prestigious items. Pork and duck are normally present. Special ritual foods abound, and include whole roast pigs and stews of great pieces of meat. Men are the cooks for these large sacrificial dishes. In general, women are the cooks in China, but men are the restaurant chefs, specialists, and preparers of large ritual meals.

Desserts are unimportant, simple fruit being generally preferred, but some sweets are prepared. Notable are small cream tarts called *taan t'a*, "egg tarts," probably English (via Hong Kong) but identical also to Portuguese *pastel de nata* and thus perhaps borrowed through Macao. Cookies and fruit are traditional gift items.

An important aspect of Cantonese food is eating for medicinal value. Dozens of foods are eaten largely for perceived healthy qualities: snake for warming during winter, watercress for cooling, wild ducks or pork liver for strength and energy (their high available iron content explains this), certain herbs for cleaning the system, and—of course—chicken soup for almost everything. In Chinese medicine, foods are heating, cooling, or neutral. Heating foods—high-calorie, fatty, reddish, or spicy—make the body hotter, or give rashes and sores. Cooling foods—very low-calorie, watery, sour, or cool-colored—make the body cooler, and in excess lead to loss of energy and strength. Neutral foods are balanced; cooked rice, noodles, and white fish are examples.

Chinese wolfthorn fruits (*kau kei ji*) and leaves *(kau kei ch'oi*) are the highest in vitamins and minerals of any common food, and are thus used as nutrition supplements. In Chinese medicine, all foods have significance for health. Food grades into medicine. Many foods, such as the wolfthorn, are eaten purely for their medicinal value. White fungus, dried scallops, and other items are on the borderline. Even medicinal herbs such as ginseng could be called foods. Food is the first recourse when an individual feels less than well. After childbirth, women eat foods perceived as strengthening and warming; modern analysis shows these foods to be high in iron, calcium, and other minerals, in vitamins, and/or in easily digestible protein. It is well known that such foods restore health and benefit milk production.

There are regional variants of Cantonese cuisine—often coterminous with dialects of the Cantonese language. The T'ai Shan area, for instance, is home to the Toisanese dialect, and to such dishes as *tsap seui* "miscellaneous leftovers." This became the infamous "chop suey" of third-string Chinese restaurants in the western world, but it began life as a good if humble dish among the specialist vegetable farmers of the area. At the end of the day, they would stir-fry the small shoots, thinnings, and unsold vegetables—up to ten species in a dish!

Changes in recent decades have been dramatic. Affluence has eliminated the famine and want that drove many within living memory to live on sweet potato vines, outer leaves of cabbages, and tiny shellfish gathered at low tide. A greater variety of food is available. Standardization has meant better and safer processed foods. Meat is relatively cheaper, and consequently more used. On the other hand, mass production in agriculture, and volume feeding in huge restaurants and chains, has spelled near-doom for the concern with quality ingredients. Much more oil, sugar, and salt is used now than forty years ago. Monosodium glutamate (isolated in Japan in the early twentieth century) spread into Cantonese cooking via overseas restaurants, and is now almost universal. Hamburgers, fried chicken, and other American fast foods abound in south China, and have inspired adaptations and hybrid descendents.

Cantonese cooking has spread throughout the world, and is the main ancestor of the simplified "Chinese cooking" found in small Chinese restaurants everywhere. Humbler variants on this theme include the "takeouts" of England, the "chop suey joints" of North America, and the "chifas" (from Putonghua *chi fan* "eat rice"[?]) of Peru. Much more sophisticated and elaborate Cantonese restaurants exist overseas, especially in major American and Australian cities; those in Vancouver, San Francisco, Sydney, and elsewhere now rival Hong Kong and Guangzhou in quality. These diaspora restaurants have affected the homeland; the fortune cookie, invented in California around the end of the nineteenth century, was only beginning to reach Hong Kong in the 1960s, but is now found worldwide.

In the future, as world population rises, the intensive, high-yielding, efficient food production and processing system of southeast China will become a more and more attractive model.

See also **Japan; Korea; Noodle in Asia; Rice; Southeast Asia.**

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E. N. Anderson

SICHUAN (SZECHUAN) CUISINE

What is widely called Sichuan cuisine is part of a broader suite of culinary traditions more properly regarded as the cuisine of west China. Traditionally, Chinese schematize the world in sets of five. In this scheme, the great cuisines of China are those of Beijing, Sichuan (or Hunan-Sichuan), Shandong, the Yangzi delta, and Guangdong. It is, however, more ecologically and geographically accurate to divide Chinese cuisine into north (including Beijing and Shandong), east, south, and west.

Included in the western group are the cuisines of Hunan, Sichuan, Yunnan, Gueizhou, and (marginally) Hubei. Boundaries of culinary regions do not correspond exactly with the boundaries of provinces. Yunnan and Gueizhou have large aboriginal populations with distinctive foodways. Parts of Hubei and other provinces shade off into other culinary regions.

West of Sichuan lies Tibet. This vast highland produces few foodstuffs. Barley and buckwheat, which grow at high elevations, are staples. Particularly important to nomadic herders and other travelers is *tsamba:* barley parched (roasted in the oven) and ground into meal. This can be mixed with tea, milk, or broth to provide an instant meal. Dairy products are extremely important and are often made from yak milk. Butter is not only a food but also serves as sunblock, sculpture medium, gift item, and more. Vegetables are few; wild herbs are used. Feast dishes include dumplings and meat dishes related to those of China and central Asia and—especially in the south—mixed dishes with Indian and Nepalese ancestry.

Several small ethnic groups related to the Tibetans live in mountainous parts of Sichuan. Many rely on thick cakes of buckwheat, maize, or other montane grains. Most share the Chinese avoidance of dairy products, but some—those near Tibet and dependent on herding—use dairy products heavily.

North of Sichuan is Shaansi, which has its own foodways. These are simpler than Sichuan's and are dominated by wheat products: noodles, dumplings, buns, and much more. Lamb is popular. Vegetables are rather few, and spicing is simple; chilies are used, but not so much as in Sichuan. The leading city of Shaansi is Xian, which was the capital of China—under the name Chang'an—for many centuries; it finally lost out to Beijing in the Liao Dynasty. Xian has a wide range of dishes, many of them using wheat, lamb, onions, and vinegar. (Vinegar is even more a specialty of Shansi, Shaansi's eastern neighbor.) Tang Dynasty texts already reflect this relatively simple cuisine. Central Asian influences were strong in those days and are still apparent (especially in the importance of lamb), though the popularity of dairy products—well-attested in texts between 400 and 900 C.E. has waned considerably.

The specifically west Chinese culinary world is that of the densely settled urban and agricultural regions of the middle and upper Yangzi River drainage and the plateau country south of it in Yunnan and Gueizhou. Most densely populated and agriculturally rich are the Yangzi valley and Dongting Lake area of Hunan and Hubei and the Red Basin (named for its red sandstones) and Min River outwash plains of Sichuan. Culinary dynamos have been the cities of Changsha in Hunan; Zhongqing and Chengdu in the Red Basin of central Sichuan, named from its red sandstones; and, to a lesser extent, Kunming in Yunnan. These areas have long been united by trade and communication. In addition, they have long-established ties to the north; the passes from Sichuan to Shaanxi have been major communication corridors for thousands of years.

The core of Sichuan was, in ancient times, the independent state of Shu, and Hunan was part of the great state of Chu. Chu, whose population probably spoke largely Thai languages, was one of the most powerful of the Warring States. Under the Han dynasty it retained considerable local authority for a long time. Han tombs reveal foods much like those of later periods; rice, wheat products, vegetables, and a stunning variety of fruits and nuts were eaten. Yunnan entered history as the ancient state of Tian, probably a Tibeto-Burman polity, which had a culture tied to both China and southeast Asia. Later, much of what is now Yunnan was the independent kingdom of Nanzhao, a non-Chinese state with Thai and Tibeto-Burman inhabitants. Nanzhao reached a peak during the Tang dynasty. Today, Yunnan is China's most ethnically diverse province, with almost forty minority groups; their languages belong to at least four totally unrelated phyla. Most of these groups have simple cuisines, based on grain and local vegetables, but the Thai-speaking peoples of the far south have complex dishes very similar to those of north Thailand.

Sichuan's population was reduced by perhaps as much as 75 percent in the violent period between the Ming and Qing dynasties, and was repopulated largely from Hunan and neighboring areas, resulting in a great culinary similarity between Hunan and Sichuan. Yunnan in turn received many of its Chinese inhabitants from

Sichuan, but they adapted to local conditions and were influenced by non-Han nationalities, and Yunnan cuisine remains rather distinctive.

Agriculture is intensive throughout the region, especially in Hunan and Sichuan. Much of the Red Basin and nearby mountain land is terraced. Heavy use of fertilizer and compost has long been typical. Sophisticated irrigation works are typical. The Min River irrigation scheme, designed by the Li family of engineers in the third century B.C.E., is still in use, being one of the oldest (and most sophisticated) irrigation systems still in use.

Historically, this was millet and rice country, with wheat important in the northern fringes. Rice is intensively cultivated in the Yangzi drainage. Locally, in areas too high and rough for rice, buckwheat becomes important; it was traditionally the staple of the Yi nationality of the Liangshan Mountains in Sichuan.

The area has long been a recipient of new crops from outside. In medieval times, Near Eastern foods such as broad beans, sesame, and walnuts became important. Since New World food crops entered China, the extent of maize, white potatoes, and sweet potatoes has exploded in the region. Maize in particular proved ideal for the climate, and quickly replaced millet. (It is often called "Sichuan millet"—*Shu shu*, using the ancient name for Sichuan.) Unfortunately, maize is a heavy feeder and a poor protector of the soil, and its cultivation has led to considerable deforestation and erosion. White potatoes, introduced apparently by Catholic missionaries, do better at higher elevations, and are more important in this region than in most of China. Soybeans do only moderately well, and so were supplemented by broad beans, which entered from the Near East in early medieval times. Later, with the New World food crops, lima beans came to the region; they are locally very important in Yunnan. A variety of fermented bean products is prepared, as elsewhere in China, but this region is distinctive for the common use of broad beans in these, and for the enormous amounts of chili peppers in many fermented sauces. Distinctive, high-quality types of pickled and salted vegetables, particularly garlic, Chinese cabbages, and bamboo shoots, are typical of Sichuan, and are widely exported. The final characteristic flavor element of Sichuan cooking is dried tangerine peel, which is most often found in mixed stir-fried dishes with relatively rich, complex sauces.

The region is even more pig-dependent than other parts of China. Pork is overwhelmingly the major meat. Yunnan produces hams generally regarded as the finest in China, being quite similar to the mountain (*serrano*) hams of Spain; the quality of such hams owes much to their production in cool, dry montane regions. Some minority groups of Yunnan produce a cured pig product consisting of a whole fat hog with the flesh, bones, and intestines removed, leaving only the fat in the skin, which is then sewn up. The pig wind-cures in the high, cool mountain air.

Chickens and ducks abound. Fish are found only in rivers and lakes, being abundant in Hunan but relatively less so elsewhere. Sheep and goats are raised. Cows and buffaloes are traction animals, but rare as food. Yogurt is made and consumed by Han Chinese (and some minorities) in Yunnan—a rare case of traditional consumption of dairy products by Han people. The custom probably spread from India via Tibet in medieval times. Mixed herds of livestock are, of course, common on the Tibetan plateau (including all west Sichuan), and dairy products are standard fare there.

Salt is produced from salt springs and wells. Drilling very deep salt wells has been an important and profitable industry in Sichuan for two millennia. Unlike sea salt, this salt lacks iodine, as does most food in these mountainous regions; goiter was thus common in historic times, and was known to be associated with eating local salt as opposed to sea salt.

West Chinese food is shaped by geography as well as history and communication. In stereotype, and indeed in reality, the cuisine is distinguished by two things: its use of mountain products, and its hot spicing. China's wettest and most biologically diverse areas occur in this mountainous region. Dense forests, the most diverse outside the wet tropics, provide a variety of mushrooms and fungi. Many species can be seen at a typical street market. Also abundant are bamboo shoots, herbs, and other wild plant foods.

A variety of game was once abundant, but this is now sadly depleted because of overhunting and habitat destruction. One animal of note is the pangolin, a superficially anteater-like creature with hair matted into hard scales. It is believed to be powerfully nourishing and is eaten as medicine rather than as a delicacy. A recipe from Gueizhou involves cooking it with almost every strong-flavored ingredient in the Chinese repertoire, suggesting that there is a need to kill the flavor of the animal. The pangolin appears to have no scientifically verifiable healing qualities, and is probably regarded as medicinal because of its strange appearance, which suggests powerful *qi* (spirit or energy).

The piquant spicing is an old tradition. The chile pepper now dominates, making this by far the spiciest cuisine in China. Chile entered from the New World in fairly recent times, probably overland from India and/or upriver from Macau and east China in the seventeenth century. However, the area relished piquancy before this. The *Songs of the South*, a compilation of poetry from the old state of Chu, mentions the use of smartweed, southernwood, and other pungent herbs and spices. Ginger and garlic were always commonly used. Dried daylily buds, also peppery in the mouth, have also been used since time immemorial. Also ancient in importance is *huajiao*, known in English as "Sichuan pepper," "brown pepper," or "fagara," and scientifically as *Zanthoxylum* spp. This plant is a sprawling shrub or small tree. Being thorny, it is sometimes used as a living fence that has the side benefit of producing useful fruit. The latter is a small brown berry. The berries grow twinned on a short stem, and provided an ancient poetic euphemism for the male genitalia. They have a pungent, rich taste with overtones of citrus as well as pepperiness, and they produce a peculiar numb feeling in the mouth when chewed.

At some point in ancient historic time, true pepper began to be traded into China from southeast Asia. It was enthusiastically accepted in west China. As elsewhere in China, pepper is used almost exclusively in the white form, made from immature fruits with the dark coat rubbed off, as opposed to the black form (entire mature fruits) used in most of the world.

Thus, west Chinese cooking was spicy long before chilies came, and preadapted it to the latter. Today, Hunan-Sichuan cuisine is the only one in the world that makes heavy use of all three types of pepper—brown, white, and red—and routinely uses all three in the same dishes. Chinese, like English, classes all as "peppers" (*jiau* is the Chinese equivalent, and originally referred to brown pepper); they are botanically unrelated. Only black (and white) pepper is in the pepper family (Piperaceae); brown pepper is in the citrus family (Rutaceae), while chilies are in the Solanaceae along with tomatoes and white potatoes.

A full meal normally consists of a starch staple, usually rice, with steamed and/or stir-fried dishes as topping, and an accompanying soup. Minor meals (breakfasts, light lunches) or snacks involve dumplings or noodle soups. Chilies, brown pepper, and other hot spices are found primarily in the stir-fried dishes and the soups.

Several Sichuan dishes have become widely known. Duck smoked over smoldering tea leaves and camphor chips is the most elegant of these. It is smoked briefly in the cooking process, not smoke-cured for long storage. More common is hot and sour soup (*suan la tang*), which traditionally involves dried daylily buds, montane fungi, slivered bamboo shoots, coagulated chicken or duck blood and/or meat, sesame oil, white grain vinegar, chilies, white pepper, and sometimes other ingredients. It is a flexible recipe, varying greatly according to taste and circumstance.

Chicken is often cut into small cubes and stir-fried with chilies and various vegetables. A variant of this with peanuts (from the New World) and (usually) dried tangerine peel is Gung Bao chicken, named for a military officer said to have invented (or relished) it. A range of "fish flavored" dishes, especially eggplant, are named not because they taste like fish but because they are flavored as fish are: that is, with garlic, ginger, scallions, oil, and often Chinese "wine."

Woman selling steamed dumplings from a street stall in Sichuan province. © NIK WHEELER/CORBIS.

Particularly characteristic are stir-fried dishes of bean curd with garlic, brown pepper, and chilies. The most famous of these today is *ma po dou fu*, literally "hemp woman's bean curd," which consists of small cubes of bean curd stir-fried in sesame oil with garlic, brown pepper, chilies, and fermented broad bean–chile paste; ground or finely chopped pork is often added, as is white pepper. As usual, countless variants of this dish exist, involving such items as mushrooms or fungi. Some are quite mild, but true Sichuan versions can be literally blistering. Also countless are the theories about the name; the most believable is that the dish was invented by women of the Ma ("hemp") family.

Hunan's cuisine has the same basic flavor mix as Sichuan's, but uses more fish and chicken. Finely chopped pork, flavored and then steamed in a bamboo tube, is a distinctive dish. Yunnan cuisine is simpler. The distinctive Yunnan ham enters into almost everything. Being expensive and strong-flavored, it is used more as a spice than as a main ingredient; small amounts of chopped ham are added to dishes. Most common, and spectacular, is a dish in which oil is heated in a pan until it actually catches fire; then cooked lima beans, garlic, chilies, and ham bits are thrown into the flaming oil and quickly seared. Noodle dishes are abundant. Often the noodles are only partially cooked, then at the table they are slid into soup that is served at the boiling point; the noodles finish cooking in the soup while the diner waits. This is known as "across-the-bridge noodles."

Drinks include some of China's best tea, raised in the mountains of the area. Yunnan in particular is famous for tea. The plant originated nearby, in the area where Tibet, Burma, and India come together. Spreading to metropolitan China at some uncertain point in early historic times, it became popular during the Tang dynasty, being seen as an exotic southwestern luxury at that time. Only during Sung did it become widely important as an everyday (if expensive) drink. Other herbal teas and drinks are common and are used for a range of ills.

Alcoholic drinks run the usual gamut of grain-based "wines" and distilled liquors. Gueizhou is famous for its *maotai*, powerful clear liquor traditionally distilled from millet. Most of the minority groups brew distinctive "wines" or beers from rice or other grains. Drinking these local products is important on festive occasions, including the widespread spring festivals at which groups of adolescent boys sing courting songs to groups of girls, who answer in kind.

Today, west China supports an enormous food industry. Yunnan hams and teas, Sichuan pickles, Gueizhou *maotai*, and Hunan hot bean pastes are world famous. Sichuan-style restaurants are found in major cities around the globe, and classic Sichuan dishes are found in virtually every eclectic Chinese restaurant.

See also **Japan; Korea, Noodle in Asia; Rice; Southeast Asia.**

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E. N. Anderson

ZHEJIANG (CHEKIANG) CUISINE

Zhejiang Province includes the core of the vast Yangzi delta region, China's richest, most highly educated, and most progressive region throughout much of history. Its great cities of Shanghai (now a separate metropolitan area), Suzhou, Hangzhou, and Ningbo form an arc around the Yangzi mouth. Each of these cities has its own culinary specialties.

Shanghai has grown very recently to prominence as a city; it is basically a product of imperialism, having been developed as a port by the English in the nineteenth century. It has its own variant of Eastern foodways, based on local traditions but adding influences from all up and down the Yangzi valley.

Zhejiang is also the core of the ancient state of Wu, which may have been largely non-Chinese-speaking, and which certainly maintained a sophisticated and elaborate culture rather different from that of the Central Plain to the northwest. The name "Wu" is still used for the region, and for the language spoken there—a language usually miscalled a "dialect," but as separate from Putonghua as French is from Spanish.

Zhejiang cuisine is the most elaborate form of a culinary style more broadly called "eastern," and found throughout the old state of Wu and its bordering areas. Besides Zhejiang, the provinces involved are Jiangsu, Anhuei, and at least part of Jiangxi. Fujian province (ancient Min) is linguistically and culturally a very different entity, but its cuisines fall into a broadly eastern pattern, blending southward into more Cantonese-oriented foodways.

Agriculture in the region is as intensive as any in the world. Multiple cropping, heavy fertilizer use, systematic intercropping, and special production systems allow farms as small as an American suburban lot to produce a (bare) living. One common system, described by writers such as F. H. King, Fei Hsiao-Tung, and Philip Huang, involved producing rice and silk; mulberries grew along the dikes between the ricefields, holding the soil while producing leaves for silkworms. The mountains that ring the delta country are usually too steep for grain farming, but they are ideal for tea. This tea region, which includes much of Fujian and leaps the narrow strait to include northern Taiwan, produces what is generally regarded as the best in the world. Green (unfermented) and oolong (slightly fermented) teas dominate, as opposed to black (fermented) teas, which are notably less important. An extreme connoisseurship of tea exists in the area. Gourmets once not only discriminated teas from particular mountains and estates, but saved snow water for tea, or went to great lengths to obtain water from special wells and springs.

The markets of Zhejiang have always been famous for their size and the variety of offerings.

The staple foods in Zhejiang, and in most of the Yangzi region, are rice and wheat. The former can be grown in the summer, the latter in winter. Both were, and are, about equally important in the daily diet. Foxtail millet was once common, but has been recently replaced by maize. Soybeans can be produced, but flourish better in more northern climes. A vast range of vegetables and fruits is produced. Specialty fruits include giant pears, mentioned by many authors, including Marco Polo. These can weigh several pounds apiece. Among the vegetables are specialized gourmet varieties of Chinese cabbage and snowpeas. The tender tips of the peavines are preferred to the pods and seeds, and are, in fact, often the most expensive items in a market. They are considered the ultimate in refinement because of their delicate taste and their *cuei* texture. This quintessentially Chinese term is the highest praise for vegetables; it refers to foods that offer initial resistance to a bite, then suddenly give way and are succulent and moist. (Usually translated "crisp," it refers to the crispness of a ripe apple, not that of a potato crisp.) Peavines are now appearing in the United States, and one can obtain seeds of the varieties in question.

Pigs, chickens, and ducks abound; sheep and cattle are uncommon and rarely eaten. The most important source of animal protein, however, is the water. Zhejiang is as amphibious as the Netherlands, with fresh and salt water interpenetrating and interdigitating in complex patterns. No one is far from water.

When the state of Wu flourished, the river carried incredible quantities of nutrients. Currents and tides brought still more nutrient from the seaward side. The result was a high-energy, high-nutrient environment, one of the most biotically productive on earth. Vast schools of fishes migrated up the river or along the coast. Alligators, river dolphins, and turtles of many species abounded. Huge beds of shellfish existed. The land was rich in game of all sorts. Today, this bounty is virtually gone. The Yangzi flow is reduced and terribly polluted. Overhunting, overfishing, pollution, and land reclamation have destroyed almost all the game and large water animals, and most of the fish stocks.

Even now, however, the delta region is relatively rich in seafood. Fish, crabs, shrimps, and shellfish remain common. Overfishing of wild stocks has been compensated by a huge expansion of aquaculture. Practiced since ancient times, fish farming now supplies most of the fish in China, and is concentrated in the Yangzi basin.

Wu's dependence on water foods was a source of merriment in earlier times. Northern and especially northwestern Chinese, from drier and more grazing-oriented lands, laughed at the "southern" taste for frogs and snails much as English used to laugh at French for eating the same. The citizens of Wu replied in kind, ridiculing the rank mutton and "barbaric" yogurt of the northwest. Françoise Sabban notes that, as early as the third century, Zhang Hua could write: "The people of the South and the East eat seafoods while the people of the North and West delight in hares, rats and other game and are not aware of their gamey smell" (p. 2). Such comments were barbed because the north usually had the political power while the southeast usually had the wealth; mutual envy sharpened tongues.

The other distinctive qualities of Zhejiang food are a proclivity for sweet and unctious flavors; a rich quality, with much oil and thick sauces; and a devotion to extreme freshness. The sweet taste seems to be ancient; in the classic fivefold division of the cosmos, typical of Chinese thought since the early Han dynasty, the flavor associated with the east is sweetness. This obviously is not mere cosmological speculation, but a recognition of reality. (The west is associated with pungency, as is true of its cuisine to this day. The north is salt, south bitter, east sour, and center sweet.)

The freshness is also a result of landscape; preserving food is not easy in the hot, wet climate, and is unnecessary because of the twelve-month growing and fishing season. However, some interesting ferments are prepared, and China's best vinegar, the aged vinegar of Zhenjiang, comes from Jiangsu. This vinegar occupies the place in Chinese cuisine that balsamic does in Italian, and, in fact, it is vaguely reminiscent of balsamic in appearance. In Fujian, a brilliant purple-red fungal ferment is cultivated, and applied to almost anything and everything. Noteworthy is a dish of raw crab marinated in this ferment along with grain "wine," vinegar, and other flavorings. It is an acquired taste.

Chinese wolfberries or boxthorn (*Lycium chinense*) are known as *gau gei choi* in Chinese. They originate in the hot western regions of China and are used extensively in cookery and in botanical medicines. The leaves are used for herbal tea. PHOTO L. WILBUR ZIMMERMAN. ROUGHWOOD SEED COLLECTION.

Those affluent enough ate three meals a day and snacks as well. The basic main-meal pattern is rice with one to three dishes for topping. Wheat appears as the basis of minor meals and snacks: filled dumplings, noodle soups, and various cakes. Sticky rice is made into cakes and noodles as well. The hot and amphibious landscape makes soup an attractive option. (China's—if not the world's—center of soup-eating is just southward, in Fujian, where it is perfectly routine to serve three or four different soups among the main courses in a twelve-course banquet, and Simoons reports a banquet at which "seven out of ten dishes were soups" [p. 50]). Ginger, green onions, garlic, local "wine," sugar, and vinegar are common flavorings. Less use is made of spices and bean pastes than in the west and south of China.

Among the major uses for the aquatic bounty are fish in sweet-sour or rich brown sauces, West Lake fish (from the West Lake at Hangzhou), braised eels, softshell crabs, crabs with roe in breeding season, countless shrimp dishes, stir-fried frogs' legs, and many snail and clam dishes. Even the tiniest shellfish are eaten. Among dishes drawing on the land, beggar's chicken is perhaps the most interesting; it is associated with the Shanghai area. A whole chicken is stuffed with fragrant leaves, buds, and spices, wrapped in still more leaves, encased in clay, and baked in a fire. The clay is broken (today, often, with an unromantic soft drink bottle) and the chicken served.

Men making nang bread at Hotan, Xinjiang Uygur Autonomous Region, China. © KEREN SU/CORBIS

Like similar preparations around the world, this dish is said to originate among thieves who had to hide their stolen fowl.

Zhejiang was once a center of Buddhism, including Zen, and thus a great vegetarian cuisine developed. Based largely on soybean and wheat gluten preparations, it sometimes extends to include oysters and similarly sedentary shellfish, which do not seem alive. Imitation meats are prepared from bean curd skin and wheat gluten; they are convincing to the degree that their flavors are disguised by thick sauces.

At the other end of the puritanism scale is a dish centered on northern Fujian, "Buddha Jumped over the Wall"; it consists of long-simmered innards and tough cuts of meat. It smells so wonderful as it cooks that it would make a meditating Buddha leap the wall of his temple compound to get to it.

Besides tea, major drinks include superb grain "wines" related to Japanese sake. Most famous is that of Shaoxing. Ningbo and other cities produce interesting and complex brews. These "wines" are technically beers or ales, being brewed from grain, but they are not carbonated, and they occupy the place in Chinese culture that wine does in Europe. They are brewed, however, in a very different way: with a complex mix of ferments, involving species of yeasts and of fungi in the genera *Rhizopus*, *Aspergillus*, and others, as well as bacteria such as *Lactobacillus* (see Huang). Each brewery has its own strains and preparations. The resulting brews differ greatly from place to place, and have rich, complex, subtle flavors. They have inspired a gourmetship equal to that of tea, or of French wine. Of course, such "wines" exist throughout China, but those of the Yangzi delta are generally considered the finest.

See also **Japan, Korea, Noodle in Asia; Rice; Southeast Asia.**

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E. N. Anderson

CHITLINS (CHITTERLINGS). Chitlins or chitterlings, the small intestines harvested from a hog, are a frugal staple of myriad cuisines. After being soaked, thoroughly scraped, and cleaned, chitterlings have long been stuffed with forcemeats and spices and served as sausages. But chitterlings usage has never been limited to sausage making.

In England, cooks combine diced, sautéed chitterlings with mashed potatoes, form the mix into rounds, cap the resulting dumplings with grated cheese, and term the dish Down Derry. In and around Lyon, France, chitterlings, or *andouillettes*, are fried in lard or butter and served with vinegar and parsley.

No matter the cuisine or continent, chitterlings have long signaled linkage to the farm-based butchery of pigs. In rural districts worldwide, the cold weather killing of a pig and the removal of the chitterlings is a ritual of great import. In the American South, chitterlings, pulled hot from a cauldron of simmering water and eaten with a dose of vinegary or peppery condiment, are considered by many to be a reward for the hard work of farm-based butchery. This farm-to-table linkage has acquired special significance in the American South, where chitterlings (termed "chitlins" by most in an approximation of the prevailing pronunciation) have come to acquire a cultural importance that arguably exceeds traditional culinary usage.

In the book *Chitlin Strut and Other Madrigals*, the novelist and essayist William Price Fox of South Carolina asks the rhetorical question, "Who will eat a chitlin?" The answer: "You take a man and tie him to a stake and feed him bread and water and nothing else for seven days and seven nights, and then he will eat a chitlin. He won't like it, but he will eat it." Fox ascribes to the idea of chitlins as a marker of poverty. According to this often espoused rationale, chitlins and other pork offal products have long been a staple of the southern diet, and their presence was dictated not by preference but by a poverty-engendered creativity that could be claimed by all denizens of rural and impoverished southern districts.

White rural Southerners of the twentieth century, faced with the prospect of a rapidly industrializing and homogenizing region, doted on both boiled and deep-fried chitterlings. For these men and women, chitterlings served as both symbol and sustenance. By mid-century there were active chitterling eating clubs, like the Royal Order of Chitlin Eaters of Nashville, Tennessee, and the Happy Chitlin Eaters of Raleigh, North Carolina. The traditional song "Chitlin Cookin' Time in Cheatham County" gives voice to the same:

> There's a quiet and peaceful county in the state of
> Tennessee
> You will find it in the book they call geography
> Not famous for its farming, its mines, or its stills
> But they know there's chitlin cookin' in them
> Cheatham County hills
> When it's chitlin cookin' time in Cheatham County
> I'll be courtin' in them Cheatham County hills
> And I'll pick a Cheatham County chitlin cooker
> I've a longin' that the chitlins will fill

African Americans with roots in the rural South also claimed a specific cultural meaning for chitlins. At an early date, forced reliance upon offal marked the foods of black southerners with a meaning different from those of whites. Until emancipation, African American food choice was restricted by the dictates of white society. Despite these restrictions, perhaps even as a retort of sorts, African Americans fashioned a cuisine of their own. Laws may have been enacted to regulate slave dress and codify slave mores, but in the kitchen freedom of expression was tolerated, even encouraged. As a result, African American cooks reinterpreted traditional foodways in an African-influenced manner and claimed chitterlings as distinctly African American.

Chitterling imagery pervades African American culture. The informal circuit of juke joints and clubs patronized by African Americans has long been called the "Chitlin Circuit." The bluesman Mel Brown, a veteran of the circuit, chose to title his early 1970s greatest hits album *Eighteen Pounds of Unclean Chitlins and Other Greasy Blues Specialties.*

When soul food came to the fore in the United States during the late 1960s and early 1970s, chitlins—along with watermelons and okra—were celebrated as a cultural sacrament. But not all African Americans embraced chitterlings as a preferred marker of identity. "You hear a lot of jazz about soul food," observed Eldridge Cleaver in 1968. "Take chitterlings: the ghetto blacks eat them from necessity while the black bourgeoisie has turned it into a mocking slogan . . . . Now that they have the price of a steak, here they come prattling about Soul Food."

The novelist Ralph Ellison understood how chitterlings functioned as both preferred cultural marker and liability. In the novel *Invisible Man* (1952), the protagonist imagines a scenario wherein he accuses Bledsoe, a pompous but influential educator, of a secret love of chitterlings:

> I saw myself advancing upon Bledsoe . . . and suddenly whipping out a foot or two of chitterlings, raw, uncleaned, and dripping sticky circles on the floor as I shake them in his face, shouting: "Bledsoe, you're a shameless chitterling

> eater! I accuse you of relishing hog bowels! Ha! And not only do you eat them, you sneak and eat them in private when you think you're unobserved! You're a sneaking chitterling lover!"

See also **Pig; Sausage; United States,** *subentries on* **African American Foodways** *and* **The South.**

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John T. Edge

CHOCOLATE. Chocolate is the name applied to the variety of products manufactured from the seeds of the tropical tree *Theobroma cacao* L. The Swedish naturalist Carl Von Linné (1707–1778), known as Linnaeus, gave the tree the attribution *theobroma* or "food of the gods," taken from the Greek. When adjoined to *cacao*, the indigenous Mixe-Zoquean term for the plant, the name is symbolic of the social, religious, and economic importance of chocolate in both New and Old World cultures. Yet while it was revered, it was also reviled, an ambivalence that attends chocolate even in the twenty-first century. Among all the fruits of tropical and subtropical America, why would this one elicit so much passion?

The Plant and Its History

The geographic origin of *T. cacao* is obscure. While most texts place its origin in either the Amazon or Orinoco River basins of northern South America, it is equally likely that a separate variety originated in Mesoamerica, perhaps in the Lacandón rainforest of the Mexican state of Chiapas. It has been hypothesized that wild *T. cacao* was broadly distributed in Central and South America and that at some time trees in the isthmus died out, leaving a northern variety and a southern variety to develop independently. The fruit of *criollo*, the northern variety, is characterized by elongated, deeply ridged yellow to red pods containing ivory or pale purple seeds, while *forastero*, the southern variety, is characterized by more ovoid, smooth, melon-like green or yellow pods with pale to deep purple seeds. The pigmented substances and related compounds in the cacao seeds impart bitter and astringent qualities to the chocolate. Hence the *forastero* variety has a robust flavor, while the delicate, "fine" flavor of the *criollo* is generally considered of superior quality. In the early twenty-first century, greater than 80 percent of commercial cacao was *forastero*, since this variety is hardier and more productive.

The word "cacao" seems to have come to the Maya from the Olmec, who inhabited the lowlands of the coast of the Gulf of Mexico between about 1500 and 400 B.C.E. and who probably first domesticated the tree. The Izapan culture that bridged the Olmec and the Classic Maya (250–900 C.E.) likely planted the *criollo* plantations of Xoconochco (Soconusco) on the Pacific coastal plains of Chiapas, later a prize possession of the Aztec (Mexica) Empire. While this suggests that cacao was an important crop to the Olmec and the Izapan, it is not known to what extent chocolate was an icon food. The pre-Classic Quiché Maya of the Guatemala highlands apparently did not hold it in exceeding high regard for it is mentioned only in passing in the sacred *Popol Vuh* or "Book of Counsel." But sometime before 250 C.E. this changed. Chocolate appears in Classic Maya iconography, where the glyph symbolizing cacao adorns ritual burial vases. Classic Maya, particularly the wealthy, imbibed cacao in betrothal and marriage ceremonies, reminiscent of the modern use of expensive French champagne. However, the ritual use of cacao reached its height during the time of the Aztec (Mexica) Empire between 1300 and 1521 C.E.

Cacao was both an elite drink and coinage among the post-Classic Maya and the Aztecs. Chocolate was considered a drink for warriors and nobles and had ritual significance as a symbol of human blood. Since cacao could not be grown in the Valley of Mexico, the site of the Aztec capital of Tenochtitlán, it had to be imported from either the conquered lands in Xoconochco or obtained by trade from the Maya of the Yucatán, which gave chocolate an exotic quality. It has been oft repeated that Motecuhzoma Xocoyotzin (the familiar "Montezuma") drank fifty flagons of chocolate a day, most especially before entering his harem, but the account of the conquistador Bernal Díaz del Castillo says of those fifty large mugs, "he would drink a little" (Dillinger et al., 2000, p. 2058S). While cacao was an integral part of the beliefs and practices of the ruling Aztec elite, the image they held of it was not wholly positive. This warning is part of one Aztec tale: "You have become old, you have become tired because of the chocolate you drink and because of the foods you eat" (Coe and Coe, 1996, p. 80). The exuberance of the puritanical Aztecs for chocolate may have been tempered by its association with the luxury-loving Maya of the warm lands to the south. This north-south conflict was repeated in Europe.

In American English usage, "cacao" refers to the tree and its dried seeds prior to further processing; "cocoa" refers to the partially defatted, roasted, and ground cacao seeds; and "chocolate" refers to a food prepared from roasted cacao seeds. Although not leguminous, the cacao seeds are often referred to as "beans." The composition of the edible cotyledon or "nib" is by weight approximately 55 percent fat; 30 percent carbohydrates, half of which is dietary fiber; 10 percent protein; and a host of minor nutrients. This breakdown provides a key to the basis for chocolate's status as a luxury food.

Cacao seeds, numbering twenty to forty, develop within a thick-hulled pod surrounded by a white, sweet, mucilaginous pulp that, with the potential to be fermented into ethanol, could have been what first attracted *Homo sapiens.* Wild cacao is dispersed by primates, who consume the sweet pulp and discard the bitter seed. *Cupuaçu*, a product made from the pulp of the fruit of *Theobroma grandiflorum*, a relative of *T. cacao*, is consumed by peoples of the Amazon. The preparation of cacao seeds for chocolate making begins with a fermentation step that at one point generates ethanol, which may explain why chocolate has at times been described as intoxicating. A "wine" produced from the liquid expressed from the cacao pulp is consumed in the Yucatán. It is speculative but possible that consumption of the cacao seeds was an afterthought, as the bitter flavor of the seeds is an acquired taste.

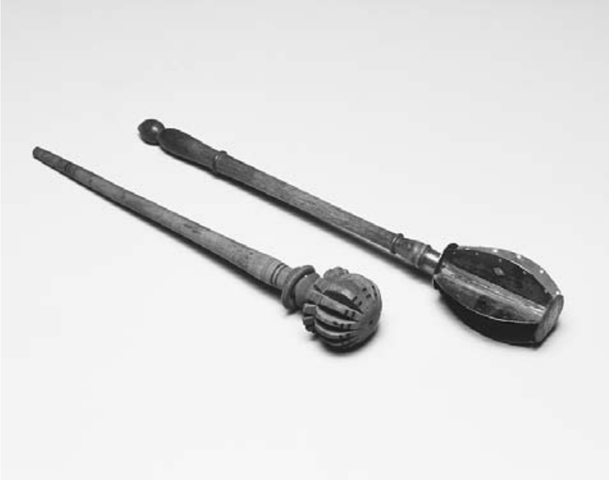
Processing Cacao

Fermentation is required for the characteristic chocolate flavor to develop when the seeds are roasted. The mucilaginous pulp surrounding the seeds is fermented to ethanol, then progressively to acetic and lactic acids, which facilitates its removal. The acid and heat generated during fermentation kill the seed embryo, preventing germination and allowing enzymatic changes that generate flavor precursors and reduce bitterness and astringency. Following fermentation, the seeds are dried, preferably in the sun, to a final moisture content of about 7.5 percent. In this form, the seeds are transported from the country of origin to the major chocolate manufacturing regions.

For the Maya and the modern American alike, the conversion of the fermented and dried cacao to chocolate involves three major operations: roasting, winnowing, and grinding. Just as with meat, roasting cacao generates complex aromas appealing to the human sense of smell. Winnowing is the removal of the inedible shell surrounding the nib. Grinding, which the Maya accomplished by hand using a *metate* and for which later processors have used a variety of mechanical mills, liberates the cacao fat (cacao "butter") from within the plant cells, extracts the aroma, and permits easy suspension of the cacao in beverages.

The quantity of protein in cacao is significant, and the amino acid composition, while limited in lysine and methionine, can be considered good for a protein of plant origin. However, unlike the leguminous beans that complement maize nutritionally, the digestibility of cocoa proteins is only about 16 to 17 percent. Therefore the proteins of cacao have little practical nutritional value.

The nitrogenous compounds of cacao include both proteins (80 percent) and the methylxanthines theobromine and caffeine, which are present in chocolate liquor (ground cacao nibs) at levels of about 1.22 percent and 0.21 percent respectively. They are both central nervous system stimulants, diuretics, and smooth muscle relaxants, although theobromine tends to be less so than caffeine. It is certainly reasonable to assume that the physiological effects of the plant alkaloids are part of chocolate's appeal. Chocolate introduced Europe to these stimulants, though in a milder form than the coffee and tea that followed. The caffeine-containing kola nut, derived from an African tree of the same order as cacao *(Sterculiaceae)*, became the basis of the American icon food Coca Cola. But it is likely that cacao butter is the soul of chocolate's appeal.



Chocolate swizzle sticks (*molinillo*). Mexico and Nicaragua, ca. 1800. Instead of pouring chocolate from a high position to create foam (the best part), the Spaniards copied indigenous forms of whisks to create foam on chocolate by spinning a stick between the hands. Both types of whisk are shown here. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

While wild game, including deer, peccaries, monkeys, tapir, birds, reptiles, and smaller mammals, were abundant in the New World, the only domesticated animals routinely used for meat were the dog and the ocellated turkey *(Meleagris ocellata)*. Muscle foods were not ordinary fare for the indigenous inhabitants of Mesoamerica, and "when the meat-eating Europeans arrived, they described Maya life as perpetual Lent" (Coe, 1994, p. 153). Perhaps just as significant, this lack of large domesticated livestock meant the Maya had no source of butter, lard, or tallow. Fats and oils have been sought for cooking, lighting, and medicine since the earliest times. Hence some of the earliest domesticated plant species in the Old World were the almond *(Prunus amygdalus)* and the olive *(Oleo europea)*. Perhaps the well-documented Maya distaste for the fat of European animals resulted from Maya familiarity with the preeminent fat, cacao butter.

Nutritional Value

Cacao butter is unique among natural fats. Its constituent fatty acids are principally the medium-chain saturated fatty palmitic acid and stearic acid and the monounsaturated oleic acid, so cacao butter exhibits a remarkable

Chocolate truffles are considered among the most luxurious of all chocolate confections. © C/B PRODUCTIONS/CORBIS.

stability against oxidative rancidity. Furthermore, the manner in which these fatty acids are distributed on the major molecule of natural fats, triacylglycerols, makes cacao butter solid at normal ambient temperatures, but it melts quickly just below body temperature. Bishop Diego de Landa reportedly said the Maya "get from cacao a grease which resembles butter, and from this and maize they make another beverage which is very savory and highly thought of" (Coe and Coe, 1996, p. 61). Fernández de Oviedo observed, "Cacao ground, and cooked with a bit of water, makes an excellent fat for cooking" (Coe, 1994, p. 54).

As in other fats, the caloric content of cocoa butter is high. Chocolate liquor contains approximately 520 kilocalories per 100 grams, 460 of which are from fat. The 1878 edition of *Encyclopedia Britannica* refers to "Cocoa, or more properly Cacao," as "a valuable dietary substance" and points out that, while only infusions are made from coffee and tea, leaving large portions of their total weights unconsumed, the entire substance of the cacao seed is utilized. Henry Stubbe, in *The Indian Nectar, or, a Discourse Concerning Chocolata* [*sic*] (1662), reported that both English soldiers and Indian women in Jamaica sustained themselves for long periods by eating only chocolate yet did not exhibit a decline in strength. The nutritional qualities of chocolate have been praised by numerous authors since the sixteenth century, and some people have called it a complete food, like bread or milk, containing as much nourishment as a pound of beef. While this helped the Hershey Chocolate Company earn the Army-Navy E award for the Ration D, it caused much consternation within the Catholic Church. Twice the residents of Chiapas consulted Pope Gregory XIII on the question of whether or not drinking chocolate broke the ecclesiastical fast, and both times he responded that it did not because it was a drink. So while coffee and tea can only be regarded as stimulant in effect, a cup of cacao is nutritive in value.

In preconquest Mesoamerica, cacao was an ingredient of a wide variety of drinks, gruels, and porridges, to which were added a great diversity of other flavorings, notably vanilla *(Vanilla planifolia)*, chilli pepper *(Capsicum annum)*, and "ear flower" *(Cymbopetalum penduliflorum)*. It is likely that some of these concoctions were served hot and others cold. The simplest chocolate drink consisted of adding ground cacao and flavorings to water and agitating the mixture by beating or by pouring the liquid from one vessel to another to raise a foam, which was considered the best part of the drink and a sign of quality. During preparation the foam was reserved, then it was added back before serving. While the Maya added indigenous plants to augment the foam, modern consumers have replaced it altogether with whipped cream or marshmallow. The ground cacao was often ameliorated with ground maize or ceiba seed *(Ceiba pentandra)*, though not in the most elite drinks. The bitter taste of most chocolate drinks was not immediately appealing to the European palate. Notable among the ingredients Europeans added to their chocolate are sugar and milk.

From at least the time of the Aztecs, people have been ambivalent about chocolate. Wolfgang Schivelbusch portrayed this ambivalence as a contest between diametrically opposed cultures: capitalist, middle-class, Protestant northern Europe versus aristocratic, Catholic southern Europe. Chocolate was a status symbol of the ancien régime, while coffee appealed to the bourgeois intellect. That chocolate became a status symbol in Europe had much to do with its richness, rarity, and exotic origins. As a status symbol, drinking chocolate vanished with the ancien régime. Cocoa became a breakfast drink for women and children; what formerly symbolized power and glory was now in the hands of the disenfranchised in middle-class society. However, at the same time, solid eating chocolate gained new significance as a luxury in its own right. Once again prestige followed the fat.

While the calories provided by chocolate may have been advantageous to a solider on the march, the idle European nobility found it exceedingly fattening and disagreeable at times to the stomach. In search of a better beverage, Coenraad Van Houten in 1828 developed a means of partially defatting cacao using a mechanical press, an invention that had unanticipated consequences.

The development of solid eating chocolate was evolutionary. Chocolate liquor is solid below 85°F (30°C); formed into small pellets or wafers, it was issued to Aztec warriors on campaign. It was an obvious step to add spices and maize to the cacao during grinding and then form the mixture into cakes. These tablets could later be dispersed into water to prepare a beverage. Seventeenth-century texts mention "eating" as well as drinking chocolate, and recipes for solid confections containing cacao appeared in the eighteenth century. In the 1820s, Goethe wrote of chocolate, "Enjoy this whenever it suits your mood, Not as a drink, but a much loved food" (Morton and Morton, 1986, p. 67). But it was the surplus cacao butter resulting from Van Houten's invention that accelerated the trend toward solid chocolate confections.

The addition of cacao butter to chocolate liquor made it possible to add more sugar to balance the bitterness of the cacao while still producing a thin paste that could be cast into a mold or used as a coating. Solid eating chocolate became an object of trade in the mid-1800s. However, these early products were coarse and gritty. Rudolph Lindt is credited with the 1879 invention of the conch that by grinding the sugar exceedingly fine and homogenizing the mixture creates a smooth and creamy textured chocolate with enhanced flavor and aroma. This "fondant" chocolate became a world standard.

Chocolate has been lauded for its purported medicinal value. Greater than one hundred medicinal uses for chocolate have been reported, and the majority fall into three main categories: 1) to aid emaciated patients in gaining weight; 2) to stimulate the nervous systems of apathetic, exhausted, or feeble individuals; and 3) to improve digestion, stimulate the kidneys (diuretic), and improve bowel function (Dillinger et al., 2000, p. 2057S). These uses can be explained either by cacao's caloric content or by the presence of methylxanthines. In the late twentieth century, attention focused on a class of compounds, phytonutrients, that tend to have antioxidant properties and are said to lower the risk of cancer and cardiovascular disease. Among these phytonutrients are the polyphenols, in particular the catechins, which have demonstrated physiological antioxident properties. Pigment cells in the cacao seed, especially in the *forastero* variety, are rich in these compounds, which may mean redemption for the lowly cousin of the *criollo.*

Chocolate has long been called an aphrodisiac, a quality that entered into the debate over whether or not it could be consumed by Catholics during Lent, and references to its stimulation of the sexual appetite are numerous. Like other luxury items, chocolate is a symbol of excess wealth, but the association of chocolate and eroticism may not be entirely iconographic in nature. While no specific chemical compounds have yet been identified that could account for either chocolate's supposed addictive or aphrodisiac properties, debate continues on its physiological and psychological effects. Chocolate has become an essential ingredient in the act of seduction. It could be that the melting of the cacao butter in chocolate is symbolic of the melting of the heart and the breakdown of sexual resistance.

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Gregory R. Ziegler

CHOLESTEROL. Cholesterol is one of the most widely disseminated organic compounds in the animal kingdom. Almost three hundred years ago, Antonio Vallisnieri observed that gallstones were soluble in turpentine or alcohol. Poulletier de la Salle, some thirty years later, demonstrated that the main constituent of gallstones could be crystallized from alcohol. This substance was thought to be a wax until 1815, when Michel Eugène Chevreul showed that it was not saponifiable and gave it the name "cholesterine" derived from the Greek *chole*, bile, and *steros*, solid. Soon thereafter, it was isolated from blood, brain, tumors, and egg yolk. The isolated compounds were shown to be identical. In 1843 Vogel found it in atherosclerotic arteries.

The chemical structure of cholesterol was elucidated over the years beginning in 1859. The compound was shown to contain a secondary hydroxyl group and a double bond. The exact empirical formula ($C_{27}H_{46}O$) was established in 1888 by Friedrich Reinitzer. Proof of structure was obtained chiefly through the brilliant work of Adolf Windaus and Heinrich Wieland. The structure of cholesterol suggested by Windaus and Wieland in the 1920s was incorrect, but that does not detract in any way from their contribution. The true structure was established in the 1930s based on X-ray diffraction data.

There were many suggestions regarding the biological synthesis of cholesterol. The biosynthetic pathway became accessible with the introduction of radioactive carbon in the 1940s. The biosynthetic scheme was generally elucidated by the work of Konrad Bloch, George Popjak, and John Cornforth. It was first shown that cholesterol could be synthesized in mammals and ergosterol in yeast from small organic molecules. Eventually it was shown that all twenty-seven carbon atoms of cholesterol were derived from the two carbon atoms of acetate. The methyl group of acetate contributed fifteen of the twenty-seven carbons of cholesterol and the carboxyl group contributed twelve. The pathway began with the condensation of two acetate residues to give acetoacetate and addition of one more two-carbon moiety to yield hydroxymethylglutaric acid (HMG). HMG lost a carbon atom and the resulting compound rearranged to provide an isoprene unit. Two five-carbon units combined to give a geranyl derivative that added another isoprene to give a farnesyl unit. Two farnesyl units united to provide squalene ($C_{30}H_{50}$), a hydrocarbon found in the livers of some species of shark that cyclyzed to yield lanosterol, a thirty-carbon atom sterol also found in sheep wool. In a series of rearrangements and demethylations, lanosterol yielded cholesterol. The key step in this complex synthetic pathway involves the reduction of HMG-CoA. Inhibition of HMG-CoA reductase is the basis of a number of potent new serum cholesterol-lowering drugs.

Cholesterol represents about 0.2 percent of the weight of the human body. As Table 1 shows, the bulk of the body's cholesterol is present in two tissues; one is the brain and nerve tissue, the other is muscle. In the brain, cholesterol is thought to act as an insulator, but there have been relatively few studies of the metabolism of brain cholesterol. The next large reservoir of cholesterol is muscle. Between them, nervous tissue and muscle carry 44 percent of the body's cholesterol. The cholesterol in these reservoirs turns over slowly.

Cholesterol is ubiquitous in the human body, where it plays structural and metabolic roles. Together with phospholipid, cholesterol is present in every cell membrane. In the adrenals, cholesterol is converted to adrenocortical hormones such as cortisone. In the gonads, cholesterol is converted to the appropriate sex hormone—estradiol in women, testosterone in men. The cholesterol in skin is the precursor of 7-dehydrocholesterol, which is ultimately converted to vitamin D. The major catabolic products of cholesterol are the bile acids—cholic and chenodeoxycholic. These are designated as the primary bile acids; they are metabolized in the liver to deoxycholic and lithocholic acids. It has been estimated that over 90 percent of biologically synthesized cholesterol is metabolized to bile acids. In general, the body synthesizes more cholesterol than it ingests.

TABLE 1

Distribution of cholesterol in a 70-kg man

Tissue	Cholesterol content (g)	% of Total
Brain, nervous system	32.0	23
Connective tissue, body fluids	31.3	22
Muscle	30.0	21
Skin	12.6	9
Blood	10.8	8
Bone marrow	7.5	5
Liver	5.1	4
Heart, lungs, kidneys, spleen	5.0	4
Alimentary tract	3.8	3
Adrenals	1.2	1
Skeleton	0.7	—
Other glands	0.2	—

In 1912 Nicolai Anitschkow showed that cholesterol-fed rabbits developed aortic deposits similar to early human atherosclerosis. His experiments presented a possible explanation of human atherosclerosis and that particular debate has not yet abated. Simultaneously with Anitschkow's studies, A. I. Ignatowski demonstrated the atherogenic potential of animal protein, but compared to work on cholesterol and fat there has only been a desultory interest in protein effects.

Since Anitschkow's results were obtained by dietary manipulation, the view that dietary cholesterol was implicated in atherogenesis was accepted generally. With development of simple, rapid methods of cholesterol analysis, it became possible to screen populations for blood cholesterol content. Large epidemiological studies were launched and their results helped to develop the concept of risk factors for heart disease. Currently, the major risk factors are hypercholesterolemia, hypertension, smoking, obesity, and maleness. However, emerging data suggest that homocysteinemia and inflammation (due to infection with cytomegalovirus or *chlamydia pneumoniae*) are also important factors.

When cholesterol is ingested, it is emulsified with phospholipid and absorbed. The absorbed lipid circulates in the blood as a water soluble lipid-protein complex called lipoprotein. Initially, absorbed cholesterol is part of a large, triglyceride-rich particle called the chylomicron. In the course of circulation, the triglyceride is removed by activity of cellular lipases and the particles become smaller and their cholesterol content increases. The cholesterol-containing, lipid-protein complex consists of several fractions that are separable by virtue of their hydrated densities. In general terms, the four major fractions are the triglyceride-rich chylomicrons and very low density (VLDL), the cholesterol-rich low density (LDL), and the protein-rich high density (HDL).

Due to development by John Gofman of methods for ultracentrifugal separation of lipoproteins, researchers have been able to isolate and study lipoproteins. The cholesterol-rich low density lipoproteins (LDL) are thought to be major risk factors for coronary disease. It was demonstrated that oxidized LDL is the real villain in coronary disease. It also was shown that LDL can be subfractionated into small, dense and large "fluffy" particles. The small particles appear to infiltrate the artery preferentially.

Researchers also know that the process of atherogenesis is not simple and is mediated by an array of small proteins. The high-density lipoproteins are about 50 percent protein. In the simplest terms, LDL facilitates entry of cholesterol into cells and HDL facilitates its removal. LDL receptors on the cell surface facilitate LDL uptake. The proteins of lipoproteins are very important because they provide recognition by cells, and it is now becoming evident that genetic differences in apolipoproteins may dictate susceptibility to disease as well as chances for the efficacy of medication.

The effects of dietary cholesterol became a concern shortly after Anitschkow's observation and warnings regarding excess levels of cholesterol intake, which constitute one of the foundations of dietary therapy. Since cholesterol occurs only in food of animal origin, it was a simple extension to seek an explanation of the role of cholesterol by examining the lipids of food from animal sources. Although no dietary fat is totally saturated or unsaturated, attention also turned to effects of fat saturation.

The amount of cholesterol in the average American diet is in the range of 300–350 mg/day. It used to be much higher. The levels of cholesterol in a number of common animal foods are given in Table 2. It is evident that most muscle contains about the same amount of cholesterol, 81 ± 7 mg/100g. Cholesterol content of butter (per 100 g) is high, but we rarely eat more than 5–10 g of butter per meal. Shrimp is high in cholesterol but very low in fat. Eggs are also high in cholesterol. Continuing research nevertheless indicates that the cholesterol level of a food per se has little effect on serum cholesterol levels. The cholesterolemic effect is a function of dietary fat saturation. It has been shown that the absorption of cholesterol is more a function of the accompanying dietary fat than of cholesterol itself. Saturated dietary fat leads to higher cholesterol levels than does unsaturated fat. This observation is true for most people who are called "non-responders" (to dietary cholesterol). A small number of people are "responders," meaning they absorb more cholesterol, regardless of accompanying fat. In the late 1960s, Keys and Hegsted developed formulas for estimating changes in serum cholesterol based upon changes in dietary fat. There have been a number of more complex formulas developed, but the originals are referred to most often today. Essentially, they found saturated fatty acids to be hypercholesterolemic and unsaturated fatty acids to lower cholesterol. Stearic acid was considered neutral. The polyunsaturated fats lower cholesterol across the board so that HDL cholesterol (the "good" cholesterol) falls as does LDL cholesterol. Oleic acid seems to affect only LDL cholesterol. The reduction in total cholesterol may not be as profound, but the LDL/HDL cholesterol ratio is improved. Recent findings show that the structure of individual triglycerides may also influence their atherogenicity.

In summary, cholesterol is a substance that appears in all cells and also has a number of metabolic functions. It is synthesized in the body and is part of every cell membrane. Cholesterol is metabolized to adrenocortical or sex hormones, bile acids, and vitamin D. Levels of serum cholesterol are related to risk of coronary disease, but it should be borne in mind that cardiovascular disease is a metabolic disease, not one of cholesterol deposition. Dietary cholesterol is absorbed, but its effects on serum cholesterol are slight. Generally, there is an increase of about 2 mg of serum cholesterol for every 100 mg ingested. Cholesterol should be viewed as a chemical necessary for life and not as a toxic substance. As with so many other aspects of life, moderation is the key.

TABLE 2

Cholesterol content (mg/100g) of selected foods

Food source	Cholesterol (mg/100g)
Egg	504
Butter	250
Shrimp	150
Mackerel	95
Herring	85
Chicken	81
Turkey	74
Lamb	71
Veal	71
Beef	68
Pork	62
Flounder	50
Milk	15

See also **Fats; Health and Disease.**

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David Kritchevsky

CHOLINE, INOSITOL, AND RELATED NUTRIENTS. Choline (2-hydroxy-*N,N,N*-trimethylethanaminium) and inositol (*cis*-1,2,3,5-trans-4,6-cyclohexanehexol) are water-soluble chemicals common in animal tissues and seeds of plants. Both compounds have been designated as water-soluble vitamins, and have also been referred to as "quasi-vitamins." Choline and inositol, while having distinctly different chemical structures, are often discussed together because they are integral components of phospholipids, some of the most important lipids in both plants and animals. Two of the most important functions of phospholipids are as structural components of cellular membranes and as second messengers, transmitting signals through cell surfaces into the cell.

Choline and the phospholipid phosphatidylcholine (PC) are typically high in foods containing relatively high amounts of fat and cholesterol such as beef liver, beef steak, and eggs. Plant-based foods follow the same generalization in that those containing relatively high levels of fat also contain relatively high levels of PC (peanuts, soybeans, and so on). All foods contain some choline or PC. "Lecithin" is a term describing the commercially available phospholipids, which can contain a variety of compounds including free fatty acids, triglycerides, and most of the phospholipids. Estimates of lecithin intake in the American population are approximately 6 g/day and an accompanying 0.6 to 1.0 g/day of choline. Adequate levels of intake are 0.125 to 0.15 g/day choline for infants, 0.2 to 0.375 g/day for children, 0.55 g/day for adult males, and 0.4 to 0.55 g/day for adult females. However, intake of choline and PC is probably decreasing in the United States because of our changing food habits. As Americans decrease intake of fats from animals, their intake of choline and PC will also decrease. Maximum daily recommended choline is 16 to 20 g/day. No maximum intake level has been identified for lecithin, but 40 g/day has been tolerated. Reactions to excessive intakes of choline include nausea, perspiring, anorexia, and cardiac arhythmias. Adults involved in strenuous exercise (such as participating in marathons) can experience significant decreases in plasma choline concentration (up to 40 percent), and there appears to be an enhancement of performance with supplemental choline intake. Commercially available sources of choline, lecithin, and PC are considered GRAS (generally recognized as safe) by the U.S. Food and Drug Administration.

Choline interacts with several drugs including anticancer drugs and nonsteroidal anti-inflammatory drugs (NSAIDs). Methotrexate is a relatively common drug in the fight against cancer and it leads to a decrease in liver choline concentrations and resulting increase in liver lipid concentrations. NSAIDs are known to facilitate changes in the gastrointestinal tract mucosal surface including perforations. Intake of PC improves such lesions.

Insufficient intake of choline can affect both acetylcholine and PC concentrations. Significant decreases in acetylcholine can result in a condition known as tardive dyskinesia (impaired movement and defective neural transmission), which can be corrected by increasing choline intake. There is also interest in choline as an aid in alleviating short-term memory loss (for example, Alzheimer's disease) and some concern that chronic inadequate intake of choline may facilitate the onset of Alzheimer's. Deficiencies of PC can result in increased lipid concentrations in liver (hepatic lipidosis), which is an analogous condition to cirrhosis of the liver caused by chronic alcoholism. If the deficiency persists, cirrhosis eventually leads to carcinoma. Choline deficiency also leads to infertility, bone abnormalities, hypertension, impaired kidney function, and decreased hematopoiesis. Similarly, deficiencies of inositol in laboratory animals leads to hepatic lipidosis and alopecia (hair loss). An inability to break down PI (Niemann-Pick disease) leads to enlarged spleen and liver, as well as mental development abnormalities.

Phospholipids are antioxidants commonly used in food products to inhibit oxidation and as emulsifying agents. Phosphatidylcholine can bind minerals such as iron and copper that are considered prooxidant minerals, or those that facilitate oxidation of lipids. Phosphatidylcholine can also help degrade hydroperoxides, or partial breakdown products of lipids and is commonly used for this purpose. The nitrogen-containing phospholipids phosphatidylethanolamine and phosphatidylserine (PI) are even more active than PC in protecting against oxidation of lipids. The two most common sources of phospholipids are soybeans and egg yolk. Lecithin from soybeans is more commonly used in commercial applications because of its lower cost. Soybean lecithin contains 50 to 70 percent phospholipid and is extracted with other prooxidants in vegetable oil processing. This process separates the oil from phospholipids, vitamin E, and other potentially beneficial nutrients. An older mechanism of lipid separation has been revived in the United States using simple pressing of soybean seeds to remove the oil instead of solvents. This results in oil with high levels of vitamin E and phospholipids. Lecithins containing higher concentrations of phospholipids and PC are also becoming available.

See also: **Antioxidants; Fats; Lipids; Minerals; Soy; Vitamins: Overview; Vitamins: Water-soluble and Fat-soluble Vitamins.**

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Paul B. Brown

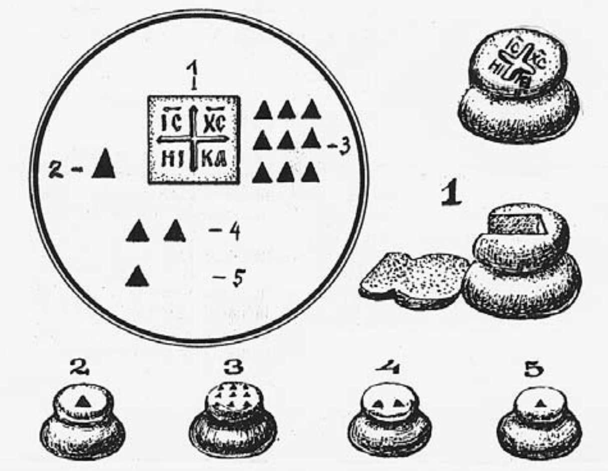
CHRISTIANITY.

This entry includes two subentries:
Eastern Orthodox Christianity
Western Christianity

EASTERN ORTHODOX CHRISTIANITY

Food plays an important role in the liturgical, ritual, canonical, and dogmatic life of the Eastern Orthodox Church. Throughout the ages, Orthodoxy—from the Greek *orthós* (correct) and *dóxa* (belief)—has come to encompass many nationalities throughout the world. Historically the early church was geographically separated into a Latin West (centered in Rome) and a Greek East in Constantinople (modern Istanbul). The Roman emperor Constantine, who sanctioned tolerance of Christians in 313, moved his capital to the Greek city of Byzantium (and renamed it Constantinople) in 330, and convened the first Ecumenical Council there. Although the Catholic Church and the Orthodox Church remained in communion through the Seventh Ecumenical Council, the Great Schism of 1054 is the generally accepted date for the division of the Christian churches.

The Russians, Ukrainians, and White Russians (also referred to as Belorussians or East Slavs) were proselytized by Orthodox missionaries beginning in the ninth century, and eventually adopted the liturgy, calendar, and many customs of the Greek Orthodox Church. (While the Slavic Orthodox and some "old calendarist" Greeks follow the older Julian calendar, non-Slavic Orthodox, such as most Greeks, Syrians, Egyptians, and the Balkan nations, have followed the contemporary Gregorian calendar since the early part of the twentieth century. Dual dates are given throughout this entry.) Despite the multiethnic and multilingual composition of Orthodox Christians worldwide, Orthodoxy remains united in dogma, virtually unchanged for almost two thousand years. There is a similar unity in the role that food plays in the life of the church.



The five main *prosforo* which are consecrated during the *proscomidia* at the beginning of the Greek Orthodox communion. Shown here are the signs on the pieces that are taken from the communion loaf: 1) the *prosforo* for St. Charalambos, 2) the *prosforo* for the Virgin Mary, 3) the nine-part *prosforo* for the saints, 4) the prosfora for the living, and 5) the *prosforo* for the dead. Original drawing by Tatiana Voronina.

Holy Bread (*Prosforo, Antidora, Artos*)

Holy bread, or *prosforo* (from *prosfora* 'offering'), plays a central role during Communion, the most important rite of the Orthodox church. For Orthodox Christians, the *prosforo* (Russian *prosvira)* becomes the Body of Christ. Often prepared by a parishioner, the bread is is round and consists of two separate parts made from leavened wheat bread. The stamped design on the upper part of the loaf is that of a cross with the letters *IC*, *XC*, *NIKA*, which stands for "Jesus Christ Conquers," and is cut out by the priest during the preparation of the Eucharist ("thanksgiving"). The service of *artoklasia* (breaking of bread) represents a thanksgiving for God's blessings and commemorates Christ's miracle of multiplying five loaves to feed thousands. Other sacred breads include *antidora* (from *dōra*, 'gift'), which is distributed by the priest to the faithful following the Divine Liturgy, *artos*, *panagia*, and Easter cake (Greek, *tsoureki)*.

The commandment to sacrifice bread is found in the Old Testament: "Besides the cakes, he shall offer for his offering leavened bread with the sacrifice of thanksgiving of his peace offerings" (Leviticus 7:13). In

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Vologda
Izhevsk
Tallinn
ESTONIA
Kostroma
DENMARK
Copenhagen
Yaroslavl'
Volga
Kazan'
Riga
LATVIA
Nizhniy Novgorod
Vladimir
Baltic Sea
LITHUANIA
Moscow
Vilnius
Ryazan'
Samara
Kaluga
Penza
Tambov
Berlin
POLAND
Minsk
Saratov
GERMANY
Warsaw
BELARUS
Voronezh
KAZAKHSTAN
Prague
CZECH REP.
Kiev
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Kharkiv
L'viv
Volgograd
UKRAINE
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SLOVAKIA
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Dnipropetrovs'k
Volga
Astrakhan
AUSTRIA
Budapest
Kryvyy Rih
Donets'k
SLOVENIA
HUNGARY
MOLDOVA
Chişinău
Mykolayiv
Zaporizhzhya
Rostov-na-Donu
ITALY
Ljubljana
Zagreb
ROMANIA
Odessa
CROATIA
BOSN. & HERZG.
Belgrade
Krasnodar
Caspian Sea
Bucharest
Sarajevo
Danube
Black Sea
Rome
YUGOSLAVIA
BULGARIA
GEORGIA
Sofia
T'bilisi
Baku
AZERBAIJAN
Skopje
ARMENIA
ALBANIA
MACED.
Yerevan
Tiranë
GREECE
Istanbul (Constantinople)
Ankara
TURKEY
Athens
IRAN
Mediterranean Sea
SYRIA
IRAQ

accordance with ancient traditions, a least five *prosforo* are used during the first part of the liturgy (*proscomidia*). The wheat used to make the *prosforo* is symbolic of the human essence, which consists of the many elements of nature; the yeast represents the life-giving force of the Holy Ghost. The division of *prosforo* into two parts is symbolic of the distinction between human flesh (flour and water) and soul (yeast and Holy Water). Traditionally, the *prosforo* is prepared by pious women and widows.

It is customary for Orthodox who are named after a particular saint to celebrate their "name day." In Greece and Cyprus the celebrant provides the five *prosforo* to their church on the eve of the saint's day. The small round loaves of white bread, which are spiced with cloves and bitter orange-blossom water, are then blessed by the priest, and one of the loaves is sent to the *yortaris*, or feast giver, while the other loaves are cut into pieces and offered to the congregation and to the poor.

Antidoron (Greek) or *antidor* (Russian) is a small piece of *prosforo* that is distributed after a mass to those who did not receive communion. *Antidoron*, from the Greek *anti* (instead) and *dōron* (gift), dates to the seventh century in the Orthodox church.

Artos, the third type of sacred bread, includes an image of the cross with a crown of thorns, which is symbolic of Christ's Resurrection. A leavened bread that is consecrated by the priest on Easter, the *artos* remains on the lectern before the iconostasis during the week. Easter cake is a kind of *artos* that is consecrated on Saturday before Easter Sunday.

Bread appears in various customs of the Orthodox church. Orthodox monasteries celebrate a ceremony to the Panagia (the Virgin Mary) in which sacred bread—*prosforo* or *panagia*—is solemnly taken to a refectory after the liturgy, reminiscent of the apostolic tradition. Special breads also mark periods of Orthodox fasting. For Greek Orthodox, Lenten fasting begins on “Clean Monday,” when a special flat bread called *lagana* is baked. Among Russians, Ukrainians, and White Russians there was a custom of baking an unleavened bread with the image of a cross during the fourth week of Lent.

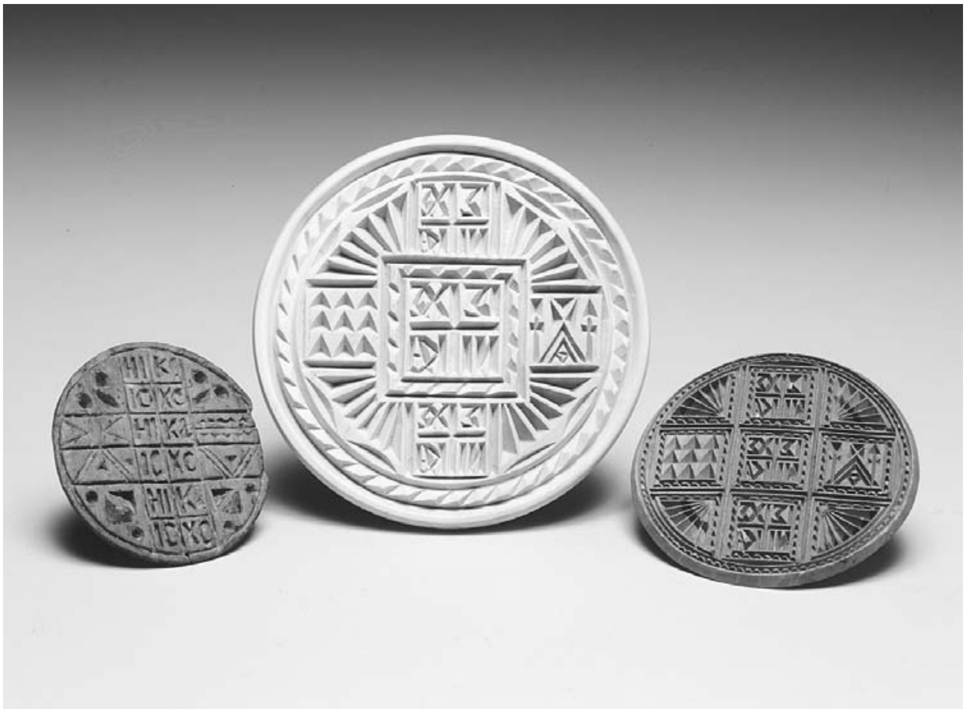
Orthodox Feasts and Fasts

Various Orthodox feasts and fasts mark the life of Christ, the Virgin Mary, and the saints. The Orthodox Church recognizes twelve Great Feast Days, eight of which are events in the life of Christ, and four in the life of the Virgin Mary. Easter stands alone as the most important Orthodox holiday, and is celebrated on the first Sunday after the first full moon following the vernal equinox. (The date is calculated on the Julian calendar and therefore differs from that of Easter in the Western Church.) Feasts like Christmas are fixed, while others such as Easter are moveable.

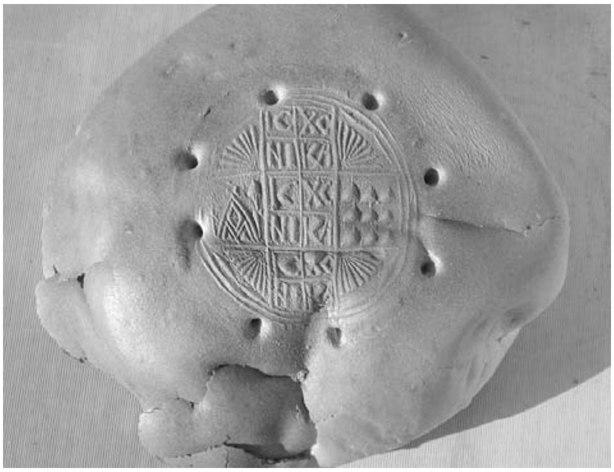
Easter. Special Easter bread and boiled eggs that are dyed blood red (symbolic of Christ’s crucifixion) are the most important food items for Orthodox during the Easter season. In Greece a large loaf of leavened bread is always present on the Easter table together with traditional sweet rolls (*koulouria*), sweetened bread (*tsoureki*), and little filled cheese envelopes (called *kaliitsounakia* on the island of Crete).

The tradition of presenting Easter eggs has its roots in the ancient notion of the cosmic Golden Egg. Early Christians regarded the egg as a symbol of life, and rebirth was made manifest through the Resurrection of Jesus Christ.

Following the midnight Easter service—held on Saturday night—the Greeks have the traditional *Anastasimo* meal, the first meal of the Resurrection, which consists of a special paschal soup (known in Greek as *mayeritsa*) made from the intestines and other organs of lamb. The soup is eaten in the early morning following the midnight service, along with the sweet bread called *tsorekia* (flavored with the spice *machlepi*, which is made from a ground seed from Syria), *koulourakia pascalina* (bread rolls), the *kalitsounia* (cheese pies), and a salad of greens. The red-dyed boiled eggs, which are prepared on Holy Thursday, are cracked by faithful Greek Orthodox accompanied with the words *Christos Anesti!* (“Christ is Risen!”) and the reply *Alithos Anesti* (“He is truly Risen”). The Easter Sunday meals consists of spit-roasted lamb, salads, grilled offal, Easter rolls and bread, and red wine.



Greek Orthodox bread stamps, olive wood. From left to right, Bulgarian stamp for the funeral mass, eighteenth 18th century; Cypriot stamp for Holy Communion, Machairas Monastery, 2001; Greek stamp for Holy Communion, Mt. Athos, Greece, ca. 1890. Roughwood Collection. Photo Chew & Company.



Holy bread stamped with religious symbols. Photo by Gian Berto Vanni. © VANNI ARCHIVE/CORBIS.

Russians, Ukrainians, and White Russians celebrate Easter by preparing sweet bread (Russian *kulich*; Ukrainian *paska*) and sweet curds with raisins or fruits (*pasha*) and by painting boiled eggs that have been consecrated. East Slavs dye eggs by boiling them with onion husk or fuchsine. Ukrainian Easter eggs are famous for their decorative art and symbolic designs.

Christmas and New Year. Christmas (25 December/ 7 January) is the second important festival in the Orthodox calendar. Roasted pig was an obligatory dish in the Orthodox tradition, but it has been superseded by stuffed roast turkey for Christmas Day, doubtless influenced by the customs of Western Europe. Turkeys are stuffed with a mixture of minced beef or lamb, rice, and pine nuts and served with a variety of salads and potatoes. During the Christmas season Greek cooks prepare *loukanika* (sausages) and *lountza* (smoked fillet), *hiromeri* (smoked ham), and *zalatina* (brawn). The Greeks also eat rose water–flavored shortbread and syrup-drenched honey cakes called *kourambiédes* and *melomakárona*, respectively.

A New Year tree is symbolic of the Tree of Life in Slavic Orthodox cultures, and is decorated with candles denoting the spiritual light and fruits implying the kingdom of paradise and its salutary fruits in Greece. The feast of St. Basil is celebrated on New Year's Day, and on New Year's Eve the head of the household cuts the *vasilopita* (literally "bread of the king"). The first slice is laid aside for Jesus Christ, and then everyone receives a slice; a lucky coin is traditionally hidden somewhere in the loaf. (The recipient of the coin is said to enjoy good fortune for the coming year.) This custom is repeated by town officials as an expression of the wish for good health and prosperity for the whole community. The story of the *vasilopita*, or the loaf of St. Basil (the Great; 330–379), dates to an incident in ancient Cappadocia (in central Anatolia), when the Archbishop Basil was said to have saved the church treasury from plunder by baking coins in small loaves that were then distributed to the whole congregation.

Other major feasts. The Holy Trinity (in Greek, *Aghia Triada*) is celebrated on the fiftieth day (the Pentecost) after Easter. Russians, Ukrainians, and White Russians historically decorated their houses with branches of birch tree, green grass, and flowers imitating an ancient harvest tradition. In Greece, on the Saturday before Pentecost, sweet cereal porridge, sweet bread, and other foods are consecrated in the church and then brought to cemeteries where they are distributed to the poor. There is a similar tradition among East Slavs.

Many Orthodox consecrate both grapes and wheat on the feast day of the Transfiguration (6 August/19 August) as an expression of thanksgiving. In Russia, where grapes are not cultivated everywhere, a related feast (of the "Apple Savior") sanctifies apples and other fruits and vegetables in the church.

Fasting

Fasting among Orthodox Christians has its basis in the Old Testament and has ancient roots in the Church. Orthodox insist that the body must be disciplined as well as the soul, and strict fasting in the Orthodox Church is demanding, especially when compared to the fasting known to some Western Christians. Extended and one-day fasts, which are linked to major Christian feasts, account for more than two hundred days of the year. There are four extended fasts in the Orthodox tradition, but their duration and the level of strictness vary. The Great Fast of Lent begins seven weeks before Easter; the Fast of the Apostles starts on the Monday eight days after Pentecost, and ends on 28 June (11 July), the eve of the Feast of Saints Peter and Paul; the Assumption Feast lasts from 1 to 14 August (14 to 27 August); and the Christmas Fast lasts forty days, from 15 November to 24 December (28 November to 6 January).

Each of the major fasts has associated foods and food traditions, but there is great variation in the duration, severity, and exceptions made (for example, monks and clerics versus the laity, the infirm versus the healthy, and so on.) In fact, there is great variation in the strictness of fasting among Orthodox worldwide, and dispensations, especially among the Orthodox diaspora, are common.

The last week before Lent is marked by carnival or Shrovetide, a celebration that dates from ancient times and has much in common with the cult of the deceased. In Greece the pre-Lenten period is called *Apokries* (literally "away from meat"). Devout Orthodox visit cemeteries with sweet wheat porridge (called *kolivo* in Greek) and other foods. In Russia the period before Lent is known as *Maslenitsa* (or "Cheese Week"), and during this time quantities of *bliny* (pancakes) and milk products, especially butter, are eaten in place of meat products. In Russia, on Saturdays before the feasts of St. Trinity and St.

Dimitry, as well as other days, a special sweet porridge (*kutja*), similar to the Greek *kolivo*, and made from cereals with honey, raisins, or fruits, is blessed during the liturgy. Such rituals are closely connected with the ancient beliefs of farmers that treat the souls of the deceased with grain, wine, oil, honey, and *panspermia*—a porridge made from cereals and leguminous plants.

During Lent, only vegetable-based foods are permitted: meat, fish (with backbone), dairy products, eggs, and sweets are specifically excluded from the diet. On Saturdays and Sundays dishes containing vegetable oil (except on Saturday of Holy Week) and wine are permitted. The greatest severity in fasting is reserved for Holy Week, when Orthodox around the world abstain from all animal products, oil, and wine. On Great Friday (Good Friday), in particular, devout Orthodox eat nothing in preparation for the church services.

Strict one-day fasts occur on Christmas Eve, when East Slavs consume nothing but bread and water until the conclusion of the evening mass (when they eat a special porridge called *sochivo* made with boiled wheat, barley, or rice with honey); on the eve of the Epiphany or the Twelfth-Day (5 January/18 January); on the Feast of the Beheading of St. John the Prophet (29 August/11 September); and on the Feast of the Exaltation of the Holy Cross (14 September/27 September). In addition, Orthodox faithful fast on Wednesdays and Fridays every week (with some days excepted).

Historically in Russia, peasants who grew their own crops and vegetables were better able to endure times of fasting than those in urban areas. "Black" or rye bread and pies made from the mixture of rye and wheat flour were a part of the everyday meal. A variety of cereals allowed the peasantry to prepare different kinds of nutritious porridges. Potatoes, cabbage, and carrots were cultivated in many provinces and were the main ingredients of traditional soup or *shchtee*.

In every family the customs of fasting were passed on from generation to generation, but there was notable differentiation even within one family. Elderly people were the authority in the practice of fasting and abstained more strictly. Children were trained to fast from the age of two or three years. The larger part of the population in Russia kept fasts.

During the Soviet period (1917–1991) the tradition of fasting was compromised in Russia by Communist Party doctrine that held organized religion a suspected enemy of the state. Adherents of the Orthodox faith nevertheless carried on these practices despite official intolerance.

See also **Christmas**; **Easter**; **Fasting and Abstinence; Feasts, Festivals, and Fasts**; **Greece and Crete**; **Religion and Food; Russia**.

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Tatiana Voronina

WESTERN CHRISTIANITY

Christianity traces its origins to the life and preaching of Jesus, a Jew living in Palestine in the first century of the Common Era (C.E.). He taught that all humans are children of God and need to repent of their sins. According to Christian sacred writings, recorded in the New Testament, he was put to death by the Roman colonial authorities but was brought back to life three days later. Christians believe that he was the son of God, and that his death and resurrection save them from sin and death.

Christianity began as a movement within Judaism but quickly spread outside the Jewish community; by the late fourth century it was the official religion of the Roman Empire. During the Middle Ages, there was theological and political conflict between the followers of the patriarch in Constantinople and the followers of the pope in Rome, leading to a split between the Western Church and the Eastern Church (also known as the Eastern Orthodox Church) in 1054. In the sixteenth century, the Western Church divided still further between Roman Catholics and a variety of Protestant groups. Although

Unlike Eastern Christianity, the Latin Church developed numerous powerful orders, each with its own dietary rules. The order known as the Teutonic Knights originated during the Crusades and became the most powerful military force in Christianity. The headquarters of the order, shown here at Malbork (former Marienburg), Poland, is one of the largest brick castles in Europe. The account books outlining the order's daily food expenses still exist and offer valuable insights into the complexities of the medieval kitchen. © PAUL ALMASY/CORBIS.

separated into hundreds of large and small groups, Christianity is now a global religion. As it has spread, it has encountered other cultures and belief systems. In the process, Western Christianity has assimilated its early practices, which were shaped by first-century Judaism, with those of its host cultures. This assimilation has influenced its food practices.

Ritual Food

One food ritual stands at the center of the religion. Christians believe that on the night before his death, Jesus gathered with a small group of followers for a meal, which, according to the Gospels of Matthew, Mark, and Luke, was a Jewish Passover dinner, but according to the Gospel of John was a *berakah* (blessing) before the Passover. Presiding over the meal, Jesus, in prayerful thanksgiving, proclaimed that the bread and wine were his body and blood; he enjoined his followers to repeat this repast in his memory.

Christians today still reenact that meal, under a variety of names. Catholics call this ritual of reenactment the Mass or Eucharist (from a Greek word meaning "thanksgiving"). Protestants call it the Eucharist, the Lord's Supper, the Last Supper, Holy Communion, or simply Communion. In early Christianity it was a real meal with a full menu, sometimes known as an *agape* (love feast). Now the ritual is celebrated as part of the worship service with only vestiges of the meal; worshipers generally eat only a small piece of bread and drink a small amount of wine or grape juice. Instead of emphasizing food, the ritual focuses on words; participants retell the story of Jesus' life and death and thank God for his salvation.

While sharing this general framework for the Eucharist, different groups of Christians carry out the ritual in different ways. In fact, many of the divisions between Christians are rooted in the different beliefs and practices regarding Communion. Throughout Christian history, believers have engaged in theological disputes as well as actual warfare over the proper celebration of the ritual.

Roman Catholics believe that the Eucharist is a sacrament, a ritual that connects them with God. For them, celebrating the Mass is a repetition of Jesus' self-sacrifice in his death; they believe that receiving Communion will help them reach salvation. In the course of the ritual, Catholics believe, the bread and wine become the body and blood of Jesus. The food attains a distinct and profound holiness. The Catholic Eucharist is very formal; the same words and gestures are used wherever it is celebrated. Specially trained and ordained priests must lead the ritual, using only wine from grapes and wheat bread. Catholic churches celebrate the Mass at every Sunday service; many congregations celebrate it daily. Episcopalians and Lutherans also believe that the Eucharist is a sacrament. Certain Episcopal churches—known as Anglo-Catholic or "High Church" parishes—are very close to the Roman Catholic Church in their beliefs and practices.

In contrast, some Protestant groups—Baptists, for instance—believe that Communion is simply a remembrance of Jesus, without any direct impact on an individual's salvation. The bread and wine remain bread and wine, serving as reminders of Jesus' death but not actually becoming his body and blood. The meal symbolizes the partakers' union with God and with each other. For these Protestants, Communion lacks the formality of the Catholic Mass, and their Communion practices can differ significantly from one place to another. In some cases, lay Protestants can lead the ritual, and it is not uncommon for some Protestant churches to administer grape juice instead of wine. Many of these groups celebrate Communion only three or four times a year. Other Protestant groups occupy a middle ground between the Catholics and the nonsacramental Protestants. They believe that Jesus is somehow present in the meal, but not that the bread and wine have become his body and blood. In their churches, Communion is a slightly more formal service, celebrated perhaps once a month; it is increasingly common in the Lutheran church for communion to be celebrated every Sunday.

Like observers of other religions, Christians also practice domestic food rituals. Many Christians, for instance, pray before meals, giving thanks to God for the food. Some churches also bless farmers' crops and animals. Particularly in the United States, many churches organize informal fellowship meals for their members, designed to strengthen the community within the church.

Taboos, Fasts, and Feasts

Since Christianity began as a movement within Judaism, many of its practices—including those involving food—are variations or adaptations of Jewish ones. Judaism has clear guidelines on proper eating behavior, including a taboo on certain "unclean" foods (pork and shellfish, for example) and rules for the preparation of other foods. In the first century C.E., Christians argued over whether they had to abide by Jewish law. There is little in Christian scripture that requires adherence to such food taboos; several texts explicitly free believers from previous laws. Nevertheless, some Christians retained the Jewish dietary laws, while others held that Jesus' teachings did away with these restrictions. Since the latter group became dominant, Western Christianity has no formal food taboos.

Some small groups do shun certain foodstuffs, based on their interpretation of Jesus' teachings. The Manicheans (members of an early Christian movement condemned as heretics by the Catholic Church), for instance, required vegetarianism. The Seventh-Day Adventists also discourage the eating of meat, while members of the Church of Jesus Christ of the Latter Day Saints (Mormons) avoid caffeine. These and several other groups also discourage the drinking of alcohol. Other than these semiofficial taboos, however, Christianity has little impact on believers' daily diets.

Christian fasting practices have changed over time. Like their Jewish brethren, early Christians fasted twice a week—but on different days. As Christianity grew, fasting became less common among most Christians; the practice was more frequent among religious elites, like monks and nuns. During the Middle Ages, particularly ascetic Christians would abstain from any food—except the Communion bread and wine—for months at a time. Most Christians, however, observed the penitential season of Lent—the forty days (not including the Sundays) before Easter, the spring festival commemorating Jesus' resurrection. Rather than fasting, most Christians would abstain from meat or some other luxury. The medieval Church also introduced a weekly fast, requiring all members to abstain from meat on Fridays, observing the day of the week on which Jesus was killed. After the sixteenth-century Reformation, newly formed Protestant groups abandoned many of the fasts, although some continued to fast during special times of prayer and penitence. Fasting is rare in modern Protestantism, although some Protestants fast as a spiritual-physical discipline. In recent decades, the Roman Catholic Church has loosened its fasting directives.

THE BOOK OF COMMON PRAYER (1979)

We celebrate the memorial of our redemption, O Father, in this sacrifice of praise and thanksgiving. Recalling his death, resurrection, and ascension, we offer you these gifts. Sanctify them by your Holy Spirit to be for your people the Body and Blood of your Son, the holy food and drink of new and unending life in him. Sanctify us also that we may faithfully receive this holy Sacrament, and serve you in unity, constancy, and peace; and at the last day bring us with all your saints into the joy of your eternal kingdom.

While early Christians adopted some of their practices from Judaism, they replaced Jewish feasts with their own set of holidays, tied to historical events in the life of Jesus. The most important ones are Christmas (December 25), marking his birth, and Easter Sunday (a movable feast that can fall from March 22 to April 25), observing his resurrection. These have become major celebrations both in the Church and in Christian societies; in many cultures, the holidays have become secularized as days for shopping and gift giving. Whether Christian or secular, food remains an important part of the holidays, often celebrated by large family meals. There are no common menus for these feasts, however; the meals are determined by the local culture rather than by the religion. In some parts of the United States, for instance, turkey is traditional fare for Christmas and ham for Easter, but other regions and other countries have their own menus.

CORINTHIANS 11:23–25

For I received from the Lord what I also handed on to you, that the Lord Jesus on the night when he was betrayed took a loaf of bread, and when he had given thanks, he broke it and said, "This is my body that is for you. Do this in remembrance of me." In the same way he took the cup also, after supper, saying, "This cup is the new covenant in my blood. Do this, as often as you drink it, in remembrance of me."

(Revised Standard Version)

Charitable Food

Like many other religions, Christianity puts a great deal of emphasis on the importance of charity. It inherited from Judaism the requirement to help feed the hungry. In the first few centuries, Christians would invite hungry strangers to join their shared meals. Certain church leaders, called deacons, were responsible for making sure that widows, orphans, and other poor people were fed. Later, monks and nuns established hospices where the hungry and travelers could stay and eat. In the middle of the twentieth century, Western Christians established agencies to help feed the hungry. They opened soup kitchens and food pantries to feed the urban poor. They also raised money to send to countries where natural disasters and poverty threatened starvation. The acquisition and distribution of food and food-related supplies for the needy continues to be among the most visible practices of modern Western Christian charity.

See also **Christianity,** *subentry on* **Eastern Orthodox Christianity**; **Fasting and Abstinence: Christianity**; **Feasts, Festivals, and Fasts**; **Fish**; **Judaism**; **Taboos**.

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Daniel Sack

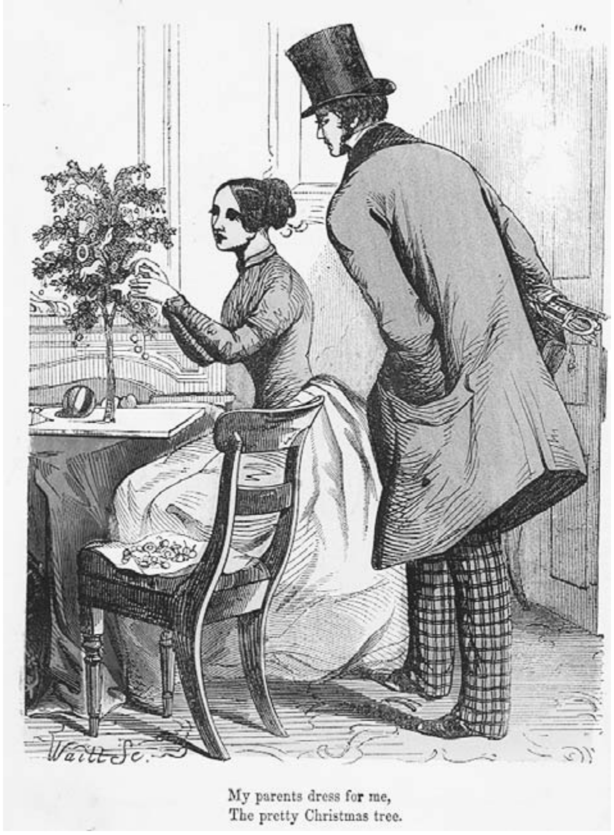
CHRISTMAS.

The word "Christmas" means the mass of Christ and is the name for the Christian observance of the nativity of Jesus on 25 December. In liturgical importance, Christmas was originally in fourth place, following Easter, Pentecost, and Epiphany, yet in terms of popular observance it has become the most important feast day of the year and the basis for a vast commercial retail industry derived from it, even in countries like Japan and Korea, where Christianity is not the predominant religion.

The early Christians were not initially concerned with the Nativity of Christ, and even in the fourth century C.E. it was not a universally fixed observance among Christians. The choice of 25 December is considered arbitrary and not based on evidence provided in the New Testament, the Christian text dealing with the life of Christ. Many theories have been put forward for the choice of the 25 December as Christ's Nativity, but that it fell during Roman Saturnalia is now largely dismissed. It appears to have been fixed in relation to Epiphany (6 January), counting backward twelve days (now the twelve days of Christmas) or thirteen nights by the lunar calendar. It also falls three days after the winter solstice, a date when a number of pagan gods underwent resurrection after the shortest day of the year. This includes Sol Invictus of the Roman state religion during pagan times, a cult associated with the deification of the emperor. Whatever the explanation, it is evident that the early Christian Fathers, in their struggle for political and psychological supremacy, turned the *interpretatio romana* (the process of romanizing foreign gods) on its ear by expropriating a number of pagan symbols and observances and providing them with new Christian meanings. For this reason, Christmas and especially the foods associated with it represent a fusion of diverse pagan strands varying widely in emphasis from one country to the next. The celebration of Yule in Scandinavia has become one of the most distinctive aspects of the holiday as observed in northern Europe. The tradition of St. Nicholas of Myra in the Netherlands and the Franciscan cult of the Bambino Gesu in Italy are examples of the many forms these fusions have taken. All are expressed symbolically in food.

The mass and the various mystery plays dealing with the Nativity and the ales, or community-wide feasts, were the core of the old observance. The mass was often preceded by abstinence, a period called the vigil, that was then broken at midnight with a large meal in which the entire village or community participated. Such midnight feasting was practiced in many predominantly Roman Catholic countries, such as Poland and Spain, into the twenty-first century.

Tin cookie-cutter dating from about 1900 makes twelve cookies at once. The cookies are small and therefore could be used as Christmas tree decorations. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.


Waitt Sc.
My parents dress for me,
The pretty Christmas tree.

This hand-tinted picture depicts on old type of Christmas tree set up on a table. The woman is decorating the tree with jumbles (ring cookies), gingerbread animals, marzipan cherries, and small baskets of candy. Her husband is holding a large package of toys under his arm. WOOD ENGRAVING FROM THE PICTORIAL SCRAP BOOK (PHILADELPHIA, 1860), ROUGHWOOD COLLECTION.

Outside of the church but parallel to its liturgies existed the folk customs carried over from pagan beliefs. Thus the ales exhibited a prevalence of mumming (playful imitations of old gods and their stories), antlered beings, pigs (associated with butchering, of course), and other oral traditions given the shape of festive breads and cakes or reflected in the choices of certain foods, such as roast goose, or dishes containing blood, such as blood soups, blood sausages, and black puddings, from which English plum pudding and mincemeats evolved. In the Orthodox tradition of the Eastern Church, which broke with Latin practice, Epiphany remained the official Nativity of Christ, and dishes containing blood are fully absent from the diet, festive or otherwise.

The late Middle Ages retained community feasting, although it became more centered on the manor house, a practice later continued on the plantations of the American South, while in towns it moved into the private homes of wealthy merchants and the nobility. The Protestant Reformation, with its emphasis on individual salvation, broke down the old community-wide feasts in favor of the family and home. This shift brought a widespread erasure of older village and folk customs (in England and northern Germany, for example) and the rise of the commercial Christmas. Gingerbreads, marzipans, and various festive foods hitherto made and sold by monks or by nunneries, moved into the general marketplace and become available to anyone with the financial means to purchase them. Dutch paintings from the seventeenth century often depict domestic feasts that present holiday foods in great abundance. In Protestant areas, the alms formerly associated with Christmas doles for the poor disappeared and did not return until the rise of urban missionaries in the nineteenth century.

The American Christmas, the primary theme of this article, inherited its major characteristics from England during the colonial period. Some religious groups, such as the Puritans of New England and the Quakers of Pennsylvania, abjured the observation of Christmas altogether on the theological basis that the day was fixed artificially by the early Church and therefore was not a real holiday. The Puritans originally created Thanksgiving as a substitute for Christmas. Thanksgiving subsequently became attached to the Christmas holiday, more or less marking the commercial beginning of the Christmas season.

Other American regionalisms gradually emerged into mainstream custom. The Christmas tree, with its huge array of food ornaments, first appeared among the Pennsylvania Dutch in the form of table-top branches of cherry trees (which were forced to bloom) or a large limb from an evergreen shrub, such as mountain laurel or cedar. These table-top trees were set into large flower pots and surrounded with plates of festive food. The shift to small table-top trees is well-documented by the 1790s, and their appearance in store windows is noted in a number of newspapers during the 1820s. Later, in the 1840s, the Christmas tree custom was further reinforced by German immigrants, and it quickly became a symbol of status in Victorian households. While its origins are undoubtedly pagan, the tree was adopted by many churches during the Sunday School movement of the 1840s and 1850s as a means of teaching Christian values to children.

Likewise, during the revival of medieval themes led by the Oxford movement in England, St. Nicholas (called Santa Claus in America), the old gift bringer of the New York Dutch, underwent a complete rejuvenation, especially after his popularization in newspapers and magazines by the immigrant artist Thomas Nast. Thus by the beginning of the twentieth century the American Christmas had acquired a new and much less liturgical focal point, that is, Santa Claus and the exchange of gifts, including a tree under which the family displayed symbols of its economic well-being.

Throughout these evolutionary changes, the basic foods of the American Christmas remained the same, especially the format of the Christmas dinner. The dinner is based on eighteenth-century English models, and at its centerpiece is a roast, normally turkey. This centerpiece is surrounded by side dishes reflecting regional tastes and often ethnic backgrounds. Italian families may add a dish of pasta, although in households adhering to a more traditional Italian fare, the "five" fishes are served. African-American families may feature sweet potatoes and cowpeas, and Mexican-American families may incorporate a salsa and the custom of breaking a piñata, which culminates the festivities on Christmas Eve. The traditional explanation for the piñata custom is that the image symbolizes the devil, and, by breaking it, he is destroyed. The act is thus rewarded by a shower of good things to eat. However, the custom of creating a shower of plenty has numerous parallels with other pre-Christian fertility rites, most of which are associated in some manner with Christmas. The earliest recorded Christmas trees (in seventeenth-century German guildhalls) were left ornamented with food until Second Christmas (December 26) or New Year's Day, when they were shaken violently to shower the food on a mob of happy children. In other parts of Germany and central Europe, apple trees were shaken on Christmas Eve to ensure that the trees would bear a good crop of fruit.

The Christmas Day meal continues to evolve as newer immigrants add their own symbolism to the old theme or as older groups create new variations, as in the case of Kwanzaa of African Americans. Ethnic nuances aside, the basic meal focuses on roast turkey, repeats much the same meal format as Thanksgiving, and finishes with a variety of traditional desserts, including pumpkin pie, mincemeat pie, and fruit cake. It has been said that the unchanging quality of the Christmas dinner has endeared it to Americans, who find a sense of continuity in its year-to-year repetition.

See also **Christianity; Epiphany; Feasts, Festivals and Fasts; Kwanzaa; Thanksgiving.**

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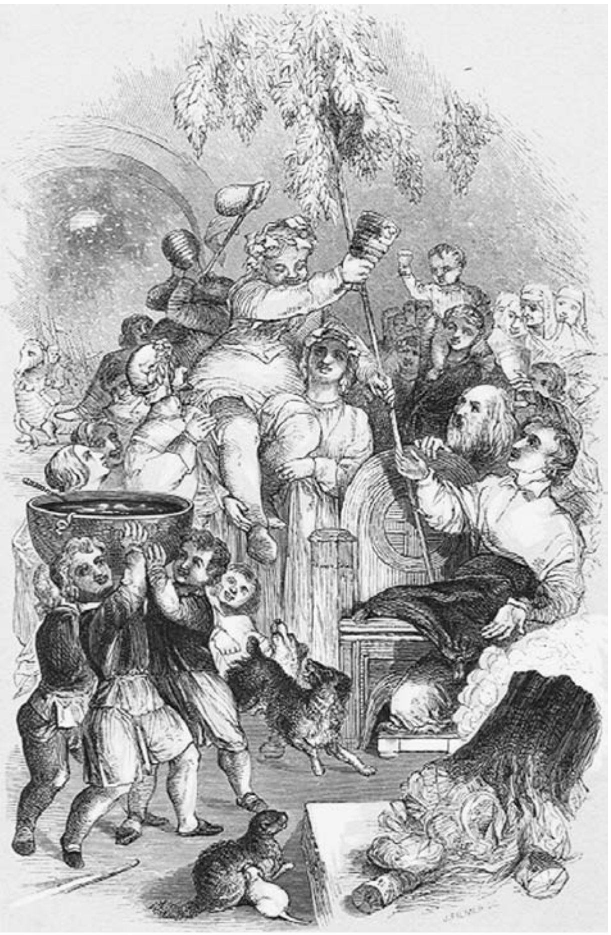
William Woys Weaver

CHRISTMAS DRINKS. Christmas is celebrated at the time of the winter solstice, and in the passage from one year to the next. The hopes and fears triggered by these two dates in the world's calendar have shaped the customs that cluster around Christmas itself, while the joy of that festival has cast a glow over the entire season. In the course of centuries, many ingenious ways have been devised to defy the darkness, feast on the bounty of the year's harvest, and perform good-luck rituals, half in jest and half in earnest, to ensure health, happiness, and abundance in the next twelve months. Christmas calls for a tightening of social bonds, and an enlargement of social sympathies. Drink, with its power to raise spirits and relax constraints, plays an important part in the characteristic ceremonies of the holiday.

A touch of extravagance, indeed excess, matches the spirit of the season and marks many traditional Christmas drinks. France and Spain may be content with a fine champagne or the best wine available, but other countries favor more elaborate concoctions. Wassail and punch in Britain, heated mulled wine in cold northern countries, and their cooling equivalents in the warmer south have one characteristic in common. They are mixed



"Bringing in Christmas," depicts a romanticized Victorian recreation of medieval English Christmas festivities. Prominently featured is a huge bowl of wassail, itself a symbol of Christmas merriment. Wood engraving from Christmas Poems and Pictures (New York, 1866). ROUGHWOOD COLLECTION.

drinks, in which some combination of sugar, spice, and fruit juice has been added to the principal ingredient, whether that be ale, cider, or wine, while in certain cases the whole has been given an extra kick with a shot of brandy or bourbon, rum or gin. Eggnog, the old American favorite, starts life as a blend of eggs and cream, but this blameless nursery food is transformed into nourishment for grownups by a potent blend of sugar, spice, and spirit.

Whatever its components, the Christmas drink has ceremonial and symbolic functions. It is a pledge of goodwill to present company and absent friends. Indeed, the name of the oldest toast in Britain, "Wassail," is derived from the Middle English words for "be well." Sometimes the ritual takes the form of toast and response; sometimes the drink is shared as a loving cup passed from one person to the next so that each can share its contents in a companionable way. In local traditions throughout the Christian world, wine has been blessed at Christmas by the church, and cider has been poured on apple trees to encourage next year's harvest. The permitted breakdown of normal social barriers in this special season is played out in small, symbolic dramas. The master of a household will prepare eggnog with his own hands and offer it to his servants. Strangers may carry a wassail bowl to any door and assume the right of entry and reward.

There is nothing immutable about any Christmas tradition. At the core is always joyful celebration, but the ways in which that sentiment is expressed are infinitely variable, depending from age to age and place to place on ingredients locally at hand, and on the tastes and fashions of the time. Anything may be acceptable, as long as the message stays the same: "Merry Christmas!"

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Bridget Ann Henisch

CHUTNEY. Chutney is a term applied to a variety of spicy relishes and condiments in Indian cookery. The term itself is an anglicized form of the Hindi word *chatni*. In India, there is an implied understanding that these preparations are also freshly made from fresh ingredients. For example, chutneys using nutmeg are prepared only when nutmeg is in season, although chutneys can be composed of a wide variety of ingredients and thus represent many types of flavors and textures. In general, chutneys fall into two distinct categories: freshly-made preparations for immediate consumption, and cooked preparations intended to keep as long as a year, which can be grouped further according to their saltiness, sweetness, sourness, or spiciness. Many recipes combine several elements of these basic flavors, and textures range from coarsely chopped preserves to smooth sauces. Conceptually, they blur the neat distinction made in Western cooking between preserves and pickles.

Some of the most common chutneys in India are those made with mangoes, coconut, sesame, peanuts, or the ground leaves of herbs, especially mint or coriander. Chutneys are served as condiments (side dishes) at Indian meals, and historically were only eaten on special occasions such as weddings or by the rich. Since Indian independence from Great Britain in 1947, the technology of canning in glass jars has now made commercial chutneys widely available throughout the country at affordable prices. Traditional cooked chutneys made for home consumption were generally infused or slowly cooked in the hot Indian sun over a period of several days until they attained the right flavor and consistency. This method is still employed in modern India in homes which do not own stoves. In fact, many cookbooks written for Indians make no mention of stoves. For example, in Aroona Reejhsinghani's *Indian Pickles and Chutneys* (1977), a Keralan region chutney made from jackfruit (a relative of the breadfruit) specifies solar cooking for one week.

Indian cookbooks devoted to chutneys generally arrange the recipes according to region, since chutney styles are strikingly different in various parts of the country and among different religious groups. The various flavors and textures are of special importance to Hindus. A few of these are worth mentioning: mango, plum, apple, and apricot chutneys, and various murabbas (fruit in thick syrup) from West Bengal; garlic, sweet and sour mango, and peanut chutney from Uttar Pradesh; dry fish, shrimp, and onion chutney from Kerala; pork sepotel and shrimp ballachong from Goa; kanji, tomato and jeera chutney from Punjab; tamarind chutney from Haryana; hot mango chutney, guramba, and panchamrit from Maharashtra; chundo and hot lime chutneys from Gujarat; guava and eggplant chutneys from Himachal Pradesh; Nagaland fish chutney; and the various Jain, Parsee, and Sindhi chutneys defined by religious dietary rules. In fact, the murabbas (also written morabbas) evolved out of the Unani system of medicine and owe their origin to Indian contact with the Arab world.

LUCKNOW CHUTNEY

Made mostly from salted limes and garlic, Lucknow chutney (or Lucknow sauce) was a popular condiment in nineteenth-century England and America. It was commonly served at hotels and appears on many menus from the period. The chutney was sold in fancy ceramic jars like the one shown here dating from about 1876. COLLECTION OF THOMAS NEFF.

The first Indian chutneys to reach the West appeared as luxury imports in England and France during the late 1600s. They were mostly mango chutneys put up in sticky syrups and shipped in ceramic pots. These luxury goods soon served as models for Western copies which appeared in cookbooks as "mangoed" fruit or vegetables. The most popular substitutes were unripe peaches or melons. However, by the nineteenth century, many chutneys were manufactured in India specifically for export to Europe, among them Lucknow Chutney (a purée of salted limes), and various brand-name chutneys like Major Grey's or Bengal Club. All of these export products were created from recipes appealing to British rather than to Indian tastes, meaning that they were generally sweet and lacked the intense flavors, saltiness, or peppery heat preferred by Indians.

See also **Condiments**; **Herbs and Spices**; **India**.

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William Woys Weaver

CIVILIZATION AND FOOD. If by "civilization" we mean the culture of cities, assumed to have emerged with the Bronze Age, in about 3000 B.C.E., then food was the decisive factor in terms of both production and consumption. Before this time, in the farming revolution of the New Stone (Neolithic) Age, crops and animals that have continued until today to provide much of human food had been domesticated. This represented a shift from hunting and gathering, from the collection of wild plants and animals, to food raised under the control of humans, leading to a great increase in the population. The bulk of cultivated foods (cereals) came from the domestication of local grasses, hitherto gathered in their wild state; root crops and vegetables proved more of a problem to grow, and fruit cultivation appeared only later on.

The Bronze Age saw another formidable move forward. The strength of animals was harnessed to wheeled transport and to the plow. Complex irrigation systems were developed. A further great increase in food production thus became possible. The animal-drawn plow enabled an individual to cultivate considerably larger areas of land; wheeled transport meant that the surplus could be shifted more easily; and irrigation in the sun-drenched lands of the Near East, India, and China again brought about increased yields, especially of rice but also of the other main Neolithic cultigens, wheat and barley. A parallel change took place in Mexico, centering on maize (corn).

These various changes led to increased production and therefore to population expansion, but they also led to socioeconomic differentiation. With hoe (manual) agriculture and a plentiful supply of land, it had hardly been profitable or indeed possible to employ others to work, except under conditions of slavery.

Landholding before the Bronze Age had been relatively egalitarian, as had food production. Most households had a roughly similar supply of food, as indeed had been the case with earlier hunter-gatherer regimes, in which the sharing of food was institutionalized to a high degree. With the plow, that equality disappeared rapidly.

One man could cultivate a much larger area than another; the acquisition of additional land became a way of maintaining a higher standard of living, not only paying agriculturalists to perform work but also using the surplus to exchange with local specialists, or to obtain luxury goods from traders. Those luxuries included culinary delicacies imported from elsewhere, particularly those that could withstand travel, such as cheese from the Massif Central of France brought to Rome, or sugared foods carried from India to China, or wine and olive oil shipped throughout the Mediterranean.

What has been called the urban revolution of the Bronze Age, giving rise to civilization in the form of cities, enabled societies to use their food surpluses to support full-time specialists; this meant the development of activities that included trading, metalworking, and writing. Trade and transport opened up distant and different food supplies and resources; metalworking and the use of ovens made possible new modes of food preparation, such as the baking of bread; and writing led to the elaboration and transmission of more complex recipes, and eventually to the emergence of a differentiated—even a high—cuisine, the latter occurring in China, in India, in the Arab and Muslim world, and later, with the Renaissance, in Italy and France. But hierarchical differences in diet aside, greater agricultural productivity meant that a society could supply a larger number of people, a proportion of whom could be engaged in activities not connected with the production of essential foodstuffs. Among other things, town dwellers required the large-scale transport of food, to markets as well as restaurants and other eating places outside the house. It was China with its vast cities that first experienced the rise of a restaurant culture, as well as the emergence of prepared foods, such as tofu (bean curd), sold in the marketplace.

Food and Class

Initially such developments affected only the rich and high-status groups. For this change in food production meant an increase not only in population but also in differentiation between owners of large estates, peasants cultivating their own fields, and the newly emergent stratum of landless laborers. A similar degree of socioeconomic stratification emerged in urban areas. These "classes" were now marked not only by differences in amounts consumed, as had long existed in the under hoe cultures, but also by qualitative differences in styles of life, with largely in-marrying subcultures, conserving their particular practices. The rich had access to dishes and drinks unavailable to the poor, either because of their lack of economic power or because of sumptuary legislation (or indeed of internalized preference or "taste"). Such differences were elaborated on and conserved in cookbooks originally compiled for the households of nobles and rich merchants and taken up more widely only with the coming of the printing press and the flowering of the urban middle classes in the sixteenth and seventeenth centuries.

This process of democratization was the result of the industrialization of prepared foods that could be said to have effectively begun with the invention of bottling by Nicolas Appert in France (1806) and its subsequent expansion into canning, especially in America during and after the Civil War, which altered the whole economy of food, interposing the grocer and later the supermarket between the producer and the consumer. Not only the industrialization of food preparation was involved but advances in food production itself, with changes in farm practice. For example, the rotation of crops and the use of manure had been adopted early on in the medieval period. The nineteenth century saw not only mechanization but also the coming of artificial fertilizers and chemical sprays and the more rapid transformation of crops by seed selection and finally by manipulation of the genes of crops, and above all the shift from the use of animal energy (which began with the plow) to that derived from mineral (fossil fuel) sources. Water of course had long been significant for food production, especially in arid regions. Its early control gave rise to extensive irrigation schemes with their heightened productivity (and problems of distribution, dangers of salinization and soil exhaustion), and later on it could be harnessed to provide the power for mills to grind grain and, much more recently, for other manufacturing processes, including the generation of electricity as a new source of power. But the basic activities of cultivation, such as plowing, were not affected by the use of waterpower nor yet by that of coal, which transformed other forms of production, leading up to the First Industrial Revolution. Farming was radically changed only with the advent of the use of gasoline in the combustion engine, during the Second Industrial Revolution, and the introduction of tractors and then of combine harvesters, inventions that affected the whole use of manpower on the land, freeing labor (and sometimes creating unemployment) as well as transforming villages from productive communities to ones dominated numerically by commuters, pensioners, and holiday makers. If by "democratization" we refer not only to political arrangements but also to the diffusion of products to the mass of the people, the transformation of small luxury into larger consumer cultures, then these changes in the production of food were as important as the changes in manufacturing and employment with which they were associated.

The Modern World

Despite enormous recent increases in world population, levels of food consumption per capita have risen rather than fallen in most regions. Owing to the Green Revolution and the adoption of "improved" plant varieties, with improved water control and fertilizing, famine has become less frequent in India and China. That is not true, however, of Africa, where total food production has decreased in relation to population growth and to consumption, mainly because the production of food is still based on the hoe; the plow (together with animal traction and elaborate water control) crossed the Sahara only recently, and its use remains scattered. Regional food deficits are largely made up through trade and aid, allowing imports of food from the surpluses of the more productive regions of the world (especially North America). The overall increase in well-being has been substantial, at all levels of society, with better health for most inhabitants—albeit with obesity and other food-related ills for some. Such productivity increases have always depended on the deliberate modification of crops, but recently the capacity to increase production by chemical means (such as adding hormones to beef), and to manipulate genes directly, has given rise to fears about the effects on human health and on our relationship to the natural world. People have always been concerned about their intake of food, fearing poison, sorcery, adulteration, and other modes of interference that might compromise their physical or mental health. That is nothing new, but these fears have grown with our capacity to intervene—that is, with the growth of civilization.

See also **Agriculture, Origins of**; **Agriculture since the Industrial Revolution**; **American Indians**; **Anthropology and Food**; **Australian Aborigines**; **Horticulture**; **Hunting and Gathering**; **Inuit**; **Maize**; **Packaging and Canning**; **Paleonutrition, Methods of**; **Prehistoric Societies**.

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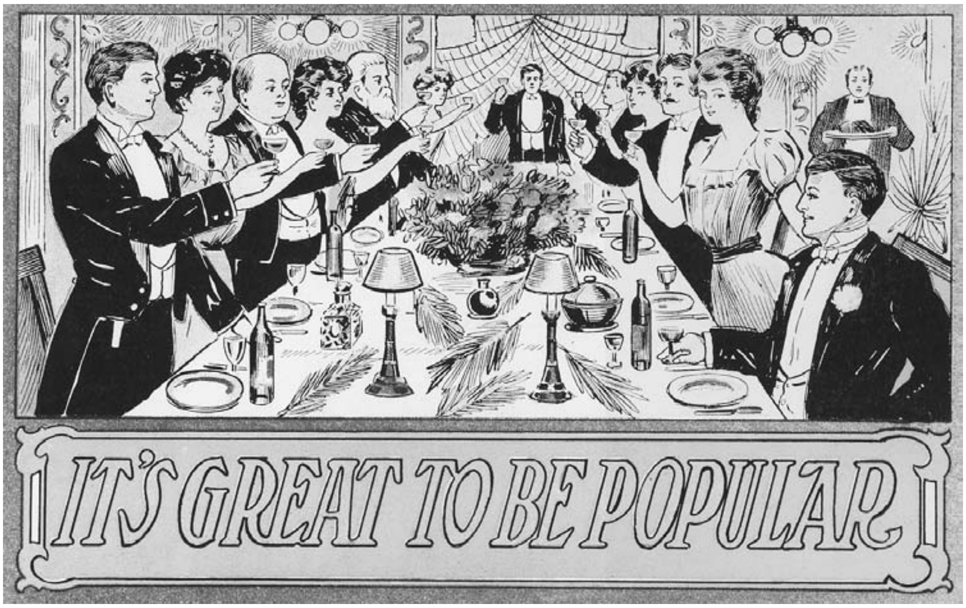
Jack Goody

CLASS, SOCIAL. Social class or social stratification is defined by unequal access to desirable resources (such as money, goods, and services) or personal gratification (such as prestige or respect). The sociologist Max Weber argued that social class was a function of differential wealth, political power, and status. The various dimensions of social class have different influences on food consumption and its consequences. Income and wealth provide access to food or constrain food purchases. Education provides knowledge, skills, and beliefs that shape food desires and place constraints on food choices by means of information acquisition and food preparation. Occupation not only represents prestige but also structures time and constrains the attention that can be given to food. Occupation-generated work hours and lifestyle choices affect what is eaten as well as where and with whom food is eaten.

Distinctions are made between classes. The lower class (often referred to as "working class" or blue-collar workers) is generally associated with people with low levels of education, unskilled or semiskilled occupations, and low income. Middle-class people (often seen as "white-collar" workers) generally have more education, usually having graduated from high school or college, hold technical or mid-level managerial positions, and earn average to above average incomes. Upper-class people tend to have high education, the highest salaries, and the most prestigious occupational positions.

The whole notion of taste, as refined food sensibilities, is class-based. Members of lower classes often strive to emulate the taste and taste practices of higher classes, who in turn attempt to change their notions of taste and eating behavior to maintain the distinction between themselves and those perceived as of lower status. Thus, what, where, and when food is eaten is shaped by social class in many societies. Historically, members of the lower class have found many of the foods of the wealthy to be strange if not disgusting. (Such stereotyping, however, applies equally to both groups: while the so-called lower classes might find raw oysters disgusting, the middle or upper classes might find roast goat equally unpalatable. These kinds of tastes—or distastes—evolve over time and cultures and are not fixed.) Members of higher classes have come to identify certain foods with impoverished status. For instance, after World War II, chicken became associated with low income and was eschewed by the wealthy because of this association. Currently whole-wheat or brown bread tends to be consumed more by people of middle- or upper-class background; by contrast, bread prepared with processed wheat (white bread), which is less expensive, is more often the choice of working-class consumers. The reason for this difference is a historical reversal of fortune. The white flour was once that of the elites, who would even color it with alum. The highly refined flour was reserved for those with great status, whereas the whole-grain flours were those of the poor. Beer is the alcoholic beverage of the working class—the exception being pricey imported beers, microbrews, and gourmet beers that are popular with "yuppies"—while wine, particularly wines with a lin-


IT'S GREAT TO BE POPULAR

An American postcard from circa 1900 taking a humorous aim at upper-class table manners. ROUGHWOOD COLLECTION.

eage, tend to be the choice of individuals of upper-middle and upper-class backgrounds.

Restaurants were once a place where only the upper class would dine, while today persons of all classes eat in restaurants. However, the choice of type of restaurant and the frequency of eating meals out varies by social class. Part of this difference is a function of income. Those with higher salaries or greater wealth can afford to eat out more frequently and to visit more expensive restaurants. Use of restaurants, however, is also a function of attitudes, which themselves vary by social class. Those in blue-collar positions are more likely than those in white-collar jobs to perceive eating out—in restaurants, that is, not fast-food establishments—as something that is done for pleasure. Those with higher incomes, university degrees, and white-collar positions seek more variety in restaurant fare. Interest in eating a variety of ethnic foods, an indication of cultural cosmopolitanism, is also more frequent among those with greater education, income, and occupational prestige.

The desire to imitate those of higher social class background is practiced by some individuals, and restaurants play a role in this phenomenon. Restaurants with expensive dishes with a cosmopolitan atmosphere are sometimes the choice of people who wish to exhibit the consumption of the upper class. At the same time, differences in consumption represent a routine form of social dominance exercised by upper-middle and upper-class members. Thus, efforts of the lower-middle class to imitate upper-class behavior are met by changing behavior among the upper class. New, more exclusive restaurants are often sought in attempts to maintain a class distinction in restaurant patronage.

Class background is also associated with the use of meals as a form of entertaining friends. As income and education rise, so does the likelihood of entertaining friends by feeding them a main meal. Those with white-collar positions are more likely to entertain friends by having them over for a main meal, though this generalization may apply more to urbanites; poor folk in the country often have big dinners, where everyone brings something potluck-style. Low-income families not only lack the money to provide such entertainment but may also inhabit housing that lacks the space to feed many people at one time. Among the very low-income, space may be so limited that the family itself cannot sit down to a meal together. Eating in the homes of kin is not a function of class, but eating with friends and coworkers is: professional and managerial classes are more likely to eat in the homes of friends than those in working-class occupations. When it comes to cooking, those with more education and income are more likely to be willing to experiment with new dishes or dishes of their own creation than are those with less income and education.

Social class background makes a difference in the food-related lifestyles practiced by many people. In addition, people's life chances are affected by their social class. The poor tend to devote high percentages of their household budgets, after paying rent, to food, yet generally have to settle for lower-quality food items and a more monotonous diet. Obesity is far more likely among persons of low income than persons in higher income groups. In more economically developed countries, the poor are more likely to experience food insecurity or food insufficiency, and in less economically developed countries, the poor are more likely to experience various nutrient deficiency diseases.

See also **Cost of Food; Fast Food; Food Pantries; Food Politics: United States; Food Stamps; Food Supply, Food Shortages; Hunger Strikes; Malnutrition; Obesity; Places of Consumption; Poverty; Restaurants; School Meals; Sociology; Soup Kitchens; WIC (Women, Infants, and Children's) Program.**

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Jeffery Sobal

CLIMATE AND FOOD. Throughout most of prehistory, humans acquired food by hunting, fishing, gathering, foraging, or scavenging. The animals and plants they consumed were native to the local climate and environment and provided highly variable diets. Arctic and subarctic populations fished, gathered shellfish, and hunted land and sea mammals; temperate forest populations gathered seasonal plants and hunted wildlife; prairie and savanna dwellers hunted and trapped large mammals; and tropical forest dwellers fished, gathered a variety of plant foods, and hunted small mammals. Climatic influences on the flora and fauna included in the local diet were rainfall, temperature, seasonality, and longer-term cooling and warming trends. The most extreme climate changes were the Pleistocene glacial advances and retreats in the northern hemisphere. Climatic variation in temperature and precipitation became central to food procurement when plants and animals were first domesticated about ten thousand years ago at the end of the Pleistocene epoch.

There are only a few small populations that subsist entirely on hunting and gathering of wild plants and animals, although many populations continue to supplement their diets with wild foods. An exception to this is the fish and shellfish that provide substantial amounts of food to people through commercial fishing. Nevertheless, most peoples around the globe consume domestic plants and animals that are grown or raised locally or are produced commercially.

Climate and World Biomes

Climate (general, longer-term) and weather (specific, short-term) tend to structure ecosystems around the world by regulating rates of plant photosynthesis and production and contributing to patterns of vegetation and animal life. The principal factors are temperature, which is largely a function of global latitude and elevation; precipitation, drainage, and stored fresh water resources; windflow, which can dry or chill; solar radiation; and seasonal patterns in all of these, particularly temperature and rainfall. Polar and subpolar ecosystems, which are unsuitable for agriculture, are characterized by cold winters, cool summers, and limited precipitation. Some livestock are kept in polar and mountain ecosystems: llama and alpaca in the Andes, yak in the Himalayas, reindeer in the Arctic. Temperate and subtropical zone ecosystems may have relatively high precipitation, marked seasonality in temperature, and agricultural growing seasons up to six months. Drier temperate continental ecosystems (prairies, steppes) are also highly seasonal in rainfall with cold winters. Relatively dry, temperate zones can be highly productive with the practice of irrigation. Mediterranean ecosystems (including California, Chile, and parts of the Near East) have cool, wet winters and hot, dry summers. Many of the major cereal crops of the world were domesticated in these seasonally dry, temperate, or Mediterranean ecosystems: maize or corn in Middle America, wheat and barley in the Near East, rice in Asia, and sorghum in Africa. Quinoa, a member of the goosefoot family, was domesticated in the cool, seasonally dry reaches of the Andes. Tropical ecosystems have warm temperatures throughout the year but often with seasonality of rainfall. Those ecosystems with limited and seasonal rainfall grade into tropical grazing lands or savanna, while increased rainfall yields forests from sparse woodlands up to densely wooded rainforests. Widespread rainforest agriculture today includes a form of shifting, swidden, or slash-and-burn cultivation. Within each of these broadly-defined ecosystems or biomes, there is considerable variation: variation by season and by year, with inherent risks to livestock and agricultural production. For example, dramatic heat waves or cold periods, droughts, floods, hailstorms, and hurricanes can destroy crops and domestic livestock, producing a loss in food security and even famine. These extreme events have a major impact when they occur in heavily populated areas.

World Biomes and Food Production

Plants and animals were first domesticated in the seasonally dry Mediterranean climate of the Fertile Crescent in the Near East. These farming and livestock practices then spread along the Eurasian east-west axis zone of similar latitude and climate. Most domestic seed plants (e.g., cereals, goosefoots) and pulses (e.g., beans, lentils, grams, peas) were temperate-zone domesticates, whereas some tubers and root crops were domesticated in the tropics (e.g., manioc, yams, taro). With the discovery of the New World by Europeans, many native American foods spread to parts of the Old World: the potato became a staple in temperate zones of Europe and the Himalayas; maize became a staple in the drier African tropics; manioc became a staple in the wetter African tropics. Other New World temperate-zone domesticates, such as chocolate, peanuts, and tomatoes, became favored foods around the globe.

Today, temperate and subtropical agroclimatic zones of the United States, Argentina, Europe, and eastern Asia (China and Japan) still have the highest productivity of domestic grains and livestock that feed a substantial portion of the world. This results from a favorable combination of sophisticated agrotechnology and climate. Figure 1 illustrates how climatic inputs interact with the flows of information and resources in a Western industrialized system of agriculture.

Temperate and subarctic marine biomes are highly productive sources of fish and shellfish, although these food resources are in decline because of effective commercial exploitation by Western nations.

Food Intake and Climate

Some patterns of food intake are indirectly or directly linked to climate. For example, tropical populations are often limited in protein intake. Solomon Katz (1987) noted that this occurs in traditional agricultural populations dependent on grains (maize, rice, sorghum, millet) or tubers (potato, manioc) that are high in calories, but relatively lower in protein. Among tropical forest dwellers, as in the Amazon and the Congo basins, protein must come from fish, insects, some game animals, and plant foods. A direct effect of climate is the high metabolic need for calories in arctic or subarctic zones and temperate zone winters because of increased energy needs for temperature regulation in the cold. Derek Roberts (1978) documented that arctic dwellers have an elevated basal metabolic rate (BMR), which may be adaptive in the cold. Infants who are kept under cool conditions have higher food calorie requirements for normal weight gain than infants kept under warmer conditions. In Western industrialized nations, reduced activity levels during the winter season lead to unhealthy increases in the accumulation of human body fat (and weight) or energy storage. On the other hand, the accumulation of body fat in Ama women who dive for edible seaweed throughout the year allows them to withstand the cold water off the shores of Korea and Japan.

Climate Change and Food Production

An alarming trend that is certain to influence human patterns of food intake is recent climate change. Some variation in weather and climate is normal. Yet within the past 250 years, however, increased atmospheric carbon dioxide (CO_2), resulting from fossil fuel combustion, deforestation, and agricultural activities, has led to a "greenhouse" effect and global warming. A major compilation of research by Houghton and other scientists from the Intergovernmental Panel on Climate Change (IPCC) in 2001 has demonstrated beyond any reasonable doubt that human activities have produced a 1.1°F (0.6°C) rise in average global temperature over the past 150 years (see Figure 2). And by the year 2100, this global temperature is expected to rise another 1.8 to 6.3°F (1.0 to 3.5°C), a change that is greater than any experienced on the globe within the past ten thousand years.

Global warming will have variable effects on local weather and climate that are dependent on latitude, elevation, and geographic location. For example, McCarthy and others (2001) have shown that sea level rise from melting glaciers during the twentieth century has been about 6 inches (15 cm), and a projected rise during the twenty-first century is an additional 18.9 inches (48 cm). This will contribute to a loss of coastal agricultural lands and an increased salinization of water and coastal lands. Influences on agricultural food production are likely to be pronounced. Higher temperatures will cause rises in rainfall and the likelihood of floods in some areas and declines in rainfall and consequent drought in other areas: extremes in weather events (floods, hurricanes, heat waves, droughts) will be more common. Both conditions will lead to crop losses and decreased plant productivity. There will be increased heat stress in livestock leading to lower milk and meat production. At the same time that coastal agricultural and grazing land will be lost to sea level rise and salinization, the human population will continue to increase, putting greater pressure on food resources.

It is estimated that the impacts of global warming will be greatest in those regions of the world such as Asia, Africa, Latin America, and the Pacific Islands, where the adaptive capacity is low and vulnerability is high because of the lack of economic resources. Africa is likely to be especially hard hit because such a large part of its land resources is arid or semi-arid savanna lands. Of the total desertification and degradation around the globe, nearly

30 percent is in Africa. Although the debate continues on whether overgrazing, overpopulation, or warming trends are the cause of desertification, nevertheless, global warming will certainly increase the expanse of dry lands on this continent and elsewhere.

Humans have a remarkable capacity to adapt to change, including climate change, through culture and technology. Global warming and its consequent negative effects on our capacity to produce food will be an unprecedented challenge to this adaptability.

See also **Agriculture, Origins of**; **Biodiversity**; **Food, Future of**; **Hunting and Gathering**; **Maize**; **Potato**; **Prehistoric Societies; Swidden**.

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Michael A. Little

COCKTAIL PARTY.

The cocktail party is a social gathering, held early in the evening, usually for a period of about two hours, typically from 5:00 to 7:00 P.M. or 6:00 to 8:00 P.M. It may take place in the home, in a foodservice setting such as the private room of a restaurant or hotel, or in a business such as an art gallery or bookstore. Cocktails, wine, and soft drinks are served, though contemporary cocktail parties may in fact offer wine and soft drinks exclusively and skip the cocktails. In any case, beverages are accompanied by finger foods, which are meant to delight the palate, stave off hunger until dinnertime, and complement the cocktails.

Depending on variables such as the host's budget and degree of formality desired, the cocktail party may be catered or prepared at home, drinks may be mixed and served by a bartender, or the host may act as bartender. Servers may be employed to pass around hors d'oeuvres or the host may simply pass them around or arrange them on a buffet.

Certain physical and social behaviors on the part of the guests characterize cocktail parties. Normally, guests are not seated, but remain standing. Drinks in hand, they mill about, socializing to the strains of music, typically an instrumental arrangement, solo piano, or vocal jazz, played at a volume that encourages conversation. Rather than allowing participants to engage in deep and lengthy discourse, the social aim of the cocktail party is for guests to participate in small talk. At purely social cocktail parties, friends catch up or become reacquainted; new friends are introduced. At business-related cocktail parties, new contacts are made, business cards exchanged, and connections renewed.

History of the Cocktail Party

The cocktail party is a modern invention, conceived in the 1920s. Before World War I, most home entertaining was quite formal: people hosted teas, dinners, and balls. After 1918 informal entertaining became much more accepted.

In 1920 when the Eighteenth Amendment put Prohibition into effect, public consumption of liquor was driven underground into the speakeasy, and brought for the first time into the home. Before that, Americans may have served wine at dinner, but the consumption of hard liquor was generally confined to the tavern; and women, for the most part, did not drink alcohol at all. Speakeasies, in an attempt to compete for business, created fanciful cocktails, heretofore unknown in the United States, and even welcomed women. Those Americans who made their own spirits at home ("bathtub gin") adapted these new cocktail recipes for home use. A boom in the manufacture and sales of bar accessories ensued, including cocktail glasses and shakers.

For the power players in the business world, the drinks are secondary to the networking and the sealing of deals. Even with lawyers present, everyone always smiles. © PAUL BURTON/CORBIS.

A simultaneous explosion in the importation of fancy canned foods, such as olives, anchovies, and smoked oysters, encouraged people to serve hors d'oeuvres incorporating these comestibles along with their cocktails. Friends came to call before dinner, as was the habit, and the cocktail party was born. When Prohibition was repealed in 1933, American zeal for the cocktail party only increased, encouraged by idealized depictions of cocktail parties in motion pictures.

With the post–World War II economic boom, cocktail parties became institutionalized as an appealing way to entertain friends at home. In addition, it became a form of business entertaining brought into the home. The man of the house (typically the sole wage-earner) would invite his employer and his wife, along with friends, coworkers, and other acquaintances; the woman of the house would act as hostess. Women wore "cocktail dresses," the knee-length sleeveless sheaths that are still in fashion.

The popularity of the cocktail party waned in the 1960s, with the rise of the counterculture. It began to see a renaissance in the mid-1980s, though at that time it was taken out of the home. Cocktail parties became popular forums for celebrating art gallery openings, book publications, product launches, and other commercial ventures. The 1990s saw a resurgence of cocktail parties given in the home, fueled partly by young adults who found the kitsch value of cocktail culture appealing.

Although the cocktail party is a purely American institution, it has been exported around the world, adopted by many other cultures. In France, for instance, the cocktail party is known as *le cocktail.*

Food and Drink

Hors d'oeuvres may be hot or cold, passed around, or placed on tables. Traditionally, cocktail party foods have tended toward the salty and fatty, encouraging the consumption of cocktails. At contemporary cocktail parties, traditional hors d'oeuvres from other cultures frequently appear—from Caribbean cod fritters to sushi. So do ingredients and techniques from other cultures used in new ways—for instance, tuna tartare canapés or mini-pizzas. Hors d'oeuvres tend to be more or less elaborate depending on whether the party is given at a business or a home, and whether they are prepared at home or catered.

Traditional cold hors d'oeuvres include boiled shrimp with cocktail sauce, smoked salmon, caviar, and olive canapés. Cold hors d'oeuvres incorporating vegetables, such as endive leaves filled with herbed goat cheese, have become popular.

Meatballs, *rumaki* (skewered chicken livers wrapped in bacon), shrimp toast, and hors d'oeuvres made with puff pastry are traditional hot cocktail party hors d'oeuvres, but today anything from Italian rice dumplings to mini "burgers" made of seared foie gras might be served. Skewered, grilled foods have become popular, including Thai satés.

The less powerful gather in the office over Chablis and potato chips to discuss résumés, rumors of downsizing, dysfunctional elevators, and the cost of MBAs. PHOTO BY RICHARD RADSTONE. © RNT PRODUCTIONS/CORBIS.

Classically, the beverages served were cocktails in the strict sense of the word, that is to say a spirit combined with bitters (or a bitter element such as vermouth), and perhaps sugar and/or water (sometimes in the form of ice). Examples of this would be martinis, Manhattans, Old-Fashioneds, Rob Roys, and champagne cocktails. Contemporary cocktail party beverages would be cocktails, especially cosmopolitans and martinis, liquor served straight-up or on the rocks, wine, champagne, and sparkling mineral water. Beer is generally avoided.

In the 1920s little single-subject recipe books began to appear, featuring recipes for cocktails and/or finger foods, many, but not all of them, published by liquor companies. These books grew in popularity with the cocktail party itself, culminating in a large number of titles published in the 1950s. Their publication died down until the mid-1980s, when a few titles appeared; by the mid-1990s they had reemerged as a significant subgenre of cookbooks.

See also **Cocktails; Fads in Food; Spirits; Symbol, Food as; Table Talk; Whiskey (Whisky).**

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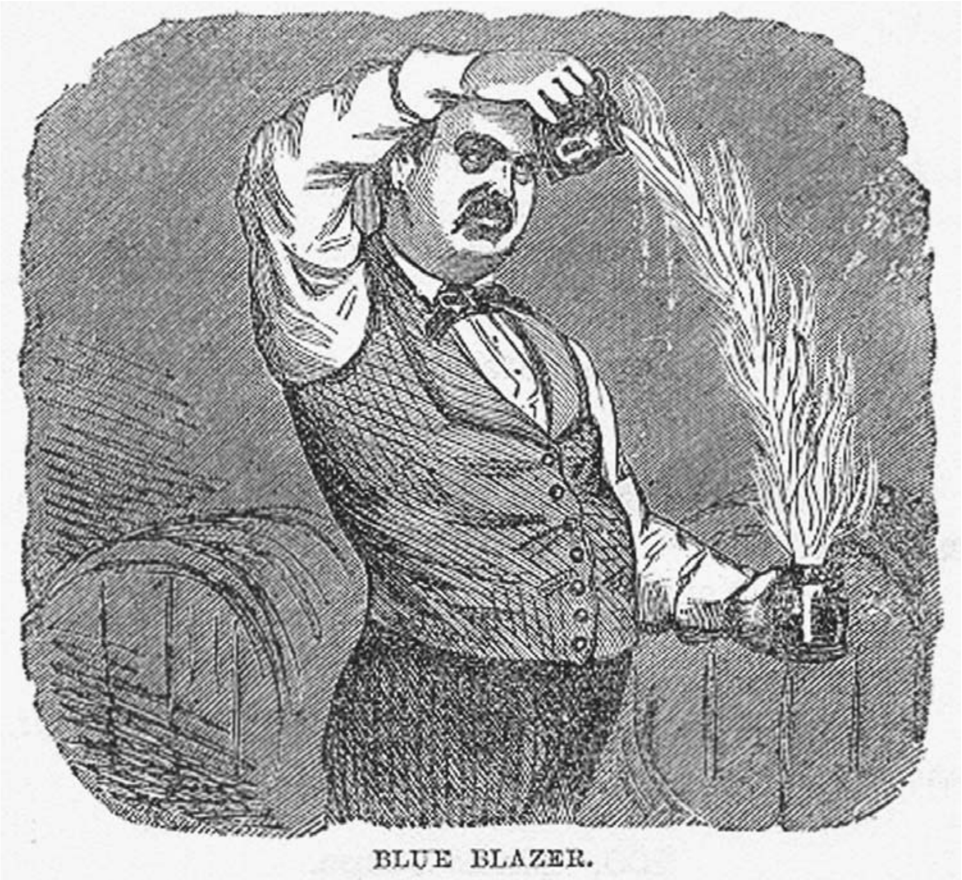
Leslie Brenner

COCKTAILS. Ever since America invented the cocktail, at the beginning of the nineteenth century, it has evolved: from sweet to dry; hot to icy; stirred to


BLUE BLAZER.

Bartender making a Blue Blazer, a drink which has since given its name to a man's jacket. Wood engraving from Jerry Thomas, *Bartender's Guide* (New York, 1862). Roughwood Collection.

shaken—a morning eye-opener to a conclusion to the day's activities.

Originally the name of a few specific drinks, the word "cocktail" soon became the generic name for almost any mixed drink. No one knows exactly why drinks came to be called cocktails, but there are many theories. In taverns, a cock is a tap; the dregs from the tap were called its tail, so some say the name signified the last dregs of a tavern tap. Others tell of a beautiful Revolutionary era barmaid who decorated drinks with cock's feathers and called them cocktails. The word might have originated with a medicinal chicken soup–like drink the English made from a cock boiled with ale, sack (wine from the Canary Islands), dates, and raisins. Thought to cure consumption, it was called cock-water or cock-ale. Another possibility is that since people generally started their day with a drink, the cocktail was named after the cock's wake-up call. Breakfast drinking was common, even among children, for centuries in Europe and continued in America from colonial times until the early mid-nineteenth century when the temperance movement gained strength. Beer soup was especially popular.

The most prosaic, and likely, theory is based on the fact that mixed, or nonthoroughbred, horses were called cocktails because their tails were clipped and stuck up like roosters' tails. Over time, the word "cocktail" came to stand for any mixture: mixed drinks, food mixtures such as fruit cocktails, and pharmaceutical combinations.

The first known definition of a cocktail appeared in an 1806 Hudson, New York, publication called the *Balance and Columbian Repository.* It defined a cocktail as "a stimulating liquor, composed of spirits of any kind, sugar, water, and bitters." By the late twentieth century, a typical dictionary definition changed the meaning of the word to "any of various short mixed drinks, consisting typically of gin, whiskey, rum, vodka or brandy, with different admixtures, as vermouth, fruit juices or flavorings, sometimes sweetened."

The definition changed because drinks changed. A late-nineteenth-century martini was made with equal parts gin and sweet vermouth, plus sugar syrup and orange bitters. A late-twentieth-century martini was made with vodka, not gin, and a few drops of dry, not sweet, vermouth, and no bitters and sugar syrup.

The First Mixed Drinks

Originally, spirits were taken for medicinal purposes. Called *aqua vitae*, or the water of life, they were thought to improve health and promote longevity. Monks and apothecaries made potions from spirits mixed with herbs, spices, and fruits. They prescribed them for the pox and the plague, and even rubbed them on stiff joints. By the seventeenth century, Europeans were drinking the concoctions for pleasure as well as for pain relief.

When settlers came to North America, they brought a taste for spirited drinks with them. They made punch with rum, tea, sugar, water, and lemon juice. They drank flips made with beer, rum, molasses or sugar, and eggs or cream, all mixed together and heated with a red-hot poker. Possets combined hot milk and spirits. Slings were made of gin or other spirits, water, sugar, and lemon and served either hot or cold.

In 1862 preeminent bartender Jerry Thomas published *How to Mix Drinks, or The Bon-Vivant's Companion*, America's first mixed drink primer. Thomas wrote, "The 'Cocktail' is a modern invention, and is generally used on fishing and other sporting parties, although some *patients* [author's italics] insist that it is good in the morning as a tonic." He called just nine of his two hundred–plus recipes "cocktails," but within a few years the term became ubiquitous.

The Party Begins

The Gilded Age was the golden era of the cocktail. At the turn of the twentieth century, affluent Americans frequented elegant hotels, bars, and restaurants; champagne cocktails were among their favorite drinks.

Talented bartenders knew how to make hundreds of cocktails—from the Adonis to the Zaza—and came up with new ones at will. They created and named drinks for regular patrons, news events, cities, and celebrities, and mixed them with great flair. Jerry Thomas was famous for his "Blue Blazer," a mixture of whiskey and boiling water, which he set ablaze and tossed back and forth between two silver-plated mugs. He said it looked like a "stream of liquid fire."

Cocktail shakers were invented in the late 1860s, and since ice was more available than it had been previously, the proper way to ice a drink became important. Drink manuals specified that some drinks be shaken, others mixed in a glass and stirred with a fork rather than a spoon.

In London, hotels and restaurants opened American bars and served American cocktails. They even hired American bartenders, especially after Prohibition went into effect in the United States in 1920.

America's party did not end with Prohibition—in fact, some might argue that drinking intensified during this era, with drunkenness becoming more commonplace—but it did go underground, and the cocktail changed. Bartenders disguised the harsh taste of bootleg liquor by adding cream to drinks. Gin became the spirit of choice because it was easy to make faux gin by mixing juniper oil into alcohol. It was more difficult to replicate the taste of whiskey. Many people opted to drink in the privacy of their own homes, and cocktail sets—tray, shaker, and glasses—became popular wedding presents.

A Drink by Any Other Name

The names of cocktails are often as inventive as the recipes. Here are a few intriguing examples.

- Cocktails named for animals: Bird, Chanticleer, Goat's Delight, Hop Frog, Hop Toad, Grasshopper, Prairie Hen, Mississippi Mule, Rattlesnake, Sherry Chicken, Yellow Parrot.
- Cocktails named for people: Bobby Burns, Charlie Lindbergh, Gene Tunney, Jack Kearns, Mamie Taylor, Mary Pickford, Phoebe Snow, Rhett Butler Slush, Rob Roy, Rudolph Nureyev, Tom and Jerry, Tom Collins, Will Rogers.
- Cocktails named for places: Big Apple, Brazil, Bronx, Brooklyn, Champs Elysées, Chicago, Cuba Libre, Fifth Avenue, Havana, Hawaiian, Manhattan, Martha's Vineyard, Richmond, Ward Eight.
- Cocktails named for occupations: Bishop, Chorus Lady, Commodore, Crook, Diplomat, Doctor G., Grenadier, Huntsman, Judge, Journalist, Kentucky Colonel, Merry Widow, President, Presidente Seco.
- Old school cocktails: Annapolis Fizz, Columbia, Cornell, Eton Blazer, Harvard, Old Etonian, Oxford Grad, Princeton, Yale.
- Royal cocktails: Count Stroganoff, Duchess, Duke, King Cole, Prince Edward, Prince's Smile, Queen, Queen Charlotte, Queen Elizabeth.
- Cocktail contradictions: Church Parade, Presbyterian, Prohibition, Puritan, Reform.

After Prohibition, which was repealed in 1933, most of the creamy cocktails disappeared, and trendsetters began ordering their martinis dry. However, in the 1933 "Repeal Edition" of the *Cocktail Book*, a dry martini was two-thirds gin, one-third French vermouth, and two dashes of bitters.

Just the Basics

During World War II, the cocktail repertoire shrank. People turned to basic drinks such as highballs, martinis, and Manhattans. In the 1950s Americans frequented cocktail lounges, threw cocktail parties, and women wore cocktail dresses. They ate bite-sized cocktail snacks and carried on brief, snappy cocktail-party conversations. Bartenders were not expected to know how to make hundreds of drinks, but they were expected to make ever-drier martinis.

Vodka, so little known in America that it was once sold as "white whiskey," began its rise in popularity. Gradually, it took the place of gin in the standard martini and eventually became the best-selling spirit in America.

During the late 1960s and early 1970s, trendy young people drank white wine or smoked marijuana instead of drinking spirits. Cocktails were for old folks. Sales of brown liquors, such as whiskey, plummeted. However, cocktails began showing signs of life during the 1980s. The martini became hip again, and bartenders created dozens of variations on the theme. At the beginning of the twenty-first century, new cocktails—cosmopolitans, chocolate martinis, black icebergs—signal the beginning of yet another era in the evolution of the cocktail.

See also **Cocktail Party; Fads in Food; Spirits; Symbol, Food as; Table Talk; Whiskey (Whisky).**

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Jeri Quinzio

CODEX ALIMENTARIUS.

Codex Alimentarius is a small global agency that establishes international standards for substances potentially harmful to human health and the environment—that is, food additives, chemicals, pesticides, and contaminants. Created jointly in 1963 by the World Health Organization (WHO), responsible for food safety and public health, and the Food and Agriculture Organization (FAO), responsible for food production, Codex is located in FAO headquarters in Rome. FAO is the dominant partner, contributes more than two-thirds of the cost of the organization, supervises the staff, and generally sets an agenda favorable to concerns of industrial agriculture.

Some 170 developed and developing countries are members of Codex. Their representatives meet as the Codex Commission every two years, alternately in Rome and Geneva, Switzerland (where WHO is headquartered), to review the status of standards being developed in some three dozen Codex committees, and to adopt or return standards recommended by those committees. Each committee is chaired by a nation that agrees to pay the committee's administrative and operational costs, an arrangement that makes a virtue out of the necessity of a small Codex budget. Not surprisingly, all major committees are headed by developed nations, with some countries chairing more than one committee. Codex members may self-select membership in committees, the choices being determined by national interest in specific standard issues and limited by national budgets for travel and staff. All substantive work on standards is done in Codex committees. The commission elects an executive committee and a chairperson every two years to supervise the work of a secretariat staff and to coordinate the work of the committees. Codex operates under consensus rules (that is, votes are rarely taken), a practice that avoids the impression that standards are based on political maneuvering for votes rather than on scientific research. Codex has voted on standards only six times in its forty-year history, and only once prior to 1994. In each of those events, the tally was so close as to lead observers to conclude that no consensus exists on global standards. Codex has a small administrative staff of six people, does no research, and relies instead on the scientific capabilities of its member countries and on the advice of international scientific bodies.

Codex was established to provide a reliable standard-setting process to assist developing countries lacking the infrastructure to create domestic safeguards for food safety and health. Codex standards also offer developing countries the assurance of a floor for health and environmental standards on which to build export markets, primarily to developed countries. A recent study estimated that, on average, each developing country would need to spend $150 million to achieve the internal capability of providing food safety and environmental standards. However, less than a fifth of developing-country members of Codex allocate staff or financial resources to participate regularly in Codex committees or in the development of a strategic Codex plan to accelerate adoption of standards. The Codex Executive Committee proposed a $98 million fund to assist developing countries to comply with the accelerated adoption procedures, with the understanding that developed countries would pay for the fund, which would become available after 2003 if the Codex Commission were to approve the fast-tracking of standards and developed countries contribute the funds.

Until 1994, Codex provided standards that were global floors that countries could apply domestically to protect consumer health and the environment. Countries could set and enforce standards higher than those recommended by Codex. After 1994, with the creation of the World Trade Organization (WTO), Codex standards were transformed into global ceilings limiting the ability of individual nations to employ standards for health and environmental protection that exceed Codex levels. Countries may adopt higher domestic standards than those approved by Codex, but those standards are considered a trade violation when challenged in the WTO, where the measures for trade-rule violations are Codex standards. No country can be forced to drop more precautionary standards, but failure to do so will result in economic penalties being imposed by the WTO. However, neither the WTO nor other global agencies penalize countries that adopt standards less protective than those that Codex provides.

See also **Additives; FAO (Food and Agriculture Organization); Food Safety; Food Supply and the Global Food Market; Food Supply, Food Shortages; Food Trade Associations; International Agencies; Pesticides.**

Rodney E. Leonard

COFFEE. Coffee refers to both a plant and to the hot and cold beverages made from the pit or "bean" of its fruit. Coffee contains significant amounts (between 0.8 percent and 2.5 percent) of the stimulant alkaloid caffeine (trimethylxanthine) as well as protein and carbohydrates. The coffee shrub or bush grows as two species, *Coffea arabica* and *C. canephora*, and is indigenous to Africa, specifically to the Kaffa region of Ethiopia. The word "coffee" is derived from the Turkish word *kahveh*, which is rooted in the Arabic word *kahwah*, meaning wine, this indicating the use of the beverage as a replacement for alcoholic beverages that are forbidden under strict Muslim religious law.

The coffee plant is an evergreen with elliptical, dark shiny green leaves that yields a red husked berry containing a seed pit or "bean." Coffee belongs to the Rubiaceae family and, depending on which of two species from which it is harvested, propagates differently. *Coffea arabica* is grown principally in Southeast Asia, Latin America, and the Caribbean. *Coffea canephora* (also known as *Coffea robusta*) is grown in Africa (mostly in the Congo), India, and Vietnam, which is its leading producer. The *arabica* is self-pollinating, while the *canephora* or *robusta* needs cross-pollination to fruit. After planting, the shrub requires four to five years of growth before it will fruit. When harvested, the ripe red husk is removed from the berry, and the fresh seed can be planted to generate seedlings or dried for planting at a later time. (It is this seed that is the coffee bean as it is commonly understood.)

Processing the beans requires two steps. In the first step, usually in the country of origin, the husk of the berry is left to ferment and soften, which facilitates the extraction of the seed or bean. The beans are then dried and shipped "green" or unroasted to a destination where they are roasted either for local consumption or for packaging and transshipping to other markets. The roasting process has a substantial effect on the color and flavor of the bean and the beverage it will produce. The darker the roast, the stronger the flavor. It is also the roasting process that eliminates water, making the bean more brittle and easier to grind.

Coffea arabica produces the "Arabica," also known as "Brazilian," varieties, which are often preferred for their balanced aroma and rich flavor. The best, rarest, and most sought after *arabica* types are harvested in Indonesia, Jamaica, Hawaii, and Colombia, where they are grown on small production farms at a relatively slow and steady growth rate, developing flavorful berries. (In this way they may be said to parallel wine production.) *Coffea canephora*, or *robusta*, tends to be strong and bitter. Because *Coffea canephora* can resist frost and disease and can sustain warmer climates and lower elevations, it experiences faster growth patterns and higher fruit yields. This generally results in beans that contain more caffeine than *arabica* types but that lack subtlety and flavor. The *canephora* bean is said by experts to be neutral by comparison to *arabica*.

TABLE 1

TOTAL COFFEE PRODUCTION
By the top 15 producing countries
Crop years 1999/00 to 2001/02
(in thousands of bags)

Crop year commencing		1999	2000	2001
Brazil	(A/R)	32,345	32,204	33,549
Vietnam	(R)	11,648	14,775	12,600
Colombia	(A)	9,398	10,532	11,500
Indonesia	(R/A)	5,432	6,733	6,446
Mexico	(A)	6,442	5,125	5,500
India	(A/R)	5,457	4,611	5,293
Côte d'Ivoire	(R)	6,321	4,587	4,100
Ethiopia	(A)	3,505	2,768	3,917
Guatemala	(A/R)	5,201	4,700	3,900
Uganda	(R/A)	3,097	3,205	3,250
Peru	(A)	2,663	2,596	2,747
Costa Rica	(A)	2,404	2,246	2,364
Honduras	(A)	2,985	2,667	2,300
El Salvador	(A)	2,835	1,717	1,630
Cameroon	(R/A)	1370	1,113	1,500
All other producers	13,935	13,043	12,742	

(A) Arabica producer
(R) Robusta producer
(A/R) Produces both types. Predominantly Arabica
(R/A) Produces both types. Predominantly Robusta

TOTAL EXPORTS OF ALL FORMS OF COFFEE
The top 15 producing countries
Calendar years 1999 to 2001
(in thousands of bags)

Calendar year	1999	2000	2001
Brazil	23,139	18,016	23,172
Vietnam	7,742	11,619	13,946
Colombia	9,996	9,175	9,944
Indonesia	5,065	5,194	4,992
Cote d'Ivoire	2,406	6,110	4,174
Guatemala	4,681	4,852	4,110
India	3,613	4,441	3,769
Mexico	4,358	5,304	3,408
Uganda	3,841	2,513	3,060
Peru	2,407	2,362	2,663
Honduras	1,987	2,879	2,392
Costa Rica	2,195	1,964	2,018
El Salvador	1,890	2,536	1,533
Ethiopia	1,818	1,982	1,376
Nicaragua	984	1,345	1,365
All other producers	9,302	8,708	8,313

SOURCE: International Coffee Organization

It is believed that the earliest producers of coffee, the Ethiopians, did not brew coffee as it is recognized in the twenty-first century from the roasted beans but made drinks from the bitter berries, combined the roasted beans with butter or animal fat (most likely that of mutton), or chewed roasted beans as a mild stimulant. Numerous tales on the subject of coffee and its discovery exist. One of the most persistent is of a ninth-century Ethiopian goat herder intrigued by his intoxicated, hyperactive flock. Having grown curious, he sampled berries his goats had been eating and felt similarly stimulated.

No extensive or significant use of the coffee crop has developed among Ethiopia's indigenous peoples, and it became an exotic crop for them, exported first to Yemen, then to other Arab nations. It is noteworthy that coffee production did not develop in Africa until the twentieth century and that consumption there is minor. (The berries are sometimes used to enhance teas, which are generally preferred as beverages there.)

A primitive approach to making the coffee beverage may have originated at the beginning of the eleventh century in Ethiopia, however, this was likely learned through Arab traders who ground roasted beans into a fine powder and stirred it into hot water. Most scholars believe the antecedents of modern brewed coffee drinks were developed in the late fourteenth or early fifteenth centuries in Yemen and accredit the processing of the beans—roasting, grinding, and ultimately brewing the pungent hot drink—to a sheik of the Sufi order. Irrespective of the drink's origins, wild coffee plants may have been cultivated as early as the sixth century, but it was not until the fifteenth century that the coffee bush, *Coffea arabica*, is believed to have been domesticated, developed as an agricultural product, and spread throughout Muslim nations from Southwest Asia to Southeast Asia, including the Indonesian archipelago.

When first brought into widespread use, coffee was usually taken as a dark, bitter drink. Sugar was rarely used in the Arabian beverage, perhaps for fear that it would overstimulate the mind. The spice cardamom was often added to the brew for a naturally sweet flavor, and perhaps to counterbalance or mediate its bitter essence. Cardamom-flavored coffee is most commonly associated with the beverage known as Turkish coffee, as is the eleventh-century approach to boiling the grounds as a brewing technique. (Sugar is often added in this version as well.)

Historically coffee was the subject of frequent controversy and confusion, and its rise—much like tea—parallels the development of international trade and economic interdependencies. Coffee was perceived, for example, early in its development to have medicinal benefits, including as a curative for mange, sore eyes, dropsy, and gout. However, it was also feared that, when mixed with milk, coffee caused leprosy. Coffee was often at the center of political turmoil, especially through the development of coffeehouses in the Ottoman Empire and throughout Europe, where people could congregate and discuss ideas in an atmosphere conducive to (literally) stimulated conversation. Coffeehouses were associated with the plotting of insurrection in the Ottoman Empire and of both the American and French Revolutions, for example.

Coffee is one of the most common delivery systems for drugs in the world. Its caffeine stimulates the brain, improving one's focus. It is also a diuretic, washing out the kidneys. When taken in large quantities, the stimulant causes irregular heartbeat, uncontrollable shaking, and dehydration. Despite—or because of—these characteristics, by the beginning of the sixteenth century coffee drinking was widespread in the Middle East. Its powerful physical effects, however, were such that some Muslim scholars interpreted it as being contradictory to the spirit of the Koran and tried to forbid it. Others opposed its banishment and ironically included the beverage in religious worship. (Records of the period indicate that coffee was drunk inside the Sacred Mosque in Mecca, in present-day Saudi Arabia.) Early accounts exist of coffee drinking, ostensibly for the purpose of staying awake to pray and chant, during the evenings of the one-month fasting of Ramadan.

Coffee is also associated with superstitions and rituals. For example, not unlike tea leaf reading by Chinese fortune tellers, Turkish fortune tellers use the finished cup of coffee—which contains both liquid and grounds—turning it onto the saucer until cool. The cup is then turned back up, and any coffee grounds remaining in the cup are "read" as a basis for predicting the future.

From roughly the fifteenth century to the eighteenth century, coffee trade was monopolized by the Yemenis. The English and the Dutch traded with the Arabs at the major trading port of Mocha in Yemen for nearly half a century before they found a way to break the Arab monopoly. Ultimately Dutch smugglers stole beans from Mocha, carrying them to colonial Java in Indonesia for propagation. Through the Dutch act of pilferage, Indonesian coffee plantations came to produce an *arabica* bean popularly known as "Java." (Eventually this bean was described by connoisseurs as among the finest *arabica* available.) The Dutch also sent beans back to Amsterdam for propagation in greenhouses. In short order coffee propagation and drinking spread rapidly throughout the Western Hemisphere and the European colonies. In an act of repilferage, for example, the French king Louis XIV engineered the theft of plants from Amsterdam, and these plants eventually were responsible for the development of coffee plantations in French colonial Martinique. In 1723 the coffee business was born of a coffee bush originating in Martinique and eventually engendered a New World coffee industry that by the twentieth century was responsible for 90 percent of coffee production internationally.

The coffeehouse became a symbol of the Beat generation during the 1950s and early 1960s. The Gaslight Coffeehouse in New York's Greenwich Village was once a well-known setting for various bohemian movements. This 1959 photo shows poet Dick Woods sitting over coffee with Eddy Slaton. © BETTMANN/CORBIS.

The early to mid-seventeenth century saw the rapid spread of coffee consumption throughout Europe, especially northern Europe, resulting in a significant demand. The possibility of financial fortunes along with the possibilities of lucrative taxes and perceived medical benefits made for both free market and government-encouraged spread of cultivation in tropical and subtropical climes across the globe.

Cultivation spread throughout Southeast Asia, the Caribbean, Latin America, Africa, and Brazil. The first Brazilian coffee bush was planted in 1727, for example, and it was cultivated by slave labor. While the crop experienced a somewhat slow beginning there, by the end of the nineteenth century Brazil's coffee-growing industry was profitable. By the early twenty-first century Brazil was the world's largest coffee exporting nation with Vietnam running second.

Coffee and its patterns of consumption were historically linked to politics as well as perceived curative and stimulant benefits. Originally coffee was enjoyed almost exclusively in coffeehouses, which were founded as specialty shops for the purpose of selling coffee by enticing traders to try the new beverage. The first coffeehouse (or café) opened in Constantinople in 1555, and within a few years the city counted hundreds of such establishments. In rapid turn the coffeehouse became a place for socializing. Paralleling the social patterns of teahouses in China, coffeehouses became meeting places for casual conversation and business and political discussions, including revolutionary

In the Arab world, the coffee break is much more than a pause in the day's schedule; it is a period of intense conversation and male socialization. These men are talking business over their cup of coffee in the Gulf Hotel at Manama, Bahrain. © ADAM WOOLFITT/CORBIS.

strategies. The empire's rulers quickly became concerned with the popularity of such places, where discontented commoners and intellectuals alike could gather and political uprising could be discussed. (Restaurants either did not exist or were forbidden.) Ottoman coffeehouse proprietors were subject to harsh punishments, including being sewn in a bag and thrown in the Bosporus.

Political mechanisms proved inadequate to stem rising enthusiasm for coffee and coffeehouses, however. Great profit centers, coffeehouses were often built in extravagant styles, imparting a social caché to the beverage. Spread by war and commerce, coffeehouses opened in European capitals throughout the early to late seventeenth century, increasing the beverage's popularity and supporting demand.

While coffee was a sort of luxury beverage at first, by the eighteenth century even less-fortunate Europeans could enjoy it (or some adulterated version of it) through sales by street hawkers. Innkeepers also made it part of their family-style menus, and some food historians link the introduction of coffee to creating the sequencing of a meal. In the mid– to late eighteenth century North American colonials drank coffee increasingly as a sort of protest against high British taxes on tea. Free to trade after independence (1776), Americans imported coffee initially from Haiti and Martinique, then Portugal and Brazil. By the mid-nineteenth century Americans consumed an average of over six pounds per capita annually. To a large extent the commercialization, mechanization, marketing, and democratization of coffee in North America evolved the beverage in modern times. The nineteenth century also saw the introduction of the drink in various styles, including Italian espresso (a concentrated one-ounce liquid), cappuccino (a "long" espresso with frothed milk), French *café au lait* or Spanish *café con leche* (strong coffee with plenty of hot milk), or iced coffee with or without milk. Other popular combinations are Irish coffee, which includes whiskey and Baileys Irish Cream, and Vietnamese or Thai coffees, in which sweet condensed milk is added.

Coffee can be "pure," using either the *arabica* or *robusta* bean, or it can be a blend of the two. One of the oldest blends simply combines various proportions of *robusta* and *arabica* beans, making the resulting item either more smooth or more bitter. Some of the more innovative blends include hazelnut and vanilla flavorings, these tied to the late twentieth-century, principally American interest in "gourmet" coffees. While for hundreds of years coffee consumers in Europe purchased a brewed cup of the beverage for quick consumption, in the United States green beans generally were sold in bulk for home roasting. This shift from public coffeehouse to domestic brewing had a profound effect on the industry and psychology of coffee consumption. The American development essentially stripped coffee of its political import, making it a modern commodity.

In other North American developments, at the end of the American Civil War, San Francisco's Folger's Coffee company gave customers a choice, offering both traditional green coffee beans and the more efficient and time-saving roasted beans. A new industry was born, and the tendency toward efficiency and rapid brewing was exacerbated. The Maxwell House company soon followed in Folger's footsteps, and in 1901 the first Maxwell House "instant" coffee came to market. This instant coffee was made by extracting water from brewed coffee and freeze-drying the remains. Other innovations followed. Decaffeinated coffee, which has significantly reduced amounts of caffeine, was made by steaming unroasted beans or by using a solvent, usually chlorine, to remove the caffeine. Because this process also removes some of the flavor from the beans, the stronger *robusta* variety is usually employed for decaffeinated coffees.

While coffee was added to a pot of water and boiled to produce the earliest versions of the beverage, Arab producers eventually filtered the brew through herbs to hold back the sediment. In eighteenth-century France, coffee was filtered through muslin bags, an innovative but ultimately inadequate process. The expatriate American inventor Benjamin Thompson—also known as Count Rumford—developed the broadly successful metal "drip pot," and a number of other inventors developed variations on coffee-brewing devices, many of which have remained in use in the twenty-first century. In 1819, for example, the percolator was invented in which hot water rises through a tube and into an upper container and infuses coffee. The early twentieth century saw the advent of true coffee filtering devices, particularly through the development of paper filters by the German Melitta Bentz Company in 1908.

The espresso machine (from Italian *caffè espresso*, literally, "pressed-out coffee") is usually associated with Italy, but it was pioneered in the early nineteenth century in German and French machines that used steam to push steam through coffee grounds. The modern espresso machine, patented in Italy in early-twentieth-century Italy, was developed by Desidero Pavoni (who bought the rights to the espresso machine patent in 1905), and was dramatically improved in Italy after World War II. The hiss of the espresso machine was a common sound in the Italian caffés of San Francisco's North Beach and in New York City's Greenwich Village decades before espresso and cappuccino became fashionable around the 1980s.

The difference in machines and grounds is important in the outcome of any coffee brew. For example, the espresso machine uses twice the amount of coffee as a percolator, a much finer ground of coffee, and much less water (actually steam), resulting in a dark, strong, bitter extraction. Different grinds exist for different styles of brewing. Coarse grounds are used to make filtered coffee, fine grounds are used to make Italian espresso, and even finer grounds resembling the consistency of flour are used to make boiled Turkish coffee.

Like tea, coffee evolved its own distinctive implements in the form of differently shaped cups, serving pots, and table accoutrements. This "Dragon Coffee Service" manufactured by the Komilov Brothers factory in St. Petersburg, Russia, between 1840 and 1860, transforms the traditional Russian tea service into a porcelain fantasy. © THE STATE RUSSIAN MUSEUM/CORBIS.

Harvested, roasted, traded worldwide, and consumed by people from different walks of life, coffee has created significant social crossroads for centuries. Once a luxurious beverage, coffee is enjoyed internationally by a diverse populace. Most often a morning beverage, its popularity has soared as both an afternoon and an after-dinner beverage. Variations abound. Aside from flavored and decaffeinated coffees, bottled coffees, coffee sodas, and other drinks are available.

Embracing this trend, and operating over 5,500 stores internationally (over four thousand in the United States alone), Starbucks is the leading coffeehouse chain of the twenty-first century. It sells coffees with multiple options (would you like a slice of banana nut loaf with your iced, decaf mocha java?) at the elevated average price of $3.50 per cup in a lounge setting, and has pastries (and sometimes, sandwiches) available for purchase. This creates a comfortable atmosphere for conversation and reading, without any pressure to make a purchase and leave. Thus, since the early 1990s Starbucks has created a coffeehouse culture for the masses. With its appeal extending from corporate executives to students and housewives, it has brought the former aristocratic atmosphere into the mainstream. In this way it typifies the late-twentieth-, early-twenty-first-century "mass-class" and "leisure-time entertainment" marketing strategies. The success of Starbucks is also bolstered by its ability to extend the brand by selling T-shirts, travel mugs, and other coffee-related accessories in its stores. Starbucks also sells coffee beans and ice cream.

Coffee is not only a modern beverage but also an ingredient in desserts, including coffee ice creams, coffee gelati, and coffee-flavored cakes. Variations include the American "chimney sweep" recipe, in which vanilla ice cream is topped with powdered coffee and drizzled with a shot of whiskey. Italian tiramisu has lady fingers soaked in espresso coffee and set in a whipped mascarpone cream. In addition, an American classic dish called "Black-eyed steak" employs coffee to deglaze a cast-iron pan in which a slice of salt-cured Virginia Smithfield ham has been pan-fried; the bitter and salty *jus* is poured over the meat prior to serving.

See also **Advertising of Food; Marketing of Food; Stimulants; Tea: Tea as an Icon Food; Tea (Meal).**

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Corinne Trang

COLORING, FOOD. Humans have always used the color of a food to form judgments about its desirability. The act of eating (and deciding what to eat) is a multisensory experience, synthesizing perceptions of sight, taste, smell, and touch. Color provides visual information about a food's quality and condition, and influences the perception of its flavor.

In nature, color is determined by a food's inherent qualities, indicating types of flavor, and degrees of sweetness, ripeness, or decay. However, humans have contrived to add or change the natural color in foods from very early times and for a variety of reasons—for aesthetic purposes, to increase appetite appeal, for symbolic effect, to make a less desirable food seem more desirable, and to mask defects.

From ancient times, wide varieties of food colorants were derived from natural sources—plant, animal, or mineral. This changed in the middle of the nineteenth century with the discovery of synthetic dyes that soon found their way into food. These synthetics were, in general, less expensive as well as more stable, controllable, and intense in hue than natural color sources. Since that time, the safety and acceptable use of food colorants, both natural and synthetic, remain controversial topics, eliciting debate, continual scientific study, and periodic legislative action.

History of Coloring in Food

There is ample evidence that early civilizations introduced color into their food. Ancient Egyptians colored food yellow with saffron, and saffron is mentioned in Homer's *Iliad*, dating from 700 B.C.E. Pliny the Elder relates that wines were artificially colored in 400 B.C.E. Wealthy Romans ate white bread that had been whitened by adding alum to the flour.

In the great houses of medieval Europe, cooks employed plant extracts of many hues. Along with the period's painting and stained glass, the cuisine of the late Gothic period was informed by rich and ornate color. Parti-colored dishes, jewel-toned cordials, and shimmering jellies were colored red, purple, blue, green, and yellow. Saffron had migrated from Persia as far as England by the mid-fourteenth century, and indigo, turnsole, alkanet (borage root), red saunders (a powdered wood), marigold, turmeric, safflower, parsley, spinach, fruits, and flower petal extracts commonly colored the foods of the wealthy.

In the early Renaissance (1470–1530), a common belief in Europe, based on Arabic ideas, was that color in food not only indicated nutritional value, but also inherent medicinal power connected to spiritual, celestial substances. Eating sweet red grapes produced full rich blood, black food like pepper or fungi induced melancholy, and coloring foods golden promoted divine solar healing.

In the sixteenth century the New World food colorants annatto, paprika, brazilwood, and cochineal arrived in Europe. In Mexico in 1518 Hernando Cortés observed the Aztecs cultivating the tiny cochineal insects (*Dactylopus coccus costa*) that fed on red cactus berries. These insects were gathered by hand and ground into pigment, requiring 70,000 carcasses to make a pound. By

TABLE 1

Naturally occurring colorants

Substance	Colors	Sources	Used in
Anthocyanins	orange-red to red to blue	berries, grapes, apples, roses, hibiscus, red cabbage, sweet potato	candy, fruit beverages, ice cream, yogurt, jams
Betacyanins	red	red beets, red chard, cactus fruit, bougainvillea	candy, yogurt, ice cream, salad dressing, cake mixes
Caramel	beige to brown	heated sugars	baked goods, gravies, vinegars, syrups, colas, seasonings, sauces
Carmine	red	cochineal insects	candy, dairy products, drinks, fruit fillings, surimi
Carotenoids	yellow to orange to red	saffron, tomatoes, paprika, corn, butter, palm oil, red salmon, marigolds, marine algae, carrots, annatto	meat products, cheese, butter, spice mixes, salad dressings
Chlorophylls	green to olive green	green plant leaves	green pasta, dehydrated spinach
Riboflavin	yellow	vegetable leaves, milk, eggs, organ meats, malt	flour, bread, pastries, cereals, dietary products
Turmeric	yellow	*Curcuma longa* rhizome	pickles, mustard, spices, margarine, ice cream, cheese, baked goods, soups, cooking oil, salad dressings

1600 approximately 500,000 pounds of cochineal were shipped annually to Spain.

It was common during the eighteenth and nineteenth centuries to employ food colorants to disguise inferior products, and the colorants used were frequently harmful (although natural) substances. In 1820 Frederick Accum described flour whitened with alum, pickles colored green with copper sulphate, and cheeses tinted with red lead and red mercuric sulfide. By the mid-nineteenth century, black lead, Prussian blue, lead chromate, copper carbonate, vermillion, and copper arsenite were also used to color food.

The British chemist Sir William Henry Perkin created the first synthetic dye, mauveine, in 1856 by oxidizing aniline. By the end of the century, eighty synthetic dyes colored foods, and coal tar derivatives were the principle source of synthesized dyes. Americans and Europeans were consuming varieties of unregulated, artificially colored food, including jellies, butter, cheese, ice cream, sausage, pasta, and wine.

Food Coloring Regulation

Government attempts to regulate coloring agents in food have had a long history. There was a 1396 edict in Paris against coloring butter. In 1574 French authorities in Bourges prohibited the use of color to simulate eggs in pastries, and Amsterdam forbade annatto for coloring butter in 1641. Denmark listed colors permitted for food coloring in 1836, and Germany's Color Act of 1887 prohibited harmful colors in food. A report to the British Medical Association in Toronto in 1884 resulted in the Adulteration Act, the first list of prohibited food additives. Australia passed the Pure Food Act in 1905.

The United States Food and Drug Act of 1906 restricted synthetic food colors to those that could be tested as safe. Of the eighty colors in use, only seven were approved as certified colors. In 1938 the Food, Drug, and Cosmetics (FD&C) Act approved fifteen dyes for use in food, drugs, and cosmetics and assigned color numbers instead of their common names (thus, amaranth became Red No. 2).

Government and consumers' concerns regarding food additives intensified in the 1950s with new scientific findings. In 1960 the U.S. Congress passed the Color Additives Amendment to the FD&C Act, which placed the burden of establishing safety on the food manufacturing industry and created a new category, "color additives exempt from certification." This includes both "natural colors" and "nature-identical" colors (those synthetically made but chemically identical to natural colors, like beta-carotene and canthaxanthin). The Delaney Clause prohibited any color additive that could be shown to induce cancer in humans or animals.

Since the 1970s the inclusion of colorants in food has received considerable scrutiny based primarily on concerns regarding the carcinogenic properties of colorants. In 1992 a U.S. court decision interpreted the Delaney Clause to mean that zero levels of carcinogens are permissible. With further research findings, certified colors continue to be delisted.

In response to increased consumer perception that natural colorants are safer, manufacturers have moved toward more natural and less synthetic colorants in food. However, the term "natural," as it pertains to colors, has never been legally defined and has no universally accepted definition. In addition, a small percentage of the population demonstrates sensitivity or allergic reactions to some natural colorants such as cochineal. Currently, consumer groups advocate the minimized use of food colorants, as well as a detailed listing of specific colorants on food labels.

See also **Additives; Artificial Foods; Food Politics: U.S.; Food Safety; Natural Foods; Presentation of Food; Styling of Food**.

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MM Pack

COLUMBIAN EXCHANGE. The title of this article refers to the interchange of plants and food products that took place between America and Europe after Columbus's voyages to the New World. Although the exchange was carried out in both directions, the article places greater emphasis upon the transfer of American plants and food products to Europe than in the other direction. European products that brought about significant changes in New World diets include wheat; meat and meat products such as milk, cheese and eggs; sugar; citrus fruits; onions; garlic; and certain spices such as parsley, coriander, oregano, cinnamon, and cloves.

Among the products that arrived in Europe after the discovery of the Americas were many plants native to the New World and unknown to Europeans. Some plants were transported intentionally, perhaps by a returning Spaniard who had become accustomed to the exotic flavors of America; others traveled uninvited, hidden in the nooks and crannies of ships or mixed with the ballast that Spanish ships carried on their return trips to the Old World.

Over the years, the seeds and plants were scattered throughout the nearby hills of the Mediterranean Basin by the wind, water currents, or birds, or by humans themselves. Now, over 500 years after their introduction to the area, they form such an integral part of the landscape that this would be unrecognizable for any Roman citizens who came in search of their ancient environment.

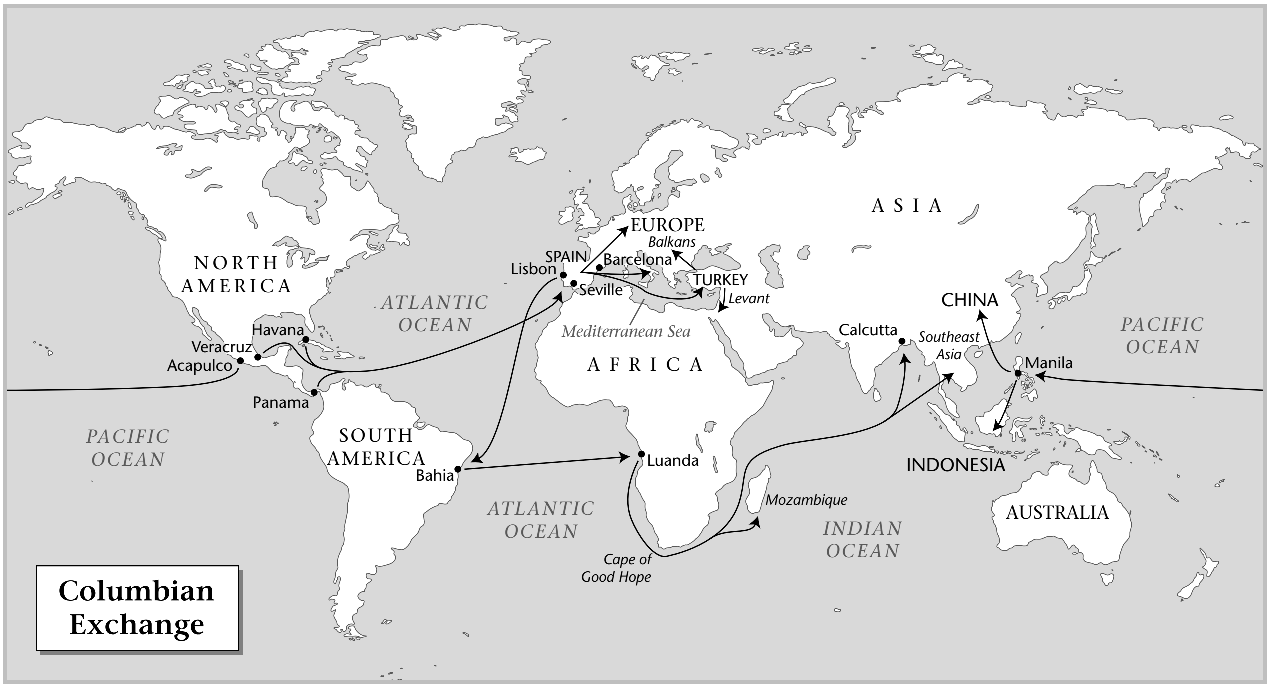
New World Plants in the Old World

American plants were not well received when they arrived in Europe. Some were the object of suspicion because of their similarity to a group of hallucinogenic plants already known and used by Europeans. Others had to undergo a genetic transformation before they could produce in the new climate and latitudes. American plants eventually became incorporated into the Mediterranean diet and now serve to identify it as readily as wheat, olives, and wine, traditional food plants of the area.

Spain became the route of dispersion for the new plants in Europe, since most of them initially arrived in the port of Seville. They extended along two distinct routes: one group was diffused toward the north of the continent, while others were found to adapt and prosper better in the south. The southern group first arrived in Italy, which should not be surprising since Spain controlled parts of Italy during the sixteenth century, and this facilitated the introduction of American plants to the area. The well-established trade routes set up by the Aragonese long before the sixteenth century were important factors in the dispersion of American products. The mild climate and loose soil that predominate in the Mediterranean helped make the area a favorable ecological niche for the adaptation and development of the new plants.

Maize and beans, subsistence crops throughout much of the Americas, prospered well in the Mediterranean Basin. Tomatoes and chili peppers adapted easily to the new atmosphere. Other crops that had little trouble in establishing themselves were several varieties of squash, sweet potatoes, the nopal, or prickly pear cactus, and the agave, or century plant. The potato, a plant that generated important changes in European social life, adapted better in the cold climates and high altitudes of Northern Europe, because of a greater similarity to their original habitat in the Andes Mountains of Bolivia and Peru.

Some of the plants rejected upon their arrival in Europe were the tomato, potato, and chili pepper. All are members of the *Solanaceae* plant family and had to confront the famous "curse of the nightshades" before being accepted in European diets. Europeans were already familiar with some poisonous members of this group of



plants such as mandrake, henbane, and belladonna, hallucinogenic plants used by witches and sorcerers of the time. They recognized these three plants as members of the same plant family by their leaves and flowers and were suspicious of them. In addition to being hallucinogenic and poisonous, the plants were believed to cause leprosy and syphilis. Soon they acquired fame as aphrodisiacs, although it is doubtful that this contributed to their rejection.

It was in the Mediterranean area where New World plants had their earliest acceptance. The Mediterranean Sea served as a background for the struggle between the Ottoman Turks and the Spanish Hapsburgs in the sixteenth century. These two empires played a dominant role in the region and were probably the most important distributors of American plants in Mediterranean countries.

The role played by the Turks is evident in the nomenclature of American plants in the sixteenth century. Maize appeared in European herbals with the name of Turkish grain, *blé de Turquie*, or *turkisher korn.* The chili pepper was called Turkish red pepper and squash was known as Turkish cucumber; even the American turkey received its well-known name in English at this time, when it was called the turkie-bird.

A Historical Comparison of Plant Introductions

The arrival of American plants in the Mediterranean during the sixteenth century can be compared to a similar occurrence during Roman times. During the first years of the Empire, Romans followed a fairly simple diet. Their meals consisted mainly of boiled grains such as millet, rye, and wheat, and of vegetables grown in the area. With the expansion of the Empire, trade and commerce began to flourish, and some Roman merchants began to introduce new food products from far-reaching corners of the Roman Empire. The best of the ancient world arrived at the tables of upper-class Romans. The variety of available food products increased considerably, and the new foods soon became a necessity in the Roman diet, giving rise to an elaborate and sophisticated cuisine.

It was not until the sixteenth century and the arrival of New World plants that this phenomenon was repeated in history. Plant specialists calculate that seventy-eight new plants, including fruit trees, vegetables, and spices, arrived in Italy during the centuries of the Roman Empire, while 127 arrived from America during just the first century following the discovery of the New World.

Factors Determining the Acceptance of Plants

Some plants were easily accepted in the Mediterranean diet due to their similarity to other plants already known in the area. This was the case for the common bean (*Phaseolus vulgaris*) that showed a similarity with the fava bean (*Vicia faba*), known since Roman times and diffused throughout the area by Romans during their conquests.

The maize plant does not resemble other grains, although its preparation in the form of ground flour in breads and gruels gave it a certain similarity to them. Maize flour was combined with other ground cereals and used in the preparation of rustic breads, favored by the poor. It also came to substitute for millet in the preparation of Italian polenta, an ancient Roman dish that had been a mainstay of the poor for centuries.

While the foods of the New World radically changed the diet of the Old, so too did many Old World foods become staples of Native American diets. Here, a Kuna Indian woman is preparing to plant rice. She is holding the young seedlings in her hands. This picture was taken among the Kuna people at Comorcas de San Blas, Panama, in 1996. © Danny Lehman/CORBIS.

The squash bore a resemblance to other cucurbits known to the Romans, although they belonged to other plant species. It received the name of *calabash* and a false identity as *zucco* from Syria. From this comes its present-day name, zucchini.

The chili pepper and the tomato arrived as new and strange plants, and people were suspicious of them. The fact that Europeans did not know how to prepare them and that they bore no resemblance to foods already in their diets made their acceptance more difficult. Chili peppers were too hot for the European palate, and they found the tomato difficult to prepare. It was too acrid to eat in its green stage, but when it ripened, it appeared to be spoiled, and when cooked, it disintegrated. Finally, they adopted the Aztec technique of grinding it into a purée. The tomato that arrived in the Mediterranean in the sixteenth century was not the bright red, smooth, juicy fruit we know today, but rather a pale fruit with an acid flavor and unpleasant smell. The first illustrations in herbals show a small, ridged, hard fruit that does not look very appetizing. It was the caring hands of Italian gardeners that improved the American tomato and turned it into the vivid, plump, thin-skinned fruit we appreciate today. They also modified the chili pepper, turning it into a large fruit without the characteristic heat of the Mexican pepper. When transformed into a green pepper, it could be eaten as a vegetable, stuffed with meat or cheese, and it has found an important place in Mediterranean salads. Sweet potatoes and the prickly pear cactus adapted and grew wherever the climate and soil permitted them.

The Turks introduced American plants into the Balkans during their sixteenth century invasions of the region. Today the Hungarian chili pepper, called paprika, is one of the predominant flavors in Balkan cooking. Maize, squash, and tomatoes also play an important role in the cuisine.

American Plants Incorporated into the European Diet

American plants arrived in Europe during the sixteenth century, but did not play a significant role in the European diet for two-hundred years. They became incorporated into the eighteenth-century diet, not as exotic or innovative dishes, but rather as additional ingredients in traditional foods already known and eaten by the masses. Cooks began adding maize and potatoes to popular soups and stews. American beans became a substitute for Roman fava beans in Spanish *fabada* (a bean stew from Asturias); white beans came to be used in *cassoulet* (a dish of southern France, made with beans and pork), as well as in Tuscan bean dishes. Sicilians discovered that tomato sauces were a good complement to pasta and pizzas and provided more color and flavor than the traditional butter or olive oil dressings. *Peperonata*, made with sautéed red and green peppers, occupies a place in all Mediterranean cuisines. The tomato and the chili pepper became a common ingredient in Greek dishes such as *moussaka*, made with lamb and eggplant, and in Hungarian dishes like chicken paprika or goulash.

Andalusian *gazpacho*, an ancient bread soup, possibly of Roman origin, suddenly took on a new presentation with tomatoes and green peppers. Valencian *paella* (a dish of rice, chicken, and seafood) and *bacalao* (a codfish casserole) soon included foods from America in their preparation. Innovative cooks created new dishes such as the *tortilla española*, a Spanish omelet cooked with potatoes, and "*pa amb tomàquet*," thick Catalan bread slices smeared with tomatoes and olive oil. The Muslim tradition of filling vegetables with meat and sauce soon found new receptacles in American vegetables such as green peppers, tomatoes, and squash. Over the years, they learned to make Moroccan couscous with tomatoes, served with harissa sauce, made with mashed chili peppers, salt, and garlic.

The exchange of food plants from the New World to the Old moved in several directions. One was trans-Atlantic, the other was trans-Pacific. In these market baskets at Neiafu, Vava'U Island, Tonga Islands, New World manioc (center) is sold side by side with mangoes, fruits that came to the islands by way of Asia. © Wolfgang Kaehler/CORBIS.

Conclusion

After an uncertain beginning upon their arrival in Europe, American plants revolutionized European diets as they slowly began replacing traditional ingredients and became staples in the basic diets of the area. They provided a more nutritional diet and helped put an end to the chronic famines that had affected Europe since the Middle Ages. Two New World plants, maize and potatoes, are considered among the four most important subsistence plants of the world and are believed to have played a role in the population explosion that began in the middle of the eighteenth century.

Maize quickly became a mainstay in the Venetian and Roman diets. It was easy to grow and so productive that many country people began living on a diet made up almost exclusively of maize products. Maize contains an incomplete protein and lacks trytophan, a precursor of niacin, which helps the body synthesize vitamins. Without this amino acid, the body cannot absorb vitamins and thus produces a nutritional deficiency called pellagra, which affects the digestive and nervous systems as well as the skin. In extreme cases, it can be fatal. No Mediterranean country was saved from this terrible disease. It was not abolished completely in Italy until after the Second World War, when the diet and living conditions improved in that country. Potatoes were accepted in the diet in places like seventeenth-century Ireland, where the people were undergoing a severe food crisis; two centuries later, they were the cause of Ireland's "great hunger" of the nineteenth century when the loss of the potato crop in consecutive years left people with nothing to eat.

See also **Caribbean**; **Central America**; **Diaspora**; **Iberian Peninsula**; **Inca Empire**; **Maize**; **Mexico and Central America, Pre-Columbian**; **South America**.

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Janet Long-Solís

COMBINATION OF PROTEINS. A thousand years ago, the Chinese poet Wu Tzu-mu listed the "seven necessities" of life that are still memorized by every Chinese schoolchild: firewood, rice, soy sauce, sesame oil, salt, vinegar, and tea. The list does not include meat. Now as then, we place great value on animal flesh as a food source, but depend on plants. Protein complementarity—or combining certain vegetable foods to achieve complete protein—solves a singular problem with that dependence.

Plant protein is an incomplete source of protein. Protein is built of amino acids, and of the twenty-two found in nature, our bodies can synthesize all but eight. These are termed "essential," and must be found in the diet. Nearly all plants, however, are deficient in the essential amino acid methionine; only soybeans (*Glycine max*) and some seeds and nuts, especially the Mongongo (*Ricinodendron rautanenii*) and sesame seeds (*Sesamum indicum*), can provide over 50 percent of our daily need. Legumes and pulses, such as peanuts (*Arachis hypogoea*), lentils (*Lens esculenta*), chickpeas (*Cicer arietinum*), and lima beans (*Phaseolus lunatus*), typically contain about half as much protein by weight as meat, and are good sources of lysine, but lack methionine. Many vegetables such as the squashes (*Cucurbita maxima*, *pepo*), cauliflower (*Brassica oleracea*), and runner or green beans (*Phaseolus coccineus*) have small amounts of protein, typically 1 to 2 percent by weight, but reasonably balanced amino acids.

Many populations, however, must find their protein in the same starchy carbohydrates that provide their calories. Corn (*Zea mays*), about 3 to 4 percent protein by weight, lacks methionine, lysine, and tryptophan, and is overrich in leucine. Rice (*Orza sativa*, typ), also limited in methionine and lysine, has less total protein than corn by weight. However, its even amino acid profile gives rice greater bioavailability (how many of the amino acids our bodies can utilize). Whole wheat (*Triticum aestivum*) has four times more protein than corn or rice, but has low amounts of methionine, lysine, and tyrosine. Some tubers such as potatoes (*Solanum tuberosum*) have superior amino acid profiles to cereals, while others such as the yams (genus *Dioscorea*) and cassavas (genus *Manihot*) offer only about 1½ percent protein by wet weight.

Plants, moreover, contain tannins, phytates, and other indigestible fibers that bind with amino acids, reducing gut absorption and increasing fecal transit rates. Cereal protein digestibility, for instance, depends on whether one eats only the endosperm, source of most amino acids, or includes the fibrous pericarp.

Taking digestibility into account, we can calculate the utility of plant proteins relative to a benchmark—egg white. Soybeans, with a score of 99, are more bioavailable than beef, while peas and beans have scores between 60 and 75, nuts fall to the thirties, and most cereals are in the 20 to 30 range. Culturally important foods such as plantain (*Musa* spp), yams, and cassava (manioc) begin with modest total protein, contain high fiber, and thus end up with very low protein scores.

Mixing Plant Proteins

With ingenuity, such shortfalls can be met by mixing amino acids from different plant foods. This has become known as protein complementarity. The best-understood example comes from Latin America's menu. Squashes supply lysine, which corn lacks, and beans provide methionine. In sufficient quantity, the triad of squash, corn, and beans provides ample protein.

Moreover, as Solomon Katz has demonstrated, Latin American cultures typically soak their tortilla corn in lime. Besides enhancing availability of the B vitamin niacin, the alkali reaction reduces the amino acid availability of all amino acids except lysine, already deficient in corn. Paradoxically, this is useful. While total protein is reduced, amino acids are "leveled," making a higher percentage of protein (approximately 8 percent by weight) complete. Finally, one of the amino acids reduced is leucine, an overabundance of which relative to lysine may be involved in the etiology of the disease pellagra. Thus lime soaking is a deceptively simple cultural practice that solves complex nutritional dilemmas.

Language itself attests to protein complementarity's importance in East Asia. The Chinese *fan* literally translates as 'grain' (usually rice), but also signifies 'food'. *Ts'ai* literally translates as 'edible leaf and stem vegetable', but also signifies 'what goes over rice to complete the meal.' One is reminded of the phrase from the Lord's Prayer, "our daily bread," that signifies all necessary food. Complementarity here rests on the soybean. Rice or wheat is mixed with dozens of soybean products, including curds (tofu), soy milk, boiled or fermented soybeans, and soy sauce. Soy sauce, in turn, typically is made with wheat flour, whose methionine enhances an already strong amino acid profile. Digestion of soy protein, moreover, is enhanced by traditional fermentation, accomplished in water containing dissolved calcium or magnesium. These inactivate the antagonists to trypsin, a digestive enzyme, found in soybeans. Finally, sesame oil, a rich source of methionine, has been a preferred cooking oil in China since the Sung dynasty. Not surprisingly, even in times of famine, straightforward protein malnutrition has been rare in East Asia.

As one proceeds inland west or north, pulses and legumes such as the red bean (*Vigna angularis*), broad bean (*Vica fava*), the mung bean (*Vigna mungo*), the peanut, and the common pea (*Pisum sativum*) are mixed with cereals to aid complementarity. Fermented milk products such as yogurt become significant in Central Asia.

In the Middle East, South Asia, and Asia Minor, complementarity typically involves green vegetables, cheese, and lentils or peas with wheat. Wheat and pulses nicely complement each other's lysine and methionine ratios; amino acid scores attain at least 85 percent of egg white. Protein malnutrition is again rare.

Comparatively protein-poor Oceanic foods such as breadfruit (*Artocarpus communis*), bananas (*Musa*), taro

(*Colocasia esculenta*), and yams tend to be served together, often with green vegetables. Fish or pork is typically added in small amounts. Except in mountainous areas of New Guinea, protein malnutrition is rare.

Both Southeast Asia and coastal West Africa illustrate a dilemma stemming from substitution of meat for plants. The dominant carbohydrate, rice, typically is topped by small amounts of fish, as a fermented paste (Southeast Asia), or dried fragments (West Africa); peanuts and green vegetables may also contribute to the sauce. With much rice and little fish, protein can become quite diluted. In northern Thailand, for instance, small children may not eat enough rice with fish paste to meet caloric needs. However balanced, the protein is broken down for energy. In Senegal, among the Wolof, dried fish tends to fragment during cooking and be diluted throughout the rice gruel. Adults consider this less tasty, and following their example, children may resist eating sufficient rice.

Origins of Complementarity

The ingenuity and specificity of protein complementarity demands explanation. How did so many cultures independently discover protein mixing? Simple trial and error is unlikely, since protein undernutrition has ambiguous symptoms; even obvious malnutrition (kwashiorkor) has been variously attributed to supernatural intervention, inappropriate parental morals, or a failure of the child's will. On the other hand, dietary practices show good congruence with underlying biochemical advantages in growth and resistance to infection. Folk knowledge of these connections, however, remains poorly documented.

The origins of protein complementarity may be ecological. Optimization strategies must lead to a cost-benefit honing of the total menu available within any ecosystem. Nutritional benefits will be balanced against procurement costs. The !Kung San, for instance, select plant foods on the basis of abundance, ease of acquisition, and nutrient value. Elaborate taboos are reserved for meat, which costs more calories to obtain than it yields. Ultimately, any population whose long-term optimizations transgress nutritional requirements will suffer demographic collapse. We may, in other words, see close linkages between food choice and protein scores because cultures that ignored such an association are no longer extant.

Practices that enhance complementarity may operate through individual health-seeking behavior. Pairing introduced foods with familiar, liked components, such as mixing cereals with pulses, has been shown to facilitate acceptance in humans, but not in animals. The !Kung San typically equate nutrient value with tastiness, including texture, flavor, and smell. Such findings locate protein complementarity within what Pierre Bordieu terms "cultural habitas": a habitual, unremarked, individual practice that reflects group consensus about "how things are done." This habitas serves to internalize biologically adaptive food choices.

Over evolutionary time spans, finally, some behaviors may have become encephalized, or incorporated into neural functioning. Monoamine neurotransmitters such as serotonin, dopamine, and norepinephrine are synthesized from two amino acids, tryptophan and tyrosine. Neuronal levels of these amino acids in plant-eating monkeys, for instance, vary systematically with intake when dietary protein is scant, but are insensitive to intakes above 10 percent. Reductions in neuronal level limit neurotransmitter synthesis in the hypothalamus, which in turn regulates appetite. The brain, then, may receive constant information about the amino acid balance of our diet, and mediate appetite to achieve optimal rates of utilization when protein is scarce. Individuals would not be conscious of such nutrient-seeking appetites. Rather, diets that yielded appropriate mixes would become associated with elevated affect; they would taste richer, or better satisfy cravings, thus conditioning individuals to seek those foods. Protein complementarity consequently appears to follow multiple adaptive paths, individual and social, using both biology and culture.

See also **Legumes**; **Maize**; **Nuts**; **Proteins and Amino Acids**; **Rice**; **Soy**; **Squash and Gourds**; **Wheat**.

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COMFORT FOOD. Comfort food is an increasingly prominent concept in the twenty-first century. Indeed, as a consequence of the term's increased use in the English language (likely a response to increasingly stressful living conditions), the editors of the *Oxford English Dictionary* added "comfort food" to its list of 1997 entries, defining it as "food that comforts or affords solace; hence any food (frequently with a high sugar or carbohydrate content) that is associated with childhood or with home cooking." That same year *Merriam-Webster's Collegiate Dictionary* added "comfort food" to the tenth edition, defining it as "food prepared in a traditional style having a usually nostalgic or sentimental appeal." Comfort food may be best thought of as any food consumed by individuals, often during periods of stress, that evokes positive emotions and is associated with significant social relationships.

Throughout history and across cultures, food arguably has always been associated with the provision of comfort. Indeed, from the moments following birth, the crying infant is immediately soothed with mother's milk or, in more modern times, infant formula. Only in the last decade of the twentieth century, however, did the notion of comfort food as a unique concept become part of the vernacular of everyday life. Julie L. Locher and colleagues have observed that "daily life in the modern world, with its concomitant stress, psychological discomfort, and personal dislocation, has given rise to the need for comfort foods, and in a capitalist economy, of course, manufacturers have fully exploited such a need" (2002, p. 5). Restaurateurs and cookbook writers have taken advantage of individuals' needs for comfort as well. Contemporary societies have witnessed a proliferation of restaurants, including high-end restaurants, that feature comfort food on their daily menus. Additionally, growing numbers of cookbooks are dedicated exclusively to recipes for comfort foods, and whole cookbooks focus entirely on single comfort foods, such as macaroni and cheese (Schwartz, 2001). The notion of comfort food appears regularly in popular magazines (aimed primarily at women), television, and literature. Heralding the rise in the popularity of comfort food, *Bon Appetit* devoted most of its February 1998 issue to comfort food.

Several researchers have either demonstrated or speculated that links exist between physical or psychological aspects associated with mood and the consumption of particular foods, especially those foods high in carbohydrates (both sugar and starch) and fat. The most conclusive and widespread evidence arising from this investigation is that foods high in carbohydrates increase the availability of tryptophan, which increases the level of serotonin in the brain and results in a better mood state. Another plausible biological explanation for the link between food and mood maintains that foods that taste good may promote the release of endogenous opioids and thereby alter one's mood state. These physical and psychological observations may help explain some of the food objects individuals consume to provide comfort but certainly not all foods. Further, they do not explain the diversity of food choices among individuals and groups or why people choose some foods and not others for comfort.

Some researchers have emphasized the social dimensions of comfort food, noting that comfort foods are those familiar to the individual, are associated with feelings of nostalgia, are usually convenient to prepare and consume, are often indulgent, and typically provide a sense of physical as well as emotional comfort. According to Brian Wansink and Cynthia Sangerman, the most commonly reported comfort foods consumed in the United States are potato chips, followed by ice cream, cookies, and candy (2000, p. 1). All of these investigators found gender differences in what individuals perceive as comfort foods. Men are more likely to prefer entire meals, while women are more likely to prefer sweets (including chocolate) and snack foods. Age differences were identified also. Younger people prefer sweets and snacks, while older people prefer hot foods like soup and mashed potatoes.

Comfort foods are consumed under different circumstances in individuals' lives. Both social and psychological research indicates that when persons are feeling either sad or lonely, they may be more likely to consume particular foods. Additionally, researchers have found that persons consume comfort food when they are feeling "jubilant," when they need an incentive to get through something particularly stressful, or when they wish to be rewarded for something they have accomplished. The emphasis in most writings on comfort foods, in both the popular press and the academic press, is on personal sources of distress that encourage consumption of comfort foods.

Comfort foods are consumed during periods of societal uncertainty and crises. For example, immediately following the 11 September 2001 terrorist attack on the World Trade Center, restaurateurs across the United States reported increased sales of comfort food items, such as soup, mashed potatoes, puddings, and macaroni and cheese (Thorn, 2001). A Nielsen survey of grocery stores reported a significant increase in the sales of both snack foods and instant potatoes ("Nation Turning to Comfort Food," 2001). These reports may help explain why the notion of comfort foods became so important at that particular time in history. Conditions of postmodern societies present individuals with stressors that are often beyond their control. At the same time, societies have become consumer-oriented, and individuals have become more defined by the objects they consume. The consumption of particular food objects for comfort may be one of the primary ways individuals can maintain control. Thus, eating comfort foods may be a means of maintaining control over the self when all else seems out of control. In essence, comfort food provides individuals with a sense of security during troubling times by evoking emotions associated with safer and happier times.

See also **Slow Food; Snacks.**

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COMMODITY PRICE SUPPORTS.

Commodity price supports are statutory devices designed to enhance the net income of agricultural producers. These laws are called subsidies because they use the power and wealth of the state to "subsidize" producers by artificially supporting prices of agricultural commodities, reducing the cost of producing them, or, in some cases, providing direct cash payments to producers. In the United States, the core of statutory authority for price supports rests in Title 7 of the U.S. code and the Agricultural Act of 1949, as amended. These laws authorize loans that producers are not legally required to repay, open-market purchase of cranberries, and direct cash payments to dairy farmers under the Obey-Kohl Amendment to the 2001 Agricultural Appropriations Bill. Most of these laws were enacted in the Depression era of the 1930s but have been modified and extended up to the present time. Price support programs started out with six "basic" commodities (four from the South: peanuts, cotton, tobacco, and rice, and two from the North: wheat and corn). There now are some two dozen commodities that receive price support benefits. Both the cost and the complexity of these laws have grown dramatically. Sometimes these programs have collided with each other (like in 1983 when a federal law to kill aging dairy cattle in a futile attempt to raise milk prices seriously depressed beef prices as an avalanche of dairy cow meat buried the beef market).

While price support laws are aimed at achieving income parity for farmers and ranchers, there are many other laws that affect agricultural prosperity. For example, the Conservation Reserve Program currently idles about 36 million acres of fragile cropland. While conservation and environmental concerns may be the prime objective of this program, a substantial side-effect is the income stability for crop producers that comes from idling that enormous acreage. This phenomenon is present in other USDA conservation programs such as wetlands and forestry.

Another important agricultural law that has a major impact on farm prices and income is P.L. 83-480, the "Food for Peace" program. Through the years this major trade law has funneled billions of agricultural commodities into developing foreign nations, thus boosting domestic prices.

Other laws that indirectly boost U.S. farm prices include: Farm Credit Programs by USDA such as FmHA (Farmers Home Administration) and crop insurance. Also helping farm prosperity are the banking services of the Farm Credit Administration.

At this point it should be noted that states use their "negative" pricing power to reduce farm prices and farm income. Examples range from price controls during World World II and Korea to embargoes by Presidents Nixon, Carter, and Bush. Even seemingly unrelated programs involving agricultural research, such as the use of genetically modified organisms (GMOs), affect farm prices. Tax policy by federal, state, and local governments can also play a major role in the economics of farm owners and operators.

One final thought: In ancient Athens, it is said that the people despaired over the high price of figs, so that Archon commissioned a bevy of "fig watchers" or sycophants to keep both fig exports and fig prices low. It was probably the first "cheap food policy," but governments have been struggling ever since to organize a price support system that will be fair to both producers and consumers.

See also **Agriculture since the Industrial Revolution; Food Politics: United States; Government Agencies, U.S.**

Hyde H. Murray

COMPOTE. The word "compote" comes from *compositum*, the past participle of the Latin verb *componere* used as a noun. The basic culinary meaning refers to any preparation assembled from a variety of ingredients, with the added inference that this was done in a predetermined or formulaic arrangement. The English word "composition" also derives from this same root, and in both terms the aspects of visual appearance and texture play a key role. Roman cooks seem to have recognized a *compositum* when they saw one, but so few culinary texts have survived from Roman times that we seem to have only one recipe from Apicius as a reference point: *Rapae ut Diu Servuntur*, or turnips preserved in honey and vinegar with or without myrtle berries, mustard seeds and salt (Lib. I, xxiv; Milham, 1969). Significantly, Apicius did not use the term *compositum* anywhere in his surviving text.

It is not until the Middle Ages that the term *compositum* appears with any regularity, and it is clear from the medieval texts themselves that several distinctly different preparations went by the name of *compositum.* One of the oldest references, from the 1300s, was called a *confectio compositi* (Moulon, 1971) and consisted of parsley and celery root, cabbage, vinegar, pork, and other ingredients. It was a layered dish evidently baked in a deep earthenware pot and the prototype of a common one-pot dish known throughout southwest Germany, Alsace, and Switzerland as *Gumbis* (or some variation of that spelling).

In his *Theatrum Botanicum* (Basel, 1696) Swiss physician Theodore Zwinger described a common *Gumbis* made from pared turnips laid down in tubs with layers of barberries and sloes, then covered with spring water and salt. This sweet-and-salty vegetable preserve was eaten as a dessert, while the liquid was used in home remedies. This is not a cooked dish, yet it does follow in the tradition of Apicius and thus must be a recipe of considerable age. It is echoed in an eighteenth-century American recipe for preserving stone fruit in honey and spring water.

Hans Wiswe (1970) published a number of medieval German recipes for *compositum* and noted that they fell into three groups: First, a type of preserve employing fruits or vegetables, or a mixture of both, together with honey. In Renaissance cookery this evolved into fruit stewed in honey or in a sugar syrup. Second, layered sauerkraut mixtures, such as the addition of root parsley (Hamburg parsley) and turnips or some other root vegetable, even, perhaps, horseradish. Third, food mixtures prepared in deep earthenware baking pans and arranged in layers, invariably with shredded cabbage, shredded turnips, sauerkraut, fruit, and quite often small pieces of meat. Thus a recipe made primarily with sliced apples becomes *poma composta* or *Gumbis äpfel* (apple Gumbis). The traditional *Gumbistöpfel* of Canton Aargau in Switzerland employs dried pears. Many of the recipes are highly regionalized and thus point to the great age of this concept.

Such medieval layered mixtures continued to be made in North America by German-speaking settlers from Switzerland, Alsace, and southwest Germany. These fruit-cabbage-and-meat mixtures are discussed by Weaver (1993), who pointed out that they represent a type of one-pot meal once common throughout the Pennsylvania Dutch settlement area. Published recipes have also emerged in a number of nineteenth century sources, such as George Girardey's *Höchst nützliches Handbuch über Kochkunst* (The Handbook of the Art of Cooking; Cincinnati, 1842). It is the sweet *compositum*, however, which has gained the most widespread acceptance in European cookery today. It is almost universally referred to by its French name: compote.

Sweet Compotes

The sweet *compositum* is doubtless itself of great age and probably draws upon antecedents in the eastern Mediterranean. A preparation known as *mahés* (pronounced mah-CHESS) made in rural Cyprus points toward the antiquity of this concept. Grapes are partially dried in the sun, then packed tightly into a *goumni* (a type of small earthenware jar holding 5 to 6 liters), closed tightly, and allowed to ferment for two to three months. The result is a thick, syrupy, alcoholic delicacy which is eaten for dessert with a spoon. Slight fermentation appears to be one of the defining elements in this type of preparation and thus would explain why "compost," the old English term for it, eventually migrated in meaning to the more narrow sense of fermenting garden debris, as in the term "compost heap."

Hieatt and Butler (1985) published a reference to *datys in compaste*, mentioned on a medieval English menu,

Gooseberry Compote with Red Currant Juice

This German recipe is structured in such a way that 1 pound of any tart fruit or berries may be substituted for the gooseberries.

Yield: Serves 4 persons

1 pound (500g) ripe gooseberries
1/2 cup (125ml) red currant juice
3 tablespoons (45g) sugar or to taste

Pick the gooseberries of their stems and tails. Put them into a sieve and blanch in boiling water for a few seconds. Then place them in a stewpan with the currant juice and sugar and cook gently until they are soft. Serve warm or cold with vanilla ice cream or with crème fraîche.

SOURCE: Adapted and translated from Hedwig Heyl, *A B C der Küche* (Berlin, 1938), p. 317.

and suggested this might be preserved dates, describing it as something akin to chutney. It is difficult to know exactly what was meant, since there are a variety of ways the dates could have been preserved—even in simple syrup, but in all likelihood, the date mixture was probably more like *mahés*, since this was a common export item from the Latin kingdoms in the eastern Mediterranean. Whatever the case, two important points emerge: the use of the term "compote" in English and a direct association with something that is sweet and sticky.

A great deal has been written on the subject of the Arabic invention or perfection of this type of confectionery, especially where cane sugar was employed. Doubtless the technological trail can be traced to Persia or even India, where sugarcane was known and used for thousands of years. If there was a more westerly epicenter for sugar confectionery, then it was most certainly Syria, for the Syrians held a monopoly on sugar technology for a very long time during the Middle Ages. Even in the Latin kingdoms established in that region during the Crusades, Syrian Christians remained in charge of the sugar mills and confection shops. Let it be said, however, that before the arrival of sugar and its commercialization in the eastern Mediterranean, *epsima* (grape syrup), carob syrup, pomegranate syrup, date syrup, and, of course, honey played a significant role in the preparation of sweet fruit dishes. These preparations were primarily medical in nature but also pleasant-tasting.

The Move to the West

Wet, sticky fruits were exported to the West as luxury medicines, but as sugar became more available to Europeans, the art of making these medicines quickly spread as well, especially among druggists. These foods were often eaten at the end of the medieval meal to help rebalance the bodily humors, but in time became associated more and more with the banqueting course, as the dessert course was eventually called during the Renaissance. Cookbooks of that period generally lump the compotes together with cakes and other desserts, and that is where the preparation has remained on the menu down to the present day.

Culturally, fruits stewed in sugar play a far more significant role in the cuisine of Scandinavia, Russia, German-speaking Europe, and the Balkans than they do in modern American cookery. In those countries, the compote is a popular warm-weather food, almost a midsummer institution, whereas in the eastern Mediterranean, fruits prepared in sticky syrup are generally eaten as a delicacy served with very strong coffee.

See also **Apicius**; **Candy and Confections**; **Fruit**; **Middle East**; **Sugar and Sweeteners**; **Syrups; United States: Pennsylvania Dutch Food**.

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William Woys Weaver

CONDIMENTS. The term "condiment" originally meant seasoned, pickled, or preserved foods in Latin. Today, the word is broadly applied to a variety of foods, including spices, herbs, sauces, seasonings, flavorings, colorings, and even beverages, such as tea, coffee, and alcoholic drinks. A more narrow definition is that a condiment is a substance added to other foods for the purpose of giving a strong flavor or relish. Condiments usually appear on the table and are intended for individual use by the diner.

Condiments fall into five nonexclusive categories. The first is salt, the earliest and most important condiment employed by humans. In addition to its ubiquitous presence on tables around the world, salt is often a constituent ingredient in many other condiments. It is employed on a wide range of foods, including vegetables, meats, fish, and poultry. Salt is also occasionally shaken on beer and sprinkled on watermelons. Salt is a major preservative and today is commonly found in most processed foods.

The second most common condiment is sugar or other sweeteners, such as honey or maple syrup. Sugar and honey are used directly in everything from bitter beverages, such as tea, coffee, and chocolate, to a topping for breakfast cereals. Sugar and honey are also employed in making other condiments such as jams, jellies, preserves, and marmalades, and are used extensively on bread, rolls, scones, and in pastries. Maple syrup is commonly used on pancakes.

A third category of condiments is pickled foods, which date back to the ancient world in Europe as well as Asia. Common pickled foods used as condiments today include ginger (Japan), chutney (South Asia), and cucumbers (dill, butter, and gherkins). Almost all vegetables have been pickled and used as condiments in some form. They are served whole, in slices, or diced in a relish. Sliced and diced pickles are frequently used on sandwiches.

Spicy and Hot Condiments

A fourth condiment category are those spicy or hot foods, such as black pepper, chili pepper, mustard, garlic, horseradish, and onions. A product of Asia, black pepper (*Piper nigrum*) is commonly served from shakers throughout the Western world in a dried state and is usually ground into coarse or fine state before consumption. Like salt, pepper is used in savory dishes. It is also a base ingredient in some pepper sauces. Chili pepper (*Capsicum*), a product of the Americas, is employed in dried form on diverse foods.

Fresh chopped chili peppers are also the base ingredient in a number of other condiments, including salsa. In pre-Columbian times, the Aztecs employed a number of sauces based on chili peppers along with tomatoes and ground pumpkin seeds. After the Spanish Conquest in 1521, fusion foods developed including *salsa*s, which combined salt with ground tomatoes and chili peppers from the New World and vinegar from the Old World.

Tabasco sauce was an early American condiment based on chili pepper and vinegar. As Mexican cookery became an important food for mainstream Americans in the latter part of the twentieth century, salsas became an important part of cookery in the United States. The fresh salsa market exploded during the 1980s and continued to increase during the following decade. By the 1990s, salsa outsold ketchup.

Salsa is also used in making other condiments, such as guacamole, a combination of mashed avocados, salsa, onions, garlic, and other ingredients. Today, guacamole is served in Mexican restaurants and used as a dip for tortilla chips. Numerous other condiments serve as dips for potato and corn chips.

Mustard and Horseradish

In ancient Roman times, mustard was made from seeds of a variety of plants in the genus *Brassica.* The word originated in Latin and meant the "must" of new wine, which suggests that mustard seeds were combined with wine or vinegar. At an early date, mustard was disseminated throughout China, where it also became an important condiment in Chinese cookery.

The use of mustard survived the Middle Ages in Europe and was commonly employed in French and British cookery. Special dishes were developed for mustard's use as a table condiment. A major area of mustard production in France was the region around Dijon. Powdered mustard was commercialized in England and was produced in the United States by the mid-eighteenth century. The R. T. French Company began bottling a mild mustard in the United States about 1900. It was soon served on hot dogs and later hamburgers.

Horseradish (*Armoracia rusticana*), a product of western Asia, is a relatively recent addition to Western cookery. Pickled and ground, it is a highly pungent condiment used particularly with roast beef in England and other meats throughout Europe. In Japan, wasabi (*Eutrema wasabi*) serves a similar function for sushi.

Other Compound Sauces

The fifth and final condiment category is compound sauces, including ketchup, Worcestershire sauce, fish sauces, soy sauce, salad dressings, curries, and barbecue sauces. The earliest known compound sauces were made of fish. In widely separated regions, such as in the ancient Mediterranean and Southeast Asia, preservation of fish in a liquid form evolved.

In the ancient Mediterranean world, fish sauce called *garum* was initially made in the Greek communities along the Black Sea coast. It was heartily adopted by the Romans, who employed fish sauces lavishly on many dishes to enhance flavor. It was used as a cooking ingredient as well as a dip for fish and other foods at the table.

Fermented condiments were also developed in ancient China and Southeast Asia, where fish and other fermented sauces played significant culinary roles. By the seventeenth century, diverse sauces were manufactured throughout East and Southeast Asia. Today, China, India, and Japan produce small quantities of fermented fish sauces, but Southeast Asia remains the center of production and consumption. Beginning in the early twentieth century, authorities set standards for fermented fish sauce in French Indochina. These and subsequent standards formed the basis for commercial production. Fermented fish sauces, such as *nam pla* in Thailand, *nuoc mam* in Vietnam, *tuk trey* in Cambodia, *ngan-pye-ye* in Myanmar, *budu* in Malaysia, *patis* in the Philippines, and *nam pa* in Laos, continue to be very popular. These sauces are more than just flavor enhancers: they contain high levels of protein and other nutrients.

Another important Asian condiment was soy sauce. Soybeans had been converted into a sauce at least since 200 B.C.E. in China. It spread quickly throughout East and Southeast Asia. Although soy sauce production is believed to have started in China, eventually Japan became a major producer. Its popularity was spread by Buddhists, who used it as an alternative to fish sauce.

Ketchup

Another fermented East Asian and Southeast Asian sauce was *kê-tsiap*, which in the Amoy dialect of Chinese meant "the brine of pickled fish." The British encountered these sauces in Indonesia in the late seventeenth century. In the late seventeenth and early eighteenth centuries, *kecap* simply meant sauce, and usually referred to fermented black soybeans with a roasted cassava flour. The English word "ketchup" derived from the Indonesian word *kecap*. Anchovies were an important ingredient in early English ketchups. Although anchovies are no longer an ingredient in ketchup, anchovies were incorporated into several commercial brand-name sauces and relishes that were created during the nineteenth century, including Harvey's Sauce, Gentleman's Relish, and Lea & Perrins Worcestershire Sauce, which still feature anchovies as ingredients today.

Like fish sauces, ketchups were used in cooking to produce particular colors, consistencies, or tastes and were used as condiments on fish, fowl, and meats. Many types of ketchup were based on other products. Among the more important were walnut, mushroom, and later tomato ketchup, which became particularly popular in the United States. As the price for tomato ketchup decreased and became accessible to all Americans at the end of the nineteenth century, tomato ketchup became America's national condiment and other types of ketchup almost disappeared. Tomato ketchup has expanded beyond the English-speaking countries and today is manufactured in more than seventy countries and is consumed to some degree in nearly every country.

Tomato ketchup has also inspired other condiments. In the Philippines, banana ketchup, a takeoff on *jufran* and *mafran*, traditional Philippine hot and spicy banana-based condiments, is produced. Tomato ketchup was also used to make other condiments. For instance, many recipes for barbecue sauce contain ketchup. While barbecue has a long history, the first actual use of the term barbecue sauce does not appear until the mid-twentieth century.

Mayonnaise and Other Condiments

Mayonnaise was based on *aioli*, a Spanish sauce that combined olive oil and egg that probably dated back to Roman times. In the seventeenth century, the French took this basic notion, refined it, and gave the world a unique sauce that they called *mayonnaise*. It could stand alone or could be employed to make other sauces. Mayonnaise, one of the French "mother sauces," was exported to England and to America, where it was used as a sandwich spread in the nineteenth century. Around the turn of the century, it was first manufactured as a commercial product in America.

Mayonnaise was initially used on salads or to make salad dressings and other condiments. For instance, commercial tartar sauce is composed of mayonnaise, relish, and spices. Salad dressings have been consumed since ancient Roman times. Commercial dressings today include ranch, italian, blue cheese, thousand island, french, and caesar.

The rapid success of many condiments can be attributed directly to the globalization of American fast food establishments. For instance, ketchup, mustard, pickles, pickle relish, and mayonnaise are spread on hot dogs, hamburgers, and french fries.

See also **Chili Peppers; Mustard.**

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CONFECTIONS. *See* Candy and Confections.

CONSUMER PROTESTS.

When enough consumers become dissatisfied with their conditions, such as the lack of nutritional food, the cost of food, and the way food is produced, they have a tendency to organize with other like-minded people. They are then likely to take part in some forms of social action. Compared to a spontaneous riot, protests tend to be relatively organized and are often catalyzed by special-interest groups—sometimes referred to as the "protest industry." That term is appropriate since some such groups are very well established and influential. They use a variety of techniques to draw attention to their cause and to obtain support.

Food riots and food protests are ongoing phenomena. Historically, food riots, common in the eighteenth and early nineteenth centuries, have generally occurred when food is in short supply, whether this is due to weather, insect infestation, or weak economic conditions and increased food prices. For example, as a result of poor harvests in late eighteenth-century France, the price of bread soared, and riots were common in all areas of the country. French farmers have become famous for protesting government policies by driving tractors to Paris. The Great Irish Potato Famine of the mid-nineteenth century was the launching point for bloody riots. It eventually led to the great Irish emigration and to technological advances in agriculture. The food riots of this period led to more organized food protests as basic needs for nutrition gave way to demands for food safety and security.

Increased food prices, along with insufficient and unequal distribution of food rations during both World Wars led women to protest all over Europe. More recently, economic mismanagement and rising food prices in Argentina led to riots despite the abundance of food on supermarket shelves. Likewise, riots in some African countries are commonplace as disreputable governments

THE COWS ARE
MAD AS HELL

Protesters dressed as cows protest outside the Ministry of Agriculture in England over the handling of Mad Cow Disease. COURTESY OF AP/WIDE WORLD PHOTOS.

hoard food shipments from other nations for themselves while starvation is rampant in the poorer, more rural parts of the country.

Protests also occur when food is plentiful, but these protests and boycotts can be more political in nature. For instance, the 1965 grape boycott in California began as a result of wage disputes between domestic union workers, migrant workers, and grape growers. When negotiations between growers and workers stalled, union leader César Chavez called for a national boycott of table grapes. The four-year dispute led to more equitable contracts for workers and was the most successful boycott in American history.

Fears over food quality and safety are also catalysts for protest. In the 1980s, a national protest group used a public relations agency to launch a protest against the chemical Alar, which was used to keep apples on the tree longer and produce redder colors. However, the U.S. government did little to limit use of the chemical, and sales of the product continued, as did the spraying of apples, under consumer protest that children's lives were at stake. By 1989, apple sales had fallen by half, and the manufacturer was forced to take Alar off the market. The event led to some lawsuits by apple farmers against the network that broke the story that led to the consumer boycott.

More contemporary food issues attracting global attention include food safety, such as "mad cow disease" in Europe and the possible spread of this disease to humans. Mad cow disease, or bovine spongiform encephalopathy (BSE), is a neurodegenerative disease that eventually destroys a cow's brain. It has been responsible for the slaughter of millions of cattle and other food animals. Its human form (Creutzfeldt-Jakob Disease) has killed 111 people in the United Kingdom alone (*New Scientist*, 20 July 2002). The death toll could rise because the incubation period is long (the "second wave") and because the disease could spread to other animals or countries. Protests over BSE have arisen on several fronts. Farmers protest that they are not being compensated for their losses by insurance companies or the government. Consumers protest both the marketing of the suspected meat and the slaughter of affected animals.

Another issue that is prompting protests involves the genetic modification of food. That is, genes have been inserted or removed to provide specific benefits. Foods have been genetically modified to resist disease, adverse weather conditions, and insects, and are modified to contain beneficial human nutrients. Proponents of biotechnology report that the seeds are environmentally safe, reduce the need for pesticides, and can be modified to include useful nutrients. Opponents are concerned that genetically modified foods may have hidden health hazards, may be detrimental to the development of the poorest countries, and may be environmentally unsafe.

Protests against genetically modified food have occurred more often in Europe than in the United States. This reflects different cultural views on science, technology, and agriculture. There are also differences in the government's credibility. Europe is regulating the process of genetic modification based on a variety of political and economic interests.

One of the main things to note about consumer protests is that they are often well-funded and centrally coordinated by groups who have a vested interest in the outcome of the protests. Most average consumers have little interest in or even awareness of some of the protests. For example, a coalition including various players in the organic industry and some environmental groups has worked together to raise public fears about the safety of modern food production technologies (including pesticides and genetic modification). The ultimate goal is to increase the sales of the more profitable organic foods. Through their campaigns they have been quite successful.

Overall, it is interesting to note how the focus of food protests shifts as a country goes through the economic development process. In poor countries, the main concern involves getting enough food to eat. It is only in the richer countries that consumers are able to spend time and money to make sure that their foods are of high quality and safety. What is certain is that the future will see more protests over both sets of issues.

See also **Biotechnology; Food Riots; Food Supply, Food Shortages; Genetic Engineering; Meat.**

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Thomas Jefferson Hoban IV

CONSUMPTION OF FOOD. Did humans once have some instinctive knowledge about which foods to eat for good health? No one knows, but whatever inherent wisdom about nutrition humans might once have had has been wiped out in most parts of the world by a persistent background "noise": from infancy, people are bombarded by the selective, but constant, advertising of certain foods and drinks. Advancing globalization has sent products such as cola drinks to remote parts of the world, and advertisements for them have been so pervasive that some people believe that water cannot satisfy their thirst. Social aspects of eating have also changed in some countries, from regularly scheduled family meals to a pattern of random snacking. Is this the way humans were programmed to eat, or is it the result of marketing? Scientific aspects of nutrition also influence food consumption in many countries as consumers decide whether to eat nutritional foods or those that have no nutritional value.

Why Humans Eat What They Eat

What, when, how, and why people eat and drink is linked not only with biological needs and the availability of various foods, but also with the customs, aspirations, and expectations of their societies. The quantity and quality of food consumed, whether people "graze" or eat discrete meals, the emphasis given to different foods (or to desirable body shapes related to diet), and the customs surrounding eating have varied throughout history and within cultures. Nevertheless, the major influence on the daily diet has been the availability of food. Humans can survive only a few days without water and, while the average healthy person can stay alive for weeks or even months without food, this will have adverse effects and sometimes cause permanent health problems.

As well as being a biological necessity, eating and drinking are enjoyable activities, and the more varied the foods available, the more most people will eat. Nutritionists generally recommend eating a large variety of foods as this increases the chances of achieving nutritional adequacy and lowers the risk of a high toxin load. Against this, however, the problem of overconsumption now affects the wealthiest countries in the world, coexisting with malnutrition in many areas. Cultural factors—taboos about eating certain items, appropriate times for meals and snacks, and the way food is distributed among members of a social group—have also played a role historically.

When debate involves morality, scientific considerations may be beside the point. Some people think that food choices have a moral dimension, for example, regarding it as wrong to kill animals for food. Scientists, however, who study the ideal proportion of fatty acids in cell membranes maintain that, once our ancestors diverged from the apes, they adopted a diet that consisted primarily of marine creatures and plant-based foods. In *The Heretic's Feast: A History of Vegetarianism*, Colin Spencer, himself a vegetarian, traces the history of our ancestors' diets to show that human survival depended on being omnivorous, and notes that our close relatives, the chimpanzees, ate meat, although not in great quantities. Gastroenterologists support this, arguing that the human intestine is designed to digest both animal and plant foods. About 500,000 years ago, the discovery of fire almost certainly encouraged meat consumption because the heat softened connective tissue and produced enticing aromas and flavors. Having the physiological ability to eat any kind of food, however, does not mean that humans must be omnivores. Many people adopt a vegetarian lifestyle because of their religious or philosophical convictions without sacrificing a nutritionally balanced diet.

Until the twentieth century, the environmental consequences of the foods people consumed were largely ignored. With an increasing world population, however, the sustainability of the world's food supply has forced itself onto the agenda. Equity issues also arose because some countries were using up scarce energy and water resources to produce an ever-expanding range of foods for an overfed population while others starved because they did not have access to basic resources. The United States, for example, had approximately 5 percent of the world's population but consumed 26 percent of the world's energy resources as the twenty-first century began.

Growing grains or legumes to feed animals, rather than letting animals graze on lands not used for human crops, is particularly wasteful as lot-feeding requires approximately 100 times more water to provide about 1 kg of animal protein than is needed to produce the same amount of plant protein (Pimmental, Houser, and Preiss, 1997). There are also nutritional implications. Researchers found that the meat from grain-fed animals had fewer essential fatty acids than meat from grass-grazing animals, and there are also concerns about the effects on humans of the use of growth hormones to increase the size of cattle or their milk yield.

Myths, Customs, and Manners

Myths and superstitions associated with food exist in all cultures. Few people believe that cucumbers must be scored "to let the poisons out," tomatoes are no longer believed to be "toxic," and the belief that eating the brains of heroes will lead to bravery has almost disappeared, but myths abound, even when science has proven them wrong. As the twenty-first century began, for example, many people still believed that eating meat, especially beef, causes aggression. Others maintained that the body is unable to digest protein and carbohydrate at the same meal, which would make it impossible to digest foods containing both, such as human milk, nuts, seeds, grains, and legumes. Forty percent of the population in the United States is taking vitamin and herbal supplements because they believe advertising claims that vegetables and fruits no longer contains vitamins.

Some enduring customs relate to religious beliefs about food. These include feasts and fasts, kosher foods, foods regarded as "unclean," forbidden foods, "holy" foods, or the supernatural doctrine of the Roman Catholic and Eastern Orthodox Churches asserting the eucharistic transubstantiation of bread and wine into the body of Christ.

Wealth or social status also determines which foods people can afford to eat, although this can change over time. When peasants ate coarse whole-grain breads, for example, white bread was preferred by the upper classes. Because scientists determined that whole-grain breads are more nutritious than breads made of bleached white flour, highly educated people began to eat the more expensive whole-grain breads.

Etiquette also varies around the world. Where food is consumed with the hands and toilet paper is not used, it is customary for only one hand to be used for eating. Touching food or shaking hands with the hand used to wipe oneself in such countries is regarded as bad manners because it is unhygienic. Many people once considered it bad manners to eat while walking along the street, although the ubiquitous habit of snacking has led to greater tolerance of this practice.

In the West, many books have been written on table manners, but context is everything when it comes to etiquette. Much depends on the culture and social class, the context of the meal (a formal dinner demands adherence to complex social rules whereas a casual snack requires few or none), and the social group involved. In some cultures resting one's elbows on the table or making loud slurping noises is considered bad manners, whereas other societies have no objection to such habits. The polite way to put down cutlery at the end of a meal varies around the world, and sometimes even within a country. Some cultures regard burping at the end of a meal as a sign of satisfaction, even as a compliment to the cook; others think it is rude. Passing gas also has varying acceptance. In Western societies, some believe passing wind (flatus), even in private, indicates some medical problem. In fact, the quantity of gas produced is related to what has been eaten. As helpful bacteria break down dietary fiber and some types of starch, they produce beneficial acids with gas as a by-product.

Convenience

Over the past one hundred years or so, anything that reduced the need for domestic labor was popular, including kitchen appliances and convenience foods. Scholars such as Lebergott (1993) estimated that the average American housewife spent thirty-two fewer hours a week on meals and housecleaning in 1975 than she did in 1910. The noted nutritionist and ecologist Joan Gussow found that much of the time people once spent in the kitchen is spent watching television, and watching television is how they learn about the latest convenience foods, which saves them more time, which allows them to spend more time watching television so they can be persuaded to buy more convenience foods, and so it goes.

By the end of the twentieth century, marketing of fast foods had shown how easy it is to change eating habits. Starting from scratch almost fifty years earlier, by 1997 McDonalds had 23,132 outlets in more than one hundred countries, with annual sales of $34 billion. The standardized foods offered by fast-food chains had come to appeal to all socioeconomic groups and changed food culture for many people in the West, encouraging eating-on-the-run rather than sit-down family meals. Somewhat ironically, the only time some families eat together is at a fast-food restaurant. Research done in the 1990s (Stanton) found that children liked fast-food restaurants because they felt welcome, the family was relaxed and happy (because no one had to cook), and there were playgrounds and gifts. The food was relatively unimportant, but they liked the standard menu and the fact that there were no vegetables except for French fries. One McNair survey in Australia (1999) found that the "golden arches" had become, in just twenty years, more recognizable as a symbol than the crucifix. As one commentator put it, "Hamburgers are now outselling heaven."

When fast-food hamburgers appeared in Rome in 1989, Carlo Petrini was so horrified that he began the Slow Food Movement, intended to counter what he considered the degrading effects of industrialized food and fast foods. In 2002, the movement operated Convivia in forty-five countries and was spreading but had not yet reached sufficient critical mass to alter the average consumer's eating habits.

Nutritional Science

Nutritionally, fast foods are a disaster: they have high levels of added saturated fat, salt, and sugar. An average fast-food hamburger contains twice as much fat as one that was served by individual outlets in the 1970s. Few fast foods feature vegetables, apart from fat-soaked potatoes, and the replacement of regular meals with fast foods partly accounts for the fact that most people in Western countries eat fewer vegetables than nutritionists recommend for good health.

Despite the increase in convenience foods, however, nutrition was gradually becoming more important in influencing consumers' decisions about which foods to buy. This is nothing new. Hippocrates said 2,400 years ago, "Let food be thy medicine." But it was not until the twentieth century that vitamins, amino acids, fats, and fiber were isolated and identified, and researchers have since been trying to unravel the role of hundreds of protective phytochemicals in plant foods.

Nutritional science can encourage change if it gets enough airtime to compete with the time purchased for "informing" consumers about the latest unhealthy convenience foods. Olive oil, for example, was vital to Mediterranean cuisines for thousands of years, but was shunned as food in other countries, although it was used as a skin moisturizer. Once studies showed its healthfulness, olive oil became popular in cooking beyond its original homelands and was outselling all other oils in Australian supermarkets by the close of the 1990s.

Nutrition may not, however, always overcome social custom. For example, among preschool children in Australia, boys are given more meat than girls, although there is no difference in their need for meat's nutrients. The assumption that men should receive more meat than women ("feeding the man meat") then continues into adulthood, with Australian men consuming more than one and a half times as much meat as women, even though women have greater requirements for meat's most important nutrient—iron.

There are also fashions in dietary recommendations and changes as new data becomes available. Consumer confusion is also fed by self-styled "experts" whose book sales depend on new diets that have little or no scientific support. Basic governmental advice to consume more vegetables, fruits, and whole-grain cereal products and less saturated fat, sugar, and salt has not changed, but governments are not immune to influence from powerful lobby groups that want more positive spin for their products.

Meals and Snacks

Studies with adults have shown that eating "small and often" can produce benefits for metabolism, reduce blood fats, and lower blood glucose levels. Babies who feed spontaneously on their mother's milk have fewer problems with health and weight than those who are given regulated formula feeds of known quantity.

Does this research mean that snacks are preferable to meals, and would a grazing pattern of eating fit our genetic background better than restricting food to three major meals a day? While nothing is true for everyone all of the time, in countries where snacking is common, so is obesity; where snacking is less common, as in France, obesity rates are lower. The grazing pattern suits makers of processed snack foods (who fund some of the positive snacking studies), but most studies favoring snacks have provided the snacks calculated to fit each individual's daily requirements. In practice, self-selected snack foods are less nutritious, and, for those who overeat every time they eat, snacking may not be ideal.

From the Past to the Future

Three prominent milestones in the changing human diet can be identified:

- hunter-gatherer diets consisting mainly of meat, birds, insects, and fresh or saltwater creatures plus fruits, seeds (including wild grasses), nuts, various green vegetables, yams, and other edible plant materials;
- the agricultural, farm-based period that began about 10,000 years ago when animals were domesticated to produce meat and milk, and crops of grains, fruits, vegetables, and nuts were planted, first for individual families and then also for urban dwellers;
- the technological age, which extended basic farm-produced foods using processing and additives to increase shelf life and provided a broader range of foods padded with extra sugars, fat, salt, flavorings, and colorings. This period decreased the role of home cooking in favor of mass-produced, ready-to-eat foods. At the beginning of the twenty-first century, 46 percent of the food dollar in the United States was spent on foods prepared outside the home.

Genetically modified (GM) foods began to extend the role of technology at the end of the twentieth century. Initially, such foods benefited only those who owned seed stocks, but this technology can also produce foods capable of filling particular nutritional or social needs. GM technology created unrest in Europe and many other parts of the world, especially because of concerns about the integrity of local foods and the plight of poorer nations forced to exchange subsistence family farming for GM crops whose seeds are owned by large agribusiness companies.

Each of the major dietary changes throughout human history has had social and environmental implications. Hunters (usually men) were given greater status in many communities than gatherers (usually women and children). Farming also divided society into owners and workers. That distinction was transformed in developed countries by mechanization and takeovers of small family farms by large commercial companies. Rural communities were impoverished and turned into ghost towns as people left, agribusiness took over what had been family farms, and farming the resulting large farms was done by machine. Whatever tasks remained that required manual labor were left to migrant workers.

The technological age of highly processed foods encouraged people of all ages and socioeconomic groups to purchase foods prepared outside the family kitchen. Increased use of such foods caused cooking skills to degenerate and even changed the physical layout of some dwellings, where there is no longer a dedicated kitchen.

The environmental effects of dietary changes were not taken into account until the end of the twentieth century. Hunting, for example, contributed to some animal species being wiped out. Farming based on technology and driven by the bottom line, with its inhumane methods of raising animals, lot-feeding, and monocultural crops, required increased use of fertilizers, herbicides, and pesticides, which caused environmental problems such as increased salinity, poor soil fertility, poisoned or polluted groundwater, loss of many plant cultivars, and climate change due to massive land clearing. As the twenty-first century began, the conflict regarding the full environmental costs of GM crops was just getting started.

See also **Biotechnology; Fast Food; Feasts, Festivals, and Fasts; Food Supply and the Global Food Market; Food Supply, Food Shortages; Genetic Engineering; Hunting and Gathering; Religion and Food; Slow Food; Sociology; Taboos**.

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COOKBOOKS. Though essentially manuals of instruction for the preparation of food, cookbooks are now coming into their own as a genre. They are rich sources of information not only about the foods of a given period but about the people who cooked and consumed those foods. Scholars are turning to cookbooks for evidence of cultural values, and are showing a new appreciation for knowledgeable writers who write well about food and its context. Cookbooks have been moving away from their origins as humble recipe books to glamorous books with lavish photographs, more likely to be found on living-room coffee tables than kitchen counters. As a result of these enhancements, cookbook collectors are not only cooks and food scholars, but people who enjoy reading recipes with beautiful photographs of dishes they may never cook.

The history of cookbooks within a culture reflects its food traditions, so that while France has produced a rich cookbook literature, other countries have not. The evolution of restaurants in France, especially since the early nineteenth century, generated books written by chefs who have codified their recipes. But in a country such as Ireland, which has no restaurant tradition, historic recipes are to be found in the handed-down oral tradition of home cooks.

In America, early settlers brought with them books written in England, and later plagiarized recipes from British books for an American audience. Not until 1796 did an authentic American cookbook appear when Amelia Simmons published *American Cookery*, a collection of recipes that included such New World ingredients as corn meal and cranberries. Other decidedly American landmark cookbooks were published by Mary Randolph, Eliza Leslie, and Lydia Maria Child, whose *Frugal Houswife*, published in 1829, was later published in England and retitled *American Frugal Housewife*.

Nineteenth-Century Cookbooks

Because the mission of a cookbook is to instruct, the voice present in the text is authoritative and often didactic. In nineteenth-century America, the division of labor within most families required women to be responsible for the smooth running of the home and the proper feeding of husbands and children. Apart from offering recipes, cookbook writers of the period who saw themselves as guardians of the public morality took on the added responsibility of advising housewives on how to manage their duties.

Catherine Beecher, who carved out a career for herself by promoting the concept that housewives were professionals, believed that American women had control over the well-being of the country's democratic system and its future as a Christian nation. Beecher dedicates *The New Housekeeper's Manual* (1873) "to the women of America, in whose hands rest the real destinies of the republic, as moulded by the early training and preserved amid the maturer influences of home." To her mind, cooking well was the patriotic duty of homemakers. Beecher, who came from a family of preachers, was given to florid pronouncements such as these comments on the results of bad cooking: "Green biscuits with acrid spots of alkali; sour yeastbread; meat slowly simmered in fat till it seemed like grease itself, and slowly congealing in cold grease; and above all, that unpardonable enormity, strong butter!" She introduces her recipes declaring, "How one longs to show people what might have been done with the raw material out of which all these monstrosities were concocted!"

Another influential nineteenth-century voice was that of author Marion Harland, pen name of Mary Virginia Hawes Terhune, a woman whose privileged circumstances never prevented her from commanding the practical details of housekeeping. She published successful novels and advice manuals that gained her the confidence of readers. Her extraordinarily popular *Common Sense in the Household* (1871) holds that "it is a mistake of Christian civilization to educate girls into a love of science and literature, and then condemn them to the routine of a domestic drudge." Her task, as she saw it, was to encourage and reassure her readers by calling a kitchen disaster "a stepping-stone to success," for, as she puts it, "not to do it right is the next thing to success." Her book is a thick collection of typical American dishes that probably would have been cooked and served to Harland by the servants she employed in her affluent home. On the other hand, the assured Catherine Beecher, who had developed a system of scientific housekeeping, never had a home, husband, or children.

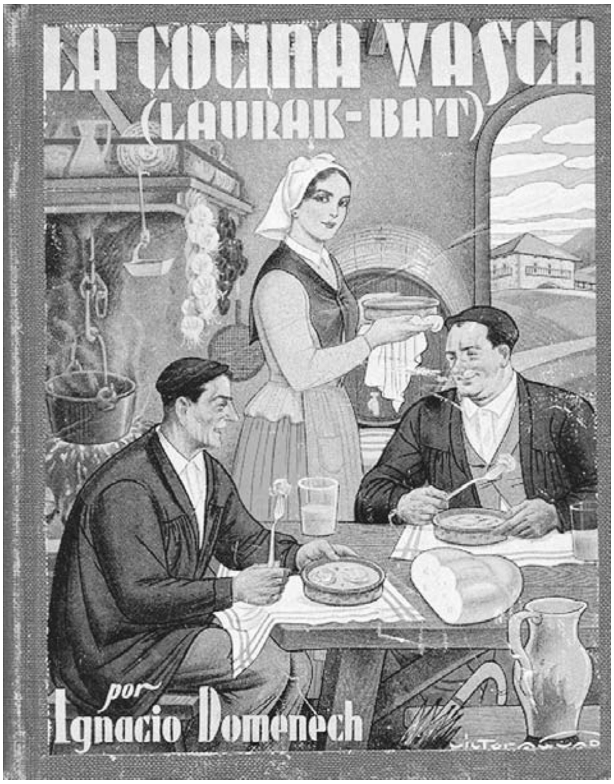
While the writings of Marion Harland and Catherine Beecher may project images that were different from the real women, there is consistency in their belief that a moral society depended on the skills of women working within the domestic sphere. Another writer of this period, Hetty Morrison, was, however, an out-and-out opponent of this view as her book, *My Summer in the Kitchen* (1878), makes abundantly clear. Morrison rails against the social forces that put women into the kitchen as though it were their natural habitat, and like Harland, deplores the quandary facing girls who were given no training in the domestic arts, yet were expected to be highly skilled homemakers when they married. But, unlike Harland, Morrison confronts the injustice of it all:

> The cunning of the serpent was nothing to that of man when he founded the institution of the kitchen and then placed woman there to tend it for him. Woman left to her natural instinct, would satisfy her appetite with a few chocolate caramels and an occasional cup of tea. But when her 'lord and master' appears upon the scene, then and there is hurrying to and fro, and fires and faces blaze, and terror, and death, and destruction go forth among the feathered, and furred, and fanny tribes.

Wartime Cookbooks

The authoritative voices in cookbooks can support the status quo by reinforcing current social values or they can dissent from conventional thinking. Another important function of cookbooks has been to help families in times of war when customary foods are scarce and often rationed. But even in times of national crisis, cookbook authors have varied in their approaches to how this challenge should be met.

During World War II, home economists and dietitians threw themselves into the war effort by educating the public about nutrition, and by trying to persuade all citizens to eat their fair share of what was allotted. Often wives would turn over their portion of the ration to husbands and sons, a sacrifice food writers hoped to correct. For instance, it was suggested that, instead of boiling eggs, they could be stretched further by scrambling them with breadcrumbs.



Cookbooks often serve as vehicles for ethnic identity. While *La cocina vasca* (The Basque Kitchen) is written in Spanish, the recipes also feature their names in the Basque language. Perhaps most important is the cover image, which emphasizes the point that the Basque kitchen is also the dining room. Shown here is the Barcelona edition of 1936. Roughwood Collection.

British wartime cookbooks. This theme of making-do was found in British cookbooks (cookery books) with titles such as *Cookery under Rations* (1941), *Health for All Ration-Time Recipe Book* (1948), and *Feeding the Family in War-Time* (1942). Their authors tended to be domestic scientists or dietitians whose task was to suggest cooking tips to keep families eating as well as possible within the limitations imposed by wartime rations. Their books make clear that monotony of diet was a big challenge. While such old-shoe crops as cabbages, Brussels sprouts, and oats grew comfortably in the British climate, such favorites as peaches, tomatoes, and wheat had to be imported and were therefore scarce. Most British wartime cookbooks are fairly somber in their instructions for plain and healthy recipes, often substituting ingredients at hand for more desirable ones.

One writer, Margaret Brady, saw fit to use the crisis of war as an opportunity to promote her prewar commitment to vegetarianism, seeing virtue in brown rather than white bread, less meat and more vegetables, and sugar-free desserts. *Health for All Ration-Time Recipe Book* (1948) has directions for such concoctions as nut and carrot rissoles, nut meat stew, and oatmeal soup, and puts emphasis on the healthful properties of raw foods, a reminder that cooking fuel also had to be conserved.

Wartime exigencies turned cookbook writers into virtuous citizens. For example, Doris Grant, who was not a food or health expert before the war, was motivated to learn more about these subjects. *Feeding the Family in War-Time* (1942) has advice on healthy living followed by recipes for such fare as wartime ice cream (made with soy flour), potato sausages (made with oatmeal), and salads made with grated carrots, a vegetable that grows abundantly in the British Isles.

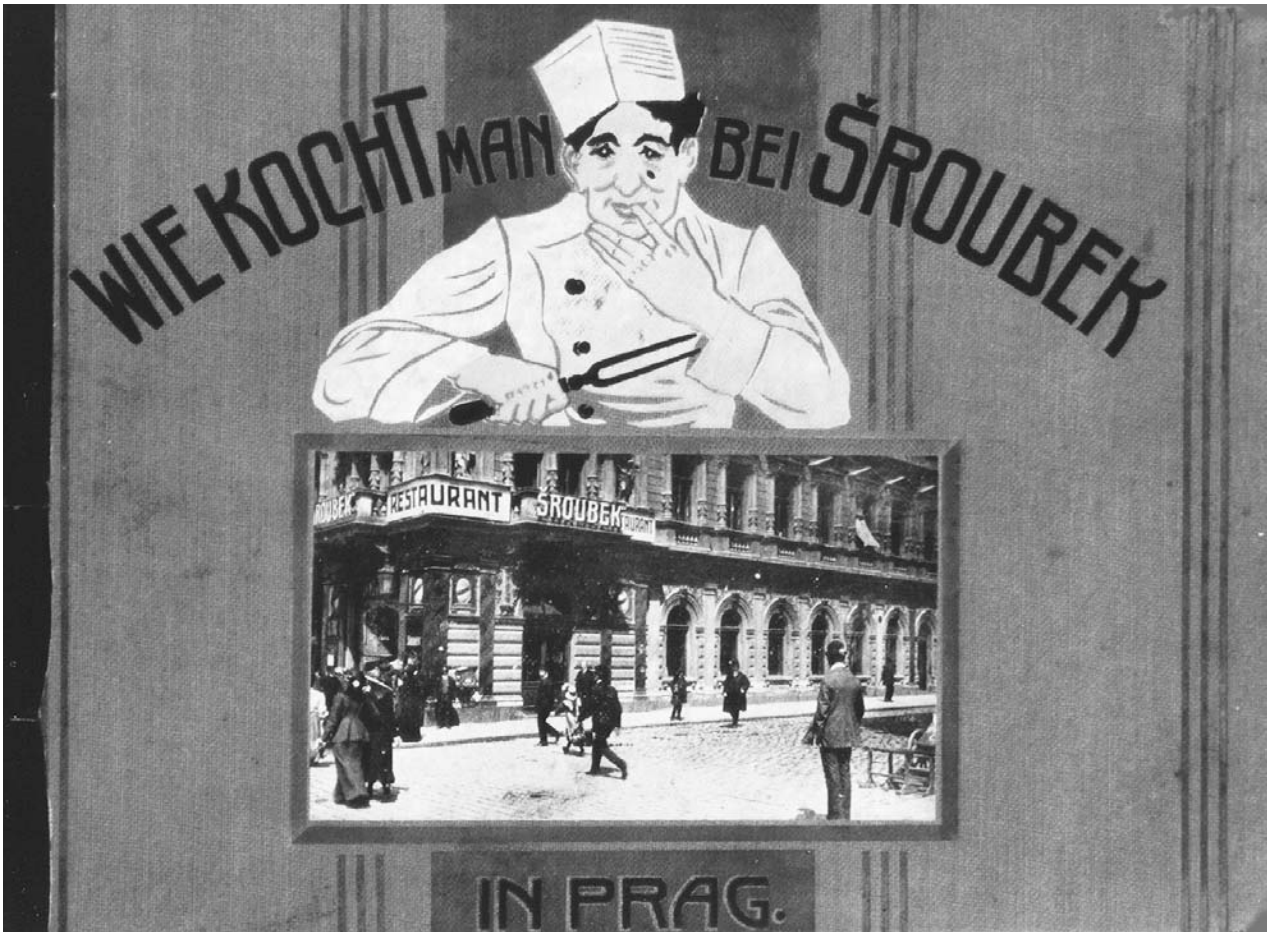
Marguerite Patten sums up wartime conditions in England in *We'll Eat Again: A Collection of Recipes from the War Years* (1985), a backward glance at how the country managed on the available food supply. She offers the surprising information that there was an improvement in overall health as measured by a decline in infant mortality and an increase in the average age of death from natural causes. The recipes and advice collected in this book make clear that poor people who subsisted mainly on bread and other starches were urged to eat more meat, eggs, and fresh produce than ever before, resulting in improved health statistics. The diet of the upper classes was also improved because people were obliged to ease up on the traditional prewar English breakfast of fatty meats and eggs, and the customary rich cakes and pastries served at afternoon tea.

Not all wartime cookbook writers addressed the needs of the body alone. In her *Come into the Garden Cookbook* (1942), Constance Spry explains, "I write this book for the people who see nothing unseemly in being enthusiastic about food, and who are willing to turn attention and energy into procuring and preparing it." Not for her are sausages extended with breadcrumbs or cabbage stuffed with oatmeal. She aims to grow good food in her garden, cook it skillfully, and pass on to others directions and encouragement for doing the same. All too aware that British cooks did not prepare vegetables with the respect they deserved, she offers excellent recipes to get people through wartime eating not just well, but deliciously so. As for gardening, she sees such activity as "a cure for frayed nerves and restless minds [that] can ease unhappiness and lighten apprehension." Spry's wartime cookbook is written as much for the spirit as for the body. Unlike other books of the time, hers does not reduce food to its nutritional components but instead describes it as a way to bring comfort and joy as well as sustenance to a population under stress.

American wartime cookbooks. In America, abundant advice about wartime cooking routinely appeared in articles and books, most of them offering practical information about gardening and canning as well as thrifty tips for dishes not requiring too much of what was rationed. A recurring theme in this material is that American housewives were performing their patriotic duty by following the advice offered by this assemblage of experts.

Alice Bradley, the principal of Miss Farmer's School of Cookery in Boston and an influential food writer of the time, published books that explained how to plan meals, shop for ingredients, and cook well despite shortages. Her dedication in *The Wartime Cook Book* (1943) is to "Women who are cooperating in winning the war by using those foods of which we have an abundance in such combinations as to make themselves and their families strong." The moral message was not dissimilar to what nineteenth-century women had been told by cookbook writers who believed that the health of the nation relied upon the smooth running of the home and the proper cooking of family meals. Bradley's wartime tips include substituting soybean flour for wheat in thickening sauces and soups, using a pressure cooker to conserve heat and retain vitamins in vegetables, replacing sugar with honey or syrup in fruit desserts, and making use of such animal parts as the liver, heart, kidney, sweetbreads, tripe, and tongue. She has a recipe for "heart ragout" that calls for "leftover heart" as its first ingredient, causing one to wonder what else Miss Bradley kept in her refrigerator. Always in the role of a teacher who dispatched cooking information with clarity and economy, Miss Bradley was never given to moments of speculation about living through difficult times.

Such thoughts were more in the mind of M. F. K. Fisher, who in 1942 brought out *How to Cook a Wolf,* a book about eating well during wartime. She states: "I believe that one of the most dignified ways we are capable of, to assert and then reassert our dignity in the face of poverty and war's fears and pains, is to nourish ourselves with all possible skill, delicacy, and ever-increasing enjoyment." Fisher was speaking to the human heart and not just to its stomach, and in so doing was taking on the food-writing establishment, who never looked beyond the mundane issue of the well-balanced meal, a concept Fisher loathed. Convinced that human requirements vary, Fisher reserved the right to eat just toast for breakfast if she felt like it, while others might feel better dining on protein alone. This is not to say that Fisher is never practical, for she does provide seventy-three wartime recipes for favorite foods using cheap and available ingredients, and it is a measure of her acclaim as a food writer that those recipes continue to have wide appeal. She talks about the comfort of such simple dishes as polenta, spaghetti, and kasha. But she is careful to say that the polenta must be made with coarsely ground cornmeal from Italian grocery stores, the spaghetti must not be overcooked, and the kasha can be made heavenly by the addition of butter and sauteed mushrooms. *How to Cook a Wolf,* a book about food that should have lost its audience when the war was over, is still read with curiosity and pleasure. For M. F. K. Fisher, writing about food was a way to share experiences and feelings, with her most memorable writing coming out of the exigencies of war. At a time when most other food writers were watering down butter or extending meat loaves and



Cookbooks by famous restaurant chefs have been an important genre since the eighteenth century. Chef Karl Sroubek's *Wie kocht man bei Sroubek* [The way we cook at Sroubek's], published in 1911, showcases dishes from this once famous temple of Central European cookery in Prague. ROUGHWOOD COLLECTION.

hashes with still more breadcrumbs, Fisher was advising her readers that "since we must eat to live we might as well do it with both grace and gusto." It was an inspiring message for a frightened world.

Modern Trends

Cookbooks have continued to reflect changes in American life in every decade following World War II. Some cookbooks of the 1950s reflect the prevalence of short-cut cooking and the use of technology. In *The Can-Opener Cookbook* (1951), Poppy Cannon tells us that "The use of a can opener may not be news, but the gourmet approach definitely is." The home freezer, an appliance that was increasingly popular after the war, inspired such books as Anne Seranne's *Your Home Freezer* (1953), which taught how "gourmet" dishes could be prepared in batches and frozen for a rainy day. Postwar inflation also prompted books that emphasized thrift. For example, Ida Bailey Allen's *Solving the High Cost of Eating* (1952) and James Beard's *How to Eat Better for Less Money* (1954) taught Americans how to best manage their food budgets. By 1961, Lila Perl had published *What Cooks in Suburbia*, with a table of contents that refers to "Pot-luck from the deep freeze" and special recipes for dinner parties that were in vogue during this period. In the same year, Julia Child published *Mastering the Art of French Cooking*, the book that inspired many adventurous American cooks to take on the challenges of French cuisine.

By the late 1960s and the 1970s, the country was seeing a radicalized youth culture developing in response to antiwar protests and the movements for civil rights and women's rights. A group called the Friends of the United Farmworkers produced a cookbook in 1976 to raise money in support of grape pickers seeking fair wages. This book is a reminder of the successful grape boycott that was observed by many American families. A short time later, the Bloodroot Collective, a feminist commune that runs a Connecticut restaurant, produced *The Political Palate, a Feminist Vegetarian Cookbook* (1980). Their political convictions included the use of vegetarian, organically grown foods and excluded the celebration of traditional holidays that were seen as endorsing "a theology and value system which continues opposition to abortion and the Equal Rights Amendment [and] believes homosexuality to be a sin or disease." The collective's political approach to food is inclusive in that their recipes take in Native-American sources as well as a range of other ethnic influences.

American cookbook publishing has become noticeably ambitious in that it covers international cuisines of all kinds. Cookbooks are often lavishly illustrated, many of them authored by well-known chefs. Another trend has been in books with a nutritional slant, most frequently on weight loss, a clear indication that the American book-buying public is not suffering from deprivation or the need to economize. An affluent, increasingly overweight society has become a ready audience for a continuing supply of books that promise painless solutions to the vexing problem of weight control.

Cookbooks have value as historical documents that can provide us with insights into people or groups by examining their relationship to food. Any culture that has a tradition of cookbook writing can be similarly approached. Until recently, researchers have overlooked or trivialized cookbooks. Now these books are beginning to be recognized as valuable records of our past, full of information waiting to be interpreted.

See also **Beard, James; Child, Julia; Community Cookbooks; Fisher, M. F. K.; Food Studies; Leslie, Eliza.**

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Barbara Haber

COOKBOOKS, COMMUNITY. Community cookbooks (also known as compiled, regional, charitable, and fund-raising cookbooks) are a unique genre of culinary literature. These volumes are produced collaboratively by volunteer women from charitable organizations, churches, synagogues, heritage associations, clubs, schools, and museums, among others. They represent the group's members and cuisine. The practice of producing these volumes to raise money began shortly after the end of the Civil War (1860–1865) when they were compiled by Northern Protestant churchwomen to raise money for the Union Army wounded and their families.

Research Tool for Culinary Historians

Community cookbooks are a rich source for the culinary historian and foodways researcher. They can be read like texts, accurate and reasonably complete reflections of the food habits of the communities that produce them. Unfortunately, community cookbooks have only recently been taken seriously, and the greatest challenge for the researcher may be in locating the books (see the bibliography below). In defining "community," these books include certain people and traditions, and exclude others. For example, a cookbook prepared by a religious group that shuns alcohol will not include a drinks section or use liquor in its recipes. These volumes provide records of regional culinary cultures, and the historical, philosophical, and religious background of their compilers.

Community cookbooks focus on home cooking, often documenting regional, ethnic, family, and societal traditions, as well as local history. Some of the earlier ones served to preserve the cooking of the homeland, those countries in Europe and Russia that produced the great wave of immigration between the 1880s and the outbreak of World War I. The cookbooks often distinguish between common, everyday foods and special occasion foods; for example, two Midwestern cookbooks, *What Albion Congregationalists Eat* and *Our Favorite Recipes* mention that meat loaf or baked beans are served only to family, whereas festive dishes were reserved for holidays. Although not submitted to the rigors of professional recipe testing, the formulas have the weight of years of experience in the home kitchen. Indeed, many of the cookbooks advertise their recipes as "tried and true," providing access to the collective culinary skills and expertise of many women.

The volumes provide insight into food preferences as well as those dishes that are disliked or taboo and simply not included. For instance, the *Swedish American Cook Book*, published in 1941 by the West Hartford [Connecticut] Ladies Aid Society, includes a wealth of recipes using canned crushed pineapple, such as Pineapple Meringue Pie, Pudding, Frosting, Icebox Dessert, Pineapple Loaf, and Skillet Sponge. This book, as well as others that focus on a particular ethnicity, offers clues to the degree of assimilation of the community. Clearly, the extensive use of canned pineapple reflects the embracing of American processed foods rather than Swedish heritage and tradition. Similarly, *The Johnstown Area Heritage Association Cookbook*, published in Johnstown, Pennsylvania, in 1989, includes Mexican recipes based on the migration of laborers into the area looking for work in the mines and mills. It documents the celebration of the Feast of Our Lady of Guadalupe, the patron saint of Mexico, every December by this community, a tradition that was abandoned toward the end of the twentieth century.

A Few Best-Sellers

Community cookbooks have proved an extremely effective means of quickly raising funds. Some, in fact, have earned millions of dollars, and transcend popularity in their original communities to take on a life of their own. One of the best known, although it was actually prepared by only two women, is *The Settlement Cook Book*, subtitled *The Way to a Man's Heart*, first published by the Milwaukee Jewish Mission and The Settlement in 1901 to benefit newly arrived Jewish immigrants. It has gone through more than forty editions, and a hundred years after its first publication it had sold over 1,500,000 copies. It was one of the first ethnic cookbooks published in English, and one of the earliest to include German-Jewish recipes. Another big seller has been *Forum Feasts: Favorite Recipes of the Forum School*, first published in 1968 to raise funds for a school for emotionally disturbed children in northern New Jersey. The fact that *Forum Feasts* went through twenty printings and sold more than 300,000 copies before it went out of print shows that it was bought by great numbers of people who had no interest or involvement in the Forum School. Part of the widespread appeal of community cookbooks may well be the strong stand they make for home cooking.

Today, some community cookbooks are expensively and professionally produced. *The High Museum of Art Recipe Collection*, published by an art museum in Atlanta, Georgia, in 1981, contains four-color plates of museum paintings and features chapter headings such as "Dinner at Eight: Recipes for Seated Dinners at Home," which reveal a cosmopolitan community where gracious living and entertaining is the norm. Another chapter is entitled "Before the Game and After the Show: Prized Recipes for Brunches and Late-Night Suppers"; the "Picnic" chapter includes "elegant picnics."

Community Cookbooks as Women's History and Literature

Community cookbooks are uniquely women's literature, created by and for women, one of the earliest ways in which women could relate their stories and history. Like quilts and needlework that have also been perceived as trivial, domestic crafts, community cookbooks have often provided the prime, perhaps only, vehicle for women to express themselves. Since they fall under the rubric of "good works," the cookbooks evolved as permissible and appropriate activities for women for whom professional careers might not be acceptable in their own eyes or those of their communities. Some of the books go well beyond these goals to provide a platform for a political or social agenda. *Our Sisters' Recipes* (Pittsburgh, 1909), a Jewish community cookbook, uses a frontispiece of an African-American woman with a head scarf, apron and spoon to symbolize that the sponsors had achieved American middle-class status and could afford to employ cooks. the National Council of Negro Women's *The Black Family Dinner Quilt Cookbook* (1993) pays tribute to a civil rights leader and discusses food traditions.

By soliciting and contributing recipes for the cookbooks, women participate in a women's network, similar to quilting. As Anne Bower points out in *Recipes for Reading*, these are women "bound together by recipes" (p. 14). Community cookbooks institutionalize the informal practice of recipe exchange among women. This dynamic process has involved and defined a vast community of middle-class women, telling stories that are both personal/autobiographical and relational. By writing their cultures into the cookbooks, these women establish their identities and reveal their history, a major aspect of female cultural heritage.

See also **Cookbooks; Recipe**.

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Linda Murray Berzok

COOKIES. *See* **Baking; Biscuit; Pastry.**

COOKING. Cooking often means the transformation of raw food by the use of heat. Conceived this way, cooking's contribution to human pleasure, culture, and survival could hardly be overstated. When interpreted more widely to include everything involved in the preparation of meals, cooking is even more extraordinarily time-consuming and far-reaching.

Cooking is so universal that it has even been proposed as the distinguishing trait of *Homo sapiens*. In a journal entry for 15 August 1773, social observer James Boswell noted that other species possessed the abilities of toolmaking and rationality, but "no beast is a cook," and his definition of humans as the "cooking animal" was the subject of much discussion and amusement at dinner tables. The paradigmatic cultural transformation of "raw" into "cooked" was brought into a more recent scholarly context by the anthropologist Claude Lévi-Strauss, who wrote in *The Raw and the Cooked*, "Not only does cooking mark the transition from nature to culture, but through it and by means of it, the human state can be defined with all its attributes" (p. 164).

Modern recipe books demonstrate cooking's great array of visual, olfactory, and gustatory effects. Increasing the attractiveness of food and altering its nutritional properties, cooking has served fundamental social and cultural purposes. Cooking made possible the agrarian mode of production, based on food storage. Even earlier, cooking widened the range of available food species and therefore of habitats, its origins traceable to the use of the first stone cook's knife.

Cooking has often been depicted as part of women's housework, which supports "real" (male or public) production. It has belonged, as stated by Simone de Beauvoir in *The Second Sex*, to women's dreary sphere of "immanence" rather than men's artistic, intellectual world of "transcendence." This split helps explain why cooking has been little studied in any systematic way. Authorities are far from agreed on the basic cooking techniques, and words are used carelessly, such as "roasting" when "baking" is, in fact, meant. The central purpose of cooking has hardly been discussed, let alone settled.

Here cooking will be examined in the context of its narrow definition as heating. Then other techniques, which include cutting, grinding, mixing, drying, fermenting, and attractive presentation, will be discussed. These techniques are grouped according to their broad outcomes, thus helping to identify cooking's cultural significance and social location. For further information on cooking's technical aspects, see particularly Harold McGee's *On Food and Cooking;* for information on its cultural and social aspects, see Michael Symons's *A History of Cooks and Cooking.*

The Use of Heat

When Jean-Anthelme Brillat-Savarin assumed in *The Physiology of Taste* that the savory results of roasting derived from a juice in meat called "osmazome," his thinking was not all that unusual in the early nineteenth century. Later work has found instead that the pleasing taste results from a complicated set of changes produced through caramelization and the so-called Maillard browning reactions. Nonetheless, as Harold McGee argues in *The Curious Cook*, "Whatever it is about a roast that inspires such devotion deserves a name, and in the absence of a better one, osmazome serves admirably" (p. 296).

Roasting, baking, broiling, grilling, and frying reach the relatively high temperatures necessary for browning to be achieved sufficiently quickly. The relatively plain-looking and bland effects of boiling and steaming follow from their temperatures being limited to the boiling point of water, 212°F (100°C). Nevertheless, all heating methods alter the aroma, appearance, and texture of foods. Furthermore, heat can turn some otherwise poisonous or inedible substances into food, and change other nutritional properties, not always for the better.

The basic techniques of cooking (in the narrow sense) rely on the physicists' three modes of heat transfer—radiation, conduction, and convection. The glowing coals radiate at relatively high temperatures to roast a joint on the spit. When food is placed on a gridiron immediately over the radiant source, this is grilling. Broiling is similarly intense but from above. Energy is transferred to the food through conduction in the separate techniques of boiling, steaming, and frying. Gentle boiling (poaching or simmering) also relies on the circulation of heat through convection.

Practical methods combine all modes of energy transfer. In baking, the walls of the oven radiate heat, hot air moves through convection, and energy transfers through conduction. Nothing could seem more direct than roasting, until processes internal to the cooked article are considered, such as conduction of heat from the surface inward and steaming within the cavity of a fowl.

Cooking methods employ different mediums, most basically water, oil, or air. Food is boiled, poached, and steamed with water. Food is either deep-fried immersed in hot oil or shallow-fried on a layer of oil in a pan. Baking employs heated air. Again, practical methods combine mediums. An obvious example is braising, which expressly relies on frying and then, after adding liquid and closing the lid, poaching and steaming in the same container.

The promotion of the "economy" stove by British Count Rumford (Benjamin Thompson) added to the confusion at the beginning of the nineteenth century, because he claimed to roast a joint in a "closed" oven, which both improved efficiency and kept flue gases separate. However, since oven temperatures were much lower than those emanating from open coals, his "roast dinner" was a misnomer. An equivalent twentieth-century misconception resulted with the microwave oven, which employs an entirely different science—the stimulated vibration of water molecules so that food heats up internally—so that the device is not really an "oven."

According to the massive *Mrs. Beeton's Book of Household Management*, published in England in 1909, the six cooking methods "commonly spoken of" are roasting, boiling, broiling, frying, stewing, and baking. These are the same methods listed in the general prologue of the *Canterbury Tales* more than five centuries earlier, when Geoffrey Chaucer claimed the cook was able to "rooste, and sethe [boil], and broille, and frye, / Maken mortreux [stews], and wel bake a pye." Although ten basic methods have already been discussed above—roasting, broiling, grilling, baking, boiling, steaming, shallow frying, deep frying, and microwaving—Chaucer reasonably distinguishes stewing from boiling, and many modern-day cooks would also regard poaching as distinct.

Claude Lévi-Strauss's much-reprinted but, for many people, puzzling "culinary triangle" had three cooking methods placed at each corner (boiled, roasted, and smoked). By then finding places for another three (broiled, fried, and braised), he again assumed a total of six methods. He omitted baking, however, and added smoking, although this sort of drying and light tarring might be better listed under preservation methods. Stir-frying deserves its own place of recognition, and so do infusion (as in preparing tea), steam extraction (as in espresso coffee), and pressure-cooking. And yet another complication in this attempt at categorization is the fact that rice largely "cooks" by absorption. In the end, any list of cooking methods remains merely indicative and conveys only broad principles.

The Cooking Fire

Basic cooking (by heating) relies on various heat sources. Any list of principal cultural variants would have to include the spit, gridiron, grill (or salamander), boiling and stewing pot, enclosed braising pot, steamer, frying pan, stir-fry wok, deepfryer, vertical oven (*tannūr*), horizontal oven (baker's oven), range, and microwave oven. Some basic features can be demonstrated by discussing just four: the open fire, the stewing pot, the oven, and the brazier.

Although not necessarily the oldest method, the open roasting fire is primordially simple, with meat and other foods skewered on vertical sticks or rotated horizontally on a spit. Roasting was first used by hunters, has often been called the *Homeric method* since its use is cited frequently in the ancient stories of Homer, and has held a particular appeal for the British in recent centuries.

The most ancient images of cookery invariably depict women, since management of the hearth was one of the traditional domestic spheres assigned to females. This ancient Greek terracotta statuette from the third century B.C.E. depicts a woman cooking. © GIANNI DAGLI ORTI/CORBIS.

Historically even more important than the spit is the stewing pot. In this vessel various ingredients are combined for long, slow heating; sometimes, the pot's contents are just continuously replenished over days and weeks. Pots have typically been made of clay but variations have included rock depressions (heated by hot stones), leather pouches, and, increasingly, metal containers. The pot was associated with the emergence of a settled society where it was used for both storage and the slow cooking generally required by storable crops.

Dedicated clay ovens are nearly as old as pots, dating from at least seven thousand years ago. These "vertical" ovens are most familiar to English speakers as tandoor ovens (from the Hindustani). Many similar words used in and around the Middle East derive from the ancient Persian, Arabic, and Hebrew *tannūr*. The classic version is a clay barrel containing the fire, entered from the top; it is characteristically used for flatbread placed briefly on the wall inside, so that one side browns through conduction and the other through radiation. Throughout Europe, the more familiar variation of this kind of oven has been the horizontal (or "baker's") oven often used to make leavened bread and sharing the floor with its fire in the simplest versions.

The brazier is another simple pot of burning dung or charcoal, on which appropriate containers are placed so that food is broiled, fried, stewed, or baked. Relatively efficient, it has been used when fuel is scarce and so has remained extraordinarily widespread—as common in ancient Athens as it has remained throughout Asia. An enlarged brazier with two or more apertures for heat is the range, fueled by wood, coal, gas, or electricity.

Most major English language dictionaries agree on the definition of the verb "cook" as "to prepare (food) by heating it," and the basic techniques and devices decribed here are commonly accepted. However, cooking plainly employs many other techniques. The development of artificial refrigeration in the nineteenth century only increased the importance of the removal of heat in certain preparations, such as freezing ice cream. Preparing mayonnaise, for instance, also involves combining oil and eggs entirely without heat.

Other important techniques will now be discussed under their broad outcomes, mainly shared by heating. For example, heat enhances pleasures, not merely taste but also texture by, among other methods, obtaining various concentrations of sugar syrup for soft fudges, firmer caramels, toffee, and spun sugar. Heating also supports two of cooking's other broad purposes, improved nutritional qualities and storage. Heating contributes less noticeably to an additional, presumably underlying task, food distribution.

Making Food Attractive

Cooks have become immensely skilled at enhancing the sensory appeal of food. Adding sugar, salt, and acid (such as vinegar) has a marked effect on flavor, although this might often be a side effect of some other desired outcome, such as preservation. Nonetheless, improved attractiveness has been the basic reason for many other simple additions, such as pepper, ginger, caraway seeds, mint, mustard, nutmeg, and vanilla. Spices typically modify aroma and taste, and sometimes they also impart a charming color, as with saffron. The English concept of "curry" does not do justice to the full range of spices ground and blended into much Indian cooking.

Subtly flavored sauces—the peak of grand French cooking—are classically based on stocks, made by simmering bones to extract gelatin (especially veal because younger bones are rich in gelatin-producing collagen). A brown stock flavored with red wine and shallots then becomes a bordelaise sauce, and so on. Other sauces are prepared by emulsification, in which oil is so finely dispersed in another liquid that it remains suspended. For instance, mayonnaise is oil dispersed in egg yolks. Flavored with garlic, mayonnaise becomes *aioli.* Other emulsions are made from butter and cooked egg, notably hollandaise and its derivatives, such as béarnaise with tarragon. McGee suggests that the "fragrant sauce" for asparagus in La Varenne's cookbook of 1651 may be the first recorded recipe for an egg-based emulsified sauce.

The improvement in the organoleptic appeal of food—and sophisticated cooking involves much tasting and visual adjustment—has been viewed as the essential purpose of cooking by ascetics and hedonists alike. Vegetarians have historically said that good cooking is necessary to disguise meat so that eaters might overcome their disgust. Likewise, the ancient philosopher Plato condemned cooking as the seduction of palates away from higher pursuits. In response, hedonists, whether on a par with Brillat-Savarin or not, have viewed cooking as not the devil's but God's gift.

A modern interpretation of this subject recognizes that food's attractiveness is for the most part socially conditioned, as proved by the wide variety of cultural taboos and preferences. Some groups, for instance, even embrace the poisonous reaction of chili. Thus, cooking does not enhance food's intrinsic attractiveness so much as transform it into a cultural or social symbol. Food has been "good to think" as much as "good to eat" (to borrow again from Lévi-Strauss in *Totemism*). Elaborate French sauces are the unspoken language of opulence and "good taste," haggis indicates Scottishness, red meat exhibits maleness, and the avoidance of pork suggests religious commitment.

Along these lines, cookbook writer Elisabeth Rozin has talked of cooking being responsible for distinct "flavor principles," so that flavoring with soy sauce, garlic, brown sugar, sesame seeds, and chili, for example, identifies food as Korean. The Hungarian flavor principle is paprika, lard, and onions. In this way, cooking adds little national flags, so to speak. Such a system might even have a sound nutritional basis in that, as omnivores, humans rely on cultural markers for safe, balanced, or otherwise appropriate foods.

Predigestion

Nutritionally, cooking is a kind of predigestion. Although cooking can reduce the nutritional value of raw foods, it may also make otherwise inedible foods accessible by releasing the nutritive parts of some foods and rendering others safe. Techniques include removing protective shells from seeds and nuts, physically softening or chemically tenderizing what would otherwise be unchewable, making certain nutrients more readily digestible, leaching out harmful compounds or inactivating them, and destroying troublesome bacteria.

Traditional cooks have gained impressively precise and presumably hard-won knowledge of how to handle local species, such as the detoxification of older strains of manioc (or cassava). Even in the industrialized world, cooks know to peel potatoes that are turning green. Through nutritional improvements, cooking has widened the spectrum of available foods, thereby increasing human adaptability to habitats.

Just as significantly, cooking has enabled different modes of production. In his *Geist der Kochkunst*, Karl Friedrich von Rumohr recognized nearly two centuries ago that the development of human settlements and agriculture approximately ten thousand years earlier had relied on cereals not readily eaten in their original state. The same qualities that keep staples through the year tend to demand that they be processed, as when wheat is laboriously milled and then parched, boiled, or baked.

This ensured the necessity of another nutritional achievement of cooking, the provision of balanced meals. The typical cuisine of agrarian societies has two building blocks: the staple and its accompaniment, a relish or sauce. The main stored agricultural product, such as wheat, corn, and potatoes, is bland, starchy and nutritionally incomplete. The staple is enlivened and supplemented by an appropriate sauce made from a little meat (fished, hunted, or taken from the herd), an animal byproduct (such as cheese), or a legume or vegetable.

The ancient Athenians, for example, based their meals on the *sitos* of barleycake and wheaten bread or perhaps lentil soup. The *opson* then provided extra proteins, vitamins, and interest, in the form of a salad of bitter herbs, cheese, eggs, fish (fresh, salted, or dried), or, less frequently, meat. Eventually, the desirable *opson* was fish. A gourmand was called an *opsophagos*, a topping- or sauce-eater.

As another example, Chinese cuisine divides a meal into *fan* and *ts'ai.* In a narrow sense, *fan* means "rice" or "cooked rice," and *ts'ai* means "greens" or "vegetables." In a broader sense, *fan* includes all cereal and starchy dishes, among them porridge, steamed bread, dumplings, pancakes, and noodles. And, *ts'ai* refers to the accompaniments, whether made of vegetables, meat, or fish. As explained by anthropologist Eugene Anderson and others, *fan* is "grain foods" and *ts'ai* "dishes to go on rice." The two types of food have to be in balance, although more *fan* might be consumed at home and *ts'ai* dishes would be more numerous and prominent at feasts or on special occasions.

Although anthropologist Sidney Mintz has wanted to further divide agrarian cuisines into "core/fringe/legume," nutritionist Daniela Schlettwein-Gsell finds enough nutritional wisdom in the typical combinations of "core" and "fringe," as when wheat is complemented by leafy green vegetables. *Polenta con funghi* (cornmeal with mushrooms) exhibits a remarkably balanced nutrient density, as do the combinations involved in southern Italian pizza, Swiss raclette, Anglo-Indian kedgeree, North African couscous, Chilean empanadas, and so on.

Storage

Settled society was made possible by stored food, which typically was not just cooked to be made edible, but often was also preserved in the first place. Preservation methods include drying, chilling, sugaring, salting, pickling, fermenting, and storing in sealed containers (often under fats and oils). They slow down deterioration by such means as removing moisture, altering acidity, and closing off oxygen. Cooking by heat has also played a role, killing microorganisms—bacteria, yeasts, and molds—that compete for the food, a process exploited in pasteurization.

Fermentation actually uses microorganisms in a controlled way to help convert raw materials into more stable forms, such as wine, beer, cheese, leavened bread, fish sauce, sauerkraut, and soy sauce. For example, in making wine, yeasts transform the sugars in grape juice into alcohol and carbon dioxide, until the yeasts have nothing to survive on. Cheese-making converts excess spring milk through lactic acid fermentation, during which the protein coagulates, and the solid mass can be retained because of its reduced moisture, together with extra saltiness and acidity.

Since the earliest division of labor between the sexes, women have generally been more intimately involved in cooking than men. However, baking, brewing, vinification, sauce-making, and the like have become important spin-offs of cooking performed by specialists, often (but not always) men. While the cooking of women has had a domestic focus (home and hearth), that of men is generally more public, or market-oriented. In recent centuries, food production has been rapidly industrialized, so that now much cooking, whatever its form, has been taken over by factories.

Distributing

Meals are essentially sharing occasions and, in serving them, cooking should be seen as distributive at heart. Cooking employs a range of food-dividing techniques, including counting, weighing, and other forms of portion control. As Michael Symons has argued in *A History of Cooks and Cooking*, the most characteristic distributive activity has to be cutting, and the most obligatory distinctive culinary tool is the knife.

The classic American cookbook, *Joy of Cooking*, includes in its listing of essential kitchen equipment: two paring knives, one bread knife, one meat knife and grapefruit knife, along with such possible variants as spatula, two graters, wooden chopping bowl and chopper, meat grinder, doughnut cutter, biscuit cutter, pancake turner, apple corer, vegetable slicer or parer, can opener, and kitchen shears. These are used in peeling, coring, and chopping food into suitable pieces for cooking; they are also used to carve meat, slice bread, and cut out biscuits for all to share.

In Chinese cooking, the *tou* (cleaver) is employed to chop meat and vegetables. The quick stir-frying characteristic of this cuisine requires that the ingredients be cut up into same-size, relatively small pieces. Nonetheless, the chopping and slicing also make the food highly distributive. The cleaver allows diners to put aside their knives and rely on chopsticks and spoons. Chinese observers have a point when they view the Western use of table knives as dangerous and barbaric, and cutting up as best left to preparation in the kitchen. The first sharp cutters, made specially from pebbles, date back to approximately two million years ago, which makes the cook's knife about twice as old as the cook's fire. The stone cutters used in scrounging and dividing up flesh heralded the "cooking animal," and innovations in knife-making technology contributed to the names of the Stone, Bronze, and Iron Ages.

The importance of sharing sustenance through meals gives the cutting or carving of foodstuffs and therefore kitchen knives a central place in human life. They are essentially generous instruments. However, the very success of cooks' knives has led to their being overlooked, because the division of food goes hand in hand with the division of labor. Meals are the mechanism by which people share not merely food, but also the associated tasks; everyone brings their contribution to the table.

Unfortunately, while the value and importance of cooking have not always been recognized, specialists have aggrandized their in many ways subsidiary trades and tools, as when men distributed meat through such rituals as temple sacrifice and courtly carving. The fundamental instruments of humankind's social interaction with nature, knives, have thus cut people off from each other and their world.

See also **Beeton, Isabella Mary; Boiling; Brillat-Savarin, Anthelme; Broasting; Couscous; Dinner; Frying; Grilling; Lunch; Pizza; Preparation of Food; Presentation of Food; Roasting; Serving of Food**.

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Michael Symons

COOKING APPLIANCES. *See* **Kitchen Gadgets; Preparation of Food; Utensils, Cooking.**

CORN. *See* **Maize.**

COST OF FOOD.

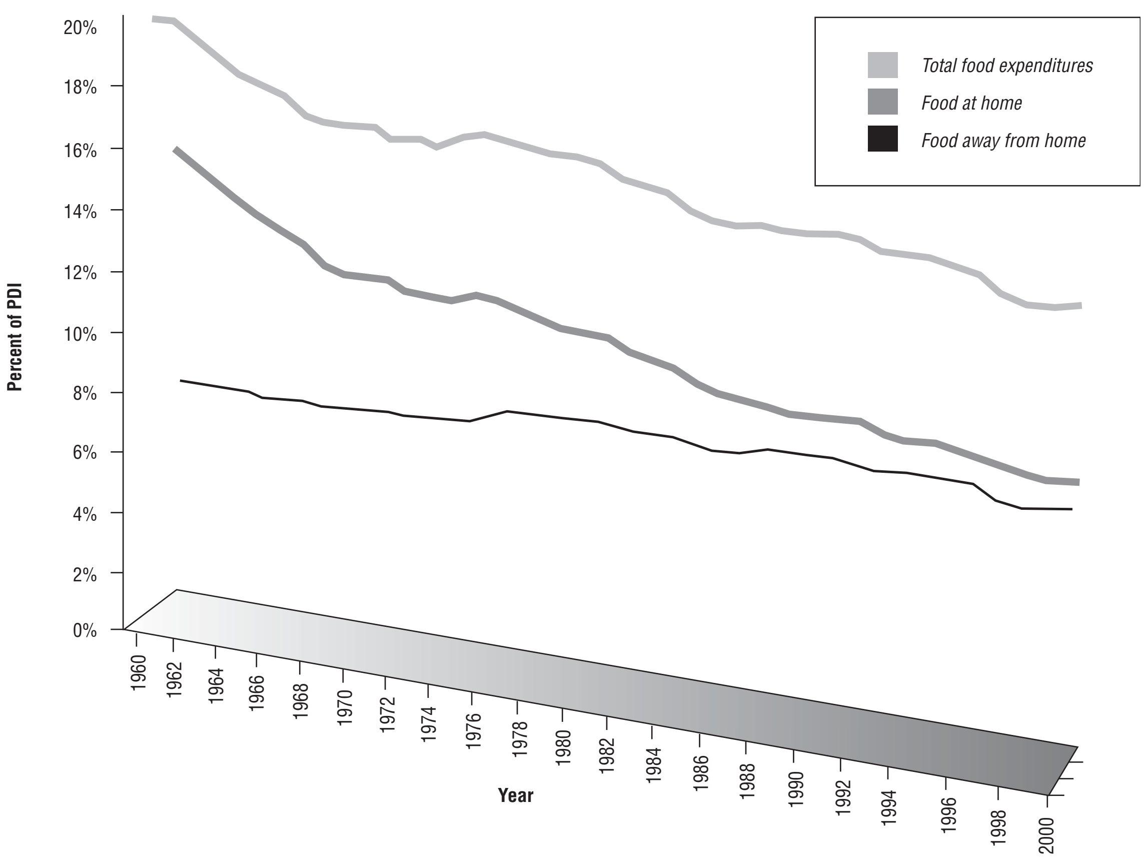
The cost of food is viewed from two perspectives. One is the cost to households, the other is the cost of production and marketing. Since food is a basic necessity in every society, a falling portion of household income needed to purchase food is an indicator of growing households' incomes and a measure of improved national economic development. In high-income countries the percentage of income needed for food is smaller than in low-income countries. This phenomenon reflects an economic principle known as Engels' Law. As income rises, the percentage of the additional income spent on food declines.

Consumers' Food Costs

In the United States the percentage of personal disposable income (PDI) spent for food fell precipitously during the second half of the twentieth century from 20 percent in 1960 to 11 percent in 2000 (see Figure 1). At the beginning of the twenty-first century the United States had the lowest ratio of food expenditures to PDI in the world. Expenditures for food ingredients to cook at home fell in tandem with the decline in the percentage of income spent on all food. Expenditures on food

FIGURE 1

Total food expenditures and expenditures for food eaten at and away from home as a percent of PDI (1960 to 2000)



SOURCE: United States Department of Agriculture, Economic Research Service (www.ers.usda.gov)

from restaurants and other food service places remained steady at around 4 to 5 percent of PDI in the late twentieth century. Consequently the percentage of households' total food budget spent for food service increased from 27 percent in 1960 to 47 percent in 2000.

Expenditures on food rise with income and the number of people in the household. The absolute amount spent on food rises with income as consumers shift to more expensive brands, higher-quality food, and more convenient forms of food, including more food eaten away from home. Households with only one person spend 16 percent more per person on food than households with two people and 62 percent more per person than households with four people. Per capita expenditures for food are greater for single people because of the economies of scale involved in feeding more people in the same household. With more people to feed, less waste occurs from preparing full recipes, and people are more inclined to cook food at home. Single persons tend to eat more food away from home, increasing their food costs (Blisard, 2000, pp. 23–26).

Lower-income households spend about two-thirds the number of dollars per person on food compared with higher-income households and about 85 percent as much compared with middle-income households. Even though households in the lowest income group spend fewer dollars on food, these expenditures account for almost half of their incomes. Those in the highest-income group spend only 8 percent of their incomes on food. The average food expenditure, 11 percent of PDI, represents middle-income households and hides the fact that great disparity persists.

Production and Marketing Costs

Production and marketing costs determine the minimum price of food in the retail marketplace. Production costs are typically called the "farm value" of food, and they comprise about 20 percent of the final food cost. This percentage varies by type of food, depending on how highly processed or perishable the food is. The farm value for meats and dairy products is around 28 percent, for poultry around 41 percent, for cereals around 5 percent, for fresh fruits 16 percent, and for fresh vegetables 19 percent. As consumers demand more highly processed foods, fresh foods from distant places, and foods ready to eat, the farm value falls as a percentage of the retail price.

Marketing costs have risen as a percentage of retail food prices. The "marketing bill" as defined by the U.S. Department of Agriculture is the difference between the farm value of domestically produced foods and the final cost to the consumer (see Figure 2). Marketing costs rose 3.5 times faster than the farm value between 1990 and 1999. At 39 percent, labor is the largest portion of the cost of food, rising 56 percent during the 1990s. Over half of the 14 million food industry workers in 1999 were in food service. Retail food stores employed 3.5 million or about one-fourth of all food industry workers. About 12 percent of food industry employees worked in food processing, and about 7 percent worked in food wholesaling. The escalating demand for labor increased wages and the benefit costs for food workers. Food store employees' wages rose 27 percent during the last decade of the twentieth century. As consumers delegate more of the basic cooking and preparation of food to others in the food chain, labor costs can be expected to rise as a portion of the total food cost.

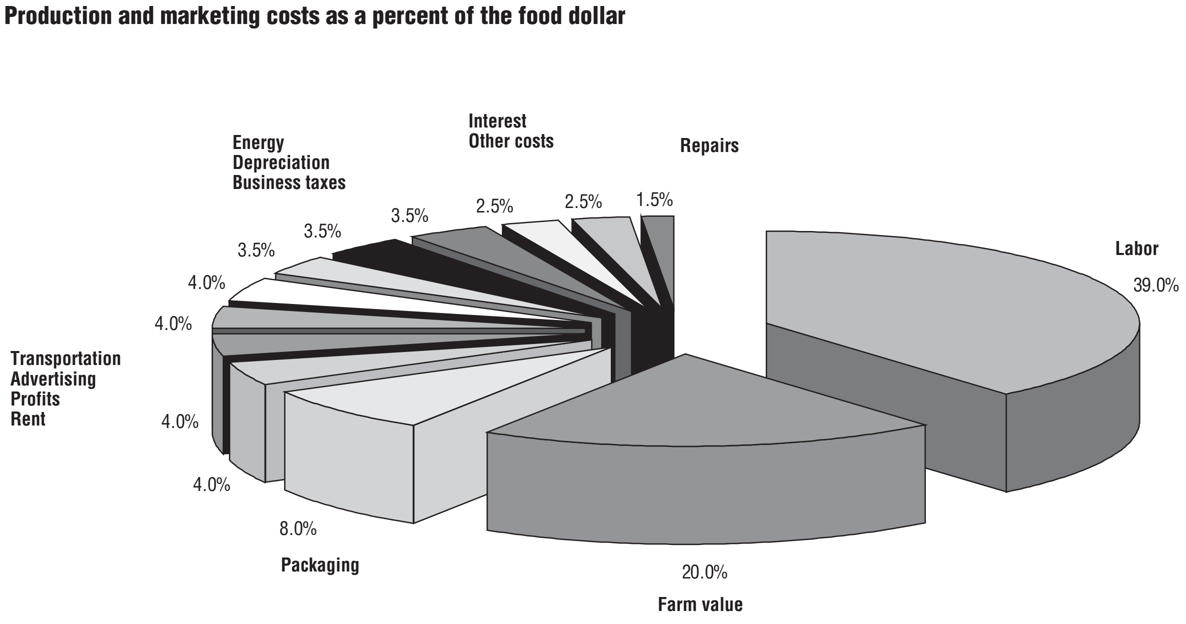
Packaging costs comprise about 8 percent of total food costs, and they increased almost 40 percent in the 1990s. This increase is a function of the cost of paper and plastics and the demand for more conveniently packaged foods. Package design changes and packages that can be used directly for cooking and for eating or drinking increase the cost of packaging relative to the basic food.

Raw commodities (farm value), labor, and packaging comprise 67 percent of the cost of food. The rest of the costs are in transportation, advertising, rent, profits, energy, business taxes, depreciation, interest payments, miscellaneous costs, and repairs. These last types of costs have increased at about the rate of inflation and have not changed their share of the food dollar much over time.

Since considerable price competition exists at the retail end of the food chain, the marketing chain tends to absorb increases in the cost of raw commodities. Also the cost of the raw commodity is a relatively small percentage of the total cost. In the case of cereals, cyclical fluctuations in grain prices barely affect the final food price. One way for manufacturers to decrease their risks of price fluctuations in raw materials is to contract with farmers for a set amount of commodity at a set price that does not change at the whims of the market.

Retail food costs are a function of the production and marketing costs and the intersection of supply and demand. Since most foods have a limited shelf life, retailers want to sell products as soon as possible, keeping prices competitive. On the other hand, total food

FIGURE 2



SOURCE: Elitzak, 2000

expenditures are a relatively small part of most consumers' budgets, and an increase in the price of one food type does not change spending patterns much in the face of numerous substitutes. Taken together these two impacts are called the price and income effects on the quantity of food purchased. The other effect is the limited capacity of human beings to consume food. Once humans are physically satiated, food expenditures rise due to consumers' demands for more quality, variety, convenience, and service but not for more food to eat.

See also **Advertising of Food; Consumption of Food; Distribution of Food; Food Politics: United States; Food Supply and the Global Food Market; Food Supply, Food Shortages; Marketing of Food; Places of Consumption; Political Economy; Restaurants.**

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Jean D. Kinsey

COUSCOUS. Couscous (from the Berber word *k'seksu*) is the staple product of North Africa and the national dish of the countries of Maghrib, that is, Algeria, Morocco, and Tunisia. Couscous spread from this area, where it originated, to Libya, Mauritania, Egypt, and sub-Saharan countries. Couscous is also consumed in the Middle East, where it is called *mughrabiyya.*

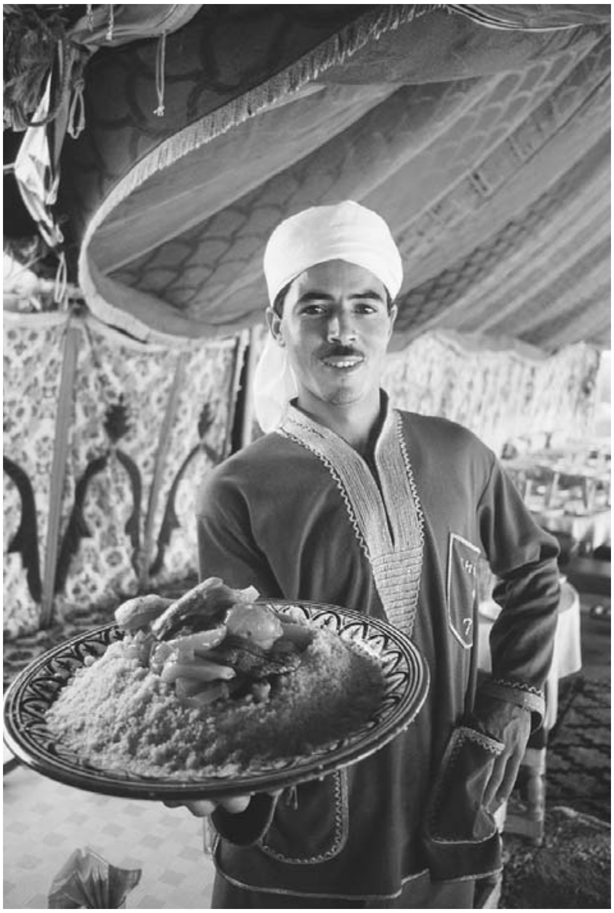
Couscous is an icon food in northern Africa for dietary and cultural reasons. Similar to rice, pasta, or bread, couscous is an inexpensive and highly nutritive product made from wheat or other cereals (barley, sorghum, corn, millet, or minor grains) with the capacity for long-term preservation. With a basic cooking system, it is possible to prepare an everyday meal or a luxury feast, a main course or a dessert. A versatile dish, couscous can be mixed with vegetables, legumes, meat, or fish, or it can be eaten with butter or fresh fruit.

Couscous is an icon also because it permits the expression of national identities and ways of life, and it has religious and symbolic meanings. Women usually prepare the grain known as couscous during a family celebration, and the dish named couscous is eaten during a family feast, thereby associating both the product and the dish with solidarity. Couscous accompanies Friday and end of Ramadan celebrations and birth and wedding feasts. The association of couscous with these festivities also attaches it to the concepts of abundance, fertility, fidelity, and Barakah (God's blessing). For example, while preparing couscous, women have to make an invocation and converse about religious facts, prosperity, and positive feelings.

Preparation

The grain. Although the use of precooked couscous has spread widely, making couscous is traditionally a female activity that involves much work. On a big flat plate, the woman in charge puts a handful of freshly ground hard wheat, sprinkles on salted water and a bit of flour, and with her palms treats the grain with rolling movements until the couscous granules appear. Later she sifts the grain with sieves of different diameters to obtain granules of similar size. Finally, couscous is sun-dried and stored or cooked.

The dish. Couscous is cooked in a special pot (a couscous steamer), usually earthen, which has two components: a bottom-perforated pan, which contains the grain, and a globular pot that stands underneath it and contains water or a boiling stew whose steam cooks the granules.



Moroccan waiter with a large platter of couscous in Marrakesh. © ROBERT HOLMES/CORBIS.

Couscous is moistened with water and oil before cooking and then it is placed in the pan. Every ten or fifteen minutes, the couscous is taken out of the pan; oil or butter is added, and it is worked by hand to avoid the formation of curds. Couscous is ready when the granules are cooked, separated, soft, and moist.

The basic ingredients of the couscous stew are seasonal vegetables and legumes (usually chickpeas), fish or meat (chicken, lamb, beef, rabbit, hare, and even camel), and spices. There are regional preferences regarding couscous. Algerian couscous includes tomatoes and a great variety of legumes and vegetables, and Moroccan couscous uses saffron. Tunisian couscous includes fish and dried fruit recipes and always contains chickpeas and a hot salsa *(harissa).* Saharan couscous is served without legumes and without broth.

After the grain is cooked, a pile of couscous is placed in a big platter topped with the meat or fish and vegetables. The couscous broth is put in a side bowl and optionally mixed with hot sauce.

The History of Couscous

Origins. The origin of couscous is uncertain. Lucie Bolens affirms that Berbers were preparing couscous as early as 238 to 149 B.C.E. (Bolens, 1989, p. 61). Nevertheless, Charles Perry states that couscous originated between the end of the Zirid dynasty and the rise of the Almohadian dynasty between the eleventh and the thirteenth centuries (Perry, 1990, p. 177).

Iberian Peninsula. Bolens dates the introduction of couscous into the Iberian Peninsula to the period of the Berber dynasties in the thirteenth century (Bolens, 1989, p. 62). The popularity of couscous spread quickly among the Moors, and the two Arab cookbooks available from that time, the anonymous *Kitâb al Tabij* and *Fadalat al Jiwan* by Ibn Razîn al Tujibî, include couscous recipes. Sephardim incorporated couscous into their cuisine because of the Moorish influence and carried it to their asylum countries after their expulsion from Iberian lands (1492). It is still popularly consumed in Israel.

Couscous also was a staple for the Moriscos, who ate it during secular and religious celebrations. Consequently, the Inquisition prosecuted its consumption. The hostility toward Morisco culture and foodways led to the disappearance of *alcuzcuz* from Spain and to the development of a derivative, *migas.* In Portugal the gentry and nobility still consumed couscous during the sixteenth and seventeenth centuries; however, the c*ozido à Madeirense* (a couscous dish) has its origin in African influences. According to Francisco Abad, the couscous recipes included in the Spanish court cookbook by Martínez de Montiño (seventeenth century) are related to the author's Portuguese origin (Abad, 2000, pp. 23–24).

Italy. *Cùscusu* is a typical dish of western Sicily, especially of Trapani, where it is eaten with a fish stew or in a sweet recipe. There is no agreement about the date of the introduction of couscous into Sicily. Some writers claim that couscous was introduced during the Muslim period (827–1063), while others state that it was introduced after the settlement of Sephardim in the island, at the end of the fifteenth century.

Brazil. The introduction of couscous into Brazil in the sixteenth century, according to Luis da Cámara Cascudo, was a result of the culinary influences of both Portugal and African slaves cultures (Cascudo, 1983, pp. 207–211). There are two varieties. Southern couscous *(Cuscuz paulista)* is a steamed cake made from corn flour, vegetables, spices, chicken, or fish (prawns and sardines). The northern variety *(cuscuz nordestino)* is a steamed pudding made from tapioca flour and sugar and moistened with coconut milk. This is a popular Brazilian breakfast.

Couscous in the Western World

Couscous has developed worldwide popularity. Among the explanations for its success are the increasing importance of vegetarianism, the preference for healthy foods that are aesthetically attractive, the trendy fascination with the Mediterranean cuisine, and the culinary influence of Maghribian immigrants in the Western world.

See also **Africa: North Africa; Brazil; Iberian Peninsula; Italy; Legumes; Mediterranean Diet; Middle East.**

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Teresa de Castro

CREOLE CUISINE. *See* **United States.**

CROP IMPROVEMENT. Crop improvement refers to the genetic alteration of plants to satisfy human needs. In prehistory, human forebears in various parts of the world brought into cultivation a few hundred species from the hundreds of thousands available. In the process they transformed elements of these species into crops though genetic alterations that involved conscious and unconscious selection, the differential reproduction of variants. Through a long history of trial and error, a relatively few plant species have become the mainstay of agriculture and thus the world's food supply. This process of domestication involved the identification of certain useful wild species combined with a process of selection that brought about changes in appearance, quality, and productivity. The exact details of the process that altered the major crops is not fully understood, but it is clear that the genetic changes were enormous in many cases. In fact some crop plants have been so changed that for many of them, maize, for example, their origins are obscure, with no extant close wild relatives.

The selection process was unconscious in many cases. For example, in wild wheats, the grains scatter by disarticulation, separation of the seed from the seed head. When these grains were harvested by cutting the heads with a sickle, an unconscious selection occurred for "nonshattering" types that would then be continually replanted. For some crops a clear conscious selection occurred, especially when the variant was obvious and would be maintained by vegetative propagation. Something so clearly useful as a seedless banana must have been immediately seized upon and maintained ("fixed") by planting offshoots of the plant. The changes wrought in domestication included alteration in organ size and shape; loss of many survival characters, such as bitter or toxic substances; disarticulation of seeds in grains; protective structures, such as spines and thorns; seed dormancy; and change in life span—increased in crops grown for roots or tubers and decreased in crops grown for seed or fruit. Selection by bulking desirable types (mass selection) is a powerful technique for making rapid changes easily while maintaining genetic diversity in the population.

The selection of naturally occurring variants is the basis of crop improvement. Over thousands of years this technique resulted in the development of modern basic crops. The discovery of techniques for asexual (vegetative) propagation, such as by using natural offshoots, rooting stem cuttings, or various grafting techniques, made it possible to "fix" genetic variants. This was the technique used for many tree fruits, enabling identical plants to be cultivated in orchards. Naturally produced seedlings derived from intercrosses of these selected plants were then available for selection again. Many present-day fruit crops are similar to those cultivated in antiquity, and some ancient selections are still cultivated—dates, for example. As humans carried improved crops to new locations, opportunities opened to increase genetic variation from natural intercrosses with new wild populations.

The changes that occur can be dramatic over time, as seen in the proliferation of breeds of animals and especially the wide range of changes brought about by fanciers of dogs, chickens, and pigeons. The observation of these changes influenced the thinking of Charles Darwin to suggest that natural selection, the survival of the fittest, could lead to enormous genetic changes if carried out over a long enough time, and could lead to the origin of new species.

In the eighteenth and nineteenth centuries a conscious attempt was made to predict the performance of plants that could be expected from one seed generation to the next. The concept that ancestry was important in crop improvement led to refinement in the selection process, brought about by keeping records and the assessment of lineage. Furthermore it became obvious that variation could be managed by controlling the mating process, an extension of what had long been known in animal breeding. This new type of selection, termed pedigree selection, was found to increase the efficiency of the process. Progeny testing (evaluating the genetic worth by progeny performance) increased efficiency of this process. The origins of commercial plant breeding began in the second half of the nineteenth century among seed producers. It involved controlled crosses (hybridization) between selections to control genetic recombination, followed by selection of improved types. This is still the basis of traditional plant breeding. Interestingly much of this early type of plant breeding was carried out without a clear understanding of the genetic mechanism involved in inheritance.

Until the famous experiments with the garden pea by Gregor Mendel (1822–1884), a Catholic priest in Brünn, a Moravian town then in the Austro-Hungarian Empire, the basic theory of inheritance involved the concept of blending. Mendel unraveled the basic concept of inheritance and clearly showed that characters in the pea were due to elements, later called genes, that remained unaltered as they were inherited. Many characters in peas, such as tallness and dwarfness, were shown to be controlled by a pair of genes, of which one member was not always expressed (the concept of dominance and recessiveness). Mendel demonstrated that the gametes of the pea contained one member of the gene pairs that controlled characters and that recombined randomly at fertilization. Mendel's paper was published in 1866, but it had no impact until the paper was "rediscovered" in 1900, when it created a sensation. It was soon obvious that the differences in appearance among plants (phenotypes) could be explained by the interaction of various genes (genotypes) as well as interaction with the environment.

Twentieth-Century Developments

In the twentieth century plant breeding developed a scientific basis, and crop improvement was understood to be brought about by achieving favorable accumulations and combinations of genes. Taking advantage of known genetic diversity could facilitate this, and appropriate combinations were achieved through recombinations brought about by the sexual process (hybridization). Furthermore it was possible to move useful genes by special breeding strategies. Thus a gene discovered in a wild plant could be transferred to a suitable adapted type by a technique known as the backcross method. A sexual hybrid was made, followed by a series of backcrosses to the desirable (recurrent) parent, while selecting for the new gene in each generation. After about five or six backcrosses, the offspring resembled the recurrent parent but contained the selected gene.

In the early twentieth century it was demonstrated that the extra vigor long associated with wide crosses (called hybrid vigor or heterosis), particularly in naturally cross-pollinated crops, could be exploited in plant breeding. For maize, a new system of hybrid breeding was developed, using a combination of inbreeding and outbreeding. Inbreeding was accomplished by crossing the plant with itself. This led to a decline in vigor as the step was repeated over several generations. Outbreeding was achieved by intercrossing the inbred lines to restore vigor. The hybrid between inbreds derived from divergent inbreds (called a single cross or F_1 hybrid) was uniform (homogeneous), and some were superior to the original populations before inbreeding. During the process of inbreeding, the inbreds became weak, but vigor was restored in the F_1. To increase seed set from weak inbreds, two hybrids were crossed; this was known as the double cross method.

Hybrid breeding technique in a sense is similar to arranging a Rubic's cube, where contradictory steps need to be taken to achieve the appropriate reformulation. In hybrid breeding, the first step produces a series of weak inbreds, followed by a series of specific combination, to produce a series of new hybrids. Hybrid maize breeding led to enormous increases in productivity, which were soon exploited in a wide variety of seed-propagated crops, including naturally self-pollinated ones, such as tomato and rice.

A number of genetic techniques were developed and refined in twentieth-century breeding, such as improved techniques to search for and store increased genetic variability, different techniques to develop variable populations for selection, and improved methods of testing to separate genetic from environmental effects. The exact details of the process for crops necessarily differed among naturally cross-pollinated plants (such as maize) and naturally self-pollinated plants (such as soybean or tomato) as well as those plants in which vegetative propagation (usually cross-pollinated) permitted the fixing of improved types directly.

Conventional plant breeding can be defined as systems for selection of superior genotypes from genetically variable populations derived from sexual recombination. The system is powerful because it is evolutionary; progress can be cumulative, with improved individuals continually serving as parents for subsequent cycles of breeding. Genetic improvement by conventional breeding has made substantial changes when the efforts have been long-term. Characters improved include productivity, quality, and resistance to diseases, insects, and stress. There are, however, limits to the progress of conventional breeding. These are due to limitations of the sexual system, because it is usually not possible to incorporate genes from nonrelated species or to incorporate small changes without disturbing the particular combination of genes that make a particular type unique. Thus a useful gene in cabbage cannot be transferred to wheat. Limitations of conventional breeding are particularly apparent when a needed character (such as disease or insect resistance) is unavailable in populations that can be incorporated by sexual crosses. Mutations may be induced, but they are often deleterious or connected with undesirable effects.

With conventional breeding, it is also not possible to improve a unique genotype, such as "Bartlett" pear, by adding a single character, since the recombination that results from hybridization makes it impossible to reconfigure this cultivar exactly. Finally, conventional breeding has technical or economic limitations to detect infrequent or rare recombinants, the lack of sufficient time to generate cycles of recombination, space to grow necessary populations to recover superior recombinants, or resources to be able to select, identify, evaluate, and fix desired recombinants.

Developments Using DNA

It has been suggested that many of the limitations of conventional breeding can be overcome with advances in molecular biology that rely on DNA, the genetic material.

Recombinant DNA technology, called transgene technology or genetic engineering, is the most powerful and revolutionary of the new genetics developed in the last half of the twentieth century. It is possible to isolate stretches of DNA from one organism, store it in a bacterial host, select unique combinations, and then incorporate them into the DNA of another species, where it can be expressed. This technique, which relies on cell and tissue culture, is truly a marvelous process. Refinements in the technique make it possible to concentrate mutations in desired genes, further increasing variability. Other uses of molecular biology known as genomics involve the detailed mapping of the DNA and the identification of useful stretches of the molecule. This makes it possible to improve the efficiency of selection, because it is based directly on the genes rather than the organism, where the effects may be confounded by environment and genetic interactions.

The limitations of the new breeding methods include technical problems, such as the difficulty of transformation, problems of gene expression, or the lack of knowledge concerning suitable genes to transfer. There are also nontechnical issues, such as legal problems, since the techniques and the genes are usually patented. However, in the short run the greatest impediment has been problems of consumer acceptability and fear of the unknown.

The term "Frankenfood" has been coined to refer to food altered by the process of using exotic genes incorporated by transgene technology. No convincing evidence shows that genetic engineering has produced harmful products, and an abundance of evidence shows that many foods derived from traditional systems have inherent problems (consider the allergic reactions of many people to peanuts). Nevertheless, molecular techniques have incited fear of this new technology in many people. Moreover, the surplus of food in the West has reduced the imperative to make the case for the need for new technology to consumers.

The biotechnology industry has sold the technology to farmers (who have accepted it) and ignored consumers. They have not been sophisticated in exploiting the environmental virtues inherent in the new technology, such as reducing pesticides, or in making the case that increased yield could free up the agricultural use of fragile environments. Because of the benefits that could accrue from this new technology, especially in the problem areas of the world, it seems certain that future progress in plant breeding will involve both conventional and unconventional techniques, but the immediate course of events is fraught with uncertainty.

See also **Agronomy; Genetic Engineering; Green Revolution; High-Technology Farming; Horticulture.**

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Jules Janick

CRUCIFER PLANTS. *See* Cabbage and Crucifer Plants.

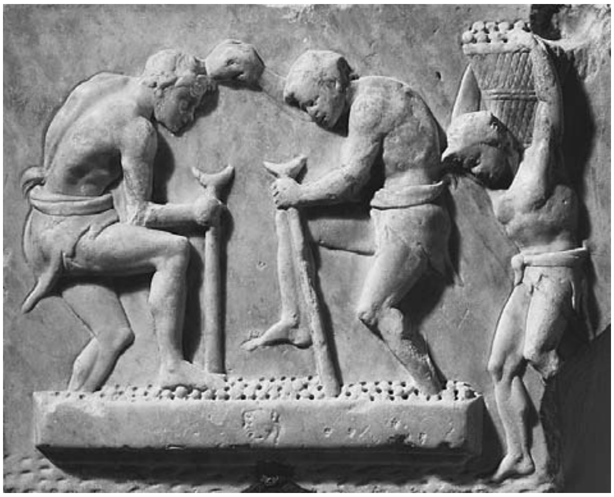
CRUSHING.

Crushing refers to the pressing, grinding, or pounding of an item into smaller particles, a powder, or a paste. The largest of the human teeth, the molars, are designed for crushing food into small particles that can be swallowed and digested. Digestion is enhanced by the breaking of food into small particles that expose more food surface to the action of digestive enzymes; the more food surface exposed, the more efficient the process of digestion.

The crushing of cereal grains (wheat, corn, rye, buckwheat, rice) into flour is a good example of the use of tools to reduce particle size. The flour can then be eaten raw, cooked with water into porridge, or moistened, formed into a loaf, and baked as bread. Another nutritional advantage of flour over the whole grain is that the flour can be sifted to remove the bran fraction, which is largely cellulose and indigestible. The germ fraction of the kernel is typically removed with the bran and hence considerably reduces the nutritional values of the flour in terms of protein, vitamins, and minerals. Flours, rather then whole grains, also have the advantage of cooking faster and can be used to make gruels that are useful for feeding infants and the elderly, who have a limited ability to chew foods into small particles.

A number of devices have been used to crush grains into flours. The Australian Aborigines used a simple wooden mortar and stone pestle to roughly crush grass seed, which they used a make bread, or *damper.* The ancient Egyptians developed a mill made of two circular stones to crush wheat into flour; modern mills operate on the same principle. Traditional peoples in Mesoamerica used a stone mortar and pestle to crush presoaked corn kernels into a wet mash to make tortillas. Foods with hard, inedible shells are crushed to facilitate removal of the shell and extraction of the edible component. Examples are hard-shelled nuts like walnuts and shellfish like lobsters. The devices used are tools like hammer-stones and metal pliers.

Other foods are crushed to extract a component of the food from the more fibrous matrix of the whole food. Seeds and palm fruits are crushed to extract the oil. Grapes and other soft fruits, as well as sugarcane, a tall grass, are crushed to extract the juice. Oils and juice tend to be more readily digested than the whole food. Also, the liquid can be added to other foods to improve their energy content and hence the energy content of the diet. This is especially important in rootcrop- and tuber-based diets, which are typically low in energy density.



Many foods are prepared or processed by crushing. This first-century C.E. Roman bas-relief depicts men crushing grapes for wine. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

The tools used in crushing foods vary with the foods themselves and level of technology. Grapes are crushed gently to avoid damaging the seed that can release bitterness into the wine. They were traditionally crushed by workers' treading on them or with wooden paddles. Olives are crushed to separate the pit from the pulp and the latter then pressed to extract the liquids. For the initial step the Romans used a roller-mill (*trapeta*), designed to ensure that the olive pit itself would not be damaged. Sugarcane was crushed historically in South America by squeezing the cane through a set of rollers (*trapiche*). The juice was then boiled to evaporate the water and the concentrated sugar allowed to crystallize.

Still other foods are crushed to achieve a particular texture in the preparation of certain dishes. In Hawaii, cooked taro corms (enlarged portion of the plant stem) are crushed to a smooth paste and then pounded in a mortar and pestle to make the famous *poi*. In Africa, cassava roots are left to soak and ferment in water and then crushed into dough that is molded into loaves and sun dried. Cooked yams are crushed with water to form soft dough called *fufu* in Ghana. In the highlands of Peru cooked potatoes are crushed on a grinding stone and then added to water or broth to make a thick soup or *masamora*. In Europe and North America, cooked potatoes are crushed to a soft uniform mass to make mashed potatoes. Nuts and meat are crushed into pastes to make sandwich spreads like peanut butter and potted meats or pâté.

In a number of different cuisines, spices are crushed to stimulate the release of flavor. In India, spices are ground in a mortar and pestle. In Mexico, spices were traditionally crushed to a paste with chili peppers using the same grinding stone (*mano* and *metate*) used for grinding maize, or in a stone bowl made from lava stone. Garlic, a flavoring agent, is also often crushed before being added to food. In all cases flavor enhancement and flavor release are the goals of the cook, but the crushing should also facilitate digestion.

Crushing is also used to meld two or more foods together. A classic example is the pemmican traditionally made by North American Indians. Pemmican is dried meat and animal fat pounded into a paste and preserved in the form of pressed cakes. A less well-known example is "desert fruitcake," a cake made of crickets pounded together with berries. Another example is *kibbeh*, a Lebanese dish made by pounding lamb and cracked wheat together in a stone mortar until they form a paste and seasoning the mix with mint and pine nuts. The resulting mix is rolled into sausage-like forms and cooked in oil or eaten raw.

See also **Combination of Proteins; Dietary Assessment; Preparation of Food; Rice; Wheat**.

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Darna L. Dufour

CRUSTACEANS AND SHELLFISH. The crustaceans are not, strictly speaking, shellfish, although they are often described as such. They are members of the animal phylum Arthropoda, which also includes spiders, scorpions, and insects. Like these other creatures they are covered with hard, horny carapaces which are jointed for movement and sloughed from time to time as their owners grow. Many have a characteristic change of color when cooked, for example the blue-black lobster turns scarlet and the semitransparent shrimp turns pink and white.

The two principal orders are Decapoda Natantia and Decapoda Reptantia, that is to say, "ten-legged swimmers" and "ten-legged crawlers." In the first category are prawns, shrimp, lobster, and so on. The second consists of the crabs.

Prawns and Shrimp

The terms "prawn" and "shrimp" require a little explanation since the two terms are used in different ways in British and American English. The FAO (Food and Agriculture Organization of the United Nations) in their comprehensive *Catalogue of Shrimps and Prawns of the World* (1980), describes the differences in useage as follows:

> we may say that in Britain the term 'shrimp' is the more general of the two, and is the only term used for *Crangonidae* and most smaller species. 'Prawn' is the more special of the two names, being used solely for *Palaemonidae* and larger forms, never for the very small ones. In North America the name 'prawn' is practically obsolete and is almost entirely replaced by the word 'shrimp' (used for even the largest species, which may be called 'jumbo shrimp'). If the word 'prawn' is used at all in America it is attached to small species.

The smallest shrimp are of considerable interest in regions such as Southeast Asia where they are eagerly collected to be fermented and made into shrimp paste, most notably in the Philippines, where it is known as *patis*, and also Malaysia and Indonesia, where it is *blachan.* Use of these products is less widespread than the ubiquitous

Southeast Asian fish sauces, but they too make a significant contribution to the diet in the countries where they are made. In Europe, especially Britain, small shrimp may also be made into a paste, but without fermentation and packed in small jars as a delicacy for the tea table. Delicate shrimp paste sandwiches are considered a real treat. It is also possible in England to buy potted (cooked and packed in butter) shrimps from Morecambe Bay, a traditional preparation which has cultural overtones, being perceived as part of the British culinary heritage and identity. In North America the very smallest shrimps attract little interest, and it is the larger species such as the brown shrimp (*Penaeus aztecus aztecus*) and the white shrimp (*Penaeus setiferus*) which are most prominent in the markets. In Europe , the counterpart of these species is the so-called deep water prawn (also known as northern prawn, *Pandalus borealis*; but this is not exclusive to Europe, being found also in the North Atlantic from Greenland down to Martha's Vineyard).

Large shrimp, especially species of the genus *Macrobranchium* which thrive in brackish or fresh water, are now the subject of aquaculture in Southeast Asia, and the large quantities exported from there go a long way to meeting demand in Europe. Large shrimp are often presented on their own (for example boiled and then served cold with mayonnaise, or broiled), while smaller ones may be used to make the shrimp croquettes which are a particularly successful dish in the Netherlands and Belgium, or a shrimp sauce or shrimp soup.

Large shrimp in the Mediterranean belong to various species which resemble each other so closely that sometimes it is only an expert who can distinguish between them. One of the best is *Penaeus kerathurus*, the Italian *mazzancolla*. It may reach a length of 22 cm/9 inches, which is large for the Mediterranean but well short of 33 cm/13 inches, the maximum length of the Giant Tiger prawn of the Indo-Pacific, *Penaeus monodon*.

Lobsters

Lobsters are larger creatures, although the smallest of the the so-called Norway lobsters (often referred to by the Italian name scampi), are no bigger than the largest prawns. The archetypal lobster, that of the North Atlantic, is not one but two species, having developed in slightly different forms on the two sides of the ocean. The American lobster, *Homarus americanus*, attains a somewhat greater size than its European counterpart, *H. gammarus*. However, the whole question of maximum sizes has become one where precision is difficult to attain. The fishery for lobsters is now so intensive that few or none approach the maximum size recorded in the past. It is generally accepted that a specimen taken off the coast of Virginia in the 1930s holds the record; it measured more than a meter (3' 3") in length and weighed about 20 kg/45 lb. No lobster of comparable size has been taken since World War II. In any case, there is no special merit, for consumers, in great size.

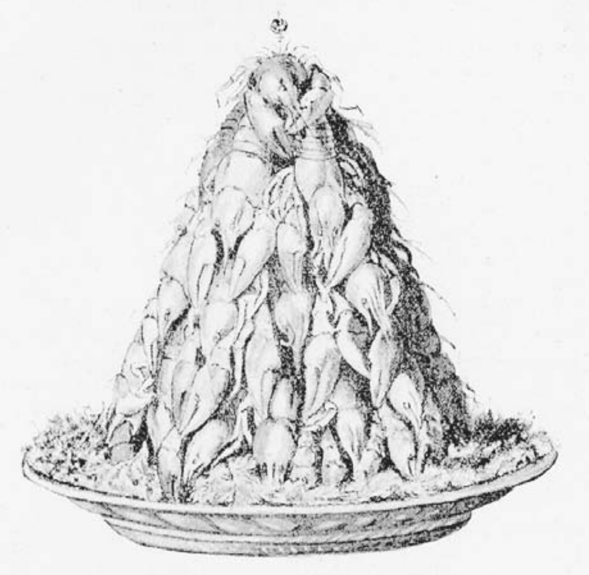


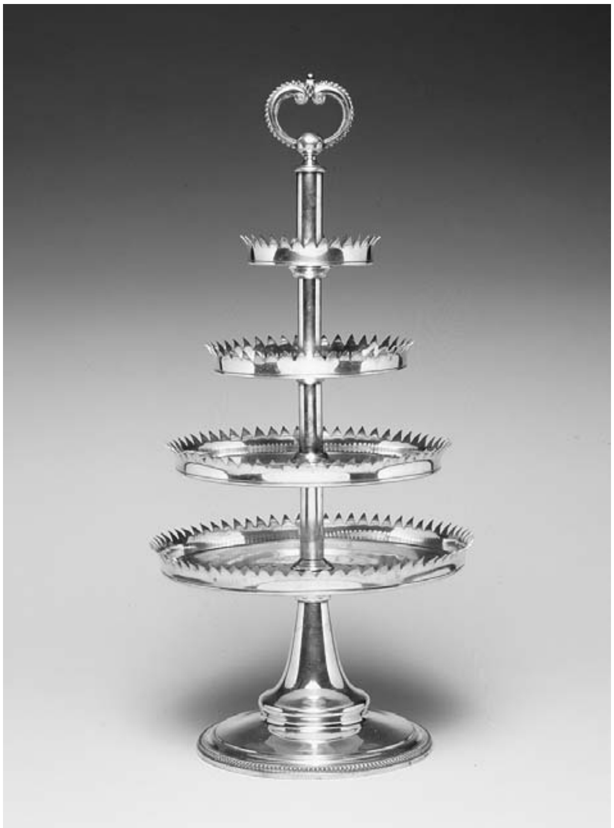
FIG. 552. CRAYFISH SERVED EN BUISSON.

Lithograph showing crayfish *en buisson* arranged to resemble a cascade. From Theodore Garrett's *Encyclopedia of Practical Cookery* (London, ca. 1890). ROUGHWOOD COLLECTION.

The value of lobsters in the market is considerable, but the supply of adult lobsters from the wild is limited. One reason is that only certain types of seabed are suited to tiny postlarval lobsters. If they don't make it to a suitable place, they perish. Also, competition among lobster fishermen is intense. So, as long ago as the beginning of the twentieth century experimental lobster "farming" was being conducted in a number of countries.

Where lobsters are "farmed," one procedure is to raise them from fertilized eggs, keeping each tiny creature in its own compartment to prevent it from being eaten, and then releasing them into the wild when they are large enough to have a good chance of survival before they reach the minimum weight at which it becomes legal to catch them. This is generally around 450 to 500 grams (just over a pound). The alternative procedure involves keeping the lobsters in captivity until ready for sale. One advantage of this is that the fully "farmed" lobster may be sent to market at a weight of only about 250 g (half a pound) and will have attained that weight relatively quickly (further growth being slower). There is a large and growing literature on all this, whether conducted by institutions to increase stocks in the wild for the general benefit or by private "farmers" for their own profit.

The red color of a cooked lobster is intense and dramatic; it has been compared to that of a cardinal's hat. However, this cannot rival the amazingly bright and com-



Silver stand (*buisson*) for serving crayfish *en buisson*. France, ca. 1845. Poached crayfish were hung by their tails from the teeth around the rim of each tier, thus creating a cascade of crayfish, truffles, and parsley. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

plex colorations of the "spiny lobsters," also known as crawfish, which belong to warmer and tropical waters. Lobsters in this other category are, some would say, not true lobsters. They lack the large claws of the Atlantic species, and hence have less meat, but they grow to a good size and are greatly appreciated as food. They too are "farmed," on an increasing scale. *Palinurus elephas* is one of several species that are present in the Mediterranean, while *Panulirus argus* is the most prominent in American waters. (The designations are confusing. The genus *Palinurus* has been recognized since the late eighteenth century, but it seems not to have occurred to the naturalist who created *Panulirus* halfway through the nineteenth century that he was sowing seeds of confusion by his choice of name.) The spiny lobsters of Asian waters include the remarkably beautiful *Panulirus ornatus* and *P. versicolor* (see illustration).

There are other "lobsters," of different shape, classified in the family Scyllaridae and going by names such as "flat lobster" and "slipper lobster." One, *Thenus orientalis*, has achieved fame and a certain cultural status in Australia, where it is the "Moreton Bay bug," a name which combines an Australian geographical identifier with an indication of Australian plebeian insouciance.

Crabs

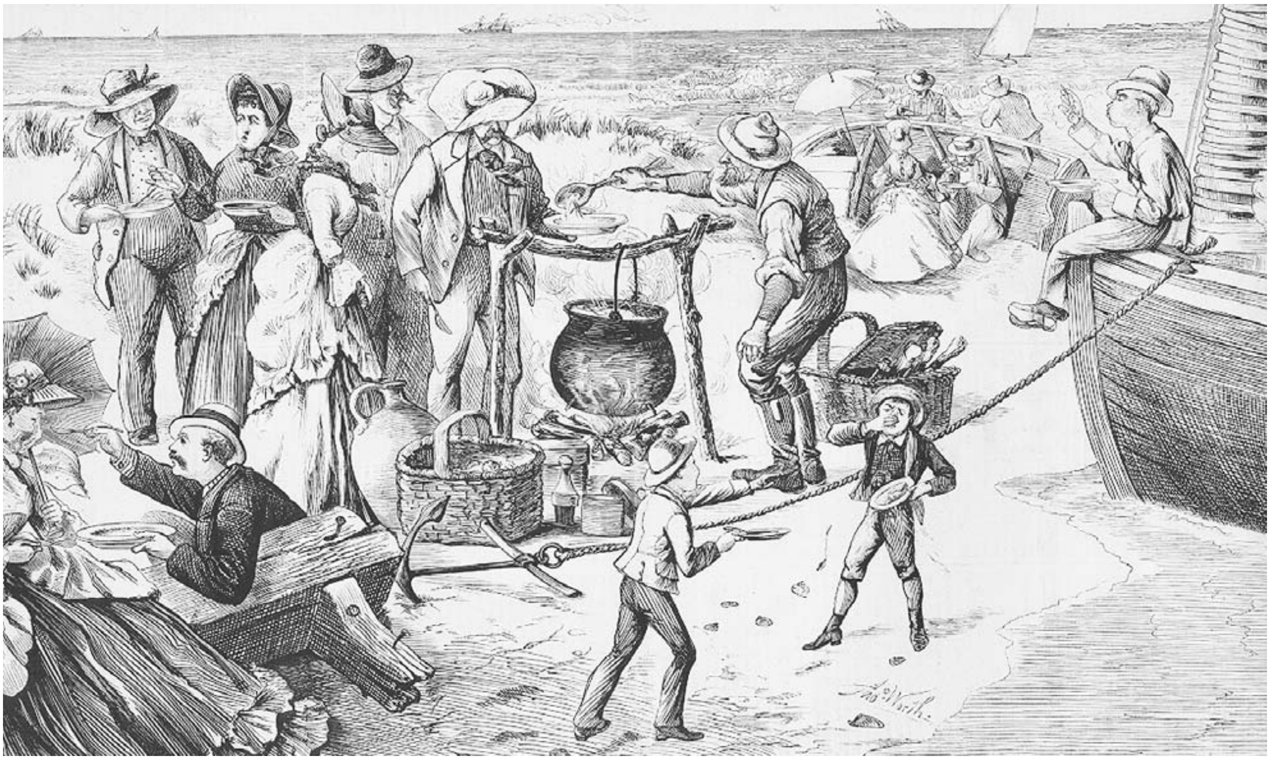
Most Europeans, invited to think of a crab, would have a mental picture of *Cancer pagurus*, the common crab of European temperate waters. North Americans would picture the famed blue crab of Chesapeake Bay and other parts of the eastern seaboard; or, if belonging to the western coast, the Dungeness crab. These three important species all share the familiar, compact, wide-bodied and big-clawed shape, and all are excellent tasting. The blue crab is, at least for east coast Americans, a cultural as well as a gastronomic phenomenon. The annual crab-picking "derby" at Crisfield, Maryland, is a symptom of its status. However, its reputation rests more on the fact that it is the crab which, when it has moulted and before the new hard carapace is grown, provides the basis for the soft-shell crab industry.

In waters that are either much colder or much warmer, crabs take on a different aspect. In the icy waters of the Arctic there is a vigorous fishery for two kinds of crab with extraordinarily long and thin legs, the snow crabs of the genus *Chionocoetes* and the king (or red) crab *Paralithodes camtschatica*. Their meat, which is of excellent quality, is usually frozen or canned, since the fishing grounds are so remote that it would be impracticable to do otherwise.

In tropical waters, on the other hand, there is a great diversity of swimming crabs and others, often brightly colored. Some spend some time on land, for example the large land crabs that are appreciated in the francophone West Indies and, in the Indo-Pacific region, the red crabs of Christmas Island and the robber crabs, which climb coconut trees and steal the nuts.

Crayfish

Although most edible crustaceans come from the sea, there are two important freshwater families, those of the crayfish (the family *Astacidae* in the northern hemisphere, and *Parastacidae* in the southern hemisphere). One interesting feature of the whole group of crayfish is that their distribution in the world is surprisingly, one might almost say inexplicably, patchy. Except for Papua New Guinea, there are none in the tropics. They are absent from most of Asia and are only found in two habitats in South America, yet there are over 250 species in North America. Europe has seven species and East Asia has four. Of the 120 species in the Southern Hemisphere, 110 are Australasian. They all resemble each other quite closely, but vary considerably in size and edibility. The largest is the giant Tasmanian crayfish, which may be 60 cm (two feet) from head to tail and may weigh as much as 4.5 kg (10 lb). Others are so small (2 cm / ¾ inch) in length that they are of no interest except perhaps as bait.



A chowder party on Fire Island. From *Harper's Weekly,* 23 August 1873. ROUGHWOOD COLLECTION.

Habitats vary. There are aquatic crayfish living in rivers or streams; semiaquatic species that live out of water in burrows connected by shafts to a body of water; and the tiny land crayfish, which live on land but only on land that has water underneath it.

Enthusiasm for crayfish is greatest in Scandinavia, France, and Australia, but nonexistent in many places where they can be found. In North America crayfish used to be a delicacy exclusive to Louisiana (where they are called "crawfish"), but appreciation of it has for some time been spreading.

The European crayfish *Astacus fluviatilis* was wiped out in many European countries early in the twentieth century. A species from North America was introduced to important crayfish regions, notably Sweden, as a replacement. Crayfish have considerable importance in the culture of Scandinavian countries, and there are many rules of procedure involved in a crayfish feast, for example, wearing huge napkins round the neck, sucking at the carapace, etc. This applies generally in countries such as Finland and Sweden, where enthusiasm is at its peak. This enthusiasm is sometimes puzzling to people from other regions, given the small amount of nourishment to be had from one small crayfish and the considerable effort and skill required to extract it. However, there are two kinds of crayfish in Australia, besides the Tasmanian one already mentioned, which are large enough to be eaten with less difficulty: the yabby (not a single species but several in the genus *Cherax*) and the marron (another *Cherax* species), which belongs to western Australia and is the third largest crayfish in the world.

To avoid confusion, it is well to note that the word crayfish is properly applied to the species described above, while the word crawfish is normally used to refer to spiny lobsters.

An Oddball

One of the most delicious crustaceans has an appearance that resembles no other crustacean and does not suggest edibility. Moreover it is immobile and has a limited distribution centred on the Iberian Peninsula, to the cultural identity of which it makes a contribution. This strange creature is the goose-necked barnacle, *Mitella cornucopia*, best known under its Spanish name, *percebe.* It looks something like a rubbery, scaly tube with a hoof on the end. To eat it, one must prise off the outer tube, exposing a stalklike protuberance which may be bitten off entire. It is usual to boil the creatures briefly before serving them, but they can be eaten raw. It is in Spain and Portugal that *percebes* are most appreciated. They are costly, since gathering them from the rocks, at the foot of cliffs, to which they are typically attached, is often difficult and sometimes dangerous. A larger relation, *Megabalanus psittacus*, is found on the west coast of South America and is eaten with enthusiasm in Chile.

See also **Arthropods; Fish; Fishing; Iberian Peninsula; Southeast Asia; United States**, *subentries on* **Cajun Cooking** *and* **Middle Atlantic States**.

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Alan Davidson

CUCUMBERS, MELONS, AND OTHER CUCURBITS. Watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*), and melon (*Cucumis melo*) are major crop species in the cucurbit or vine-crop family (the Cucurbitaceae), an important family of flowering plants (the angiosperms). The family also includes squash, pumpkin, and gourds.

Cucumber, melon, and watermelon are originally from the Old World (primarily Africa and Asia). Although they are in the same family (Cucurbitaceae) with the squashes, pumpkins, and gourds (mostly of the genus *Cucurbita*), they are only distantly related. The *Cucurbita* species are from the New World (primarily Central and South America).

Watermelon, cucumber, and melon plants are trailing or vining, tendril-bearing, frost-sensitive annuals. They are mostly monoecious (separate staminate and pistillate flowers, sometimes referred to as male and female flowers) and require various insects, especially bees, to effect pollination. The fruits are variously shaped, multiseeded, specialized berries called pepos. Together, plants in this family are called cucurbits.

Watermelon (*Citrullus lanatus*)

Watermelon is originally from central and southern Africa. The citron (*Citrullus lanatus* var. *citroides*) grows wild there, and is thought to be related to the wild ancestor of watermelon. The related species known as Egusi melon (*Citrullus colocynthis*) is found wild in west Africa and is also thought to be related to the wild ancestor of watermelon.

Watermelon is consumed for its fresh fruit, pickled rind, glacé candy, and for its dry seeds (harvested from confectionary type cultivars). The watermelon fruit contains 93 percent water, with small amounts of protein, fat, minerals, and vitamins (Table 1). In some arid regions, watermelon is used as a valuable source of water. The major nutritional components of the fruit are carbohydrates (6.4 g/100 g), vitamin A (590 IU), and lycopene (4,100

TABLE 1

Nutritional composition of cucumber, melon, and watermelon (amounts per 100 g edible portion)

Nutrient	Cucumber (slicing)	Cucumber (pickling)	West Indies gherkin	Casaba melon	Honeydew melon	Musk-melon	Watermelon (fruit)	Watermelon (seeds)
Water (percent)	96	96	93	92	90	90	93	5.7
Energy (kcal)	13	12	17	26	35	35	26	567
Protein (g)	0.5	0.7	1.4	0.9	0.5	0.9	0.5	25.8
Fat (g)	0.1	0.1	0.3	0.1	0.1	0.3	0.2	49.7
Carbohydrate (g)	2.9	2.4	2.0	6.2	9.2	8.4	6.4	15.1
Fiber (g)	0.6	0.6	0.6	0.5	0.6	0.4	—	4.0
Ca (mg)	14	13	26	5	6	11	7	53
P (mg)	17	24	38	7	10	17	10	—
Fe (mg)	0.3	0.6	0.6	0.4	0.1	0.2	0.5	—
Na (mg)	2	6	6	12	10	9	1	—
K (mg)	149	190	290	210	271	309	100	—
Vitamin A (IU)	45	270	270	30	40	3,224	590	—
Thiamine (mg)	0.03	0.04	0.1	0.06	0.08	0.04	0.03	0.1
Riboflavin (mg)	0.02	0.2	0.04	0.02	0.02	0.02	0.03	0.12
Niacin (mg)	0.30	0.4	0.4	0.40	0.60	0.57	0.20	1.4
Ascorbic Acid (mg)	4.7	19.0	51.0	16.0	24.8	42.2	7.0	—
Vitamin B6 (mg)	0.05	0.4	0.4	—	0.06	0.12	—-	1.4

SOURCE: Gebhardt, Cutrufelli, and Matthews, 1982; Haytowitz and Matthews, 1984; Rubatzky and Yamaguchi, 1997.

μg/100g, range 2,300–7,200), an anticarcinogenic compound found in red flesh watermelon. Lycopene may help reduce the risk of certain cancers, such as prostate, pancreas, and stomach. The lycopene content of the new dark red watermelon cultivars is higher than in tomato, pink grapefruit, or guava. Orange flesh types do not contain lycopene, but have a high carotene (vitamin A) content. Citron and Egusi type watermelons are used to feed cattle in Africa. Watermelon seeds are rich in fat and protein.

Wild watermelons have hard, non-sweet, sometimes bitter, white flesh. Through plant breeding, the domesticated watermelon now being grown has fruit with a protective rind, sweet edible flesh, and bright red color. Specialty cultivars are available with orange, yellow, or white flesh.

Through history, watermelon was distributed throughout the world as trade and knowledge of central Africa developed. The crop was grown in India by at least 800 C.E., and in China by 1100 C.E. The Moorish conquerors of Spain introduced watermelon into Europe, where it was noted in Cordoba in 961 C.E. and Seville in 1158 C.E. Watermelon's spread into northern Europe was relatively slow, since it was not noted in the British Isles until late in the sixteenth century, perhaps because of the generally unfavorable climate for watermelon culture in much of Europe. About this time, watermelons were introduced into the New World, with culture of the plants noted in the Massachusetts colony in 1629. The introduction of watermelon into other parts of the world has followed established trade routes.

In the United States, Thomas Jefferson, as indicated in his garden record, was a watermelon gardener at Monticello, as was Henry David Thoreau in Concord, Massachusetts. Mark Twain wrote in *Puddn'head Wilson* that "The true southern watermelon is a boon apart and not to be mentioned with common things. It is chief of the world's luxuries, king by the grace of God over all the fruits of the earth. When one has tasted it, he knows what the angels eat." Even today, watermelon exerts an influence over popular culture in festivals throughout the rural South.

Watermelon is grown commercially in areas with long frost-free warm periods. Plants are widely spaced because of the long, trailing vines. They may be established in the field by planting seeds or by transplanting containerized plants. Management of plant pests (weeds, insects, and diseases, including nematodes) is essential during the production period. Three-fourths of the world production is grown in Asia (Table 2), with China the leading country in production.

Watermelons are grown in most states of the United States, but the major producers are in the South and West (Florida, Georgia, California, and Texas).The fruits are harvested by hand, with the most experienced workers doing the cutting (removal of the fruit from the vine) and the others loading the bins or trucks. The fruits are shipped to markets throughout the country, with some exported to Canada.

TABLE 2

World production of cantaloupe and melon, cucumber and gherkins, and watermelon (1997)

Continent or area	Production (mg x 1000) Cantaloupe (melon)	Cucumber (gherkin)	Watermelon
Africa	1,045	390	2,679
North & Central America	1,966	1,589	2,539
South America	427	76	1,497
Asia	12,071	20,245	35,730
Europe	2,421	3,504	3,601
Oceania	78	22	90
World	18,009	25,827	46,135

SOURCE: *FAO Production Yearbook* 51 (1997).

Watermelon fruit will keep for two to three weeks after harvest if it is stored properly at 10 to 15°C and 90 percent RH. Besides whole watermelons, it is becoming popular to sell watermelon in pre-cut halves, quarters, slices, and chunks. Whole fruit are usually cut in the store under cold, aseptic conditions since the cut product does not ship or store well. Seedless watermelons are especially popular for pre-cut sales, since that shows their seedless quality.

In the 1800s, most watermelon was grown for local sales. Development in the last few decades of rapid shipping in refrigerated railroad cars and trucks has led to distribution of watermelon throughout the United States from major production areas. Southern production areas begin shipping early in the year, and the harvest continues throughout the summer in more northern areas.

Depending on the cultivar, watermelon fruit are produced in different sizes: ice box, small, medium, large, or giant; different shapes: round, oval, blocky, or elongate; different rind patterns: gray, narrow stripe, medium stripe, wide stripe, light solid, or dark solid; different flesh colors: white, yellow, orange, or red; and different types: seeded or seedless. Commercially, the most popular seeded cultivars are red flesh, blocky shape, and large sized (8–11 kg), like the cultivar Allsweet. For seedless watermelons, the popular cultivars are red flesh, oval shape, and medium sized (5–8 kg), like the cultivar Tri-X-313. Per capita consumption of watermelons in the United States is 7.2 kg (Table 3). Watermelon seeds can be harvested and roasted for eating as well.

Watermelon is served fresh as slices, as chunks (often in fruit salad), as juice, and as edible seeds for the confectionary types. In the United States, watermelon has typically been part of the summer picnic, where the

TABLE 3

Per capita consumption of cucumber, melon, and watermelon in the United States, 2000

Vegetable crop or group	Consumption (kg/person)
Cucumber (fresh)	3.13
Cucumber (processed)	2.18
Honeydew melon	1.27
Muskmelon	5.44
Watermelon	7.21
All vegetables (fresh)	104.33
All vegetables (processed)	102.06

SOURCE: USDA (2000), VGS-281.

giant (15 kg) fruit is popular. Picnic events that feature watermelon include eating contests (who can eat the most), seed spitting (who can spit the seeds the farthest), or greased watermelon games (which team can move a greased watermelon—which floats but is hard to hold onto—over to its side of the lake). However, watermelon is no longer just a summer fruit and is becoming an everyday fruit like apples, bananas, and oranges.

Cucumber (*Cucumis sativus*)

The cucumber is thought to have originated in India, where it is found wild and is cultivated in many diverse forms. Accessions of *Cucumis sativus* L. var. *hardwickii* may be related to the original ancestors of the cucumber, and have been collected in the foothills of the Himalaya Mountains. These forms are not directly useable in agriculture because of their bitter fruit, dormant seeds, and late maturity. However, they have some traits that have been transferred to elite cultivars by plant breeders.

Secondary centers of diversity for the cucumber exist in China and the Near East. Related species are *Cucumis hystrix* from China and the African *Cucumis*, such as melon (*Cucumis melo*), gherkin (*Cucumis anguria*), and their wild relatives.

Cucumbers were probably domesticated in Asia and then introduced into Europe, where the first cultivars were selected in the 1700s. The first cucumbers were brought to the Americas by Christopher Columbus, and Native Americans were growing cucumbers from Florida to Canada by the early 1500s. Formal plant breeding began in the United States in the 1880s, when cultivars diverged into fresh-market (slicing) and processing (pickling) types.

The cucumber is grown for its fruits, which are eaten fresh or pickled in most countries, but which are also eaten fried (usually when fruit have been harvested at a more mature stage). Slicing and pickling cucumber fruit are mostly water, but they provide some vitamin A and C, especially when pickled with dill and other spices (Table 1). Cucumber is the ideal food for people having trouble with body weight, because it is mostly water, with some fiber, and few calories. Cucumber causes burping and mild stomach upset in some people when eaten raw, but not when soaked in vinegar or pickled before eating. Cucumber is also among 35 fruits, vegetables, and herbs identified by the National Cancer Institute as having cancer-protective properties.

Cucumbers are served and eaten at home and in restaurants (especially fast food establishments) where pickle chips or relish are served on hamburgers and hot dogs. Pickles are also served as appetizers. Fresh cucumbers are sliced and served in salads or as garnishes to add color to the meal. Per capita annual consumption of fresh cucumber is 3.1 kg and processed cucumber 2.2 kg in the United States (Table 3).

Cucumber is used in most countries in the world, where particular types have been developed to fit local requirements. The common types are American pickling, American slicing, European greenhouse, Middle Eastern (Beit Alpha), Dutch pickling (parthenocarpic), oriental trellis, and specialty (such as the round or "lemon" cucumber). Some types referred to as cucumber, such as Armenian cucumber, are actually melon (*Cucumis melo*).

Fresh-market cucumbers are grown primarily in the southern and western states of the United States, especially Florida, Georgia, North Carolina, Texas, and California. Processing cucumbers are grown from Mexico to Canada so they are available year around for processors,

WEST INDIAN GHERKIN (*CUCUMIS ANGURIA*)

The West Indian gherkin (*Cucumis anguria* var. *anguria*), also known as the bur gherkin, was thought to have originated in the Caribbean, but now is considered to be of African origin. The African progenitor is *Cucumis anguria* var. *longaculeatus*, formerly called *Cucumis longipes*. It was probably brought to Brazil and the West Indies (where it got its name) by Africans in the slave trade. The term gherkin is also used for the pickling type of cucumber, especially the small sizes.

Fruit of the bur gherkin are smaller (5 cm) than those of the cucumber, but the defining characteristic of this species is the long peduncle or fruit stem (up to 20 cm in length). The fruit are light yellow to pale green, and are covered with short, fleshy spines. The fruit are eaten fresh or pickled.

often at a considerable distance from the production site. About 80 percent of the world's cucumber production is in Asia (Table 2), with China being the leading producer (Table 4).

Cucumbers are harvested by hand for fresh-market use, and by hand or machine for processing use. Michigan and Wisconsin have an estimated 50 to 75 percent and 25 to 50 percent machine harvest, respectively. Once-over harvest machines destroy the vines as they harvest the fruit (pickling type only). After harvest, the fruit are cooled, graded, packed, and shipped. The cucumbers will have fewer post-harvest rots and a longer storage life if they are cooled soon after harvest.

Fresh-market cucumbers are transported to market and displayed for a few days for sale to consumers. The fruit may be shrink wrapped in polyethylene or coated with vegetable wax to extend shelf life, or they may be sold with no protection. For fresh-market cucumbers, storage at 50°F (10°C) and 95 percent relative humidity (RH) will permit the produce to hold for approximately two weeks after harvest. The American slicing type cucumber has a thick tough skin to reduce shipping damage and increase storage life. Pickling cucumbers are graded and then loaded into tanks of brine (salt water) for fermentation and storage.

The pickling industry originally used brine tank storage to provide brine stock (pickles) to the factory during the off-season. Currently, however, more than half of the crop is processed without brining. Pasteurization is used to produce fresh pack pickles, and refrigeration is used to produce overnight pickles. Fermentation in brine tanks is used less for storage now, and more to produce particular types and flavors (for example, by using acetic acid or lactic acid fermentation).

Storage of pickling cucumber is usually in barrels, pails, jars, or plastic pouches. Preservation is by fermentation, pasteurizing, or refrigeration. For pickling cucumber, it is common and economical for growers to supply markets around the world. For example, growers in India and Sri Lanka supply small pickles in barrels of vinegar or salt brine to processors in Europe and North America.

In the 1700s, cucumber production in the United States probably was small scale; individuals and families would grow a few plants in their garden for the home, probably using the fruit fresh during the summer harvest season and pickled (using a favorite recipe to preserve the fruit) during the off-season. In the 1800s, family farmers grew small areas of cucumbers to supply the fresh market and pickle companies. Even when growers became specialized in cucumber production in the 1900s, family farmers continued to supply small size (grade 1, under 26 mm diameter) fruit to pickle companies. Large field crews generally do not harvest each field every day and usually do not search the vines for small fruit as required to produce a high percentage of grade 1 fruit from the field.

TABLE 4

Leading countries in production of cantaloupe and melon, cucumber and gherkin, and watermelon (MT x 1000) in 1997

Cantaloupe (melon)	Cucumber (gherkin)	Watermelon
China	China	China
Turkey	Turkey	Turkey
Iran	Iran	United States
United States	United States	Iran
Spain	Japan	Republic of Korea

SOURCE: *FAO Production Yearbook* 51 (1997).

Cucumber production is now being done by growers with large farms, specialized equipment, and excellent marketing skills. The small-scale production of cucumber has also increased, as home gardening in the United States has become very popular.

The major modification made to the cucumber in the 1930s was to begin breeding for disease resistance. In the 1960s, gynoecious cucumbers (pistillate or female flowers at every node) were developed, and are now used to make gynoecious hybrids using bee pollination (rather than the more expensive hand pollination). The gynoecious hybrid cucumber, usually with 15 percent monoecious hybrid pollenizer seeds blended into the seed packet, is a major success story. Current cultivars are resistant to anthracnose, downy mildew, powdery mildew, angular leafspot, scab, fusarium wilt, cucumber mosaic virus, and other major diseases found throughout the United States.

Plant breeders have developed a new type of cucumber capable of being grown in the greenhouse. The modifications include making the plant gynoecious (all pistillate or female flowers) and parthenocarpic (fruit set without pollination to eliminate the need for bees or hand pollination, and making the fruit seedless), and of high quality (genetically bitter-free plant for mild-flavored fruit).

Other modifications made by plant breeders include the development of cultivars having large diameter fruit for use in chipping. Thus, a sandwich or hamburger can be made using one large-diameter pickle chip rather than three of the standard size. However, that development was negated by the use of large pickling cucumbers (grade 3) sliced longitudinally to make a rectangular chip. Two of those can be used on a sandwich or hamburger instead of the single large chip, and the quality is often superior.

Melon (*Cucumis melo*)

Melon originated in southern Africa and has many wild relatives there. Related species include cucumber (*Cucumis sativus*), the West Indian gherkin (*Cucumis anguria*), and the

A cucumber melon in the Kalahari Desert of southern Africa. This region is also the genetic homeland of the watermelon. © ANTHONY BANNISTER: GALLO IMAGES/CORBIS.

horned cucumber (*Cucumis metuliferus*). Cucurbits, including melons, have complex symbolic associations with sex and sexuality, fertility, abundance, and gluttony. They may denote wealth in areas where melons do not normally grow.

Melon fruit have a high water content (about 90 percent), and contain sugars and fiber. Nutrients found in melon include vitamin C, and in the case of muskmelon (and other orange-fleshed types), carotenes. Nutritional compositions of casaba, honeydew, and muskmelon (cantaloupe) are shown in Table 1.

The major changes made by plant breeders to the domesticated melon compared with wild relatives have been to add disease resistance, remove seed dormancy, increase fruit size, increase the size of the mesocarp (the edible portion of the fruit), improve the quality, reduce the frequency of defects, and increase the sugar content.

Melon was brought from Africa to Europe and Asia, and from Europe to the Americas. It is now cultivated throughout the world, where specific types have been bred for local use. A useful horticultural classification of melons follows:

- The *Cantalupensis* group includes cantaloupe, muskmelon, and Persian melon. The fruits are oval or round; sutured or smooth; mostly netted, some slightly netted or nonnetted; and abscise from the peduncle when mature. The flesh is aromatic and is usually salmon or orange in color, but may be green. In the United States, the term "muskmelon" and "cantaloupe" are used interchangeably, but some horticultural scientists suggest that they be used to distinguish between types of the *C. melo Cantalupensis* group. This group includes the *Reticulatus* group used in some older classifications.
- The *Inodorus* group includes winter melon, casaba, Crenshaw, honeydew, Juan Canary, and Santa Claus. The fruits are round or irregular, smooth or wrinkled, but not netted; nor do they abscise from the peduncle at maturity. The flesh is mostly green or white, occasionally orange, and not aromatic.
- The *Flexuosus* group includes the snake or serpent melon and the Armenian cucumber. The fruits are quite long, thin, ribbed, and often curled irregularly.
- The *Conomon* group includes the oriental pickling melon. The fruits are smooth, cylindrical, and may be green, white, or striped. The flesh is white and can taste either sweet or bland.
- The *Dudaim* group includes mango melon, pomegranate melon, and Queen Anne's melon. The fruits are small, round to oval, and light green, yellow, or striped. The flesh is firm and yellowish-white in color.
- The *Momordica* group includes the phoot and snap melon. The fruits are oval or cylindrical with smooth skin that cracks as the fruit matures.

Melons require a long growing season with warm, sunny days and cool nights to achieve maximum quality. Plants are established by seeds or containerized plants after danger of frost is past. Stringent management of plant pests is necessary for high yield and quality. As with other cucurbits, it is necessary to have a large honeybee population to facilitate pollination. Asia produces about two-thirds of the world supply, with China being the largest producer (Tables 2 and 4). Several countries in Central America are major melon producers for export to the United States in late winter and early spring. In the United States, most melons are produced in California, Arizona, Texas, and Georgia. In Japan, melons are grown in greenhouses to produce high quality fruit commonly used as gifts.

Melons are harvested by hand from the vine. Maturity in the *Cantalupenis* group is by separation of the fruit from the peduncle (fruit stem) with minimal force. Maturity in the *Inodorus* group melons is not as easily determined, and they may be treated with ethylene after harvest to enhance the ripening process during transit to the market. Cantaloupes are best stored at 3°C and 95 percent RH, whereas other melons are best stored at 7°C and 95 percent RH. The effective postharvest life is about two weeks for both types.

Melon is served fresh as slices, chunks, or juice. Chunks are often used in fruit salad, made into melon balls and frozen, or prepared and sold in grocery stores to be eaten as is. Total per capita melon consumption in the United States is about 7 kg (Table 3). The vitamin A and C content make melon a nutritious food (Table 1).

See also **Fruit**; **Squash and Gourds**; **Vegetables**.

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CUISINE, EVOLUTION OF. Throughout evolutionary history humans have prepared or transformed foods to make them edible. The preparation of food before consumption, which is the foundation of cuisine, has always been a part of the human behavioral repertoire and helps define the species. Unlike most related mammals and primates that begin their digestion in the process of chewing their food, humans often begin digestive processes outside of the body, using tools for this purpose. In other words, what humans do to food before eating it often transforms the food in ways that make it more digestible.

Abundant archeological evidence shows all kinds of tools used for food preparation throughout human evolutionary history. For example, ancestors from the genus *Homo* perfected tools that could cut a piece of meat more effectively than their canine and incisor teeth. They found they could crush a nut or other hard seed pod more efficiently with a stone pestle than with their molar teeth. Human ancestors added controlled use of fire several hundred thousand years ago, so apparently the potential for predigesting food outside the body was well developed by the time *Homo sapiens* emerged. From a biological evolutionary perspective, the continued use of tools and fire and the broad effects of the domestication of plants and animals has altered important aspects of the human food chain and has significantly affected the evolutionary dynamics that underlie the species.

The effect of these important developments in the processing of foods is most evident in human digestive tracts and some of the metabolic pathways associated with the foods humans eat. Evolutionary biologists refer to the changes in the human digestive tract as a result of a relaxation in evolutionary selection. This is evident in the variability of structures that no longer have importance for survival, such as in the structural reduction in size and formation of human teeth or the function of the appendix.

Much of this biological evolution occurred prior to the origin of agriculture that was marked by the domestication of plants and animals. The enormous success of agriculture and horticulture (beginning approximately ten thousand and five thousand years ago respectively), provided the practicing societies with the ability to feed an excess number of their members and thus served as the basic economic subsistence engine for the broad emergence of human civilizations and the overall growth of humanity to its megapopulation size.

Influences of Agriculture

Since the Neolithic era, agricultural practices have continuously improved the productivity of certain plants over others. This intensification has led to an increased dependence on fewer and fewer plants to provide the bulk of most human diets. However, no single plant or any small group of plants, when consumed as raw products from the field, can satisfy all of the nutrient needs of the species. Hence, dependence on fewer plants could have produced nutritional problems (and to some extent this did happen) if humans had continued to eat them more or less raw, as more ancient ancestors did over the thousands of years before the Neolithic era. Thus the Neolithic agricultural diet, characterized by a narrow range of cereal grains and legumes, represented a substantial change from the Paleolithic diet, characterized by a great diversity of hunted and gathered foods. However, this substantial change in diet raises important questions about how and if the species continues to evolve biologically in response to the decrease in the diversity and contents of diets brought about by agriculture.

The relatively rapid shift to an agricultural diet represented a significant nutritional challenge because the diets were largely dependent on relatively few cereal grains and legumes that had serious nutritional limitations. These new limitations included specific nutrient deficiencies, antinutritional properties (such as antitrypsin factors, high levels of phytates, and lectins), and various toxic constituents (such as cyanates and tannins). This shift to agriculture could and did result in strong new sources of natural selection and the rapid evolution of biological traits that tended to compensate for these limitations. However, the vast majority of the adaptations to this new agriculturally based diet came from the increased use of cuisine-based technologies that went far beyond the use of tools and fire, already well established in Paleolithic times. In essence the emergence of a wide variety of cuisine technologies counterbalanced the more limited but important potential of the genetic changes required to adjust to the nature and rate of these new dietary constituents.

It is clear that significant biological adaptations underlie the success of the evolution of some agricultural practices. Many experts accept the evidence that it is the continued secretion of lactase enzyme that makes milk sugars digestible by most northern European adults in contrast to most other adults of the world, who stop secreting the enzyme at the time of weaning. This evolved trait for adult lactase enzyme sufficiency underlies the high and continued dependence of these populations upon dairy foods following the domestication of cattle over eight thousand years ago. Although the specific cultures of northern Europe have undergone many cultural and historic changes in diet over that long period, all of those cultures continue to consume dairy foods in unbroken traditions, such as making yogurts and cheeses that partly lower the milk sugar content. Likewise, good evidence indicates a genetic cline (or gradual geographical change in the gene frequency) of adaptations to the gluten protein in wheat (to which some people have serious intolerance) tracked with increasing frequencies from the Levant, where wheat was first domesticated, all the way across Europe, where it was introduced at later times.

Other genetic adaptations involving nutrition and food also work pharmacologically to influence disease problems. For example, the disease called favism, which results in a profound life-threatening, hemolytic anemia, is due to another enzyme deficiency that helps protect the affected populations from malarial infection. However, the gene Glucose-6 dehydrogenase deficiency (G6PD), a sex-linked gene associated with males, makes afflicted males particularly sensitive to the profound hemolytic affects of the oxidant compounds in the beans. Although the G6PD gene is widespread in all of the regions where fava beans are consumed and causes many deaths every year among sensitive individuals, the pharmacological effects of the beans help prevent malaria. Not surprisingly, more myths and stories promote and prohibit the consumption of these beans than any other food in Indo-European history. Thus foods may have pharmacological properties in addition to nutritional properties, which makes interaction between their consumption and the continued evolution of the populations that eat them complicated.

While genetic adaptations to diet did evolve over the last ten thousand years, most adaptations to agricultural diets evolved at the cultural realm in the form of cuisine technologies. While becoming more dependent on fewer plants in the diet, human forebears produced a classic evolutionary bottleneck in which the increased dependence on fewer plant crops increased the nutritional liabilities each plant retained. Consequently, a continuous complementary evolutionary process related the increased agricultural productivity with the evolution of new cuisine technologies that enhanced the nutrient composition and often simultaneously rid the plants of their toxic and antinutritional effects.

Nutriculture

The term "nutriculture" refers to the reciprocity of these preparatory technologies with the overall advantages that agricultural practices have provided for the enormous success in increasing the productivity of plants. In other words, every advance in the agricultural productivity of plants was accompanied by the evolution of cultural strategies to offset the nutritional disadvantages of depending on so few nutritionally unbalanced and potentially toxic foods. Hence "nutriculture" represents the evolved cultural strategies that turn these disadvantages into advantages and the complementarity of these preparative technologies with agriculture. Treating foods before they are consumed can and often does have nutritional and pharmacological consequences for the finished consumable. For example, many different physical, chemical, biochemical, and microbiotic steps "prepare" the plant-based staples in the human diet. These transformations from the "raw to the cooked" become the culturally recognized foods humans eat, and with which they celebrate, remain nutritionally healthy, and ultimately survive and prosper around the world. Thus the evolution of food nutriculture has been just as important as the success of agriculture in producing enough food to continue to feed the world.

In fact many of these technologies become parts of long-standing recipes that fill this encyclopedia and the cookbooks and cooking traditions of the world. These technologies are so important in defining the foods consumed that they become part of the cultural worldview of every society that has ever lived. Every society celebrates with food and incorporates foods as symbols, and many of these traditions provide the cultural memory for how foods should be prepared for healthful consumption.

Although evolutionary anthropologists and biologists have not looked at what humans do to food as part of an evolutionary process equal in importance to agricultural practices, the evidence for such a process underlying basic cuisine practice is strong. Of course this does not mean that every aspect of cuisine practice involving innovations, presentation, and the like has some kind of evolutionary basis. However, it does suggest that many of the fundamental aspects of the transformation of raw materials into foods often has a long and highly evolved natural history that is not always readily recognized as optimizing their nutrient and other qualities. Hence transforming the raw foods for consumption can and does make a difference in health and survival. In some respects this knowledge about preparation and consumption of foods is so much a part of the existence and identity of a society that its members often are more conscious of making food "palatable" to culturally conditioned tastes and expectations than of the nutritional and pharmacological significance of the steps taken.

Importance of Preparation

Other major sources of nutrition follow the nutricultural principle. A classic example of the evolution of cuisine practices involves maize or "corn." While maize is the most productive crop in the world, and virtually all of the great Mesoamerican civilizations depended upon it as a staple, it is not nutritionally the best balanced of staples. Maize has low lysine and tryptophan levels, and its niacin levels, when stored as a staple, are nutritionally indigestible. Specifically the B vitamin niacin becomes bound in a complex called niacytin, and this bound form is indigestible to the effects of stomach acid and gastrointestinal enzymes. However, it is known that the chemical bond that makes niacytin resistant to digestive acid is broken in the presence of an alkali that frees the bound niacin. Although humans can make a small amount of niacin from the essential amino acid tryptophan, corn is deficient in tryptophan. Fortunately beans have relatively high levels of tryptophan, and as long as beans are consumed with corn (maize), the diet is balanced. However, if beans and other regular sources of tryptophan or niacin are not available in the diet, the disease pellagra makes people sick with diarrhea, dermatitis, dementia, and ultimately result in death.

While alkali treatment also enhances the solubility of lysine, it is not universally used, even in the Americas where the crop evolved. However, the Native American societies that were high consumers and growers of maize always used alkali in their cuisine technology. It was a one-to-one relationship between high consumers and growers and their subsequent use of this critical step in the preparation of their food staple. In terms of their recipes, the added alkali was prepared in several different ways, including crushed limestone, roasted mollusk shells, and wood ashes. The net effect of this step was always the same. The food was heated and "cooked" in the lime, and then most of the alkali was removed prior to consumption. Even though the recipes varied among different cultures and traditions, these basic cooking steps did not vary.

In this regard it is interesting to note that Christopher Columbus, who first introduced maize to the Old World, only introduced the food and not the critically important recipe. Pellagra became widespread, resulting in a gradual decrease in the use of maize as a human food. Not until the discovery of vitamins beginning in the 1920s, over four hundred years later, was pellagra defined as a nutritional deficiency associated with the consumption of maize.

However, considering the history of every major civilization, it becomes clear that all depended upon the solutions to similar problems to survive and prosper. Thus, while it is possible to innovate new food technologies that may not have many or any negative consequences in times of nutritional abundance, the same practices may produce serious deficiencies during times of nutritional stress. Thus food preparation has substantial survival advantages, and undoubtedly significant wisdom resides in the related food practices that maintain food preparation traditions.

The use of fermentation to enhance the nutrients of wheat and barley in the production of beer and bread is a classic example of how foods become staples of the diet. Fermentation of wheat and barley with yeast not only produces the alcohol in beer and, to a lesser extent, in bread; it also synthesizes nutritionally essential amino acids from nonessential ones, reduces the toxicity of the tannins in the wheat, and lowers the phytate levels that interfere with calcium absorption. Squeezing, crushing, and heating the manioc (a good source of nutrition known throughout the world for yielding the tapioca starch of dessert puddings) reduces the plant's cyanide content, which can be so high that even breathing the cooking fumes can be deadly. With the notable and important exception of fruits, which evolved to attract mammals to eat the seeds and thus to disperse them, the raw produce is not a viable source of nutrients without the culturally evolved capacity for transforming it into an appropriately edible food.

Biology and Culture

Over time, a trial-and-error process results in the nutritive success or failure of new cuisine strategies. Those strategies that satisfy basic nutritional needs become incorporated into food traditions and provide subtle and not so subtle advantages to the people who practice them. When the cause-and-effect relationship between the cuisine practice and the outcome are readily evident, as in changing the appearance, taste, or aroma of a food and then noting a benefit, it is relatively simple to understand the functional significance of the cuisine practice. However, when considering subtle cause-and-effect relationships not readily evident and expressed some time long after the prepared food is consumed, it is difficult to detect the relationship and consciously to behave in the appropriate way. For example, the time it takes to develop a nutritional disorder for a vitamin like niacin is so long that the appropriate cuisine practice may not ever evolve, as was the case for extracting the niacin from maize in Europe. Epidemiological studies of long-term disease outcomes that may extend over a substantial portion of a lifetime, such as cardiovascular disease and some forms of cancer, demonstrate how subtle some of these effects are.

On the face of it, the degree to which a culturally based diet satisfies basic nutritional needs is a matter related to the biology of humans as omnivores. Humans uniquely depend on cultural adaptations concerning diet to solve the nutrient problems that biology is incapable of solving on its own. Instead, humans have discovered and encoded in cultural traditions wisdom about diet that provides a culinary prescription for survival and good health. What people eat is largely dictated by cultural traditions, but the degree to which a diet satisfies basic nutritional needs largely depends on human biology. This obvious interface between biology and culture has encouraged the development of a new approach or paradigm that analyzes and interprets biological and cultural adaptability as continuously interacting phenomena throughout human evolution.

No doubt the evolution of agriculture would not have occurred without these counterbalancing nutricultural evolutionary steps. In fact this basic theme of nutriculture is repeated with other aspects of cuisine and thus forms the basis of a broad trend throughout history in the consumption of every major plant food.

The remarkable growth of knowledge about what people eat arises from an understanding of both the prehistory of diets and the recorded history of foods. Also a substantial and growing ethnographic and cross-cultural literature concerning folk cooking practices allows tests of specific hypotheses about food processing. The available data in food science and technology, the nutritional sciences, biochemistry, ethnobotany, pharmacology, and the neurosciences is extensive. Using this knowledge to extend the understanding of the biological and biocultural evolutionary processes produces the potential for providing important insights about this nascent study of nutriculture. The varied contents of this *Encyclopedia of Food and Culture* suggest avenues and examples of nutriculture for exploration.

See also **Agriculture, Origins of; Anthropology; Eating: Anatomy and Physiology of Eating; Evolution; Food Archaeology; Maize; Nutrition Transition: Worldwide Diet Change; Paleonutrition, Methods of; Prehistoric Societies; Preparation of Food; Vitamins.**

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Solomon H. Katz

CURDS. Curds are a by-product of milk, and in the traditional agrarian societies of Europe and America, indeed in most parts of the world, the processing of milk belonged to the woman's sphere. In many farmhouses, there was a cold room or a freestanding springhouse nearby known as the dairy, and like the kitchen, this was the domain of the wife and her daughters. For this reason, much information about curds and curd-making can be found in cookery books and in books on household management.

Curds may be best described as condensed milk fat that has not yet aged into cheese, although it is also fairly common to refer to unpressed curds as "fresh" cheese—fresh in the sense of raw or unprocessed. The most popular form of curds consumed in the United States is cottage cheese, which is fresh curds combined with cream, sour cream, or milk. Low-fat cottage cheese is generally considered a health food and therefore plays an important role in many types of weight-loss diets. Greek feta cheese is essentially fresh salted curds preserved in whey, the watery liquid that comes with every jar or package of feta.

The word "curd" evolved from Middle English *crouden*, a verb meaning 'to press or push hard in a downward direction'. This association may derive from the fact that curds were normally poured into a cloth bag and pressed dry of the whey, or hung from a hook and allowed to drip over a basin, hence the old term "hung cheese." In the eighteenth and nineteenth centuries,

GOAT CURDS

Goats lactate seasonally and while they produce less milk than cows, their milk is richer in vitamins and minerals. The ancient Greeks always recommended goat milk for babies because they observed that it was easier to digest. This is due to the fact that a high proportion of small- and medium-chain fatty acids are more easily absorbed into the body. Likewise, goat curds are much easier to digest than curds from cow milk. Goat milk is naturally homogenized because it lacks a protein called agglutinin; thus the fats in the milk remain dispersed. This, plus the lower casein proteins in goat milk, results in smaller curds, which is why fresh goat cheese has such a dense paste-like texture. The halloumi cheese of Cyprus is so dense that it can be grilled without melting or falling apart. It is made from goat curds that are pressed together with mint, then heated in salted whey.

curds were also pressed into molds made of ceramic or tin and sold in farm markets in a wide variety of shapes, usually hearts of various sizes.

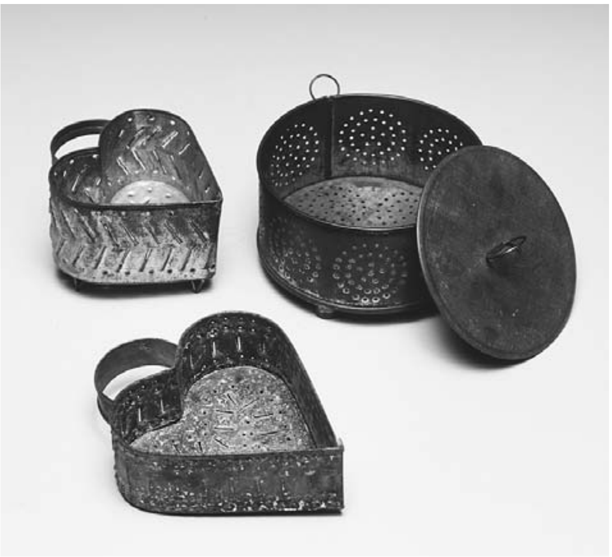
From *crouden* also comes the Southern term "crowder," any sort of cowpea that was cracked (pounded) and cooked for porridge. A crowder pea was a porridge pea, and in the Scotch-Irish cookery of Appalachia, this porridge might also contain whey or curds, or even both. In rural Scotland, curdy-butter or cruddy-butter was a spread for oat cake made by mashing together fresh curds and salted butter. In Appalachia, it was eaten on johnny cake. It goes without saying that curds and whey have been dietary staples for thousands of years in every household where milk was readily available.

In composition, curds are the fatty part of milk that has become solid. When milk undergoes acidification, it sours. This souring process is induced by lactic acid bacteria streptococci and lactobacilli. They feed on milk sugars (lactose) and change it to acid. When this happens slowly at room temperature, the result is clabber or "thick milk," as it was often called in Colonial America. Clabber is milk that has attained a consistency resembling junket, and in this form, it was an important ingredient in traditional cookery. It was also eaten by itself as a breakfast and supper food, often mixed with fresh fruit (during the summer). German *Quark* is very similar to clabber in composition and is eaten like yogurt in many parts of Central Europe. Clabber is no longer eaten in the United States because of regulations requiring the pasteurization of milk. Pasteurized milk will not clabber because the bacteria have been killed during the heating process.

However, when the souring process of raw milk is speeded up, the acid causes the fatty solids in milk to migrate and stick together, thus forming curds (called protein clump among cheesemakers) and watery whey. In traditional cookery, whey was considered a useful food in its own right, mainly because it was easy to digest. It was therefore employed in foods prepared for children, the elderly, or the sick. In regions where dairy culture predominated, whey was available in such abundance that it was often fed to livestock, especially pigs. Whey was also used in hearth cookery for making griddle cakes, muffins, and cornbread, since the acid would react with such old-time leavening agents as Hirschhorn salts, saleratus, and pearlash. Cow's milk yields the largest amount of whey since it is about 85 percent water.

Renneting

Curd formation could also be hastened by a process known as renneting. This was based on an enzyme called rennin, which is found in the stomach lining of ruminant animals. The rennet preferred by most cheesemakers generally came from the stomach of a young animal, such as a calf for cow's cheese, kid for goat cheese, or lamb for sheep's cheese. The use of animal rennets in cheesemaking is the reason many vegetarians will not eat cheese—the young animal of course must be killed in order to obtain the rennet. Tofu, a curd made from soybeans, has been eaten in Asia as a milk curd substitute for over a thousand years. However, there is also a long history of rennets obtained from plants, and cheeses made with them are acceptable to those vegetarians who consume dairy products.



Traditional tin curd molds. Left top and bottom: Pennsylvania, circa 1900; right: France, circa 1890. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

One of the earliest known plants employed as a renneting agent was the wild artichoke of the eastern Mediterranean and North Africa. It is believed that the Phoenicians discovered this process and disseminated the technology, since the earliest cultivation of artichokes (and cardoons) is associated with Phoenician colonies. These plants may have been first brought under cultivation expressly for their renneting qualities, only later employed in cookery. In any case, it was the "choke" or flower head that was heated in the milk in order to make it curdle. These plants flower in late spring when milk production is at its peak, especially among goats.

Other renneting plants from this same region were milk thistle (*Silybum marianum*) and blessed thistle (*Cnicus benedictus*), which were also eaten as spring greens (the leaves were tied up and blanched under mounds of soil). In northern Europe, the flower heads of several species of native thistles were used in the same manner, as well as the old Celtic rennet plant, Lady's Bedstraw (*Galium verum*). In the case of Lady's Bedstraw, it is the golden yellow root that is used to curdle milk. In the Celtic areas of Spain and Gaul, this plant, like milk thistle and blessed thistle, was under the protection of the fertility goddess Brigantia, who presided over matters dealing with the dairy and whose name survives in many place names where her cult was celebrated annually at Imbolc (February 1).

Brigantia's offices were subsumed by the early Church and assigned, in Ireland at least, to St. Bridget (a goddess transformed into a saint) as well as to Maria Lactans, the Virgin Mary depicted with streams of milk flowing from her breasts. It was Maria Lactans to whom village women prayed not only to ensure their own lactation after childbirth, but also to ensure the proper curdling of milk during cheesemaking.

See also **Cattle**; **Cheese; Dairy Products**; **Goat, Lactation; Vegetarianism**.

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CURRY. The term "curry" is an Anglicized spelling of Tamil *kari*, a general term for any spiced sauce, or in some south Indian dialects, an old word for black pepper. There is no fixed recipe for curry, and the Indians themselves generally refer to this broad range of spice preparations as *masala*, such as the powdered *garam masala* of the north, *chat masala* (tart and salty), *kala masala* (black curry), and *dhansak masala* (hot Parsi curry). These can be blends of powdered or whole spices and seasonings, wet or dry mixtures, mild or hot, depending on preference and regional style of cooking. As a rule, northern Indians favor dry powders, while in the South, pastes are more common. Most Indians prefer to make their spice mixtures fresh from raw or green ingredients, and this is one reason why recipes prepared in India taste so differently when made abroad.

However, curry, not *masala*, is now used the world over as a symbol for the spicy food of India, and especially for flavorings made for export, with powders based on such key ingredients as ground mustard seed, turmeric, coriander, cumin, and fenugreek. Cinnamon, cardamom, and chili peppers may also be added, as well as a variety of other flavorings. Most commercial curry powders are yellow, due to turmeric, a spice often connected with magic and ritual in traditional India. In spite of their universal appeal, spicy foods were condemned by most of India's ancient religions and forbidden to those seeking an austere and virtuous life. Curried foods were, therefore, equated with luxurious living.

Judging from the poems extolling them, the concept of serving a spicy sauce over rice is extremely old in India—there are references to crab and vegetable curries from ancient Jaffna in the south, but the term "curry" was not used to describe them. The Portuguese may have been the first Europeans to mention this type of cookery as early as 1502, but it was the Greek and Roman traders who first encountered it many centuries earlier. The traders are mentioned in Tamil accounts, which make it clear that they were quite fond of south Indian cookery, at least along the coast where they had established trading ports. The use of spice mixtures to flavor sauces, however, was not strange to either the Greeks or Romans, and such common curry herbs as cumin and fenugreek were actually introduced to India from the Mediterranean at a very early date.

The earliest reference to curry in English appeared in a 1598 Dutch travel account, but it was English cookbook author Hannah Glasse who first published a curry recipe in 1747, transforming it from a true sauce to a stew. This began the gradual yet steady evolution of curry into a dish quite at odds with its original Indian forms. Both the Dutch and English, through East India trade, spread the popularity of curry far beyond its original borders, but in doing so, they also changed it. The Dutch created the *rijstafel* and its numerous curried dishes out of their culinary experience in Indonesia. The English did the same with Indian *masala*.

True Indian-style curried sauce and rice are mentioned in numerous English accounts of life in India, even during the eighteenth century, and this remained a feature of the typical colonial meal; yet when it traveled back to England, it changed into a meat stew with rice added, or into something else altogether—such as the main flavoring for mulligatawny soup. Eliza Acton listed several curry dishes in her *Modern Cookery* (1847), including a rather telling discussion of curry, along with potted meats—telling because of its positioning among hashes as a supper dish or something for high tea, not a main course. She not only supplied a recipe for curry very similar to the powdered sorts sold in tins during that period, but she also detailed directions for making curried eggs (deviled eggs flavored with curry), curried sweetbreads, and curried oysters.

American cookery books do not trace as avid a taste for curries as their English counterparts, but Eliza Leslie did tackle curry in her *New Cook Book* (1857), and complained about the common adulterations and the widespread overuse of turmeric and hot chili. She made an interesting remark: "The best curry powder imported from India is of a dark green color, and not yellow or red. It has among its ingredients, tamarinds, not preserved, as we always get them—but raw in the shell. These tamarinds impart a pleasant acid to the mixture. For want of them, use lemon." Leslie was describing a true *masala*, and she stands out for taking a stance on authenticity mostly lacking in European cookery books of her period. However, her words were to no avail.

Tinned curry powder, imported or imitation, became a standard household spice, because it was an ideal ingredient for dressing up processed foods and the sort of bland preparations championed by the home economics movement of the late nineteenth and early twentieth centuries. Suddenly, curry was everywhere, "Beetonized" by the publishers of Isabella Beeton's *Book of Household Management*, the culinary bible of the British Empire. Curry met its ultimate apotheosis in the empress of India, the aging Victoria, presided over by Indian manservants and an Indian groom.

On the commercial side, marketing genius E. P. Veerasawmy promoted this lifestyle of the imperial raj as Edwardian chic. His food specialty company (established 1896) and famous restaurant on Regent Street in London (established 1926) became English institutions and synonymous with the "other English cuisine." Veerasawmy was also a champion of authenticity in his culinary writings. In *Indian Cookery* (1957), he said about curry: "Curries should always be served in separate dishes and never with rice as a border. The accompaniments of rice with curry are usually Bombay ducks, puppadums, chutneys (various kinds), Indian pickles, and sambals. It is best to eat curry and rice with a dessert spoon and fork. A knife should never be used. A well-cooked curry will not need one."

If curry has undergone a change since then, it has taken its cue from the large numbers of Indians and Pakistanis who have settled in Britain, Africa, South America, and the United States during the second half of the twentieth century. No longer do non-Indians imagine that curry is a flavor peculiar to one rare fragrant spice. The proliferation of Indian-style restaurants, especially the inexpensive ones with highly varied menus, has at least driven home the idea that curried sauces come in many styles and forms. Most importantly, however, is the printed menu itself. All over the world, anywhere English is spoken, Indians prefer to use the term curry, regardless of what they may call their sauces in the homeland.

See also **Beeton, Isabella Mary; British Isles; Herbs and Spices; India; Leslie, Eliza**.

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CUSTARD AND PUDDINGS. Custard and puddings are words that describe several important sweet foods. The strict culinary definition of custard is eggs and milk mixed and baked, or stirred over gentle heat until thickened. Used in desserts, pies, pastries, and as sauces, it is well known in European countries and in cultures influenced by them.

After this, there are significant differences between custards and puddings in North America and the United Kingdom. Currently, in North America, pudding, and often egg custard, is made up from a flavored cornstarch mix to give creamy-textured desserts, and is eaten alone or used as pie filling. Mixes are also known elsewhere, for instance, in Germany, Central Europe, and Southeast Asia. In Britain, pudding mix is unknown, but a similar product, custard powder, is found in most kitchens. It is vanilla flavored and used mostly to make a sauce for puddings. Puddings are a complex subject in English cookery. The word "pudding" is used for numerous sweet dishes—some crisp, some cake-like, some soft and smooth, some like plum pudding. They have no convenient overall definition, but sweetness and the presence of flour or other cereal is important, and they are essential to a proper dinner. Pudding is also used as a collective name for the dessert itself, and applied to special groups of savory foods, not discussed here.

In scientific terms, cornstarch puddings are starch gels, and egg-and-milk custards are protein gels. To achieve their creamy texture, old-fashioned cornstarch pudding mixes and British custard powder must be brought to the boil. This gelatinizes the starch: the granules of which it is composed swell and some long-chain starch molecules migrate out, making the liquid thick and viscous. When this cools, it becomes gel in which the starch molecules form a network, enmeshing the water. Instant pudding mixtures rely on chemically modified starches that

Custard Pies

The appearance of early custards is unknown. In seventeenth-century England, the author Robert May (1685) gave patterns for baked custard tarts. Pastry for the base was cut to make fancy leaflike shapes. Vertical strips were added to the edges to make walls to retain the mixture. The shapes were baked blind, then filled with flavored egg and milk, and baked again to set the custard, which was finally decorated with a sprinkle of little colored candies. These custards were probably eaten by spooning the filling out of the pastry, which recipes suggest was tough and essentially for structural and decorative purposes.

Such elaborate dishes are unknown today, and custard pies are plain in appearance, their only decoration being a scatter of grated nutmeg, but individual custard tarts are made in deep pastry shells, recalling a little "flowerpot" shape, originally known as a dariole. The large French apricot tarts with custard baked around the fruit are not found in English cookery. A short pastry is always used for the crust in England, unlike Portuguese *pasteis de nata*, rich custard tartlets in flaky pastry.

Several distinctive North American variants of custard pie have appeared. These would not necessarily be considered custard pies by their makers, but a certain basic reliance on eggs and milk can be seen in the recipes. They include pumpkin pie, key lime pie, chess pies as made in the southern States, lemon meringue, and various "cream" pies. These products represent a distillation of centuries of ideas about custard and puddings from various European cultures, with some distinctively American twists added. Finally, custard pies also became important in early movies, but as ammunition, rather than as food. They were specially constructed with pastry sturdy enough to hold in the hand and included a satisfyingly messy filling.

gelatinize without heating. Flavors of pudding mixes are limited only by technology and the tastes of consumers; almond, vanilla, chocolate, coconut, caramel, butterscotch, and lemon are considered old favorites.

Egg-based custards require gentle cooking. A standard recipe is one cup milk, scalded, mixed with two eggs and two tablespoons sugar, poured into a dish or a pie shell and baked at an oven temperature of about 350°F (180°C). During baking, the egg proteins coagulate to become a firm but tender gel (milk contains naturally occurring salts that aid this process). Alternatively, the mixture is cooked in a double boiler on the stove top to make a boiled custard. This is a confusing name, as the temperature of the custard must not rise above 189–193°F (87–90°C) or it curdles and the texture is spoiled. Richer custards require cream or high proportions of egg yolk.

Custard or pudding recipes that involve both cornstarch (or flour) and eggs are also known; *crème pâtissière* (pastry cream) is based on this principle. These are heated to boiling, but do not curdle because the starch stabilizes the egg proteins. Other special types of custard dessert, such as the decoratively molded *bavaroise* (Bavarian cream) rely on gelatin to hold a firm shape. In the tropics, cow's milk is replaced with that of water buffaloes, or by coconut milk. Some Chinese custards have a sugar syrup base, and the Japanese make savory *chawan mushi* using *dashi* stock as the liquid. Vanilla is the classic haute cuisine flavoring for custards, but the English use nutmeg on baked custards, the Spanish and Portuguese flavor with lemon and cinnamon, and the Chinese with fresh ginger.

In the complex history of custards and puddings, mixes are a relatively recent invention. Convenience was a factor in their development over time, but they must also have resonated with ideas about soft milky desserts from previous centuries. To disentangle these, one has to look at the European history of such dishes.

Baked egg and milk custards are of ancient origin; a Roman recipe of this type survives. The combination was also liked in the Middle Ages, when pastry was used to contain the mixture. The word "custard" comes from *crustade*, meaning a single-crust pie. Sugar, spices, vine fruit, almonds, and ground meat were added to custards. Little distinction was made between sweet and savory foods until the seventeenth century (the idea of a savory custard containing meat has survived into the twenty-first century as quiche Lorraine.) Possets, warm drinks of eggs, cream, wine or ale, sweetened and spiced, were also made. They were popular in the seventeenth century, and may have influenced ideas about custard as a dessert sauce, as well as being ancestors of eggnogs.

With or without pastry, custards were popular in eighteenth-century Europe. In England, rich ones flavored with almonds, pistachios, or orange flower water were called creams. Lemon cheese, a mixture of lemon juice and rind, butter, sugar and eggs—almost a milkless custard—was popular for tartlets, as was egg custard. Custards also acquired a new role as a base for ice creams, which later became important in North America.

Elsewhere, elegant custard desserts developed, such as the egg yolk and cream *crème brûlée*, with a crust of caramel sugar, and *petits pots de crème*, cooked in little cups or *ramekins* (itself a Flemish word which originally meant 'little cream'). Custards cooked in molds lined with caramel sugar—*crème caramel*, Spanish *leche flan*—later became cliches of restaurant cookery in the twentieth century.

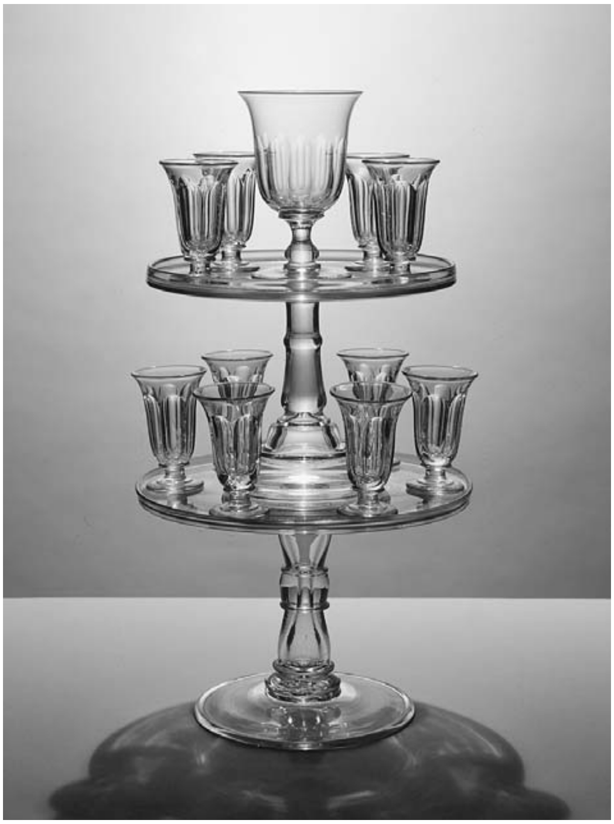
The history of English puddings is obscure, but sixteenth century versions seem to have been sausage-like, with meat and cereal fillings, ancestors of suet and plum puddings. Early eighteenth-century recipes included boiled custard puddings and quaking puddings of egg, cream, and flour. Both types were wrapped in cloths and boiled. These were all staple foods, as was hasty pudding, hot milk with flour stirred in to thicken it. Sweet baked puddings in pastry-lined dishes became fashionable, too; a custard done this way was sometimes called a custard pudding. Other recipes used fruit, nuts, vegetables such as carrots, or sweetened rice, barley, or sago with milk, cream, and eggs. Similar cereal mixtures with milk, sugar, and eggs were known elsewhere in Europe.

In early nineteenth-century America, ideas about custard and puddings were probably little different than those of the English. One influence at this time was the availability of easy-to-use starches such as arrowroot, tapioca, and potato flour, which gave a pleasing transparent appearance, and were used for invalid food. The critical development was the extraction of cornstarch in 1842 in New Jersey; by 1850, food-grade starch was being produced. Secondly, in Birmingham, England, in 1844 a pharmacist named Alfred Bird devised custard powder, a flavored starch mix, for his wife who was fond of custard but allergic to eggs. It is unclear if he used cornstarch (at that point, mostly used in laundries) or another type such as arrowroot or sago. Custard powder soon became popular in Britain.

American housewives continued to make puddings with cornstarch, milk, and eggs, using chocolate, vanilla, or fruit as flavors. Cooks also found that cornstarch "stretched" an inadequate egg supply and, added to custard, made it more stable. Recipes increased in number, and flavors increased—caramel, lemon, almond—recalling custards and puddings of other traditions and centuries.

Convenience puddings appeared in the mid-1920s, when the Jell-O Company introduced a chocolate mix for use in institutions. Surprisingly, in view of the move toward convenience foods, ordinary consumers had to wait until 1934 until they could buy a similar product, sold as Walter Baker's dessert. Although the British used starch mixes for cold-molded blancmanges, they never took to pudding mixes. In contrast, in North America, other flavors soon appeared and the mixes were also marketed as pie fillings. Instant mixes came onto the market in the 1950s.

By this time, the defining characteristics of pudding seem to have emerged as softness and sweetness, echoing custards, batter, and milk puddings. Speed was also important, perhaps influenced, by the idea of hasty pudding, to which cornstarch puddings bear some resemblance when reduced to basic principles. Puddings and custards also converged as cornstarch mixes were increasingly uses in pies. "Cream" pies have picked up elements of the sweetness and softness of custard and acquired a name associated with it, while maintaining a link, through cornstarch, with the cereal element so important in puddings.



Glass pyramid with cream or custard glasses. Mixed pieces from England and America, circa 1790-1800. The custards were cooked in a double boiler, then poured hot into the glasses, which were then stored away in a cool place until the custard set. The custards were brought to the table and served from the pyramid. The large glass on top is intended for a fruit or floral centerpiece. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Nutritionally, a standard egg custard provides about 380 calories, a little under 20 g protein and 17 g fat, plus about 170 mg calcium. The composition of richer custards or English puddings is infinitely variable, depending on the whim of the maker: more cream, more sugar, higher calories. Standard mixes and custard powder made up with whole milk provide about 90 calories per 100 g when mixed; most of the calories are from sugar and starch. The high-protein or low-sugar pudding mixes marketed in the United States as snacks and for dieters are a notion that would amuse the English originators of puddings, for whom it was, by definition, a high-calorie, filling food and an essential part of a proper dinner.

See also **British Isles: England; Gelatin; Pastry; Starch.**

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Laura Mason

CUTLERY. For a very long time humans used their fingers to convey food to their mouths, tearing pieces off with their teeth, which had evolved for this purpose. Then they found that, by using small flakes of sharp-edged flint as cutting tools, they could skin and cut up the carcass of a heavy animal and remove the small pieces to a safer place to eat. Similarly, natural objects, such as shells, could be used to hold and carry water.

With the discovery and use of copper, humans moved into the age of metal. The early Egyptians, who already had very beautiful and skillfully executed flint knives, made copper knives that were small and leaf-shaped in design and may have been used for domestic or ceremonial purposes. These copper knives did not have as hard and sharp an edge as flint and probably did not replace the flint knives entirely until it was discovered that combining the soft copper with tin produced the much harder alloy of bronze. This extended the use of metal into everyday objects and gave bronze knives a hard and sharp edge; the distinct advantage of these blades was that they could be resharpened.

Further specialization of knives occurred throughout the Middle East and spread among the Celts of central and northern Europe in the Bronze Age. There are some extant small knives with considerable decorative style that were probably personal eating implements, perhaps carried on a type of chatelaine. Additionally, other larger and decorative knives, capable of being used for eating or defense purposes, were possibly carried in a sheath on a belt.

The next important advancement was the slow introduction of the use of iron, which started with meteoric iron in Egypt in the third millennium B.C.E. with very small improvement in the technology and was probably in the beginning not a great improvement on bronze.

During the Roman period, divisions of society appeared with their own rituals for eating and drinking. Some Roman illustrations show diners in a reclining position, which must have made cutting food with a knife quite difficult. Perhaps the food was cut into bite-sized pieces before serving, similar to the custom in most Asian countries today. The reclining style of eating was not for everyday, but for banquets and entertaining. Iron knives, some with decorative bronze handles, were now common, and the Romans had a large range of knives to meet their various requirements, including specialized knives for eating and food preparation.

The Romans also developed folding knives with blades of iron, some with spoons attached, with decorative bronze handles showing hunting scenes of hounds chasing hares; another version of the folding type is a figure of a lion with an iron knife blade, folding spoon and sometimes a "spike," perhaps for eating snails. It is not inconceivable that these utensils were used and lost by legionaries moving around the country; they are among the more common Roman objects excavated in Britain.

There is evidence from Saxon grave sites of women and children having small personal knives of iron interred with them during the early centuries following the withdrawal of the Romans. Some of these knives reflect the style that was developed by Northumbrian monks. The larger knife, called a "scramasax," was a general-purpose iron knife having a very distinct shape and point, with a thick back and a blade that was sometimes inlaid with silver and brass in a wooden "bobbin" handle. Some of the better examples show great skill in the patterned inlay work on the blade. The scramasax became quite famous and popular throughout Europe; a well-recorded knife owned by Charlemagne is an example of its status. Some of the excavated medieval knives from the foreshore of the Thames still show this influence.

Illustrations from medieval manuscripts show rich tables set with ewers and bowls, a knife or two, and occasionally a fork. The number of knives on the table does not match the number of diners present, so, according to the custom of the time, the diner would carry and use his own knife and spoon, or perhaps share a knife provided on the table. The ewers and bowls were for cleansing the fingers before taking food from the communal dishes. A small fork was most likely provided for picking up preserved and sticky food. The fork was shared and, like the spoon, did not become an eating companion with the knife until after the second half of the seventeenth century. Most of these early forks are bronze and silver, with two tines, and have been excavated in Europe, particularly Italy. They did not change very much in style until the late sixteenth and early seventeenth centuries, when the number of tines varied from two to four. However, the two-tined fork, also in steel, lasted in common usage in western Europe, including Britain, until the twentieth century.

The personal carrying of knives is well illustrated by Bosch and later by Breughel, both of whom show knives worn in the belt ready for eating or, if need be, self-defense. Spoons were usually tucked into hats and clothing and were perhaps easily lost. This might explain the many spoons that have been excavated at the apparent crossing point of one of London's ditches where we can assume people dropped the spoons when they jumped and then failed to retrieve them.

Medieval travelers were expected to supply their own eating utensils at any lodging house or inn in which they stayed overnight. Most men carried a knife of some sort in their belts as a matter of course, but a rich traveler might have a more elaborate sheath, perhaps containing a large knife and an extra sheath containing a small eating knife and spoon. Later medieval knives were subjected to considerable innovation in both design and construction. The reason for this is not entirely clear, but one suspects that location, novelty, desirability, and profit were factors.

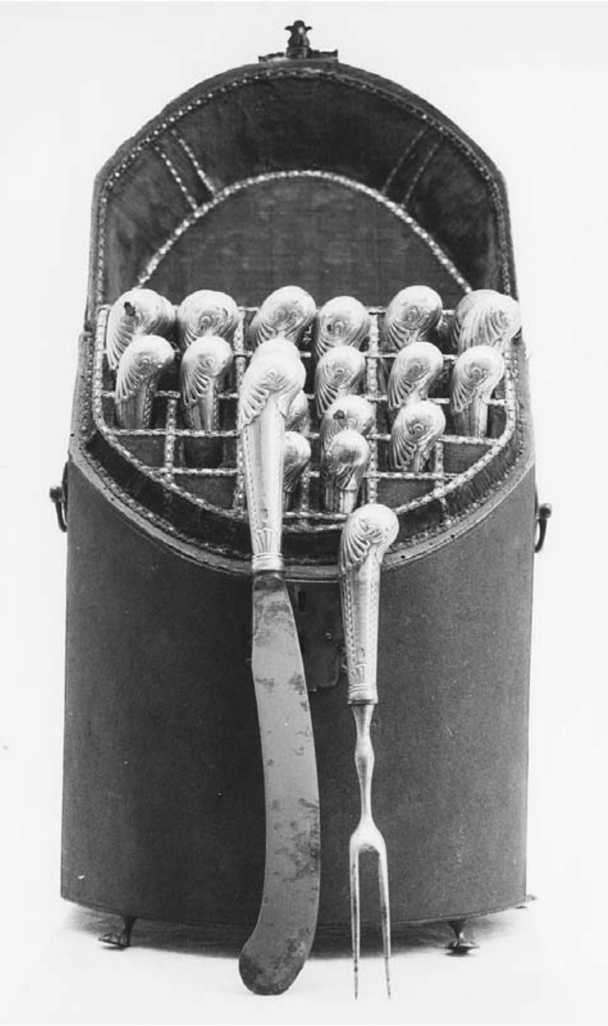
National styles were also appearing, although with so much trade and importation plus the movement of people, it is not always easy to determine where a particular excavated knife was made. The style and cutler's mark or other inscription might help to identify country or origin. Knives from the Thames foreshore would suggest that knives were frequently dropped overboard from visiting foreign ships and that local inhabitants were using the river as a highway and rubbish dump, thus increasing the difficulty of identification many years later.

Eating knives of the seventeenth century became thin and elegant and, toward the end of the century, were more decorative, with carved ivory figures and composite handles of jet, ebony, amber, colored bone, hardstone, agate, cut steel, and precious metal. Such knives were accepted as a decorative part of dress and were suitable as impressive gifts. Very few of the common knives have survived except in an excavated condition, whereas many of the fine-quality knives that were often given as gifts have survived and been handed down through the centuries.

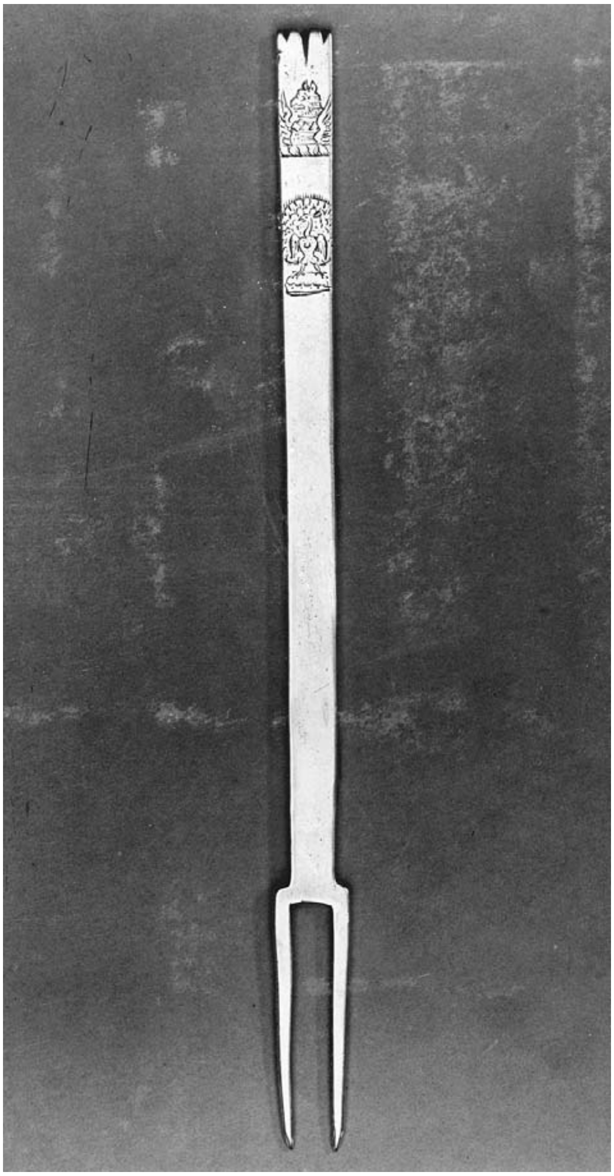
A pair of knives given by the groom to his bride as a wedding gift was an indication of wealth. The bride then wore the knives as a token of her position as mistress of the house. This custom lasted until the early seventeenth century. Many other crafts were involved in the making of these quality knives. Although a cutler was required by his guild to make a complete knife, the handles were made by specialized craftsmen and even imported from abroad. The sheaths were made by experts in the field of leather, wood, fabric, and beadwork.

Parallel with the decorative knives was a type of knife that was very long and elegant; it was made of one piece of iron, and the handle was decorated with balusters and turning. These knives, with handles showing traces of black enamel, may have been given as "memento mori" presents.

The first half of the seventeenth century saw a change in the size and style of the knife. It was getting shorter, the point was removed (since it was no longer required as a spike to transfer food to the mouth), the blade was sometimes wider at the tip than at the bolster, and there was a short handle of a round tapering section in ivory, bone, or wood, sometimes decorated with inlaid wire. The result was a strong, very purposeful "prime" knife that matches the basic simple Puritan spoon of this period, which has a plain, flattish oval bowl with a simple parallel-sided bar stem.


Plush-lined knife box with cutlery, showing a typical "scimitar" knife blade and fork with pistol handle. It was this distinctive knife that gave its name to the eighteenth-century "caseknife" bean, due to the similar shape of its pod. William H. Brown Collection.

The early seventeenth century also saw the general introduction of a fork at all social levels, usually as a matching companion to the knife. Forks had been used in Europe from early times, perhaps among the Romans—after all, a trident is only a large-sized fork—and large iron forks had been used for many years as cooking implements. This is well illustrated in the Bayeux Tapestry, which shows a cook removing a piece of meat from a cauldron with a long wooden-handled "fleshing" fork. Travelers from abroad brought back from Italy the habit of eating with a fork—they were probably impressed with the novelty, not least the hygiene—and after some resistance, the custom was accepted in England. At first the style, construction, and material of the fork



Silver fork made in London and dated 1632, with the crest of John Manners of Haddon Hall. COURTESY OF THE VICTORIA & ALBERT MUSEUM.

matched that of the knife with the handle being slightly smaller in size and the tines of the fork made of steel. This continued to the middle of the seventeenth century when the spoon finally joined the knife and fork, giving us a typical Puritan knife, fork, and spoon.

The evolutionary design of knife blades goes through a line of many peaks and troughs throughout the centuries. The "peaks" throw up a perfect "prime" knife, highly suitable for its purpose; this depends on all the components' being sympathetic to each other whether they were made by one or by many craftsmen.

However, another introduction of the fork emerged at the same time; this was in silver and was hallmarked in London, dated 1632, and engraved with the crest of John Manners of Haddon Hall. This simple one-piece silver fork was in the style that was current in Paris at that time and matched the very plain Puritan spoon used in Paris and London. This set the custom of a spoon and fork matching, with the knife following suit and later in the eighteenth century all three pieces came together in large services of various patterns.

During the latter part of the seventeenth century, traveling sets containing knives, forks, and spoons were still necessary and continued throughout this and the next century. Most of these sets consisted of a knife and fork in a slip case, some with spoons. Others were more elaborate, containing a folding or dismantling knife, fork, and spoons with a beaker, corkscrew, and perhaps other items. The sets were likely to be made to special order, making the container very compact.

With the restoration of the monarchy in 1660, the design of knives slowly changed from the rather severe Puritan knife.The blade became longer, very curved, and spatulate at the tip, and the handle had a distinct pistol-shape, By the first quarter of the eighteenth century, it finally evolved into a prime example of a Baroque knife. The popular term for this type of knife is "scimitar," and it can be found in all its stages, from its rudimentary beginnings to another "prime" knife of 1720. The silver-handled scimitar knife is very satisfying and comfortable to use and is a favored antique for the table even today.

Contemporary with this change of style and the practice of laying the table with matching knife, fork, and spoon was the introduction of the separate dining room with dining table and chairs and other furniture. Some of the wealthier middle-class merchants began to supply their guests at the table with cutlery from fishskin-covered boxes on the dining room sideboard that contained knives, forks, and spoons in quantity, thus making the carrying of cutlery by guests unnecessary.

One of the most prolific suppliers of this style of cutlery, and probably an early entrepreneur of the factory system using local labor, was the Master Cutler Ephraim How. He and his son John made cutlery first at Chingford, then at the Southend Mill, Lewisham, and sold it from their shop at Saffron Hill, London.

From 1720 the scimitar became debased with the straightening of the blade and a hump on the back, but it still retained the round spatulated end; the handle lost its pistol shape. All of this disappeared after the middle of the century when a change occurred in the evolutionary chain of the eighteenth-century knife with the introduction of the "French" style. This was consistent with all the other similar fashions in the second half of the eighteenth century.

Knife blades became long and spear-shaped with the point on the central axis and the widest section halfway along the length of the blade. Handles were tapered with a round to oval section and sometimes capped with silver. Others were made of stamped silver with a raised foliate design, soldered together and filled with resin; they later became straight-sided and square using green-stained ivory, bone, or ebony.

Knife boxes continued to be used as pieces of quality furniture, holding a dozen or more knives and forks and sometimes silver spoons. Spoons in a larger variety of sizes, including servers, could be found in a separate box, that is, the middle box of a set of three. Most early- and late-eighteenth-century boxes had locks with keys and were kept in the dining room; the contents were washed *in situ* after each meal by the servants and locked away until required again.

It is about this time—1800—that dessert sets appeared; they were popular as gifts right through the nineteenth century. This was exploited by the cutlery trade, as knives have always been acceptable gifts.

There was no return to the evolutionary course of the design of the knife until 1820, when British style, after making weak attempts at bringing back the scimitar blade, settled for a large, parallel-sided blade with a rounded tip and a straight, simple handle made of ivory, stained green or plain, or of figured silver in many styles. This continued to the end of the nineteenth century with only small interruptions from the influence of various art movements and fashions that affected the decoration rather than the construction or size. Examples would be the influence of art nouveau and of gardening implements, such as serving utensils shaped like spades; the term "butter spade" is still in use.

Industrial exhibitions in this period were popular and fashionable and would have provided ample scope for displaying high-quality skills and innovations. During the early part of the twentieth century came a slow reduction in the size of the knife, along with corresponding changes in other pieces of tableware. The days of having to carry personal eating equipment were long gone, but with modern traveling by train and motor car, small folding fruit knives, cutlery for picnic hampers, and military and camping canteens were developed.

In 1914 there was an important change in the construction of the knife: stainless steel was commercially produced. Its application to knife blades was enormous. It meant that blades would no longer rust readily and would resist staining from acids and foods, both being the bane of most carbon steel blades.

There was one style of knife that appeared at the end of the nineteenth century and evolved slowly, both in England and in Germany. This was the all-metal one-piece knife in both iron and steel that had appeared at various times in the past and reappeared with the introduction of stainless steel. This knife is an obvious candidate for a "prime" knife of the first half of the twentieth century and, with the partnership of stainless steel spoons and forks, must have seemed the ultimate in cutlery. Such knives were produced in large quantities.

However, in recent times, industrial and silversmith designers have been involved in producing a proliferation of styles and novelties, perhaps to cause comment as well as to eat with.

See also **Etiquette and Eating Habits; Kitchen Gadgets; Utensils, Cooking.**

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CZECH REPUBLIC AND SLOVAKIA. *See* **Central Europe.**

D

DAIRY PRODUCTS. Dairy products are derived from milk, the secretion of the mammary glands of mammals, usually cows (bovine), sheep, goats, buffalo, mare, camel, or yak. Most dairy products originate from bovine milk and, to a lesser extent, sheep and goat milk. As milk contains approximately 80 to 90 percent water, it is prone to undesirable microbial growth with concomitant product deterioration. To prevent this problem from occurring, and to ensure a longer shelf life, milk is processed to form different products such as ice cream, cheese, milk powders, yogurt, butter, lactose, and anhydrous milk fat (also known as butteroil). Milk can be separated into a cream fraction and a skim milk fraction by a centrifugation technique called separation. This process concentrates the fat present in the milk into the cream phase, leaving a skim or partially skimmed phase with much lower fat content. Typical fat and water contents of selected dairy products are shown in Table 1. The speed of centrifugation can be adjusted to yield different fat content in cream. Milk processing applies different preservation techniques to allow for longer storage of dairy products. Milk powders are produced by concentration to remove some of the water, followed by atomization into a fine mist and drying at high temperatures. Heat and dehydration (water removal) are employed to give a long shelf life for milk powders. Ice cream is a dairy product preserved by the action of freezing. Yogurt and cheese are both fermented products. A bacterial culture is used to inoculate milk, for which the primary function is to lower the pH from 6.7 (typical for fresh bovine milk) to 4.2 for yogurt and in the range 4.6 to 6.0 for most cheese varieties. The bacterial cultures also assist in breaking down proteins and fats in the milk product to develop some of the flavor. The preserving function of added bacterial culture is to compete with unwanted pathogens for nutrients. Thus cheese and yogurt are preserved by dehydration, acidification, and competition with pathogens for survival in the product.

Heat Treatment of Milk

For food safety reasons, milk is often heat-treated prior to consumption or further processing. The most common heat treatments are holding at 162°F (72°C) for 15 seconds, called pasteurization, or at 145°F (63°C) for 30 minutes, called batch pasteurization. Both of these treatments have similar effects on killing undesirable microorganisms in milk. The treatment is sufficient to destroy two indicator organisms, *Mycobacterium tuberculosis* and *Coxiella burnetti*.

Another common heat treatment is to hold milk at 284°F (140°C) under pressure for 2 to 3 seconds, producing ultra high temperature (UHT) milk. This milk is essentially sterile and can be packaged in cardboard containers and stored at room temperature for up to six months with little microbial-induced deterioration. UHT milk is more commonly consumed in Europe than in Australia, New Zealand, or North America.

An alternative to preserving milk by heat pasteurization is high-pressure processing, where pressures of around 300–600 MPa are employed to rupture the membranes of pathogens and denature enzymes that cause de-

TABLE 1

Average composition of selected dairy products (grams per 100 grams of milk)

	Water	Fat	Protein	Lactose	Sodium chloride	Calcium
Cheddar cheese	37	32	24	0	1.6	0.8
Ice cream	61	10-14	3.6	22	0.2	0.15
Full-fat yogurt	89	3	3.5	7	0.15	0.1
Butter	16	81	0.9	0.06	0-1.2	—
Skim milk powder	3–4	1	35	52	1.3	1.3
Whole milk powder	2	27	26	38	1	0.9
Whey powder	4	0.6–6	80–93	1–7	3	0.8–2.2
Cream	55–80	12–40	1.8–2.6	2.5–4.5	0.01	0.1

terioration in milk quality. This process has not been adopted to any significant commercial extent as the milk must be processed in batch quantities rather than in a continuous fashion as in a pasteurizer. Gamma irradiation of milk for the purpose of preservation is not practiced as it tends to produce off-flavors. Ultraviolet light can be used to pasteurize milk, and has the additional benefit of increasing the amount of available vitamin D. Bactofugation is sometimes employed to remove bacteria in milk by a process of centrifugation. Hydrogen peroxide can also be used to improve poor-quality milk. This preservative can be removed by heating milk to 122–131°F (50–55°C), whereupon the enzyme catalase present in milk destroys the added hydrogen peroxide.

Milk Composition

Milk contains proteins, fat, water, lactose, inorganic salts, and other minor organic material such as phospholipids, organic acids, enzymes, hormones, vitamins, nucleotides, amines, amino acids, alcohols, aldehydes, ketones, and esters. (A complete set of detailed compositional tables can be found in Noble P. Wong et al., *Fundamentals of Dairy Chemistry*, pp. 1–38.) An understanding of how the major constituents are structurally arranged in milk is necessary to predict how milk processing conditions affect flavor, texture, and the keeping qualities of dairy products.

The gross composition of milk varies according to the species of mammal, the breed of the cow (especially for bovine milk), and the stage of lactation. Note the relatively low amount of casein in human milk, rendering it difficult to make cheese. The breed of cow will affect the level of fat and protein. Holstein cows are common in dairies in North America, Australia, and New Zealand.

An important advancement in milk compositional study was the development of a rapid test for milk fat by Stephen M. Babcock of the University of Wisconsin in 1890. This procedure allowed for accurate marketing of milk, resulted in a more consistent quality of dairy products, and facilitated the development of better farming practices to optimize fat content in milk.

Milk composition and volume are affected by the season, particularly in milder climates such as Australia and New Zealand where cows are pasture-fed all year round. Milk production drops during the winter months of May to August in the Southern Hemisphere, to a level such that there is little excess milk available for dairy processing beyond that of market consumer milk. In the colder climates found in Canada and the north of the United States and Europe, cows are fed on silage during the winter months. This produces a more uniform supply of milk and often results in paler and less yellow-colored dairy products, especially butter and cheese, due to the lower levels of beta-carotene in silage feed. Fat and total milk solids (fat, protein, and minerals) are lower in summer months compared to winter in both hemispheres. The effect of pasture quality and quantity on milk composition is a complex issue. Feed quality is affected by the level of roughage, fat, protein, energy level, and the fatty acid profile.

One important factor in milk quality that has important consequences in dairy processing is the health of the cow. Mastitis is an infection of the udder that results in high somatic cell counts in the milk. Immunoglobulin levels are higher in mastitic milk, whereas fat, lactose, casein, and whey protein levels are lower. Treatment for mastitis requires antibiotics; however, this has the undesirable effect of killing introduced bacterial cultures in the manufacture of cheese and yogurt. Milk processing factories rigorously and routinely check milk samples from individual farms for antibiotics, as well as for levels of fat, whey proteins, caseins, urea, and lactose. Milk containing antibiotics is discarded and a penalty fine may be imposed on the farmer. Routine testing also allows correct payment to be made to the farmer, usually based on the amount of casein plus fat. In addition, due to the variable composition of milk, testing allows batches of milk to be standardized to a particular casein or fat content depending upon the type of dairy product to be made.

Milk Fat Globules

The fat in milk is emulsified with a membrane material consisting primarily of proteins, phospholipids, and enzymes. Other minor components of the membrane include glycoproteins, phospholipids, carotenoids (including beta-carotene), and sterols (including cholesterol). There are approximately 15 trillion fat globules in one liter of milk, with a size in the range of 0.1 to 20 micrometers. The membrane surface serves to protect the fat from undesirable oxidation. Fat globules will still cream given sufficient time. The creaming effect is accentuated by the agglutinin reaction, which results in fat globules clustering and rising rapidly to the surface to form a cream layer.

Approximately 98 percent of the fat in milk exists in the form of a triacylglyceride, where three fatty acids are attached to a glycerol molecule. The fatty acids comprise CH2 methylene groups linked together to form a chain of varying carbon lengths. Milk fat has a significant proportion of fatty acids with a length of four carbon atoms (C4), known as butyric acid, which causes the sharp, acidic taste in some cheese varieties. This flavor is often described as rancid. Other major fatty acid components of the triacylglyceride include myristic acid (C14), palmitic acid (C16), stearic acid (C18), and oleic acid, which also contains 18 carbon atoms but differs from stearic acid in that it contains one unsaturated C=C bond.

Due to the many possible arrangements of different length fatty acids, the melting point of milk fat is not as sharply defined as for pure compounds, but rather extends over a wide range of temperatures. Milk fat is entirely solidified at −40°F (−40°C), and has melted completely at 104°F (40°C). At refrigeration temperature milk fat is between 40 and 50 percent solid, despite the apparent solid appearance at this temperature.

Milk fat, when solidified, crystallizes into three main forms (alpha, beta, and beta′ polymorphs) depending upon the rate of cooling. Tempering of a food product containing milk fat is a process of careful adjustment of the temperature at different heating and cooling rates. This process promotes the formation of a particular polymorphic structure with desirable texture. Tempering is used in butter manufacture.

Unsaturated Milk Fat

Butters, spreads, and margarines that are high in unsaturated fatty acid content are believed to protect against heart disease. Margarines usually contain a higher level than butter. The unsaturated C=C bond in oleic acid (and other unsaturated acids) can exist in two forms, the cis form where hydrogen atoms are on the same side as the C=C bond, and the trans form where the hydrogen atoms are on either side. The cis form is more common in nature and believed to offer better protection against heart disease.

Conversion of a polyunsaturated liquid oil to a higher melting point mono-unsaturated solid fat (such as in margarine manufacture) can take place by the process of partial chemical hydrogenation, where hydrogen atoms are added to some of the C=C bonds to form saturated C=C bonds. The process of hydrogenation requires the initial removal of polar lipids such as phospholipids, and heating the oil at 320°–428°F (160°–220°C) under a pressure of 2–10 atmospheres with a 0.01–0.2 percent nickel catalyst. Consumption of trans mono-unsaturated fatty acids has been associated with heart disease (see Beardsley, p. 34).

The degree of unsaturation is measured by the iodine test, where the number of grams of iodine reacting with the C=C bonds in 100 grams of oil or fat is determined. Generally, the higher the number of unsaturated bonds and the lower the carbon chain length, the lower the melting point of the fatty acid.

Milk Fat Deterioration

Deterioration of milk fat can occur by two main mechanisms: fatty acid release and oxidation of C=C bonds. Release of fatty acids occurs by cleavage (hydrolysis) of a fatty acid from a triacylglyceride molecule. The presence and release of butyric acid will give the typical rancid flavor found in blue and Italian-style cheeses. Oxidation of C=C bonds results in formation of hydroperoxide radicals that form high molecular weight compounds over time with increased viscosity and propensity for foaming. This is more of a problem with vegetable oils used for frying where extreme temperature fluctuations take place. Oxidation is promoted by the presence of oxygen at high temperatures and high water activity.

Fatty acid hydrolysis is catalyzed by an enzyme called a lipase. Milk contains 1–2 milligrams per liter of a native lipase called milk lipoprotein lipase. This enzyme is 90 percent inactivated under pasteurization conditions. Hydrolysis (more specifically lipolysis, in the case of oils) is exacerbated at higher pH, a temperature of around 37°C, by light, and by the degree of agitation of milk. Exposure of milk fat as a result of agitation will provide access by the milk lipoprotein lipase, and lipolysis will occur. Sufficient agitation of milk can occur during homogenization. If milk is not pasteurized prior to homogenization, enough lipolysis can take place, with release of fatty acids, to burn the throat of someone unfortunate enough to consume this milk. Needless to say, milk is always pasteurized before homogenization.

Milk obtained fresh from the cow is partially protected against lipolysis by the milk fat globule membrane, and also by the separation of milk lipoprotein lipase (largely bound to the casein micelles) from the milk fat substrate. As already stated, agitation of milk promotes lipolysis. Heating fresh unpasteurized milk to 86°F (30°C) then cooling back to refrigeration temperatures will cause rancidity to occur within twenty-four hours. This problem will occur if warm fresh morning milk is added to cooled evening milk from the previous day, then cooled back down again. In addition, spontaneous lipolysis occurs in one out of five cows after cooling milk to 59–68°F (15°–20°C). This problem is circumvented by mixing with four to five times the volume of normal milk. Freezing and thawing of milk can also promote lipolysis. A slower rate of freezing will increase the rate of lipolysis.

In the United States, whole milk powder from lipase-treated milk is used in the manufacture of milk chocolate to impart a slight rancid flavor note. This flavor is what the U.S. consumer has come to expect in milk chocolate flavor, presumably for historical reasons when low-quality and less expensive milk may have been used in the manufacturing process. This flavor is absent in milk chocolate produced in Europe, Australia, and New Zealand.

Milk Proteins

Proteins in milk are broadly classified as either caseins or whey proteins. Caseins are mostly insoluble in water and exist in an aggregated form called a casein micelle of average size 0.2 micrometers. This is sufficiently small to scatter light and render to milk its white appearance. Whey proteins are soluble over a wide pH range and have high nutritional value.

Whey comprise the class of proteins that are soluble in milk. They are globular proteins of size 2–4 nanometers. The major subcomponents of bovine whey are a-lactalbumin and β-lactoglobulin. Human milk does not contain β-lactoglobulin, and a-lactalbumin is highly valued when extracted from bovine whey for use in powdered infant formula. Consumption of bovine milk or formula containing β-lactoglobulin may elicit an allergic response when consumed by very young infants. The main utility of β-lactoglobulin is as a gelling agent in food products such as comminuted meats. The presence of a-lactalbumin will impair the gel structure formed from

HOMOGENIZATION

Food products that contain fat and water phases must be emulsified to prevent creaming or sedimentation. In most biphasic dairy-based food products (with the exception of butter), water is the predominant phase, and the fat phase is emulsified. Emulsions are energetically unstable systems, and given enough time, will separate out into the two phases. This process is greatly hindered by covering the surface of the emulsion globules with some kind of surface-active component, commonly a protein, polysaccharide, and/or monoacylglyceride. Slowing down the rate of destabilization of an emulsion enables a food product to be stable over a period of weeks or months. Milk and cream are naturally occurring oil-in-water emulsions. Others include mayonnaise, spreads and dips, cheese, yogurt, sauces, ice cream, and salad dressing.

For fat to be broken up into small micrometer-size globules, energy must be supplied to the food product. This process is called homogenization. The types of homogenizers range from simple rapid and turbulent stirring devices, to more complex valve equipment that forms emulsions under high pressure, turbulence, and cavitation. A detailed overview of the different types of homogenizers is given by Mulder and Walstra in *The Milk Fat Globule* (pp. 163–194) and by McClements in *Food Emulsions: Principles, Practice, and Techniques* (pp. 161–184).

As a general rule, the more energy supplied by a homogenizer, the smaller the fat globules formed, with a greater stability against creaming. Typical pressures for homogenization of milk in a dairy factory are 17 MPa first stage and 3.5 MPa second stage, the latter of which is used to break up aggregates of fat globules that may form in the first stage. This process produces globules of size 2–3 micrometers in bovine milk.

Other types of homogenizers that are not commonly used in dairy processing include ultrasonic and membrane units. Some of the effects of milk homogenization on dairy products include smaller fat globules as pressure increases, whiter colored cheese with higher moisture, increased viscosity of yogurt, increased lipolysis of milk, less oxidized off-flavors in milk, faster clotting of milk in cheese manufacture, and inactivation of the agglutinin properties (the agglutinin reaction causes clustering of fat globules).

β-lactoglobulin, hence the requirement to separate these two components from whey.

Other components of bovine whey include bovine serum albumin, immunoglobulins, lactoferrin, and lactoperoxidase. Lysozyme is an enzyme found in milk that also has antimicrobial activity. This enzyme is found in higher concentrations in milk colostrum, protecting the gut of a newborn calf against invasion by pathogenic bacteria.

Colostrum is the initial secretion of the mammary gland after birth and contains a much higher casein and whey protein concentration than milk at later stages of lactation. The level of lactose is less than in milk, and the amount of fat is slightly higher. Colostrum confers immunity to a newborn calf through the high levels of immunoglobulins, and also provides a high-quality nutritional diet.

Whey is the main by-product of cheesemaking. It has historically been considered to be of low value, and used as pig food, fertilizer for agricultural fields, or simply disposed of into the ocean. Now, whey is spray-dried to produce a powdered protein ingredient, highly valued by the food processing industry for its excellent nutritional and textural modifying properties. Whey can be further fractionated into components that are spray-dried, and these command a premium price for food and pharmaceutical applications.

Functional Properties of Whey Proteins

Functional properties of whey proteins include its water solubility, viscosity modification ability, gelation, texturization, high nutritional value, flavor-binding, foaming, emulsification, fat and water retention, and control over shrinkage in products such as yogurt and gelled foods. The high solubility and excellent nutritional properties allow whey proteins to be used to fortify high-energy sports beverages. Increasing the viscosity of fluid food products by whey protein addition will affect the sensory properties, and reduce the tendency for particulate matter (if present) to sediment. Different types of gels can be created by heating β-lactoglobulin. The pH, concentration and types of mineral salts present, and the rate of heating will affect the properties of the gel, such as opacity, elasticity, and the propensity for shrinkage with expulsion of liquid during storage (syneresis). Gels that are formed far from the isoelectric point (around pH 5.5, where there is no average net charge on the whey proteins) will tend to be less opaque, more fine stranded, and more elastic.

Texturization of whey proteins is achieved by heating to form a coagulum followed by extrusion though small diameter holes under high pressure to align the protein fibers. These can be further processed between heated rollers to remove more moisture, promote adhesion, and increase the toughness and chewiness. Textured dairy proteins have an application in forming vegetarian meat-like products.

Food products that contain oil require stabilizers to emulsify the oil and prevent excessive separation from the water phase. Both whey proteins and caseins can perform this function by homogenization to create small oil globules coated with proteins. Generally, the smaller the globules, the more stable the food product will be against creaming or oil separation. Examples of this type of food product include salad dressing and mayonnaise. Most oil and water food products are emulsified such that the oil globules are suspended in the water phase. If the oil or fat content is too high, a phase inversion takes place where water droplets are then suspended in the oil phase. In this case, whey proteins have little efficacy to act as emulsifiers. An example of a water-in-oil emulsified food product is butter.

Foam formation and stability are important attributes in food products such as ice cream, cappuccino coffee foam, meringue, marshmallow, mousse, and bread. Air bubbles are induced by rapid whipping and are lined with stabilizers to prevent rapid collapse of the foam. Whey proteins are excellent foaming agents, and their ability to unfold (denature) and cross-link at the air-water interface provides for good foam stability. Strong protein-protein interactions, such as that which occurs near the isoelectric pH of around 5.5, will promote foam stability. Free oil will cause a decrease in foam stability, which is the reason egg yolks (containing oil) are separated from egg white (containing proteins capable of stabilizing the foam) prior to whipping of the egg white. Emulsified oil, such as in milk or cream, will not affect foam stability to the same degree, as the oil is coated by the native milk fat globule membrane and does not come into direct contact with the protein foaming agents in dairy foams. However, if the native membrane is ruptured, perhaps due to enzymatic action or excessive turbulence when pumping milk during processing, the foaming ability is impaired. This is often a seasonal occurrence in some countries, creating cappuccinos with poor foams at certain times of the year when enzymatic activity is more pronounced. Special cappuccino milk is sometimes sold containing a higher proportion of added spray-dried foaming whey proteins to alleviate this problem. Further details about functional properties and emulsions are provided by Walstra in *Food Chemistry* (pp. 95–155).

Calcium Phosphate in Milk

The major mineral component in milk (and most dairy products) is calcium phosphate, an inorganic salt of low solubility in water. A high intake of calcium in the diet is believed to promote strong bone development, hence the recommendation of calcium in the diet of young children. The low solubility of calcium phosphate in water (and also in milk) would result in calcification, or boiler-scale, in the mammary gland if it were not for the unique properties of the casein micelle in solubilizing this mineral.

Each of the four main casein molecules (α-s1-casein, α-s2-casein, β-casein, and κ-casein) contain at least one phosphate group that is capable of binding to the calcium phosphate mineral complex in milk. Some twenty-five thousand of these casein molecules, with bound calcium phosphate, aggregate to form the heavily hydrated casein micelle of molecular weight 108–109 Daltons. Thus calcium phosphate is rendered soluble in milk (as the casein micelle itself can exist in milk as a stable suspension) and can be considered to be the binding agent that holds the micelle together. There is some controversy over the nature of the substructure of the casein micelle. The two main competing models are described by Pieter Walstra (1999) and Carl Holt and David S. Horne (1996).

Formation of Milk Curds

Cheese and yogurt making has been in existence for thousands of years. Milk would have been carried around in the warm Middle Eastern climate in sacks made from animal skins, such as the stomachs of ruminant animals. Milk stored in a sack made from the fourth stomach of a young calf and carried around at temperatures in excess of 68°F (20°C) would eventually coagulate and separate into curds and whey given sufficient mechanical disturbance. The curds would have provided a nourishing meal and the whey a refreshing and nutritious beverage. This process has evolved into the highly scientific and mechanized approach used today in modern cheesemaking plants.

The casein micelle will undergo extensive aggregation as the pH approaches the isoelectric point. For caseins in milk, this occurs at pH 4.6. This is the basis for the coagulation of milk and separation of the curds from the whey to make cheese. A comprehensive treatment on the physical chemistry of curd formation and subsequent reactions is given by Dalgleish (pp. 69–100), Green and Grandison (pp. 101–140), and Walstra (pp. 141–191) in Patrick F. Fox, ed., *Cheese: Chemistry, Physics and Microbiology*.

Curds are composed of aggregated casein micelles and trapped fat globules within the protein matrix. The whey phase contains mostly water with soluble minerals, whey proteins, and lactose. Casein micelle clotting (with consequent curd formation) can also occur by addition of coagulating enzymes or 20 percent alcohol. Most cheese varieties are manufactured by enzymatic coagulation, with some formed by acid precipitation to pH 4.6. Acidification can also take place by the addition of bacterial culture, directly by addition of acids such as hydrochloric, sulfuric, or lactic acids, or a combination of bacterial culture and direct acidification. Most bacterial cultures used in fermented dairy products are classified as lactic acid bacteria, as they are capable of metabolizing lactose present in milk into lactic acid. This will lower the pH of milk and aid in the formation of a milk clot.

Casein micelles are prevented from forming a rapid milk clot in fresh milk by the presence of a hairy layer of adsorbed κ-casein molecules on the surface of the micelle. The κ-casein prevents the close approach of micelles at the natural pH of milk (6.7) by a mechanism known as steric stabilization. Both acid and alcohol addition cause a partial flattening of the κ-casein hairy layer, allowing coagulation to occur. Acid coagulation occurs via an electrostatic attraction mechanism, and alcohol coagulation by hydrophobic interaction. Casein micelles have sufficient inherent hydrophobicity to cause aggregation to occur in much the same way as hydrophobic oil droplets will coalesce, once the κ-casein layer has been flattened or removed.

Milk Clotting Enzymes

The enzyme present in the fourth stomach of a calf, chymosin, is extracted by maceration of the stomach lining in a salt solution. The purified salt solution containing chymosin is called rennet. Chymosin will cleave the κ-casein hairy layer on the casein micelle at a very specific location, between the phenylalanine and methionine amino acids at positions 105 and 106 in the primary sequence of the protein. This cleavage point is fortuitously located at the point where the κ-casein molecule extends away from the micelle surface to form the hairy layer. Chymosin is therefore capable of removing the k-casein steric stabilizing layer, allowing micelles to coagulate and form a curd, such as found in yogurt and cheese.

As the demand for chymosin is greater than the supply of calf stomachs, other enzymatic methods to coagulate milk have been investigated. An enzyme called pepsin, extracted from the stomach lining of pigs, calves, and chickens, has some efficacy; however, cheese made from this enzyme is often too soft due to excessive protein degradation. Often, rennet extracts contain a proportion of bovine or porcine (from pigs) pepsin in addition to bovine chymosin.

Enzymes extracted from fungi, bacteria, and plants can also be used to coagulate milk. Plant coagulants can be extracted from papaya, figs, pineapple, kiwi fruit, and *Cynara cardunaculus* (cardoons and artichokes), a thistle which in Portugal is used to make Serra cheese. Most enzymes derived from plant sources are highly proteolytic (capable of extensive degradation of proteins) and nonspecific in their action on proteins. The resultant small peptides, which are the degradation products of enzymes acting on proteins, produce a soft and pasty cheese with bitter flavor unless other steps are taken to circumvent these problems. Bitterness in cheese is correlated with higher amounts of hydrophobic peptides.

An increasingly common method to produce milk coagulant for cheese and yogurt manufacture is by recombinant DNA technology. The gene for expressing chymosin is spliced into the DNA sequence of bacteria, such as *Escherichia coli*, which is then grown in a reaction vessel to levels that permit the extraction and subsequent purification of chymosin.

Endogenous Milk Enzymes

The main native milk enzyme that hydrolyzes proteins is plasmin. This enzyme is located in the casein micelle, and therefore concentrated in cheese during the manufacturing process. Plasmin will hydrolyze proteins during cheese ripening and contribute to texture and flavor development. It has an optimum activity at pH 7.5, hence the term alkaline protease, and at 99°F (37°C). Pasteurization has an effect of increasing the total plasmin activity, as the otherwise inactive precursor, plasminogen, is activated. Plasmin itself can be inactivated by heating at 176°F (80°C) for ten minutes.

Alkaline phosphatase is another enzyme present in milk, and is inactivated by pasteurization. A test for alkaline phosphatase activity is used to determine if milk has been pasteurized, as the conditions of inactivation mirror those of pasteurization. This enzyme is preferentially adsorbed onto the surface of fat globules.

It is interesting to note that enzymes in milk are often segregated away from their respective substrates, thus preventing rapid deterioration of milk. Alkaline phosphatase reacts with the phosphate ester groups in the casein micelle, and would result in micelle disintegration if the enzyme were located there. In the same fashion, lipases are often found adsorbed into casein micelles away from the milk fat substrate.

Lactose, the Milk Sugar

Lactose, also known as milk sugar, is a disaccharide molecule comprising two simple sugars (glucose and galactose) linked together. This sugar is rarely found outside of dairy products, unless specifically added. Lactose crystals present in dairy products, particularly ice cream, can cause a sandy texture if the crystals are too large.

Lactose must first be hydrolyzed by the enzyme lactase into glucose and galactose before it can be further metabolized in the human body. If lactase is absent from the body, a common occurrence among adult Asians and Africans, digestion problems may arise after consuming milk. These problems are referred to as lactose intolerance, and for this reason, milk is not usually consumed by adults from these two racial groups. Lactose is water-soluble, therefore largely absent in high-fat dairy products such as butter, butteroil, and ghee. In aged, fermented dairy products such as cheese, all of the lactose is metabolized by lactic acid bacteria into lactic acid within the first three to four weeks, so consumption of this product will not cause lactose intolerance. Even freshly consumed cheeses such as cottage and cream cheese are low in lactose. Lactose intolerance is discussed in Wong et al., *Fundamentals of Dairy Chemistry* (pp. 328–330).

Lactose Intolerance

Lactose intolerance is a disease characterized by symptoms such as abdominal cramps, bloating, and diarrhea, brought about by the inability to metabolize lactose. This condition is more prevalent among Asians and Africans. It is not a normal occurrence among young children, and the incidence rises as age increases.

Lactose, often called the milk sugar, is primarily found in milk. The level in bovine milk is around 5 percent. This relatively high concentration means that digestion of milk can be a problem for people who suffer from this disease. Lactose is a disaccharide consisting of a glucose and a galactose molecule joined by a glycosidic covalent bond. In normal digestion, an enzyme called lactase will hydrolyze lactose, producing glucose and galactose, which are subsequently further metabolized in the body. People who suffer from lactose intolerance lack this enzyme. The onset of symptoms is related to the level of lactose ingested. Small amounts of milk may not be a problem for some people who would otherwise suffer from lactose intolerance.

Lactose is found in relatively large quantities in milk, ice cream, and other nonfermented milk products. It is not usually found in matured cheese. Very small amounts may be found in yogurt and fresh cheeses, such as cottage or cream cheese, but probably not sufficient to cause lactose intolerance symptoms. Digestive complaints after consumption of pizza is most likely due to the high amount of fat in this food, rather than the presence of lactose, which is barely present at all.

A remedy to aid digestion is to consume lactase in liquid form or as a tablet. An alternative solution is to manufacture low-lactose milk by the addition of lactase during processing. This step will produce a much sweeter milk, as both glucose and galactose are sweeter than lactose. To prevent the problem of excessive sweetness in milk, lactose levels must be reduced before the hydrolysis step takes place. Other more novel techniques involve adding lactic acid bacteria to cold milk; the bacteria remain dormant until the milk is consumed and warmed up in the body. They then metabolize lactose in the human gut. Another processing technique utilizes encapsulated lactase added to milk. The microcapsules remain intact at the low temperature and pH of milk during storage. After consumption, the higher temperature and lower pH rupture the lactase microcapsules, allowing lactose hydrolysis to take place.

Browning Reactions in Milk

Two types of browning reactions occur in food products, enzymatic browning and the non-enzymatic Maillard reaction. The Maillard reaction is the more relevant of the two in dairy products, and is initiated by reactions between the amine part of a protein with sugars such as lactose. This reaction is inhibited at lower moisture content, pH below 6, and lower temperature. Besides the color change in some processed dairy products, there is also a nutritional consequence to the Maillard reaction. An important amino acid in milk proteins, lysine, contains an amine group that can participate in the Maillard reaction, resulting in a loss of bioavailability of this amino acid.

Goat and Sheep Milk

It is of interest to note that the average size of fat globules in goat milk is slightly smaller (2 micrometers) than bovine milk (2.5–3.5 micrometers), and that the agglutinin reaction does not occur in goat milk. This latter effect is the primary reason for the scarcity of goat cream and butter on the market today, as the fat globules will not rise to the surface to the same extent as in bovine milk. Before the advent of centrifugal separators, it would not have been possible to obtain large amounts of cream from goat milk. Most goat milk is processed into cheese, rather than into yogurt or consumed fresh. A component of goat milk fat, 4-methyloctanoic acid, is responsible for the "billy-goat" flavor of goat milk cheese.

Sheep milk has almost twice as much fat and protein, and slightly more minerals (ash), than bovine milk, and contains a higher proportion of immunoglobulins so is more resistant to unwanted microbial growth. The fat in goat and sheep milk is whiter than in bovine milk due to a lower amount of b-carotene, and contains a higher proportion of the medium chain length fatty acids C_6-C_{12} that provide a better and more rapidly utilized energy source than the more common longer chain fatty acids. The suckling period for young kids and lambs is three to six weeks, and the milking period extends for a six-month period in spring and summer.

The volume of goat and sheep milk obtained in traditional sized family-owned farms or nomadic flocks is 40–100 liters per year. In contrast, commercial goat and sheep milk farms produce about 400–600 liters of milk per year. By comparison, 4,000–7,500 liters per year are obtained from bovine cows in commercial dairies.

The milk fat globule membrane is more fragile in goat milk compared to bovine milk, therefore there is a

MILK NUTRITION

It is not always true that altering the dietary intake of fat, containing cholesterol, will alter the blood cholesterol level. Other factors such as the total diet, genetics, and exercise play an important role. The level of cholesterol in milk fat is 0.35 percent, whereas the level in milk is about 0.014 percent. Cholesterol levels in human blood average around 200 milligrams per 100 milliliters. Milk fat contains as much as 25 percent cis 18:1 fatty acid, one of the healthy fatty acids thought to help prevent heart disease.

Vitamins

All of the essential vitamins are found in milk, although in some cases the amount is not sufficient to meet the recommended daily allowance. Vitamin C levels are reduced by approximately one half under pasteurization conditions; however, this is of limited concern, as milk is such a poor source of this vitamin. Folacin and thiamin (vitamin B_1) are reduced by around 10 percent during pasteurization. The water-soluble vitamins (B and C) are largely lost into the whey during cheesemaking, whereas the fat-soluble vitamins are concentrated, although some molds are capable of synthesizing vitamin B in mold-ripened cheeses. Riboflavin has an orange color that is more evident in skim milk than whole milk, and can be seen very clearly if fat and protein are removed from milk by membrane filtration. A vitamin A precursor, beta-carotene, gives milk fat its characteristic yellow color.

Milk is an important source of vitamins A and D, the latter due largely to fortification, which is common in the United States. Vitamin D fortification came about as a result of research performed by Harry Steenbock at the University of Wisconsin in 1924, and is largely responsible for the virtual elimination of the bone disease rickets, caused by a vitamin D deficiency. Milk is otherwise a poor source of vitamin D; however, it assists in the absorption of dietary calcium. Vitamins A and B were first discovered by Elmer V. McCollum of the University of Wisconsin; vitamin A was identified in butter fat in 1913, followed later by the discovery of vitamin B in cheese whey.

Minerals in Milk

Dairy products are a good source of many minerals, particularly calcium (see Table 1) where it furnishes about 75 percent of the dietary need in the United States. The bioavailability of calcium from milk products is around 85 percent, compared to 20–75 percent from vegetable sources. Low calcium dietary intake is generally recognized to contribute to osteoporosis and to predispose people to hypertension when consuming large amounts of salt. Bone mineralization requires a ratio of calcium to phosphorous of between 1.3 and 1.5 to 1, such as found in dairy products. Other nondairy sources of calcium have a much lower ratio.

Other trace elements of nutritional importance found in milk include iodine, which is required for thyroid hormone production, magnesium for energy-requiring biological functions, and zinc for the function of some enzymes in the human body. Bovine milk is a poor source of dietary iron; infants can develop anemia if not breast-fed with human milk (which contains a higher bioavailability of iron compared to bovine milk) or if other dietary sources are not found.

greater propensity for development of off-flavors. Goat milk is also more liable to undergo spontaneous lipolysis at 39°F (4°C). Further information on the processing of goat and sheep milk is provided by Frank Kosikowski and Vikram V. Mistry in volume 1 of *Cheese and Fermented Milk Foods* (pp. 297–313).

Liquid Milk

Consumer milk is often sold in the United States according to the percentage of fat: 1 percent, 2 percent, whole milk (about 3 percent), and skim (less than 0.5 percent fat). The shelf life is usually around two weeks. The milk can be fortified with vitamins A and D. Full fat milk is often simply referred to as Vitamin D milk in the United States. Frozen milk may be stored for several months before use; however, it is prone to fat separation, lipolysis, and curd formation.

Flavored milks are becoming increasingly popular as a nutritious beverage, particularly among young people. These drinks are often low in fat with added stabilizers (such as guar and carrageenan) to compensate for the loss in creaminess. An unfortunate problem with gums and stabilizers is that drinks can frequently take on a viscous and elastic texture if too much is added. A wide range of flavors are added to milk, particularly in Australia, where chocolate, coffee, caramel, strawberry, banana, and vanilla are very popular. These have never reached the same level of popularity in North America.

Yogurt

Yogurt probably originated in the Middle East, where goat and sheep milk was soured by the presence of naturally occurring bacteria. It is a favorite food in India, where it is unflavored and made from the milk of buffalo. Its consumption in India signifies the end of the meal. Plain yogurt is often used as a garnish in Middle Eastern meals. A discussion on yogurt manufacture is given by Kosikowski and Mistry in volume 1 of *Cheese and Fermented Milk Foods* (pp. 87–108).

Lactic acid bacteria (a 1:1 ratio of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus*) convert lactose to lactic acid in milk, lowering the pH from 6.7 to around 4.2 and giving yogurt its characteristic clean, acid taste. Often fruit and fruit flavorings are added to make yogurt into a dessert or snack product. The reduction in pH by added bacterial culture, along with refrigerated storage, contribute to the preservation of yogurt. The most common form of yogurt is a smooth viscous liquid; however, it can be frozen and served as a nutritious and refreshing yogurt-based beverage. The trend in the United States is for reduced fat (or nonfat) yogurt, more so than in Europe. The fat content in North American yogurt is typically around one percent.

To enhance the creaminess sensation of reduced or nonfat yogurt, polysaccharide stabilizers such as gelatin, pectin, or locust bean gum are often added, although they are not entirely successful at mimicking fat. These stabilizers have the additional function of reducing syneresis, the clear yellow liquid (whey) that appears on the surface of yogurt due to partial shrinkage of the casein protein network. Probiotic cultures, such as *Lactobacillus* species (*casei* and *acidophilus*) and *Bifidobacterium* species can be added to yogurt and also to milk protein-based beverages. The combination of bacterial cultures, including probiotic cultures, found in yogurt has long been believed to provide good health. This may explain the relatively large number of centenarian inhabitants of the Caucasus region in southwest Asia, who consume large amounts of yogurt.

Milk for yogurt manufacture is firstly standardized to the appropriate fat and protein level (commonly 12–15 percent total solids and 1–2 percent fat) using skim milk powder. The milk is heated at 185°F (85°C) for thirty minutes, or alternatively, 194°F (90°C) for forty to sixty seconds. The stabilizers are next added, followed by homogenization at 7 MPa and cooling to 86–113°F (30°–45°C). Bacterial cultures are added, fruit puree is mixed in if desired, and the milk is allowed to set for sixteen hours to form a coagulum before refrigerating to 39°F (4°C) and packaged for consumption.

Homogenization of milk prior to yogurt manufacture increases the viscosity of yogurt and inhibits the formation of syneresis during refrigerated storage. The shelf-life of yogurt at 39°F (4°C) is from thirty to sixty days. The two main types of yogurt are stirred and set. In set yogurt, milk is allowed to coagulate to form the yogurt network structure without mechanical disturbance. In stirred yogurt, the coagulated milk is stirred while cooling down, then the fruit puree is added if required.

Yogurt cheese is prepared as for other types of yogurt in the initial stages of manufacture, except that *Lactococcus lactis* bacterial culture and rennet are mixed with the milk one hour into the setting period, and a cheese similar to cream cheese is manufactured.

Cream and Sour Cream

Cream is produced by separating milk into a skim phase (with less than 0.5 percent fat) and a cream phase. The fat content of the cream increases with the speed of the separator. A separator consists of concentric stainless steel cones rotating at high speed. Fat in cream can vary from as little as 10–12 percent in half-and-half, popular in the United States, to 30–40 percent in table cream and whipping cream. Plastic cream can contain up to 80 percent fat. Off-flavors can be removed from milk and cream by the process of vacreation, where steam is injected into the product and removed, along with the unwanted flavors, under a partial vacuum.

Sour cream is produced by lactose acid bacteria fermentation or direct addition of mineral acids to cream. Fresh cream is first standardized to 20 percent fat, homogenized at 20 MPa and 160°F (71°C), pasteurized at 165°F (74°C) for thirty minutes, cooled, and then inoculated with bacterial culture. Rennet can be added to produce a firmer product. The fermenting cream is incubated for sixteen hours at 72°F (22°C) until a pH of 4.5 is reached, then cooled and packaged. The shelf life is three to four weeks. Condiments such as blue cheese, seafood, and onion can be added to sour cream to produce a dip.

Ultra High Temperature Milk

Ultra high temperature (UHT) milk is produced by heat-treating milk at 284°F (140°C) for two to three seconds, essentially sterilizing the milk. It is packaged aseptically and stored at room temperature for up to six months. The two main methods of producing UHT milk are direct steam injection, and indirect heating by passing milk over a stainless steel surface that is heated by high pressure steam. UHT milk is characterized by a cooked flavor that dissipates over time and which is then replaced by a stale oxidized flavor that develops during storage. Another potential problem with UHT milk is that it is susceptible to gelation and sedimentation. The chemical and physical mechanisms for this are unclear.

Some work has been done using a spinning cone column to eliminate undesirable flavors from UHT milk. This technology utilizes a series of rapidly rotating concentric cones through which milk or cream can be passed down. Low temperature steam under a partial vacuum is passed up in the counter-current direction, which strips flavor components from the dairy product. The steam can be condensed and the flavor compounds distilled and kept for later use. This process can be used to remove feed-related off-flavors from milk, the oxidized flavor from UHT milk, or to strip desirable buttery flavors from cream for subsequent addition into low-fat dairy products.

Buttermilk, Butteroil, and Ghee

Buttermilk is a by-product of churning in butter manufacture. It is low in fat (about 1 percent), and rich in the phospholipid and protein components at the milk fat globule membrane layer. Milk fermented with lactic acid bacteria and subsequently separated into cream can be used in the manufacture of cultured or ripened butter. Cultured buttermilk is derived from cultured butter.

Butteroil is produced by centrifuging liquid butter to a fat content in excess of 99 percent, the remainder being mostly water. This product is solidified at room temperature. A higher grade, at more than 99.8 percent fat, is called anhydrous milk fat.

Ghee is a product similar in composition to butteroil and used for confectionery manufacture and for cooking in India, and in Egypt where it is called *samma*, or *samn*. Buffalo milk is boiled for one hour, the curd skimmed off, and churned for thirty minutes to form a butter. This is heated and strained to yield ghee, a clear oil with a characteristic cooked odor and flavor.

Other Milk Products

Kefir is an alcoholic, carbonated milk-based beverage popular in eastern and central Europe. Yeast and bacteria convert lactose into lactic acid, carbon dioxide gas, and alcohol (ethanol) overnight at ambient temperature. The levels of lactic acid and alcohol are around 1 percent each. Koumiss from central Asia is similar to Kefir but made from mare's milk, and has a higher alcohol content of 2.5 percent. Other nonalcoholic fermented milk beverages include acidophilus milk, and Bulgarian buttermilk with a comparatively high lactic acid content of 2–4 percent.

Evaporated and Condensed Milk

Concentrated milk can be produced by partial evaporation of water to yield either evaporated or condensed milk. The removal of water is done by heating under reduced pressure to avoid excessive heat damage to proteins. Evaporated milk is sterilized and aseptically packaged, whereas condensed milk does not have this extra heat treatment step. Variations of condensed milk include sweetened, where 18 percent sugar is added to milk before evaporation, and condensed skim milk.

Whey

Liquid whey is an orange-colored liquid comprising about 5 percent lactose, 0.7 percent whey proteins, and 1 percent minerals. The disposal of whey has always been an issue in the manufacture of cheese due to the large volumes produced. Approximately 90 percent of the volume of milk is removed as whey when making cheese. The high biological oxygen demand of whey prevents disposal into lakes and streams, where it can deprive fish of oxygen.

Whey proteins are very nutritious and have a high protein efficiency ratio (ratio of weight gained to weight of protein consumed). Fruit juices can be fortified with around 6 percent acid whey powder to increase the nutritional value without adversely affecting flavor and color. Whey powder is highly water-soluble and adds vitamins, minerals, and high-quality nutritional proteins to other food products.

Liquid whey can be manufactured into cheese by adding milk or cream and then concentrating by evaporation. Cheese made by this method includes Brunost, Mysost, Gjetost, and Primost, which are popular in Scandinavian countries. The last two of these cheeses are made from goat whey. Ricotta is a whey-based cheese made by heating acidified bovine milk.

Whey Protein Powder

The two main types of whey are acid and sweet whey. Acid whey is obtained by addition of acids such as lactic, phosphoric, hydrochloric, sulfuric, and acetic to skim milk, reducing the pH from 6.7 to 4.6 and causing the casein to precipitate (which is then removed). Milk has a very high buffering capacity, requiring large quantities of acid to reduce the pH to this level. Acid whey contains very little lactic acid, as curds and whey are separated without the fermentation step.

Sweet whey originates from the cheese manufacturing process. Curds and whey are separated at a pH of approximately 6.2 in cheddar cheese manufacture, therefore sweet whey from this cheese is less acidic than acid whey. Sweet whey from cheesemaking contains around 0.5 percent fat. Whey from cottage cheese contains little fat, and around 0.4 percent lactic acid as a greater amount of fermentation of lactose to lactic acid takes place before the curds and whey are separated.

Sweet whey contains an additional protein fragment, the glycomacropeptide (GMP), which originates from the surface of the casein micelle as a consequence of enzymatic hydrolysis during the milk clotting reaction. The presence of GMP affects the textural functionality of whey powder when used as a food ingredient. GMP does not contain the amino acid phenylalanine, which can cause brain damage in children suffering from the disease phenylketonuria, an inability to metabolize this amino acid. There has been some research done on the extraction of GMP from sweet whey for use as a protein source for phenylketonuriacs.

Fractionation of whey into components with very specific nutritional, textural (functional), and pharmaceutical properties is a burgeoning field of research with the potential of large profit margins for the dairy industry. Components of whey that inhibit microbial growth include lactoferrin, lactoperoxidase, lysozyme, and various immunoglobulins. Lactoferrin binds iron necessary for microbial growth. These antimicrobial agents have the potential for use as "natural" preservatives in food products.

Sweet whey from cheesemaking is first clarified to remove casein particulate matter, then separated to re-

World Dairy Market

The three largest export regions of dairy products, with the percentage of the total world dairy market in 2000, were the European Union (36 percent), New Zealand (31 percent) and Australia (16 percent). Australia and New Zealand each account for around 2 percent of the world's production of milk. Due to their relatively low populations, most of the milk in these two countries is processed and exported, hence the apparent over-representation in the export market.

The major export products on the international market are milk powders, cheese, and butter. There is no economic gain in exporting fluid milk as most of this product consists of inexpensive and readily available water, hence the development of the dairy processing industry to create products with lower water contents.

According to the United Nations Food and Agriculture Organization, the total volume of milk produced in the world in 1996 was around 550 billion liters, of which about 12 percent comes from buffalo, sheep, and goats. The two largest milk producing regions in 1996 were the European Union, with 24 percent of the world's production, and the United States with 15 percent. The United States accounts for only 4 percent of the export market.

Milk production per cow per year is around 4,500 liters in Australia, where cows are pasture-fed, and increases to 5,000–7,500 liters in Europe and North America where supplemental feed is given. The volume of milk per cow can be increased by administering a hormone, bovine somatotropin, a practice allowed in the United States, but not in Australia or New Zealand.

Dairy product commodities are subject to large price fluctuations on the international market. To even out the price instability, and to support the local dairy industry, governments (particularly in the European Union) heavily subsidize milk prices. This has resulted in a surplus of some dairy products.

According to the Australian Dairy Corporation (1996), consumption of milk is highest in Ireland and the Scandinavian countries at about 150 kg per person per year. Butter consumption is highest in France, Germany, and New Zealand at around 7–8 kg per person per year. Cheese is most popular in Germany, France, Italy, and Greece, the inhabitants of which consume around 20 kg per person per year. Consumption of yogurt is highest, at around 20 kg per person per year, in France and the Netherlands.

move most of the fat. The whey is initially concentrated to around 40–60 percent solids in a vacuum evaporator before homogenization and drying. Most drying is done using a spray-dryer where the concentrated viscous whey is passed through an atomizer and allowed to fall through a chamber with countercurrent heated air to produce a dispersible and nonhygroscopic powder of around 10 percent moisture. Spray-dryers can produce as much as twenty metric tons per hour of powder. Further processing can take place on a fluidized bed dryer where heated air is passed up through a vibrating layer of powder to further reduce the moisture to around 4 percent. A lecithin mixture can also be sprayed onto the powder to promote dissolution in water, a procedure known as instantization. Other types of dryers that are less commonly used include drum and roller dryers and freeze dryers. Roller dryers result in a much more irregularly shaped powder particle than spray-dryers.

Typical composition of whey powder is shown in Table 1. These powders are called whey protein concentrates (WPC), and suffixed with a number to indicate the percentage of protein, for example, WPC 80 contains 80 percent protein. Generally, the higher the protein content, the higher the price that the powder commands in the market. The solubility of powders can be enhanced by collecting the smallest particles in a spray-dryer cyclone and mixing back with the partially dried powder at the top of the dryer. This creates an agglomerated particle with a surface containing many crevices, thus increasing the total surface area of a particle and increasing the solubility.

Higher protein levels in excess of 90 percent can be achieved by a combination of ion-exchange chromatography, electrodialysis to remove minerals, evaporation, ultrafiltration, lactose crystallization, and filtration. Whey protein isolates (WPI) are produced by ion-exchange and have a typical protein content of 93 percent. These isolates command a higher market price than WPC powders. The amount of fat in WPI is much lower than WPC, at around 0.5 percent. Ingredient applications for WPC and WPI include fortifying beverages such as high energy sports drinks, infant formulas, salad dressings, ice cream, custards, reformed meats, yogurt, surimi, bakery, and dessert products (as an egg replacement).

Lactose in milk powder is in the form of a concentrated amorphous (non-crystalline) glass that is very hygroscopic (high propensity for absorbing water). Milk powders that are high in lactose can potentially aggregate and lose the ability to flow freely. To avoid this problem, concentrated liquid whey is held at refrigeration temperatures for twenty-four hours prior to drying to ensure that lactose crystallizes into the stable and non-hygroscopic α-hydrate polymorph to reduce the propensity for powder caking. The concentrated whey is injected into the spray-dryer at less than 126°F (52°C) to prevent solubilization of the α-hydrate crystals.

Lactose can be converted to galactose and glucose by the enzyme lactase. This procedure can be utilized to manufacture a low-lactose whey powder, which is sweeter, but more likely to undergo Maillard browning reactions than regular whey powder. Lactase can also be encapsulated and added to milk. Once the milk is consumed, the capsules break open, releasing the lactase, thus preventing the occurrence of lactose-intolerance symptoms.

The degree of heat-treatment of milk powders is quantified by the whey protein nitrogen index (WPNI), a measure of the quantity of whey proteins that are not denatured. Excessive heat during spray-drying causes a large degree of protein denaturation with subsequent loss of solubility of the powder. Low heat powder has a WPNI greater than 6 milligrams of nitrogen per gram, medium heat between 1.5 and 6 milligrams of nitrogen per gram, and high heat less than 1.5 milligrams of nitrogen per gram of powder. The degree of heating of powder during manufacture has implications for solubility, heat stability, viscosity, and flavor of the dairy product containing whey powder. High-heat powder will give high viscosity when added to yogurt, good heat stability in reconstituted evaporated milk, and intense flavor when used in milk chocolate, but poor clotting properties for recombined milk used in cheese manufacture.

Buttermilk Powder

Buttermilk contains many surface-active components that function as emulsifiers. By making changes to the butter manufacturing process, different kinds of buttermilk powder (BMP) can be produced with various functional properties when used as a food ingredient. There is some scientific evidence that the components of the milk fat globule membrane layer are essential for development of cheese flavor during the ripening period. If this is so, BMP could find a use in fortifying low fat cheese to improve the flavor. Other applications for BMP include emulsifying fat in salad dressing, bakery products, ice cream, dips, and spreads.

The composition of BMP is not as tightly controlled as for other milk powders, as it is often thought of as a secondary product coming out of the primary process of butter manufacture. Volumes produced of this powder are generally much lower than for other powders, so their full potential has not yet been fully explored. BMP comprises mostly lactose with around 10 percent fat. About one-fifth of the fat comprises phospholipids, the highly surface-active components that are used as emulsifiers.

Casein and Caseinate Powders

Casein powder is produced by isoelectric precipitation of milk using mineral acids, lactic acid bacteria fermentation, or enzymatic coagulation by chymosin (rennet). New Zealand is the world's largest producer of casein powder. A combination of acid and chymosin is used to prepare a low-viscosity casein for use in the paper industry to bind pigments. Precipitated casein curds are washed in water to remove residual lactose, whey proteins, and minerals, then pressed with rollers, dried (using a fluid bed dryer), and ground into a powder. Attrition drying occurs when casein curd is ground and dried by exposure to hot air concurrently. These particles are highly irregular in shape and more soluble in water.

Applications of casein powder include paper coating, adhesives, water-based paints, food ingredients, and animal feed. Food ingredient applications include beer and wine clarification, protein fortification of food, and texturized simulated meat products. Casein hydrolyzates are formed by partial acid hydrolysis of casein to improve the flavor of soups, dried meat products, crackers, and snack foods.

Caseinate is produced from acid casein by increasing the pH toward neutrality to dissolve the precipitated casein. Most commonly, sodium and calcium hydroxides are used to prepare sodium and calcium caseinate, respectively. Caseinates can be spray-dried after reconstituting in water to around 20–25 percent total solid material. The ingredient application for dried caseinates includes sausages, coffee whitener, ice cream and dairy-based desserts, soups, crackers, and sauces.

Other Milk Powders

Other types of milk powder include skim milk powder (SMP), whole milk powder (WMP), cream powder, lactalbumin, colostrum, cheese powder, and milk protein concentrate. WMP contains around 30 percent fat, whereas SMP contains less than 1.5 percent. Lactalbumin powder is formed by heat-induced precipitation of cheese whey followed by drying. This powder is insoluble in water.

Cheese powder is produced from highly flavored cheeses such as cheddar and parmesan, by grinding, adding water and emulsifying salts to form a viscous suspension, followed by pasteurization, homogenization, and spray drying. This product quickly deteriorates after several months. The major ingredient application is for use as a cheese flavoring in food products.

Cream can also be spray dried to form a high fat (40-75 percent) powder. The amount of free fat in milk powders is of importance and affects dispersibility in water. This free fat is usually located on the surface and within crevices on the powder particle.

Co-precipitates are produced by heating skim milk to 185°F (85°C), whereupon the whey proteins denature and bind to the casein micelles. This complex is precipitated by acid and processed to a powder using the same procedure as casein powder production.

Milk is an important food from a nutritional perspective, largely due to the presence of proteins and calcium. The high water content and only slightly acidic pH render this food susceptible to microbiological spoilage. The dairy processing industry has developed to circumvent the spoilage issue through production of products with low moisture and higher acidity. This allows the development of a dairy products export market, as milk products can now be shipped to distant lands without compromising quality and safety. The huge variety of dairy products, most notably illustrated by the seemingly unending array of cheeses, is a testimony to the potential of milk for continued development of nutritious and tasty milk-based foods.

See also **Butter; Cheese; Curds; Ice Cream; Lactation; Milk, Human; Pasteur, Louis.**

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DAY OF THE DEAD. In Mexico, the festival of Día de los Muertos embodies the greatest expression of both popular Catholicism and the national cuisine. People construct altars in homes and graveyards throughout the country in order to feed the souls of the dead. Church

The Mexican Day of the Dead combines customs from both the ancient Aztecs and the Spanish who settled in Mexico. These women are holding a vigil in Michoacán, Mexico. © CHARLES AND JOSETTE LENARS/CORBIS.

officials recognize two holy days, November 1 (All Saints' Day), in commemoration of saints and martyrs, and November 2 (All Souls' Day), in memory of the faithful departed. According to popular belief, the *angelitos* (deceased children) return on the evening of October 31 and the adults on the following night, although the dates in local celebrations vary all the way from October 28 to November 4. The feast for the dead originated as a form of ancestor worship, and the clergy were long reluctant to incorporate such pagan practices into the liturgical calendar. The festival held particularly strong associations with pre-Hispanic agrarian cults because it coincided with the maize harvest.

Celebrations begin with the cleaning of the graves and the construction of the *ofrenda*, or altar. At home this consists of a table or platform hung from the ceiling, covered with a white cloth and supporting an arch of palm fronds. The *ofrenda* are decorated with flowers, particularly the *cempasúchil* (marigold), the "flower of the dead," as well as the magenta-colored cockscomb, a white gypsophila, gladioli, and carnations. The same flowers are also used to decorate tombs, and the sweet smell of copal, the Native American incense, is ubiquitous. Other altar decorations include images of the deceased as well as *papeles picados*, colored paper with cutout designs.

The foods offered to the dead vary according to age and taste, but bread, water, and salt are always included. The bread is made from a special egg dough in a round shape, with crisscrossed strips of dough forming bones, and a skull in the center. Sugar candies with similar skull and *calavera* (skeleton) designs are also popular. In some areas of Oaxaca and Michoacán, bakers shape the bread to resemble humans or animals. Offerings for children are miniature in size and relatively simple: breads, candies, fruits, and milk or soft drinks. The adult dead receive the finest foods, grown-up breads and sugar figures, as well as candied pumpkin and other sweets. More elaborate preparations include mole (turkey in a rich chili sauce) and tamales (corn dumplings stuffed with meat and chili and steamed in husks or banana leaves). The spirits also drink their favorite beverages, whether soft drinks, coffee, chocolate, beer, or tequila. Some people maintain that the level of the liquid decreases overnight, showing that the dead do indeed return to share in the feast.

The Day of the Dead has recently become an important tourist attraction for towns such as Mixquic, near Mexico City, and in the state of Oaxaca. Yet despite this increasing commercialization, the festival exemplifies the distinctiveness of the Mexican mentality; rather than a time of trick or treat, it celebrates the intimate connections between the living and the dead.

See also **Christianity; Death and Burial; Feasts, Festivals, and Fasts; Halloween; Holidays; Mexico; Religion and Food.**

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DEATH AND BURIAL.

As far back as records go, we have evidence of the dead being laid to rest with care and ritual. Burial gifts, including food vessels and household utensils from different eras, have been discovered in archaeological remains in various parts of the world. These gifts are thought to have been intended for the use of the deceased on his or her journey to paradise or the land of the dead and to secure entry and acceptance in the new abode. Even those who suffered violent death were buried in specific ways, and it is of interest to note that two young men who appear to have been ritually sacrificed during the European Iron Age had consumed a meal before being killed. The so-called "Tollund Man," buried in a Danish bog about 500 B.C.E., had eaten a meal of porridge of some kind, and the "Lindow Man," buried in a peat bog at Lindow Moss, Cheshire, England, sometime during the fourth century B.C.E., had consumed "a kind of wholemeal bread consisting of different kinds of grains," just prior to his violent death (Green, 1992, pp. 132 and 210–111).

Although the Christian churches have, for centuries, regulated the liturgy and ceremonies for the dying and the dead, people everywhere have created their own death rites and have often retained them in addition to those of the official Church. Food and drink are often important elements of these rites, and they are sometimes associated with the dying state. In Ireland, for example, as Patricia Lysaght has shown, the dying were thought to suffer from hunger and thirst at death, and thus a dying person's request for food and drink always had to be granted. This food, served in anticipation of death, was termed *lón báis* (death sustenance); it was thought to be necessary to enable the person to die and thus to enter upon the journey to the land of the dead (Lysaght, 1995, p. 32). In many cultures this journey was said to be long and hazardous, and sustenance, provided by the living, was considered necessary. Food and drink were, therefore, served at various junctures during the wake and funeral, so that, as Greek tradition expresses it, "the dead may eat" (Danforth, 1982, Plate 22).

These foodstuffs were often left specifically in the presence of the deceased or placed in the coffin, or put into or placed on the grave. Formerly, in parts of Britain, bread and beer, or salt and bread, were consumed by a so-called "sin-eater" in the presence of the deceased; this person was thought to take on the sins of the deceased and thus enable him or her to be incorporated into the Christian otherworld (Hole, 1953, pp. 224–225; Kvideland, 1993).

Food and drink consumed by the living during the wake and at the post-funeral meal were evidently also thought to provide necessary nourishment for the deceased, and thus to facilitate the transfer to the other world. Such food and drink have also been looked upon as a means of strengthening family and community in the face of death.

Food and drink also featured in ceremonies for the dead held at intervals varying from thirty or forty days after death in some societies, to three years among the Skolt Lapps of northern Europe when the dead person's final incorporation among the confraternity of the dead was thought to take place (Storå, 1971, p. 272), to several years in cultures where secondary burial was customary. At Christmas, Easter, and Whitsuntide (or Pentecost), the family dead were remembered by, among other things, gifts of food and drink. On November 2, the Feast of All Souls, prayers were recited throughout much of Catholic Europe for the souls of the dead. In addition, food and drink were placed on graves or left ready in the family home for deceased members, particularly the suffering souls in purgatory, who, according to an ancient and widespread popular belief, were thought to congregate there from midnight until cockcrow.

FOOD AND THE SIN-EATER

Sin-eating as a funeral custom was once common in parts of England, Scotland, and Wales. It is mentioned in records from the seventeenth to the nineteenth century. For a trifling payment, a man or woman of the locality known as a sin-eater was believed to take upon him or herself, by eating and drinking, the sins of the deceased. According to John Aubrey, writing in 1686–1687 (Aubrey, 1972, p. 179) and referring to the County of Hereford in England, the rite was performed when the deceased was being removed from the house for burial. The corpse was placed on a bier before the door, and a loaf of bread and a bowl of beer were passed over the deceased to the sin-eater, who consumed them and was given a sixpence as payment. The sin-eater was thus thought to assume the sins of the deceased and thereby bring ease and rest to the departed soul.

What is probably an older form of the custom is mentioned for western Scotland in 1879. Here the sin-eater was taken into the corpse-room where he was said to have consumed a plate of salt and a plate of bread placed on the breast of the corpse, and thus to have eaten his sins (Napier, 1879, 60–61).

The custom of sin-eating is apparently older than the seventeenth century and is said to derive from the scapegoat in Leviticus 16: 21, 22. What might be regarded as a symbolic survival of the custom in parts of Europe was the passing of drink and a funeral biscuit over the corpse, or the placing of a funeral cake on the breast of the deceased for consumption by the nearest relative, or, indeed, the placing of salt on the breast of the deceased as was common, for example, in Ireland. The "death cakes" introduced into America from Europe in the seventeenth century and served to guests at a funeral and the "burial cakes" still made in parts of rural England in the early twentieth century might well reflect the custom of sin-eating.

Kinds of Drink and Food

Alcoholic beverages were a feature of wake and funeral hospitality throughout much of Europe until relatively recent times (Ó Súilleabháin, 1967, pp. 154–157). In Latvia, for example, the expression *dzert bïres*, 'to drink a funeral', is testimony to this (Dumpe, 2002, p. 125). The apparently liberal provision of alcohol at wakes and funerals in Ireland was repeatedly condemned by secular and ecclesiastical commentators from the seventeenth to the twentieth century. Occasional references to elaborate funeral meals that included beer, wine, beef, and wheaten

Philadelphia funeral biscuit mold from about 1785 depicting the plumes that decorated the corners of the hearse and were also worn by the horses pulling it. There were bakers in most East Coast cities who specialized in funeral biscuits and in catering funerals. ROUGHWOOD COLLECTION.

bread occur in seventeenth- and eighteenth-century literature, but by the late nineteenth century, the wakefoods commonly mentioned include shop-bought goods, especially white bread, fruit cake, jam, and tea, and alcoholic beverages in modest quantities. Today, where wakes survive, food (sandwiches, cake, tea, coffee), and alcoholic beverages (wine, beer, Guinness, spirits) are served, but the most significant funeral repast in rural and urban Ireland today is generally the postburial meal in the mourning home or in a restaurant (Lysaght, 2002).

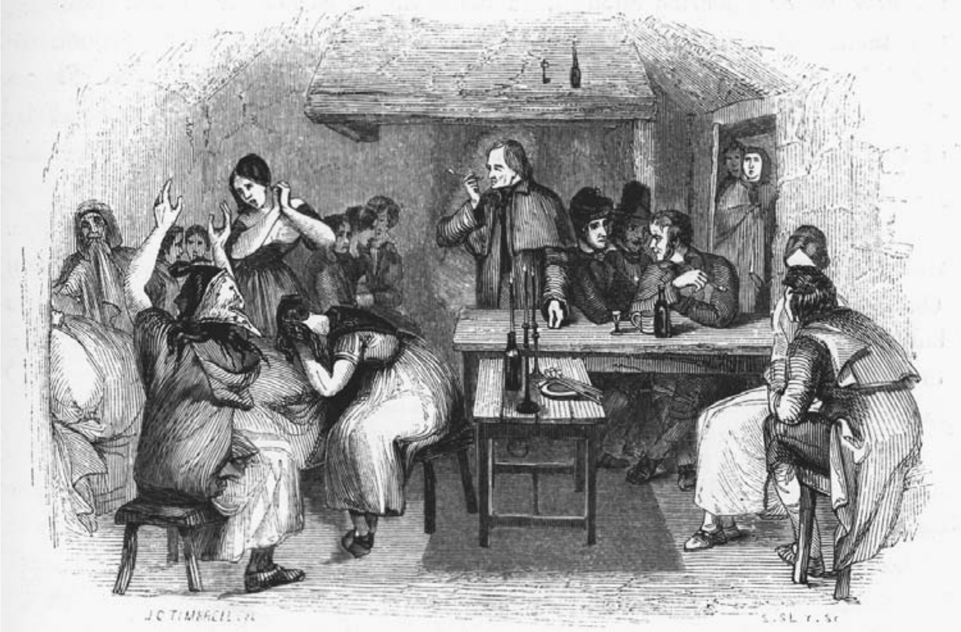
In eighteenth-century Scotland, England, and the Isle of Man, food and alcohol were liberally provided at wakes and funerals by people of rank (Bennett, pp. 207–211; Hole, pp. 228–229 and 233; Moore, p. 160). More typical, at least for Scotland, in recent times, was the provision of cheese and oatcakes, sometimes shortbread, served with ale or tea, and spirits, to which could be added wine and biscuits. The corpse-watchers received whisky (and pipes and tobacco), and often tea, or bread and cheese with ale, about midnight. Funeral guests were similarly treated. If the cemetery was some distance away, whisky was sometimes served at a particular spot en route, and again in the cemetery after burial. In parts of northern Scotland a meal called a *dredgy* was served in the deceased's home after the burial (Fenton, 2002, pp. 212–213).

In Portugal, as shown by Mouette Barboff, grain, bread, and wine have played significant roles in death customs. Lamenting women were paid in rye and wheat, while water, millet-bread soaked in wine, and a coin were placed in the deceased's coffin, for the journey to the otherworld. In the north, where death customs remain particularly strong, funeral bread is distributed at the church and cemetery. In the Beira region, two cornbread loaves, divided into eight pieces, are given to the poor on removal of the coffin from the house, while in the Barroso, rye loaves (*o carolo*) are distributed on leaving the church. In the Minho, a slice of cornbread with a piece of fish (sardine or cod), or wheaten bread (*molete*), is distributed to all funeral guests. The priest is given bread, wine, or grain, and perhaps fish or meat. Nowadays, the tendency is to pay the priest in cash. On the first anniversary of the death, thirty or forty loaves of bread called *pão da caridade* (charity bread) or *pão das almas* (soul bread), baked by the family, are distributed to the poor of the parish in return for prayers for the deceased. On the Feast of All Souls (November 2), children call to houses asking for the *pão por Deus* (God's bread) for the holy souls (Barboff, 2002, pp. 204–206).

Elsewhere in Europe, the provision of food and drink on the occasion of death has also been highly structured. In Westphalia in northern Germany, it is still customary to provide *Beerdigungskaffee* (funeral coffee), with plain or sugar biscuits (*Zwieback/Zuckerzwieback*), pastries, and open sandwiches (*belegtes Brötchen*) for the funeral participants in a local hostelry after the burial. As late as the 1960s, a very elaborate meal (*Leichenmahl*) consisting of, for example, *bouillon*, a large meat platter with roast sausage, pork, and fowl, served with potatoes, red cabbage, and applesauce, followed by a pudding dessert, cigars for the menfolk, and afternoon coffee with pastries and sandwiches, might still be provided in well-to-do farmhouses for the relatives and near neighbors of the deceased.

In parts of Lower Austria in the 1970s, food and drink were served at certain junctures during the wake for the dead. On completion of the rosary, bread, wine, and fruit such as apples, dried prunes, and pears were provided. After the singing of funeral songs, more food and drink, which could include coffee and the much-

A funeral biscuit made from the circa 1785 mold. Reconstructed recipe and icing technique by William Woys Weaver. ROUGHWOOD COLLECTION.



An Irish wake, complete with wailing relatives and a spread of whisky on the table to the far right. An engraving from Mr. and Mrs. Samuel Carter Hall's *Ireland. Its Scenery, Character &c.* (London, 1841). PUBLISHED WITH PERMISSION OF THE FOLKLORE SOCIETY, LONDON.

appreciated crumbled bread soaked in coffee and eaten with a spoon, were served. Schnapps was provided in most areas, followed sometimes by black bread but mostly by white *Totenbrot* (funeral bread), with wine or beer. Much alcohol was drunk. Meat was only seldom offered.

Early on the morning of the funeral, relatives, friends, neighbors, and the coffin bearers were invited to the funeral breakfast, consisting mostly of coffee and white bread, although a nutritious meal with a substantial fat content was sometimes served to the coffin bearers. Schnapps and wine were also provided.

The funeral meal (*Leichenmahl*), to which relatives, neighbors, helpers, the priest, and mass servers were invited, was held either at an inn or in the mourning house. It could be very elaborate, consisting of several courses and including various kinds of bread and cheese, and, in certain areas, wine or beer (Huber, 1981, pp. 74–147).

In eastern Europe, festive food and drink were also associated with death in Slovakia. A slice of bread and a small glass of brandy were placed in the room for the soul of the deceased. Bread was placed in the coffin or grave or given to beggars or gravediggers in payment for prayers for the deceased. In the mountain regions, bread, salt, curds or cheese, and brandy were served. A cock was killed for the death of a farmer and a hen for that of his wife. A weddinglike feast was held for an unmarried deceased, especially a young man or woman (Stoličná, p. 118). A similar practice formerly took place in Hungary (Viski, pp. 181–182) and elsewhere in Europe (cf. Fielhauer, 1970).

In parts of southern Europe, for example in Greece, food plays a very substantial role in the elaborate and extended funeral customs of Greek Orthodox tradition. (Danforth). At the burial, prior to the closing of the coffin in the grave, the priest pours a bottle of red wine in the form of a cross over the shrouded body of the deceased. *Koliva* (boiled wheat mixed with sugar and cinnamon and decorated with nuts and raisins) and bread are shared in the church courtyard by the funeral participants, who pray for the forgiveness of the deceased. None of this food is brought into the deceased's house, where the guests are offered water, cognac, cigarettes, and candy as they convey their condolences to the relatives. After coffee and biscuits have been served, the priest blesses *koliva*, wine, and bread (i.e., *makario*, "that which is blessed") and distributes them to the close relatives of the deceased (Danforth, 1982, pp. 42–43).

On the eve of the third day after death, *koliva*, bread, candy, and pastries are again distributed in the church courtyard after the memorial service at the grave, and guests again receive coffee, cognac, biscuits, and candy in the house of the deceased. These ceremonies may be repeated on the ninth day and six months after the death. Forty days after death, another memorial service is performed in the cemetery, after which a sweet wheaten pudding called *panhidha* is blessed by the priest and served to the guests in the church courtyard together with special funeral bread, pastries, honey, candy, and vermouth. Finally, guests are invited to the deceased's house for a very elaborate meal that includes meat, indicating that the relatives—who have abstained from meat for forty days—are being reincorporated into the normal life of the community (Danforth, 1982, pp. 43–44).

On occasions of collective commemoration of the dead, called *Psihosavato* (Soul Saturdays or All Souls' Days), offerings of *koliva*, bread, cheese, olives, and fruit are brought by women in rural Greece to the village church. There they are blessed by the priest, who also recites the names of the village dead. The food offerings brought by the women individually in honor of their own dead are then distributed to the others present in honor of all the dead (Danforth, 1982, p. 56).

The rite of exhumation, in which food and drink also feature, is normally performed after five years, at which stage the deceased is thought to have reached his or her final resting place. The priest pours a bottle of red wine over the bones, making the sign of the cross three times with the liquid. Those present are offered "a small glass of sweet red wine," *koliva*, "a slice of bread, a spoonful of honey, and several pastries, sweets, and other candies," by distant relatives and friends of the family. On returning to the family's house, they are "offered water, cognac, and candy" and later "coffee, small biscuits, and pastries," after which they compliment the family in a traditional manner for the reception provided (Danforth, 1982, p. 21).

Many Old World death customs, including the provision of refreshments at wakes and funerals, traveled to the New World with emigrant groups. William Woys Weaver shows that in colonial America, the provision of lavish funeral hospitality, either in the deceased's home or in a local hostelry, was well established by the late eighteenth century. Among the foods served by the Pennsylvania Dutch was a rich fruit cake, but funeral biscuits were also common. Some varieties, like the Dutch *doodkoecks* (death cakes), bore the initials of the deceased and were given to mourners in old New York. Others featured highly symbolic motifs such as a rooster, a heart, "a cherub or winged head . . . an hourglass, or even a skull" (Weaver, pp. 107–108). As in the Yorkshire Dales and Lincolnshire in England, the biscuits were flavored with caraway or tansy seeds (Weaver, p. 108). In Montgomery County, Pennsylvania, "funeral bread" (bread "sweetened with sugar or honey and containing caraway seeds or dried fruit"), funeral biscuits, and wine were served to the guests as they left the church on their way to the cemetery (Weaver, 1989, p. 110).

Commemoration of the dead during the feasts of All Saints and All Souls (November 1 and 2) is an especially exuberant affair in Mexican Catholic tradition. During the festival of *Todos Santos* (All Saints), or *Dia* or *Dias de Muertos* (Day or Days of the Dead), extending from the eve of October 30 to the evening of November 2, offerings of food and drink are made to the dead by being placed on the "dressed" graves and on the very elaborate altars for the dead that are prepared in the family home (Carmichael and Sayer, 1991, pp. 14–21).

In the New World, therefore, as in the Old, the provision of food and drink at wakes and funerals was an important act of *pietas* and effectively a social obligation. Thus, their provision was highly regulated and a matter of strict observance in many different societies.

See also **Christianity; Day of the Dead; Religion and Food; Sin and Food.**

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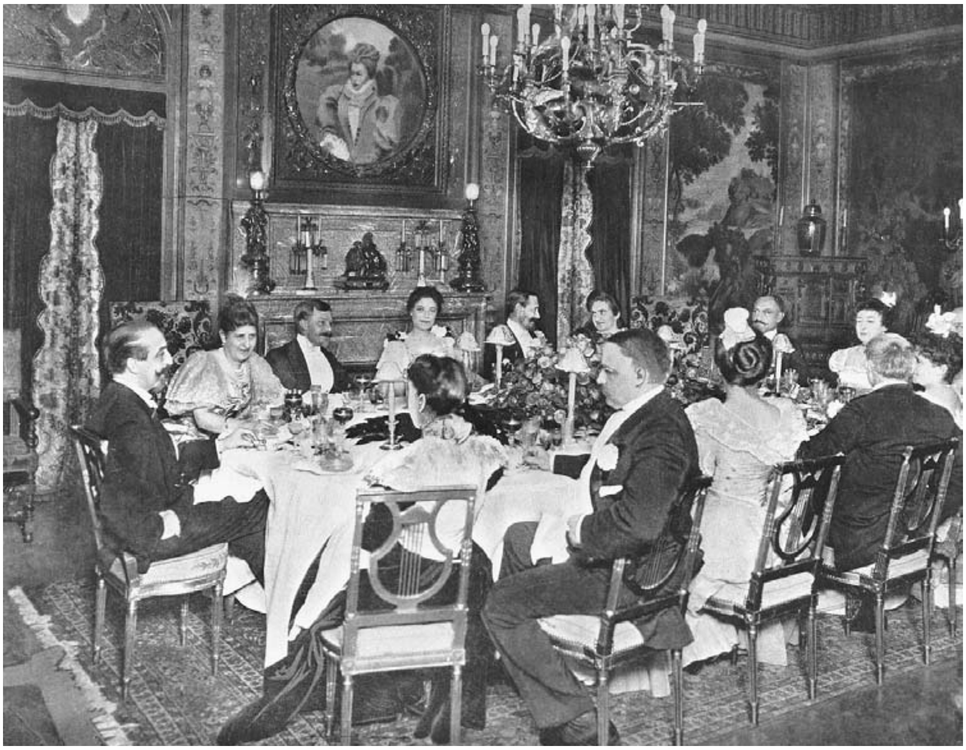
Patricia Lysaght

DELICATESSEN. *See* **Retailing of Food.**

DELMONICO FAMILY. The Delmonicos are a family dynasty of restaurateurs of Italian Swiss origin who created some of the most legendary and opulent restaurants in the United States.

The principal founders of the American clan were the brothers Pietro Antonio (1783–1861) and Giovanni (1788–1842) Del Monico, who established themselves under the names Peter and John Delmonico at 23 William Street in New York in 1827. Shrewdly advertising their business as a European-style café in New York's business district, the brothers quickly amassed a fortune based on excellent service and a menu that became a magnet for New York's European expatriates and American nouveaux riches.

As the business grew and thrived, other members of the family emigrated from Switzerland and joined Peter and John, including a nephew Lorenzo (1813–1881) who eventually became the genius behind the success of the family's restaurant empire. Lorenzo joined the firm in 1831 when it expanded from a café into a true *restaurant française*. This first restaurant, at 25 William Street, was only the first of several locations that eventually opened and operated under the Delmonico name. As businesses moved uptown, Delmonico's followed. In 1876, Lorenzo moved the main restaurant to Fifth Avenue and Twenty-sixth Street, facing Madison Square. This new address, complete with a ballroom that quickly became the centerpiece of New York society, launched Delmonico's into



A private dinner at Delmonico's Forty-fourth Street restaurant in 1898. © BETTMAN/CORBIS.

New York's Gilded Age and perhaps the restaurant's greatest period of fame.

Under the oversight of European-trained chef Charles Ranhofer, Delmonicos became synonymous with ostentatious banquets and gastronomic sensations. Ranhofer's encyclopedic cookbook called *The Epicurean* (1894) records many of the recipes and menus that made Delmonico's famous during his culinary reign. *The Delmonico Cookbook* (1880), a less opulent cookbook by former Delmonico chef Alessandro Filippini, also records many of the foods served in the restaurant. Throughout much of the history of the various restaurants owned by the family, the majority of customers were businessmen; women were not served in the public dining rooms unless escorted, although this rule was relaxed somewhat during the 1880s. The famous dinners at which women were present were held in ornately furnished private rooms designed for this purpose.

The restaurant's last move occurred in 1897 when it took up a new location on Fifth Avenue at Forty-fourth Street. The Delmonico restaurant empire eventually became overextended and difficult to manage. The business closed its doors in 1923, a victim of income tax, Prohibition, and changing lifestyles of New York's rich and famous. Today the name Delmonico survives in a pudding, a melon, and a cut of steak taken from a rib of beef, the American equivalent of entrecôte.

See also **Restaurants**.

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William Woys Weaver

DENTISTRY. Food and dental health interact, with each having effects on the other. Patterns of eating affect the health of the teeth and other tissues in the mouth, while the ability to chew a variety of foods without discomfort influences a person's nutritional state as well his or her enjoyment of eating.

Sugar and Dental Caries

The clearest link between food and dental health is between sugar consumption and caries (cavities). A study in the 1940s compared the dental health of children in an area of northern India, where food was scarce and malnutrition common, to that of better-nourished children in Lahore and in Rochester, New York. The poorly nourished children had the fewest cavities. Subsequent research confirmed that populations who enjoyed a good nutritional status had more caries than less well-nourished populations.

Researchers then looked at the mechanism of caries development to discern the role of diet. Cavities are the end result of a process that involves bacteria and sugars in the mouth over time. *Streptococcus mutans*, bacteria that are normally present in plaque, a very fine film which covers the surfaces of the teeth, metabolize sugar and form acid. When a person consumes sugar in foods or beverages, acid is formed that can dissolve minute amounts of minerals from the enamel surface of the tooth. When this happens repeatedly over time, enough minerals are lost for a cavity to form.

This relationship between sugar consumption and caries was tested in a classic study conducted at Vipeholm, a mental institution in Sweden, and reported in 1954. Although modern ethical standards would preclude a study in which subjects were unable to give informed consent, it remains a landmark piece of research. Residents were assigned to several groups. All ate the standard diet of the institution, but some were given additional sweets in varying quantities and frequency, up to twenty-four sticky toffee candies per day. After five years of observation, the researchers concluded that the stickiness of the sweets and the frequency with which they were consumed, both increasing the amount of time that the bacteria in plaque could produce acid, were more important than the total amount of sugar.

Streptococcus mutans can feed on any carbohydrate, not just sugars. The bacteria make no distinction between "natural" carbohydrates, such as the sugars in fruit, and refined sugars; they make acid from any of them.

Oral bacteria also make acid from sugar in liquids. This can lead to a particular pattern of caries called "baby-bottle caries," which develops when a baby is put to bed with a bottle filled with sugar-containing liquid, including milk. When the baby falls asleep, the liquid pools in the mouth, leading to decay, most often of the front upper teeth.

Since sugar has been shown to play such a significant role in the development of tooth decay, a basic preventive measure is to limit the frequency of sugar consumption. Because it is the action of bacteria on the sugar that is of concern, minimizing the bacteria by careful attention to oral hygiene is equally important. Fluoride, a mineral that is naturally present in water in some areas, has a strong protective effect as well. It binds to the other minerals to become part of the enamel, making the enamel harder and more resistant to decay. It also slows acid formation and promotes repair of places on the teeth where acid has dissolved some of the minerals.

In areas where the naturally occurring level of fluoride in water is low, it is often added during water treatment. Although there have been controversies about water fluoridation, public health authorities, including the American Dental Association, the United States Public Health Service, and the World Health Organization, all support it as a safe and effective preventive measure. One can see its effectiveness in the fact that, although sugar consumption in the United States has been increasing, children have fewer cavities than they had in the years before fluoridation became widespread.

Sugar substitutes are used to produce candies, chewing gum, and beverages that taste sweet without harming the teeth. Chewing gum containing xylitol, one of these alternative sweeteners, has been shown to be protective.

Diet and Periodontal Disease

Gingivitis, or periodontal disease, is the other common dental disorder. The bacteria in dental plaque cause an infection of the gums and structures that hold the teeth in place. The gums become red, swollen, and tender. Food does not play an important role in the development of gum disease, as it does in the formation of caries. Good oral hygiene is the most important preventive measure. A nutritious diet, which supplies generous amounts of vitamins and minerals, can offer some benefit by helping to maintain the immune system's ability to fight the infection.

Dental Status and Eating

The other side of the food and dental health interaction is the importance of healthy dentition in enabling people to eat and enjoy a wide variety of foods. The absence of a significant number of teeth or a condition such as periodontal disease or poorly fitting dentures, which makes chewing uncomfortable, may limit a person's food choices and compromise his or her nutritional status. This problem occurs most frequently in elderly and low-income populations, who are more likely to be at risk for nutritional problems.

Some researchers do not find this effect, possibly because the subjects with poor dentition have chosen nutritious foods that are easy to chew, or because the comparison population ate no better in spite of good dental status. In general, however, poor dental health increases the risk of poor nutritional health. Good dental care can correct most of these problems and enable individuals to enjoy eating a nutritious diet.

See also **Digestion**; **Fluoride**.

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Mona R. Sutnick

DESSERT. *See* **Cake and Pancake; Chocolate; Ice Cream; Pastry; Sherbet and Sorbet.**

DIASPORA. The term "diaspora" was first used to describe the shared experience of the Jewish peoples—experience of exile and displacement, but also of continuing (some would say strengthening) connection and identification. Etymologically, "diaspora" derives from Greek *dia* ('through') and *speirein* ('to sow, scatter'). The word is used more broadly to refer to the cultural connections maintained by a group of people who have been dispersed or who have migrated around the globe. Each distinct "diasporic group" or "community" is a composite of many journeys to different parts of the world, occurring over very different timescales. The experiences of particular subgroups can therefore vary considerably—to the extent that some writers argue it is meaningless to talk of shared identities and experiences of, for example, "the South Asian diaspora," at the global level. Avtar Brah's book *Cartographies of Diaspora* provides a detailed discussion of the complex history and uses of the concept.

A key characteristic of diasporas is that a strong sense of connection to a homeland is maintained through cultural practices and ways of life. As Brah reminds us, this "homeland" might be imaginary rather than real, and its existence need not be tied to any desire to "return" home. The maintenance of these kinds of cultural connections can in some cases provoke both nostalgic and separatist tendencies. The focus here is on the place of cooking and eating among the enduring habits, rituals, and everyday practices that are collectively used to sustain a shared sense of diasporic cultural identity, in recognition that culinary culture has an important part to play in diasporic identifications.

Diasporic Foodscapes

Among the everyday cultural practices routinely used to maintain (and in some cases enhance or even reinvent) diasporic identities, food is commonly of central importance. There are a number of reasons for this. First, food traditions and habits are comparatively portable: groups that migrate around the world often carry with them elements of the diet and eating habits of the "homeland." Indeed, the migrations of foods can be used to track the past movements of people, a cornerstone of research into foodways and foodscapes. Every nation's diet therefore bears the imprint of countless past immigrations. Second, foodways are adaptable: While migrations can map the movements of ingredients, foodstuffs, or methods of preparation into new habitats unchanged, they also tell tales of adaptation, substitution, and indigenization. As people and their cuisines move, they also change to suit local conditions. Ghassan Hage's research with Lebanese migrants in Australia provides a simple illustration. In his essay "At Home in the Entrails of the West," based on interviews with Lebanese migrants to the Parramatta area of Sydney, Hage reports on this process of adaptation and substitution. One of his respondents talks about using peanut butter in Lebanese dishes in place of tahini, which was not at the time available in Australia. (In fact, when tahini later became available, the respondent admits to craving peanut butter.) Over time, this reshaping of ingredients and cooking methods often leads to a reshaping of diasporic culinary cultures, such that the dishes sometimes bear little resemblance to the original version. Comparing the same dishes among diasporic groups in different countries (say, the Chinese in the United States and in the United Kingdom) makes this clear, as does comparing diasporic versions of dishes with those served "back home."

This mobility and adaptability assures that food habits are usually maintained (even while they are transformed) among diasporic groups. Occasionally entire culinary cultures may be preserved. More often, "traditional" foods are maintained only in particular symbolic meals or dishes. For example, the small community of Russian Molokans in the United States perpetuates the rituals of preparing and sharing formal community dinners, or *obedy* (as reported by Willard B. Moore in "Metaphor and Changing Reality"). Alternatively, a particular dish can be singled out as embodying and preserving diasporic identity, as in the case of the *ghormeh-sabzi*, a stew eaten by Iranian immigrants in central England. This dish has particular significance as a way to reconnect with Iranian culture, tradition, and beliefs. A detailed discussion of the place of *ghormeh-sabzi* can be found in Lynn Harbottle's essay, "'Bastard' Chicken or *Ghormeh-sabzi?*" Harbottle's respondents report that they had to make compromises in their families' diets, allowing some Western dishes onto the table, even though they were generally wary of losing their cultural identity through Westernization. However, they expressed health concerns about the inferiority of the food in England compared with their diet back in Iran, and were keen to maintain the cultural and religious significance of food habits and pass them on to future generations. (These habits were mainly connected with their Shi'ite faith and the consumption of *halal* ingredients in accordance with Islamic dietary law.) In some cases, this led to the transformation of some staples of contemporary English cuisine, such as pizza or burgers, to realign them with Shi'ite custom. The diasporic transformation of diet is, therefore, a two-way process.

In fact, the arrival of diasporic foodways can more broadly transform the "host culture" into which migrants move. In Britain, for example, the migration of South Asian peoples has brought with it a variety of "immigrant" cuisines. While these were maintained initially for the migrant communities as a reminder of "home," their popularity among non-Asian Britons is longstanding and has continued to grow. Certain indigenized dishes, such as chicken *tikka massala*, are among the most enthusiastically and widely eaten meals in Britain today. (This, of course, need not signal comfortable race relations away from the table; see Uma Narayan's essay on Indian food in the West, "Eating Cultures.")

Diasporic Dilemmas

It would be wrong to simply equate the popularity of chicken *tikka massala* in Britain with the comfortable accommodation of South Asian migrants into a commonly shared and widely adopted multicultural identity. This is one of Hage's main points: the adoption of diasporic cuisines by host cultures often does little to encourage other forms of productive encounter between different ethnic groups. In fact, for Hage, the availability of diasporic foodstuffs permits a lazy "cosmo-multiculturalism," in which eating foreign dishes substitutes for other forms of engagement. Moreover, the necessity of maintaining "exotic" foodways can produce a distinct diasporic burden, fixing migrant culinary cultures rather than allowing them to change. There is, therefore, a set of ethical questions attached to the existence of diasporic foodscapes: For whom are they produced? What are their outcomes and effects? What alternatives might be suggested?

Two discussions can serve as illustrations of this dilemma. The first focuses on the role of the *döner kebap* among Turkish "economic migrants" in Germany. In his essay "*McDöner*," Ayse Caglar traces the ways in which the symbolic meaning of the *döner* has shifted over time. He notes its immense popularity in Germany, and reminds us that the dish was invented for non-Turkish Germans and does not exist in Turkey in the form it is now served—as a fast food consisting of meat slices in *pide* (Turkish flatbread), garnished with salad and sauces, bought on the street from an *Imbiss* (mobile stand). Moreover, the vast majority of *döners* are eaten by non-Turkish Germans. Back in the 1960s, *döner* vendors traded heavily on the ethnic exoticness or Turkishness of the *döner*, but since the early 1990s the food has been increasingly deracialized, shedding its ethnic signifiers and in many cases being rebranded using American symbols—hence the "*McDöner*" of Caglar's title. This shift, Caglar explains, mirrored the mounting social marginalization of Turks in Germany.

In the case of the *döner kebap*, then, we can witness the "invention" of a food symbolic of ethnic identity, though in this case (unlike the Iranian *ghormeh-sabzi*) the food is largely consumed by the "host culture" rather than by the immigrants. The "ethnic" markers attached to the *döner* have subsequently been shed, reflecting the shifting social position of the migrant group. As a final irony, Caglar notes that successful Turkish caterers in Germany have switched to serving Italian food to a more upmarket clientele.

A second example is provided by David Parker, in an essay called "The Chinese Takeaway and the Diasporic Habitus." Like the indigenized Indian curry house (a key provider of chicken *tikka massala*), the Chinese takeaway (takeout shop or restaurant) has come to occupy a particular symbolic location on the British culinary landscape. However, foods from the South and East Asian subcontinents are available through all kinds of other food outlets, from supermarkets to trendy eateries. Moreover, food is only one cultural product used in diasporic identifications; the development of distinct "ethnic quarters" such as Chinatowns in many cities testifies to a broader-based cultural infrastructure. For critics, the existence of such "ethnic quarters" merely furthers the economic exploitation of diaspora, while for other commentators it suggests the success of multiculturalism. Food outlets are commonly center stage in these kinds of urban areas, testifying to the significance of the food distribution as a site for diasporic cultural production.

Parker reads the Chinese takeaway as a key site for the negotiation of British Chineseness in relation to the global Chinese diaspora. By focusing on the encounters between workers and customers, Parker reveals a mode of interaction that he names the "diasporic habitus," defined as "the embodied subjectivities poised between the legacies of the past, the imperatives of the present, and the possibilities of the future" (p. 75). This habitus shapes ways of "being Chinese" in diasporic contexts, and is the result of the uneven distribution of "imperial capital" between Chinese and non-Chinese Britons: what occurs in the takeaway bears the enduring imprint of colonial contact between Western and non-Western peoples. Parker shows not only how these encounters are overlaid by orientalist racialization, but also how this "contact zone" offers critical possibilities. Parker argues (like Hage) for a contested (instead of celebratory) multiculturalism that explores the complex interplay of identities in everyday locations. The takeaway, therefore, is an emblem of British Chineseness rather than Chineseness—a situational outcome of one particular diasporic foodscape.

Of course, the notion of British Chineseness still retains an emphasis on being (at least in part) Chinese, rather than simply British. This is part of the diasporic burden mentioned earlier: the necessity of retaining some degree of ethnic difference. In some cases, of course, migrant groups may wish to reject, either partially or wholly, their ethnic identity, and adopt the identity of their new "home." They may, however, be denied that possibility by the "host culture," which wants to preserve their ethnic identity for a variety of reasons. The deracializing of *döner kebap* illustrates an attempt by German Turks to integrate more fully into German society at the same time that the ethnic marker of Turkishness was becoming increasingly problematic there.

The existence of diasporic cuisine marks a complex negotiation between cultural identities. For both German Turks and British Chinese, elements of their cuisines (or "invented" versions of them) have become institutionalized on the foodscape. While this may provide some level of economic security—the "success" of Chinese takeaways in Britain is often reported as evidence for multiculturalism, at least in terms of business culture—there are many compromises and dilemmas involved as well. As the *döner Imbiss* and the Chinese takeaway both illustrate, mundane yet intensely symbolic items such as food are woven in complex and shifting ways into discourses of tradition and transformation, identity, and community. Diasporic diets, like all aspects of diasporic identity and culture, are constantly remade, even while some key elements endure over time.

See also **Judaism**; **Travel**; **United States: Ethnic Cuisines**.

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DIETARY ASSESSMENT. Dietary assessment is the process of evaluating what people eat by using one or several intake indicators. It is the best approach for identifying nutrients that are likely to either be under- or overconsumed by the individual or groups of interest. It also can be used to identify food patterns and preferences.

Dietary Status versus Nutritional Status

Dietary status is related to but not necessarily reflective of nutritional status. Nutritional status is a more comprehensive term, referring to health status as it is affected by nutrition. It is measured not only by assessing dietary status, but also by anthropometric, biochemical, and clinical measures. Because dietary methods are less invasive, somewhat easier to obtain than other physiological measures, and do not require medical training, they often are used initially for assessing nutritional inadequacy or excess. Physiological measurements are then used to confirm and corroborate dietary intake evaluation and to arrive at definitive assessments of nutritional status.

Tools and Standards for Assessment

To assess dietary intake, food composition tables for translating foods consumed into nutrients, and a reference against which dietary intakes may be compared, are needed. These tools have been updated and refined periodically and appropriate ways for applying them to assessment tasks are steadily clarified.

Overcoming Imperfections in Assessing Dietary Intake

All dietary assessment methods are imperfect, regardless of how well they are designed. Their major shortcomings and measures for dealing with the imperfections are described briefly below.

Capture Actual Intakes

The various methods for assessing dietary intake are summarized in Table 1 and elsewhere in detail (Dwyer, 1999). All assessment methods fail to capture actual energy intakes precisely and probably intakes of nutrients as well. Some of the errors are inevitable because human beings tend to misreport their food intakes, but the method used also influences assessment outcomes.

Dietary intake is sometimes assessed by an objective observer rather than by the eaters themselves. For example, the intake of a hospitalized patient often is assessed from measured differences of the food served to a patient less any unconsumed amounts. Such objective methods have the advantage of being less subject to reporting biases than those that rely solely on recall. However, more objective methods are time-consuming, costly, cannot usually be employed to assess typical intake, and fail to record all intake. Moreover, they may not reflect what people really eat, since people may eat differently when they know that they are being observed. For these reasons, most commonly used dietary assessment methods rely on eaters' self-reported intakes.

Most methods such as twenty-four-hour recalls, food records, and diaries underreport actual energy intake by at least 20 percent. Underreporting errors are even higher (30 percent or more) in certain groups, such as the obese, women, and the elderly. However, they also vary among individuals in ways that are not always easily identified by demographic or other distinguishing characteristics. The causes of underreporting include forgetting, unconscious alterations in recalling foods eaten (for example, when the individual knows that he or she is being watched), attempts to please the questioner, and occasionally lack of cooperation by the subject. Nonrandom biases are difficult to deal with statistically.

Intakes obtained using semiquantitative food frequency questionnaires have other shortcomings. This method presents the respondent with a food list. These prompts may decrease forgetting, but insertions and "false memories" of foods consumed or of the consumption of socially desirable foods may be reported rather than true intakes. Semiquantitative food frequency questionnaires are too imprecise to estimate individual intakes quantitatively. Nutrient intakes from semiquantitative food frequency questionnaires usually are overestimated. They usually are adjusted statistically to obtain more accurate estimates of usual intakes. Measures of usual energy intakes for accurate groups specified by sex and age obtained by other methods or from estimates of energy outputs are used to adjust them. They are often derived by "food frequency" approaches and may be accurate enough to provide reasonable group estimates, although such measures are not sufficiently accurate for individuals. Also, precise quantification of absolute amounts (as opposed to levels of intake ranked into quartiles or quintiles) is not possible. The biases involved in food frequency questionnaires are complex, and statistical methods for obtaining valid estimates of intakes are unavailable.

Understandably, retrospective methods that rely on memory are subject to "forgetting bias." Prospective methods, which rely on reporting food intake immediately or shortly after eating, are more subject to alterations in intake due to the individual's awareness that his or her intake is being recorded. The extent to which social desirability and reporting biases intrude in the various methods is unknown, but is probably considerable.

Not all of the problems associated with misreporting can be overcome by the method of choice, but some can be minimized by selecting the appropriate tool for the task at hand.

Obtain Representative Intakes

Dietary assessments must be done frequently and randomly to reflect usual intake faithfully. This is an important shortcoming because only usual intake is

TABLE 1

Dietary assessment methods

Method	Description, advantages, and limitations of method
Retrospective Methods	
24-hour recall	Respondent recalls all foods and beverages consumed in a given 24-hour period and reports them to a trained interviewer, who probes to get additional details on portion sizes, frequency, and forgotten items. Positive aspects include low respondent burden, ease in administration, and minimization of biases associated with altering food intake because of knowledge that one is being observed. Negative aspects of the method include forgetting, deliberate misreporting, need for a trained observer to administer, need for several days of intakes to obtain estimate of usual diet, and costs associated with computerized analysis of records
Telephone recall	The respondent is contacted or instructed in advance and given instructions about estimating portion sizes and other details. Then the respondent is called by telephone and asked to report dietary intake over the past 24 hours. Probes and techniques are usually standardized to minimize reporting error. Positive aspects of the method include those listed above plus ability to obtain representative random days of intake, and decreased cost of administration. Negative aspects include inability to obtain interviews from those without telephones, and for those who find telephones difficult to use, and errors in reporting portion sizes.
Food frequency and semiquantitative food frequency questionnaire	Respondent chooses from a list of different foods or food groups usually eaten over the past month or year. The number and type of foods, and whether portion sizes are specified, varies from one questionnaire to another. Positive aspects of the method include ease of administration, low expense, less forgetting because of prompts furnished by food lists, somewhat more of an estimate of usual intake (perhaps equivalent to 2–3 days), and low costs of data analysis. Negative aspects of method include incomplete reporting of items not included in food lists, overreporting, incomplete or inaccurate response, inaccurate translation of food and food groups to nutrients, and imprecise estimates of nutrient intake
Dietary history	Respondent reports all foods and beverages consumed on a usual day to a trained interviewer. The interviewer then probes further on the frequency amount and portion size consumed. Diet diaries are sometimes used to assist respondents in recalling their intakes. Positive aspects of the method are that respondent burden is low and complete intakes are provided. Negatives include high cost, need for trained interviewers, and lack of standardization
Prospective Methods	
Weighed food record	After being instructed, respondent weighs all food and drink consumed on a small weighing scale and reports it on a record that is kept as close to the time of consumption as possible. If observers are available, they can carry out the weighing themselves. Positive aspects of the method are lack of forgetting bias, and ability to obtain random days of intake. Negatives include high respondent burden, refusal to record intakes, need for an expert observer to review and clarify intakes reported, tendency of respondents to alter food intake when they know they are under observation, and costs of data analysis.
Food diary	The respondent records all foods consumed in household measures, usually without measuring them, or only measuring foods that are particularly difficult to estimate. Positive aspects are same as food records but respondent burden is less. Negative aspects are that more errors in estimation of portion size may occur
Duplicate portion analysis	An observer takes duplicate portions of all foods consumed by the individual and weighs or measures them; in some cases, these may also be chemically analyzed. Positive aspects are similar to food records. Negative aspects are lack of respondent cooperation, need for trained observers, cost of food analysis, and inability to obtain estimate of usual intake.
Other: Direct observation by trained observers or by videotaping subjects	Observer records or watches food intake in a controlled or highly supervised environment in which it is possible to videotape or directly observe food intakes. Positive aspects of the methods are that they do not rely on respondent burden. Negative aspects are that the methods are usually too imprecise for obtaining valid estimates of individual intakes.

correlated with nutritional status. A representative sample of randomly chosen days that includes both weekdays and weekends is best for obtaining accurate twenty-four-hour recalls or records. Semiquantitative or other food frequency questionnaires also may assist in providing information on usual food intake patterns.

Obtain Total Intakes

Many foods and beverages are fortified with nutrients, and a substantial proportion of the population takes nutrient supplements on a regular basis. For some individuals, these nutrient sources contribute a substantial amount of vitamins and minerals. Nutrient intakes from all sources, including foods and beverages, fortified foods, and nutrient supplements must be included in all dietary assessments. If only food sources are queried, this fact should be noted.

Use Complete Food Composition Tables

Once food intakes are obtained, these must be translated into nutrients using food, beverage, and supplement composition tables. Accurate nutrient intakes can be obtained if up-to-date and complete food composition tables are available; that is, the composition of fortified foods, nutrient supplements, and beverages must be included and tables must be complete for all nutrients and other bioactive substances of interest.

Appropriate References

Estimated nutrient intakes must be compared with appropriate references; in the United States and Canada, these are the Dietary Reference Intakes, or DRIs. Their use in dietary assessments is the subject of a recent report (*Dietary Reference Intakes*, 2000).

Inadequacies, Excesses, and Imbalances May Coexist

In the past, dietary assessments focused on dietary inadequacies. Although these are still relevant, nutrient excesses and imbalances of nutrients also are of concern in most Western countries, and therefore also must be considered. Several of the DRIs are helpful in these respects. DRIs for macronutrients will be published in the near future.

Appropriate Interpretation of Assessment Results

The estimated average requirement, or EAR, is the nutrient intake estimated to meet the requirement of half the healthy individuals in a particular life stage or gender group. The recommended dietary allowance, or RDA, is the average daily dietary intake that suffices to meet the nutrient requirement of nearly all (97–98 percent) healthy individuals in a particular life stage and gender group. The adequate intake, or AI, is a recommended intake based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of healthy people whose intakes are assumed to be adequate. The AI is used when an RDA cannot be determined. When the AI's are not based on mean intakes of healthy populations, these values are likely to be less accurate. The tolerable upper intake level (UL) is the highest usual daily nutrient intake likely to pose no risk of adverse health effects to almost all individuals in the general population. As intakes increase above the UL, the risks of adverse effects also increase. The assessment of dietary adequacy is imprecise. A specific individual's actual requirement for a specific nutrient generally is never known. Second, often the number of days that intakes are measured are likely to be insufficient to overcome errors in measuring intake and normal day-to-day variation. Although dietary data alone are not sufficient to assess nutritional status, intakes of individuals can be compared to certain of the DRIs. A usual intake based on a large number of days that is at or above the RDA or AI has a low probability of inadequacy. An intake above the UL places an individual at risk of adverse effects from excessive nutrient intakes. When observed intakes are habitually below the EAR, increased intakes usually are needed because the probability of adequacy is 50 percent or less. Habitual intakes between the EAR and the RDA also probably need to be improved because the probability of adequacy is less than 97 to 98 percent. Quantitative estimates of risk of inadequacy are more difficult to obtain. However, they can be calculated using methods described in a recent report (*Dietary Reference Intakes*, 2000).

The DRIs also are used to assess the dietary intake of groups. These assessments determine the percentage of individuals whose intakes are estimated to be inadequate. The EAR is used to estimate the prevalence of inadequate intakes within a group. A mean usual group intake at or above the AI implies a low prevalence of inadequate intakes. The UL is used to estimate the percentage of the population at risk of adverse effects from excessive intakes consumed on a chronic basis. Thus, the RDA is not used to assess nutrient intakes of groups.

Conclusions

Dietary assessment is a necessary component of nutritional status assessment of individuals, and also is useful for other purposes. It can be done using a variety of methods, each of which has advantages and limitations. However, regardless of which method is chosen, it is important that certain criteria be met. Intake from all sources (food, fortified food, beverages, and nutrient supplements) must be included. Sufficient numbers of days to represent usual intakes must be obtained. Complete food and supplement composition tables must be employed. Appropriate reference standards and statistical procedures for assessing intakes must be used. Dietary assessment methods work best in combination with other methods for the assessment of nutritional status.

See also **Dietary Guidelines; Nutrition.**

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DIETARY GUIDELINES. The 1969 White House Conference on Food, Nutrition, and Health was instrumental in the development of the first set of U.S. dietary guidelines. Specific recommendations emerged out of this conference, which advocated that the government examine more closely the links between diet and chronic disease. The 1969 conference was followed in 1977 by the release of the U.S. Senate Dietary Goals, which summarized specific recommendations for the American diet.

The dietary guidelines are the cornerstone of the federal nutrition policy for the U.S. nutrition programs; thus programs such as food stamps, school lunch/school breakfast, and WIC use the dietary guidelines in developing program services. In addition, all nutrition education programs at the federal level must have messages that are consistent with the dietary guidelines. Thus the impact of the dietary guidelines is wide-ranging. It is estimated that one of every five Americans participates in at least one federal nutrition program.

History of the Dietary Guidelines for Americans

The Dietary Guidelines attempt to answer the question, "What should Americans eat to stay healthy?" Specifically, the dietary guidelines provide advice for healthy Americans aged two years and older about food choices that promote health and reduce the risk of disease.

The Dietary Guidelines were first developed in 1980 and have been updated every five years since then—1985, 1990, 1995, and 2000. The National Nutrition Monitoring and Related Research Act of 1990 requires the Secretary of Agriculture and Secretary of Health and Human Services (HHS) to publish jointly every five years a report entitled *Dietary Guidelines for Americans*. The report must contain nutrition and dietary information and guidelines for the general public; be based on the preponderance of scientific and medical knowledge current at the time of publication; and be prompted by each federal agency in carrying out federal food, nutrition, or health programs. The 1995 Dietary Guidelines were the first to be statutorily mandated by the U.S. Congress.

Since 1985, USDA and the Department of Health and Human Services have used essentially the same process to prepare the dietary guidelines. An external Dietary Guidelines Advisory Committee (DGAC) has been appointed by the two secretaries to review and revise as necessary the guidelines. The members of the DGAC are widely recognized nutrition and medical experts. A series of public meetings are held to review and discuss the guidelines. Upon completion of the DGAC process, a technical report is sent to the two secretaries and reviewed within the two departments. In addition, in both 1995 and 2000, consumer research was conducted to test consumer reaction to specific design and content elements of the technical report. The consumer research is also used as one element in promoting the dietary guidelines.

Elements of the Dietary Guidelines

Between 1980 and 1995, the dietary guidelines were relatively stable (Table 1), maintaining seven guidelines. However, the 1995 guidelines reflected some exciting and important changes. More so than ever before, they put an emphasis on total diet; the wording in the 1995 guidelines moved away from individual foods in the direction of a total diet based on variety, moderation, and proportionality. The concept of total diet is reflected symbolically through the graphic of the 1995 Dietary Guidelines bulletin that links all seven guidelines together, anchored around the admonition to "Eat a variety of foods."

In the 1995 guideline on variety, the bulletin stresses a total diet rather than an individual food approach to healthy eating. The recommendation is to choose foods from each of the five major food groups in the Food Guide Pyramid. Also an emphasis is placed on foods from the base of the pyramid (grains) to form the center of the plate accompanied by food from other food groups.

For the first time, the dietary guidelines in 1995 recognized that with careful planning, a vegetarian diet can be consistent with the dietary guidelines and the Recommended Dietary Allowances. The guidelines also present a clear message that food sources of nutrients are preferred to supplements. This "food first" strategy is reinforced by a discussion of other healthful substances present in food, but not in dietary supplements. However, the 1995 guidelines do provide specific examples of situations where dietary supplements may be needed.

The 1995 guidelines also moved more forcefully in the direction of providing a discussion of the direct link between diet and health. Weight gain with age was discouraged for adults. Weight maintenance is encouraged as a first step to achieving a healthy weight. The benefits of physical activity are emphasized. And for the first time, a statement was included on the benefits of moderate alcohol in reducing the risk of heart disease. On this later point, both HHS and USDA were clear that the alcohol guideline was not intended to recommend that people start drinking.

In the 1995 guidelines there was also direct reference to the nutrition education tools that could be used to promote the dietary guidelines. The guidelines explain how consumers can use the three "crown jewels" to build a healthy diet: the Dietary Guidelines, the Food Guide Pyramid, and the Nutrition Facts Label.

The Dietary Guidelines 2000, released by President Bill Clinton in May 2000, break with the tradition of seven guidelines and now include ten separate guidelines. Not only do the Dietary Guidelines 2000 continue to emphasize a total diet approach, they also emphasize a healthy lifestyle. This is reflected clearly in three new concepts that are used as organizing principles for the 2000 Guidelines: "Aim for fitness," "Build a healthy base," "Choose sensibly."

TABLE 1

Dietary guidelines for Americans, 1980 to 2000

1980 7 Guidelines	1985 7 Guidelines	1990 7 Guidelines	1995 7 Guidelines	2000 10 Guidelines
Eat a variety of foods	Eat a variety of foods	Eat a variety of foods	Eat a variety of foods	Let the Pyramid guide your food choices
Maintain ideal weight	Maintain desirable weight	Maintain healthy weight	Balance the food you eat with physical activity—maintain or improve your weight	Aim for a healthy weight
Avoid too much fat, saturated fat, and cholesterol	Avoid too much fat, saturated fat, and cholesterol	Choose a diet low in fat, saturated fat, and cholesterol	Choose a diet low in fat, saturated fat, and cholesterol	Choose a diet that is low in saturated fat and cholesterol and moderate in total fat
Eat foods with adequate starch and fiber and fruits and vegetables	Eat foods with adequate starch and fiber and fruits and vegetables	Choose a diet with plenty of grain, fruit, and vegetable products	Choose a diet with plenty of grain, fruit, and vegetable products	Eat a variety of grains daily, including whole grains Eat a variety of fruits and vegetables daily
Avoid too much sugar	Avoid too much sugar	Use sugars only in moderation	Choose a diet moderate in sugars	Choose beverages and foods to moderate your intake of sugars
Avoid too much sodium	Avoid too much sodium	Use salt and sodium only in moderation	Choose a diet moderate in salt and sodium	Choose and prepare foods with less salt
If you drink alcohol, do so in moderation	If you drink alcoholic beverages, do so in moderation	If you drink alcoholic beverages, do so in moderation	If you drink alcoholic beverages, do so in moderation	If you drink alcoholic beverages, do so in moderation
				Keep food safe to eat
				Be physically active each day

There is now a separate guideline for physical activity that states, “Be physically active every day.” In addition to helping to maintain a healthy weight, this guideline also discusses the other health benefits of physical activity. Specific quantitative recommendations are given for amount of physical activity for adults (30 minutes or more) and children (60 minutes or more) per day. For the first time ever there is now a guideline on food safety. Again, this reinforces components of a healthy diet and healthy lifesyle.

The consumer research that was conducted as part of the Dietary Guidelines 2000 process influenced the development of the guidelines. One clear message is that consumers preferred simple, action-oriented guidelines. Thus the guidelines themselves are much more direct and action-oriented as evidenced by: “Aim for a healthy weight!” or “Keep foods safe to eat.”

The guidelines are more consumer-friendly and emphasize practical ways in which consumers can put the concepts into practice. To that end, sections entitled “Advice for Today” are included at the end of each individual guideline and include suggestions on key ways to operationalize the guidelines. The consumer research on the 2000 Dietary Guidelines indicated that consumers particularly liked the Advice for Today section.

Comparison with Other Dietary Guidelines

A large number of countries—both industrialized and developing countries—have authoritative sets of dietary guidelines. Despite the vastly different geographical and sociocultural contexts of the countries, there are six elements that are common to the sets of dietary guidelines that are in place. Those elements are: (1) Aim for a healthy weight; (2) Let the Food Pyramid guide your choices; (3) Eat a variety of grains daily, especially whole grains; (4) Choose a diet that is low in saturated fat and cholesterol and moderate in total fat; (5) Choose and prepare foods with less salt; (6) If you drink alcoholic beverages, do so in moderation.

A guideline on variety is common, and is often the core element used to reflect the concepts of dietary diversity. The variety ranges from general statements such as, “Eat a variety of foods,” to a very specific quantification, as found in the Japanese guideline, which states that, to obtain well-balanced nutrition with a variety of foods, one should eat thirty foodstuffs a day.

Many of the country-specific dietary guidelines emphasize limiting or moderating total fat and saturated fat intake. Where there is a quantification of limits, this is most commonly a diet containing no more than 30 percent of total energy from fat and less than 10 percent of energy from saturated fat.

Countries typically also include a weight guideline, which emphasizes very clearly the maintenance or achievement of a healthy weight; in the French guideline, there is more specificity indicating individuals should weigh themselves monthly. Most of the dietary guidelines worldwide promote a plant-based diet as the building block of healthful eating. To that end, many countries emphasize grains as the basis of good diet. Reduction of salt and/or sodium is emphasized in a number of the sets of dietary guidelines.

Finally, the issue of alcohol consumption is addressed in many sets of dietary guidelines. There is always a level of caution related to the role of alcohol as part of a healthy diet. The 2000 dietary guidelines for Americans, as an example, indicate that benefits of alcohol in reducing the risk of heart disease can be achieved in other ways, such as maintaining a healthy weight, cessation of smoking, increasing physical activity, and reducing the level of fat and saturated fat in the diet. Indeed, countries like Venezuela go even further and specify: "Alcoholic beverages are not part of a healthy diet" (14).

Comparison with Disease-Specific Guidelines

A number of professional associations such as the American Heart Association (AHA) and American Cancer Society (ACA) have developed sets of dietary guidelines. Clearly the AHA and ACS have somewhat different objectives in developing their specific sets of guidelines; the American Heart Association guidelines put forward recommendations for a healthful diet, which if followed, reduces the risk of heart disease. Similarly, recommendations from the American Cancer Association are for dietary guidelines which, if followed, reduce the risk of cancer. Given the somewhat different objectives, there is a remarkable degree of similarity in the three sets of guidelines. Here again, the USDA/HHS, the AHA, and the ACA each recommend dietary guidelines related to weight, total saturated fat, salt, and alcohol in moderation as the basis of a healthful diet.

Guidelines for Children under Age Two

A limited number of countries have some parts of their food-based guidelines devoted to children less than two years of age. In most cases, the advice relates to a discussion of breast-feeding. Australia, for example, states: "Encourage and support breast-feeding." There is similar wording in guidelines from the Philippines and Singapore.

Most industrialized countries rely on national pediatric associations to guide the broad policy recommendations for infant feeding and/or feeding practices for the first two years of life. In almost all cases advice from pediatric associations stresses that human milk is the preferred form of infant feeding.

In devising food-based dietary guidelines for children under two, there is a clear need to segment this group of children by age groups: birth to 6 months, 6 to 12 months, and 13 to 24 months.

Future Directions

Worldwide major improvements in public health will be accomplished by an improvement in dietary patterns. Food-based dietary guidelines have been developed in a broad range of countries. A move toward consensus on food-based dietary guidelines is a practical way to develop core elements of global dietary guidelines that can be effectively promoted by individual countries as well as international health organizations.

See also **Body Composition; Eating: Anatomy and Physiology of Eating; Food Stamps; Government Agencies, U.S.; Nutrients; Nutrition; Nutrition Transition: Worldwide Diet Change; School Meals; WIC (Women, Infants, and Children's Program).**

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Eileen Kennedy

DIETARY SYSTEMS: A HISTORICAL PERSPECTIVE. The urge to classify foods and frame complex dietary laws is as old as civilization itself, if not older. Most dietary systems around the world are explicitly religious. But some dietary systems that arose were more secular in nature; their ultimate goal was to maintain or restore physical health. The most influential of these were produced in Greece, India, China, and the modern West.

The superficial similarity of the ancient systems may have arisen from a common prehistoric root, or they may have influenced each other across trade routes. Separate civilizations also may have arrived at similar ways of describing physiologic functions because some human experiences are universal. The fact that most of these systems assess food qualitatively, using descriptive terms such as hot, cold, moist, and dry, appears to be coincidental. They do not understand or apply these terms in the same way.

Greece

The Greek dietary tradition stems ultimately from the body of writings attributed to Hippocrates of Cos. Dietary regimen in all these works was considered the most important way to prevent and cure disease, but the concept of diet encompassed much more than food intake. It also considered air quality, exercise, sexual activity, emotions, and the elimination of waste products. Although a fully elaborated theory of the four humors was not yet in place among the Hippocratic writers, in later years and especially in the writings of Galen of Pergamum it came to be the cornerstone of this system. Just as four elements were considered the building blocks of all physical matter, so four basic regulatory fluids were believed to control the human body. These are blood, phlegm, choler, and black bile or melancholy. Each in turn was described as hot and moist, cold and moist, hot and dry, or cold and dry, respectively. Every individual is born with a tendency for one humor to predominate, sometimes excessively so. This was called the complexion, which also was considered affected by age, gender, and a variety of external factors.

The Greeks also classified foods according to their propensity to increase particular humors in the body. Thus cucumbers were considered cold and moist, spices hot and dry. In a body with an abundance or plethora of any given humor, a food or medicine of the opposite quality would act as a corrective. This therefore was an allopathic system that corrected with opposites. The Greeks also were intensely conscious of the texture and consistency of food and how easily it might be broken down and passed through the body.

The Greek system was elaborated upon in several succeeding civilizations, the most important of which were the Byzantine Empire; the Muslim world, which stretched from northern India to Spain; and medieval and Renaissance Europe. Although folk beliefs in Central and South America were influenced by Hippocratic ideas introduced by the Spanish, it appears that an older native system forms the foundation of ideas there.

India

Ayurvedic medicine is rooted in medical texts known as the *Carakha Samhita*, which may have originated before the first millennium B.C.E. but were written down much later. They include a dietary system still practiced in the twenty-first century. This system bears some similarities to the Greek system, but in practical application it is quite different. Ayurvedic physiology also begins with elements, but it recognizes five: air, fire, water, earth, and space. Each in combination with another creates what is called a *dosha*, a basic life force that governs physiologic functions but not exactly a humor. For example, space and air combine to create the *vata dosha*, which controls movements within the body, such as respiration, circulation, nerve impulses, and even ideas. Fire and water combine to form the *pitta dosha*, which is the principle of digestion and metabolism. Water and earth create the *kapha dosha*, which is the structural principle, giving solidity to the body. Too much or too little of each of these forces causes illness. The key here is a balance. As in the West, individuals are presumed to be born with a certain predilection toward an excess of one *dosha*. This is the *prakriti*, comparable to the concept of complexion in the West.

Just as in the Western system, foods and medicines can increase or decrease the power of any one of the *doshas*. For example, a weak digestion *(pitta)* is improved by heating the body with spicy foods, while an excess of *pitta* causes inflammation and dehydration and is corrected with foods that moisten the body. A weak *kapha dosha* leads to brittle bones and joints, so solid foods that strengthen the body are required.

Another concept in this system is that of the *ojas*, a form of vital energy that supports the immune system. *Ojas* can be increased by meditation and moderate eating but also with special substances like ghee or saffron. Foods also are classified according to their specific virtues or *gunas*, twenty in total, which assign foods values, such as cold or hot, soft or hard, oily or dry, heavy or light, dull or sharp, solid or liquid. All these terms reflect how food behaves in the body. With an excess of hot *pitta* (digestion), a cold food would be prescribed. With an excess of *vata* (transport), something heavy or dry would be corrective. Like the Greek system, this one is allopathic.

China

Another major system arose in ancient China, and it too was based on a revered text, in this case *The Yellow Emperor's Classic of Internal Medicine*, composed by one of the so-called celestial emperors, Huang-ti. Probably it was written during the Han dynasty and thus is roughly contemporaneous with the other systems. The first important concept in this system is *qi*, translated as energy, life force, or spirit. *Qi* supports life and helps fight off malign external influences. It also flows through the entire universe, so the individual microcosm is linked to the macrocosm. Health results when the two are in harmony, as do prosperity, peace, and good crops.

The central governing principle in the Chinese system is the opposition of two basic universal forces, yin and yang. Yin is female, dark, cold, soft, empty, night. Yang is male, light, warm, firm, full, day. Universal as well as physical harmony depends on a balance of these two forces. In addition, phases or processes of transformation in nature, not exactly elements as building blocks of nature, exist. Here too are five: earth, fire, wood, metal, and water. As processes of change, they govern, for example, generation. Water makes trees grow, wood burned creates fire, fire creates ash. Earth is the source of metals, and metals flow like water when heated.

All physiological functions can be described in terms of these transformations, like breaking down and processing foods. Specific foods or drugs aid a particular process, build up good *qi*, or promote the flow of *qi* through the body, as does acupuncture. Just as in the other systems, this is a holistic medicine that takes into account exercise, air quality, sleep patterns, sexual activity, and of course diet to keep the yin and yang forces in balance, the *qi* flowing, and physiological transformations in good order. The idea that certain foods are heating, cooling, drying, or moistening appears to have been imported from India around the sixth century C.E.

The Modern West

The modern concept of diet is much narrower than in the ancient systems, for it is concerned merely with food intake, calories, vitamins, and the like. Little consideration is given to the holistic aspect of living in harmony with external influences. Diet is not carefully prescribed according to the individual's unique complexion and habits. Calorie needs are defined by the rate at which energy is expended. All bodies are assumed to require the same nutrients of a specified range to allow for genetic and other sources of variation. This line of reasoning stems from envisioning the body as an engine fueled by food, a concept that arose in the nineteenth century following the research of the chemist Antoine-Laurent Lavoisier and later of Justus von Liebig. Only with the discovery of vitamins in the early twentieth century was this transformation complete. The concept of diet also was defined more narrowly as food intake or as a strict regimen intended to promote weight loss.

See also **Calorie**; **China: Ancient and Dynastic China; Dietetics; Greece, Ancient; Indus Valley; Nutrition Transition: Worldwide Diet Change.**

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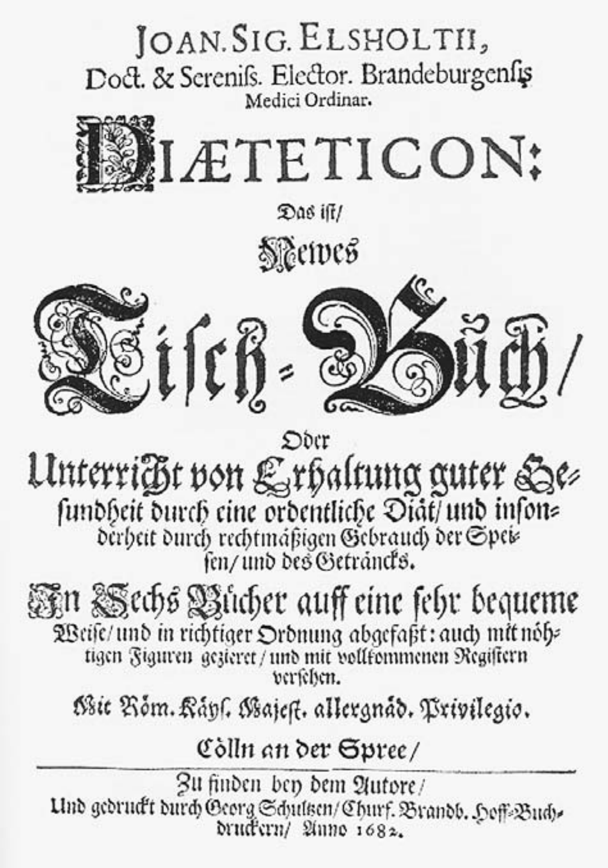
Ken Albala

DIETETICS. Dietetics is the integration and application of principles derived from several disciplines—including nutrition, biochemistry, physiology, food science and composition, management, food service, and the behavioral and social sciences—to achieve and optimize human health. Dietetic professionals translate the scientific evidence regarding human nutrition and use that information to help shape the food intake or choices of the public (ADA, 2002).

Dietetic professionals work with individuals and groups of all ages to assess nutritional health and provide recommendations and therapies to assist individuals, groups, and populations in achieving a diet based on scientific evidence. The diet is generally a variety of foods but may include supplements and tube or parenteral feedings. Nutrient needs vary based on age, genetics, body composition, health status, and lifestyle. Dietetic professionals specialize in different aspects of care: They serve as translators of nutrition science to the public, as specialists in business and industry, as advocates to change food policy, as managers of food operations, as educators and researchers, and as clinicians in many different settings.

Education of Dietetic Practitioners

The majority of dietetics professionals are registered dietitians (R.D.s) and members of the American Dietetic Association. These individuals have various job titles including but not limited to dietitian, nutritionist, medical nutrition therapist, food service director, and public health or community nutritionist. The R.D. signifies that the individual has completed an academic education leading to at least a B.S. in dietetics, with coursework in



JOAN. SIG. ELSHOLTII,
Doct. & Sereniſs. Elector. Brandeburgenſis
Medici Ordinar.
DIÆTETICON:
Das iſt/
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Unterricht von Erhaltung guter Ge-
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In Sechs Bůcher auff eine ſehr bequeme
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druckern/ Anno 1682.

The 1682 *Diaeteticon* of Prussian physician Johann Sigismund Elsholtz (1623–1688) was one of the first medico-culinary works to treat the subject of dietary regulation and health, thus foreshadowing modern dietetics. ROUGHWOOD COLLECTION.

nutrition, social sciences, biological sciences, and food science, along with a planned clinical experience conducted under supervision for at least six months, and has passed a national credentialing examination. The credentialing examination for the R.D. was introduced in 1969. The education and clinical experience components were first established in 1927. In 2002, about 41 percent of R.D.s had master's degrees and about 4 percent had doctorates (Bryk and Soto).

Established in the early 1980s, a two-year credential as a dietetic technician registered (D.T.R.) involves the same three-prong approach of education, experience, and examination. The D.T.R. functions clinically under the supervision of an R.D., and often manages a food-service operation. The D.T.R. has a more limited scientific education, but has similar management skills. The accreditation of entry-level dietetics programs is done by the Commission on Accreditation for Dietetic Education, and the credentialing is under the Commission on Dietetic Registration. In 2002 there were about 75,000 R.D.s or D.T.R.s in the United States.

The Evolution of Dietetic Professionals

The American Dietetic Association was founded in 1917. Its immediate goal was to assist in the feeding of World War I soldiers and to "benefit as many as possible." At that time, preventing deficiencies and providing enough food to support health were key goals. The feeding of institutionalized patients in hospitals and sanitariums quickly followed, as well as the provision of diet therapy for conditions such as diabetes mellitus and nephritis. In the 1940s, recommended dietary allowances (RDAs) were introduced, setting a standard in gauging what to feed groups; the RDAs were established to feed populations, not individuals. At the same time, the role of diet therapy was expanding. By the 1960s, understanding of the role of nutrition in the treatment of chronic diseases such as cardiovascular disease was emerging. Dietetic professionals were designing formulas for feeding patients via tubes and evaluating the composition and consistency of commercial tube-feedings that were beginning to be introduced.

In the 1970s the role of dietetic professionals expanded to include assessing the nutritional health of hospitalized patients and recommending feeding based on this assessment. Dietetic professionals began to educate the public on the use of food labeling to encourage eating properly, and to place emphasis on the use of nutrition to prevent chronic disease. Programs such as WIC (the federal Women, Infants, and Children nutrition program) expanded the dietetic practitioners' role in women's and children's health. During the 1970s roles for dietetic practitioners diversified, with dietitians working in dialysis centers, in rehabilitation, in marketing and public relations firms, and for food companies. Within the American Dietetic Association, practice groups formed to meet needs in specialty areas, for example, taking consulting roles in long-term care facilities and nutrition support roles in hospitals. During the 1980s roles continued to expand, and specialty credentials in diabetes, nutrition support, renal care, and pediatrics were introduced. The 1990s saw an expansion into outpatient care, expanding private-practice opportunities, and a movement to cross-train and become multiskilled.

Medicare part B reimbursement for nutrition counseling of nondialysis renal patients and individuals with diabetes mellitus was introduced in January 2002. It is anticipated that reimbursement would expand to cover counseling for other conditions. Private insurance coverage for medical nutrition therapy is also increasing as proper diet and lifestyle are recognized as key elements in maintaining or enhancing the health of the American public. The role of the dietetic professional continues in managing disease, has expanded in prevention, and will expand to include forecasting disease as the impact of genetics research reaches health care. As Americans eat out more and purchase more prepared foods, the role of the dietitian in dining establishments and supermarkets should expand.

The early twenty-first century is witnessing a focus on enhancing well-being and physical strength and stamina through nutrition. The dietetics profession promotes a total-diet approach to nutrition, with balance, variety, and moderation key to successful nutrition health. The newest aspects of dietetic and nutrition counseling include functional foods (that is, foods that are modified to provide a health benefit beyond the food's traditional nutrients) to enhance health, the use of dietary supplements, and the integration of alternative products such as botanicals. Dietetic practitioners assist individuals in determining if products are beneficial, whether research has been too limited to be determinative, or if the products may in fact be detrimental. Opportunities for research on the value of these products in promoting health abound. With technological advances in data collection and storage, better analysis of dietary intakes should contribute to a better understanding of the role of nutrition in health and disease.

Summary

Dietetic practitioners translate the science of nutrition into practical applications for individuals, groups, and communities. This requires a solid foundation in cultural competency, including knowledge of food composition, preparation methods and cultural values associated with particular foods, and skills in the culinary arts as well as in nutrition, science, social sciences, management, and communications. Dietetic practitioners will continue to provide nutrition therapy to individuals and groups, manage the feeding of individuals and groups, provide public education, and contribute to research about the links between food, nutrition, and health. Dietetic practitioners have a major contribution to make in the public-policy debate on issues such as obesity and its prevention and management, hunger and its prevention, and genetic modification of foods. The role of dietetic professionals will expand as nutrition becomes a major focus in addressing health issues in the nation and the world.

See also **Dietary Assessment; Dietary Systems; Nutrition Transition: Worldwide Diet Change; WIC (Women, Infants, and Children's) Program**.

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Julie O'Sullivan Maillet

DIGESTION. Digestion can occur at many levels in the body; generally, it refers to the breakdown of macromolecules or a matrix of cells, or tissues, into smaller molecules and component parts. This particular section will focus on digestion of food in the gastrointestinal tract: the process that is required to obtain essential nutrients from the food we eat. The gastrointestinal tract (GIT) is a highly specialized organ system that allows humans to consume food in discrete meals as well as in a very diverse array of foodstuffs to meet nutrient needs. Figure 1 contains a schematic of the GIT and illustrates the organs of the body with which food comes into contact during its digestion. These organs include the mouth, esophagus, stomach, small intestine, and large intestine; in addition, the pancreas and liver secrete into the intestine. The system is connected to the vascular, lymphatic, and nervous systems; however, the function of these systems in gastrointestinal physiology is beyond the scope of this article, which focuses primarily on the process of breaking down macromolecules and the matrix of food.

Mechanical Aspects of Digestion

Food is masticated in the mouth. Chewing breaks food into smaller particles that can mix more readily with the GIT secretions. In the mouth, saliva lubricates the food bolus so that it passes readily through the esophagus to the stomach. The sensory aspects of food stimulate the flow of saliva, which not only lubricates the bolus of food but is protective and contains digestive enzymes. Swallowing is regulated by sphincter actions to move the bolus of food into the stomach. The motility of the stomach continues the process of mixing food with the digestive secretions, now including gastric juice, which contains acid and some digestive enzymes. The action of the stomach continues to break down food into smaller particles prior to passage to the intestine. The mixture of food and digestive juices is referred to as digesta, or chyme. The stomach, which after a meal may contain more than a liter of material, regulates the rate of digestion by metering chyme into the small intestine over several hours. Several factors can slow the rate of gastric emptying; for example, solids take longer to empty than liquids, mixtures relatively high in lipid take longer to empty, and viscous, or thick, mixtures take longer to empty than watery, liquid contents.

In the upper part of the small intestine, the duodenum, receptors appear to influence the rate of gastric emptying either through hormonal or neural signals. Peristaltic motor activity in the small intestine propels chyme along the length of the intestine, and segmentation allows mixing with digestive juices in the intestine, which include pancreatic enzymes, bile acids, and sloughed intestinal cells. Digestion of macronutrients, which began in the mouth, continues in the small intestine, where the intestinal surface provides an immense absorptive surface to allow absorption of digested molecules into circulation. While the intestine from the outside appears to be a tube, the lining of the inner surface contains tissue folds and villi that are lined with intestinal cells, each with microvilli, or a brush border, which greatly amplify the absorptive surface. The intestinal cells can absorb compounds by several cell membrane–mediated transport mechanisms and then transform them into compounds, or complexes, that can enter circulation through the blood, or lymphatic, system.

What is not digested and absorbed passes into the large intestine. In this organ, water and electrolytes are reabsorbed, and the movements of the large intestine allow mixing of the contents with the microflora of bacteria and other microbes that are naturally present in the large intestine. These microbes continue the process of digesting the chyme. Eventually the residue enters the rectum and the anal canal, and stool is formed, which is defecated. Transit time of a non-digestible marker from mouth to elimination in the stool varies considerably: normal transit time is typically twenty-four to thirty-six hours, but can be as long as seventy-two hours in otherwise healthy individuals.

Breakdown of Macromolecules in Foods

Foods are derived from the tissues of plants and animals as well as from various microorganisms. For absorption of nutrients from the gut to occur, the cellular and molecular structure of these tissues must be broken down. The mechanical actions of the GIT help disrupt the matrix of foods, and the macromolecules, including proteins, carbohydrates and lipids, are digested through the action of digestive enzymes. This digestion produces smaller, lower molecular weight molecules that can be transported into the intestinal cells to be processed for transport in blood, or lymph.

Proteins are polymers of amino acids that in their native structure are three-dimensional. Many cooking or processing methods denature proteins, disrupting their tertiary structure. Denaturation, which makes the peptide linkages more available to digestive enzymes, is continued in the stomach with exposure to gastric acid. In addition, digestion of the peptide chain begins in the stomach with the enzyme pepsin. Once food enters the small intestine, enzymes secreted by the pancreas continue the process of hydrolyzing the peptide chain either by cleaving amino acids from the C-terminal end, or by hydrolyzing certain peptide bonds along the protein molecule. The active forms of the pancreatic enzymes include trypsin, chymotrypsin, elastase, and carboxypeptidase A and B. This process of protein digestion produces small peptide fragments and free amino acids. The brush border surface of the small intestine contains peptidases, which continue the digestion of peptides, either to smaller peptide fragments or free amino acids, and these products are absorbed by the intestinal cells.

Carbohydrates are categorized as digestible or non-digestible. Digestible carbohydrates are the various sugar-containing molecules that can be digested by amylase or the saccharidases of the small intestine to sugars that can be absorbed from the intestine. The predominant digestible carbohydrates in foods are starch, sucrose, lactose (milk sugar), and maltose. Glycogen is a glucose polymer found in some animal tissue; its structure is similar to some forms of starch. Foods may also contain simple sugars such as glucose or fructose that do not need to be digested before absorption by the gut. Alpha amylase, which hydrolyzes the alpha one to four linkages in starch, is secreted in the mouth from salivary glands and from the pancreas into the small intestine. The action of amylase produces smaller carbohydrate segments that can be further hydrolyzed to sugars by enzymes at the brush border of the intestinal cells. This hydrolysis step is closely linked with absorption of sugars into the intestinal cells.

Non-digestible carbohydrates cannot be digested by the enzymes in the small intestine and are the primary component of dietary fiber. The most abundant polysaccharide in plant tissue is cellulose, which is a glucose polymer with beta one to four links between the sugars. Amylase, the starch-digesting enzyme of the small intestine, can only hydrolyze alpha links. The non-digestible carbohydrates also include hemicelluloses, pectins, gums, oligofructose, and inulin. While non-digestible, they do affect the digestive process because they provide bulk in the intestinal contents, hold water, can become viscous, or thick, in the intestinal contents, and delay gastric emptying. In addition, non-starch polysaccharides are the primary substrate for growth of the microorganisms in the large intestine and contribute to stool formation and laxation. Products of microbial action include ammonia, gas, and short-chain fatty acids (SCFA). SCFA are used by cells in the large intestine for energy and some appear in the circulation and can be used by other cells in the body for energy as well. Thus, while dietary fiber is classified as non-digestible carbohydrate, the eventual digestion of these polysaccharides by microbes does provide energy to the body. Current research is focused on the potential effect of SCFA on the health of the intestine and their possible role in prevention of gastrointestinal diseases.

For dietary lipids to be digested and absorbed, they must be emulsified in the aqueous environment of the intestinal contents; thus bile salts are as important as lipolytic enzymes for fat digestion and absorption. Dietary lipids include fatty acids esterified to a glycerol backbone (mono-, di- or triglycerides); phospholipids; sterols, which may be esterified; waxes; and the fat-soluble vitamins, A, D, E, and K. Digestion of triglycerides (TG), phospholipids (PL), and sterols illustrate the key factors in digestion of lipids. Lipases hydrolyze ester bonds and release fatty acids. In TG and PL, the fatty acids are esterified to a glycerol backbone, and in sterols, to a sterol nucleus such as cholesterol. Lipases that digest lipids are found in food, and are secreted in the mouth and stomach and from the pancreas into the small intestine. Lipases in food are not essential for normal fat digestion; however, lipase associated with breast milk is especially important for newborn infants. In adults the pancreatic lipase system is the most important for lipid digestion. This system involves an interaction between lipase, colipase, and bile salts that leads to rapid hydrolysis of fatty acids from TG. An important step in the process is formation of micelles, which allows the lipid aggregates to be miscible in the aqueous environment of the intestine. In mixed micelles, bile salts and PL function as emulsifying agents and are located on the surface of these spherical particles. Lipophilic compounds such as MG, DG, free sterols, and fatty acids, as well as fat-soluble vitamins, are in the core of the particle. Micelles can move lipids to the intestinal cell surface, where the lipids can be transported through the cell membrane and eventually packaged by the intestinal cells for transport in blood or lymph. Most absorbed lipid is carried in chylomicrons, large lipoproteins that appear in the blood after a meal and which are cleared rapidly in healthy individuals. Bile salts are absorbed from the lower part of the small intestine, returned to the liver, and resecreted into the intestine, a process referred to as enterohepatic circulation. It is important to note that bile salts are made from cholesterol, and drugs such as cholestyramine or diet components such as fiber that decrease the amount of bile salt reabsorbed from the intestine help to lower plasma cholesterol concentrations.

Regulation of Gastrointestinal Function

Regulation of the gastrointestinal response to a meal involves a complex set of hormone and neural interactions. The complexity of this system derives from the fact that part of the response is directed at preparing the GIT to digest and absorb the meal that has been consumed in an efficient manner and also at signaling short-term satiety so that feeding is terminated at an appropriate point. Traditionally, physiologists have viewed the regulation in three phases: cephalic, gastric, and intestinal. In the cephalic phase, the sight, smell, and taste of foods stimulates the secretion of digestive juices into the mouth, stomach, and intestine, essentially preparing these organs to digest the foods to be consumed. Experiments in which animals are sham fed so that food consumed does not actually enter the stomach or intestine demonstrate that the cephalic phase accounts for a significant portion of the secretion into the gut. The gastric and intestinal phases occur when food and its components are in direct contact with the stomach or intestine, respectively. During these phases, the distension of the organs with food as well as the specific composition of the food can stimulate a GIT response.

The GIT, the richest endocrine organ in the body, contains a vast array of peptides; however, the exact physiological function of each of these compounds has not been established. Five peptides, gastrin, cholecystokinin (CCK), secretin, gastric inhibitory peptide (GIP), and motilin are established as regulatory hormones in the GIT. Multiple aspects have been investigated to understand their release and action. For example, CCK is located in the upper small intestine; protein and fat stimulate its release from the intestine, while acid inhibits its secretion. Once released, it can inhibit gastric emptying and stimulate secretion of acid and pancreatic juice and contraction of the gall bladder. In addition, it stimulates motility and growth in the GIT and regulates food intake and insulin release. Among the other established gastrointestinal peptides, secretin stimulates secretion of fluid and bicarbonate from the pancreas, gastrin stimulates secretion in the stomach, GIP inhibits gastric acid secretion, and motilin stimulates the motility of the upper GIT. In addition to investigating the various factors causing release of these hormones and the response to them, physiologists are also interested in the interactions among hormones as well as those with the nervous system, since the response to a meal involves release of many factors.

Obtaining food and digesting it efficiently are paramount to survival. The human GIT system most likely evolved during the period when the species acquired its food primarily through hunting and gathering. The overlapping regulatory systems, combined with an elevated capacity to digest food and absorb nutrients, insured that humans used food efficiently during periods in which scarcity might occur.

See also **Eating; Intestinal Flora**; **Microbiology**.

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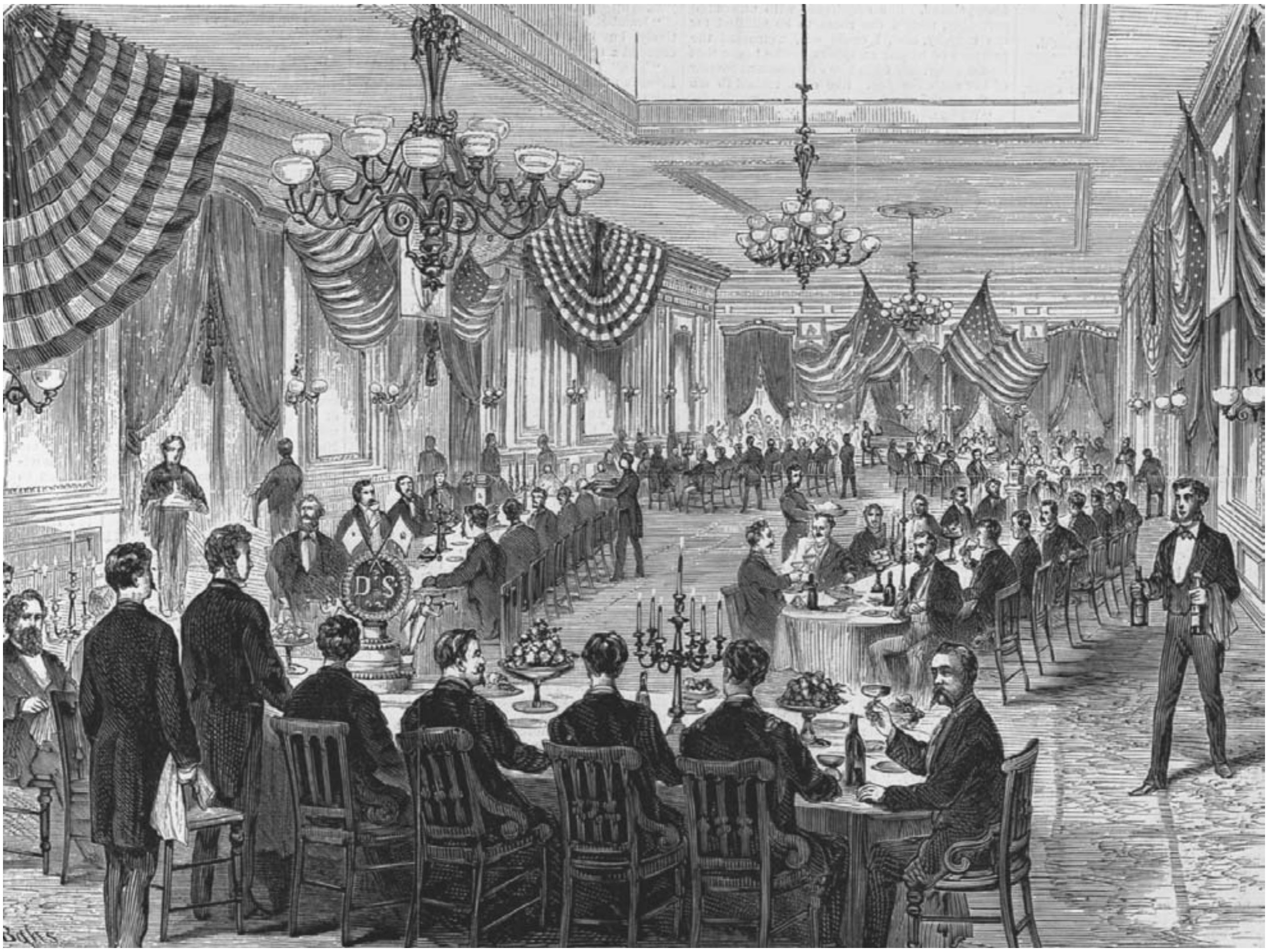
Barbara O. Schneeman

DINNER. Dinner is the important meal in the daily or another cycle of meals, typically requiring more formal culinary arrangements, table trappings, and etiquette, and probably more abundant foods and drinks. While rural households have tended to share the main daily meal during daylight hours, industrial societies have pushed dinner into the evening, thereby making this meal more important than breakfast, lunch, tea, subsequent supper, or any intervening or alternative snack. Major meals within weekly, monthly, and annual cycles are often identified as "dinner" (Sunday meals, Christmas, and Thanksgiving). However, with rites of passage, dinner's importance may be transcended by something grander: a banquet, feast, wake, or wedding breakfast.

In the West, all family members attend the conventional dinner. In religious homes, the meal may be offered with grace. In some patriarchal versions of the family dinner, the head of the family sits in a carver (chair with arms) at one end of the table while a woman (generally the wife)



A large dinner given by the Third Army Corps Union for former commander Major General D. E. Sicles at Delmonico's in New York, February 22, 1873. It was not customary in this period for women to be present at such "public" meals. FROM *FRANK LESLIE'S ILLUSTRATED NEWSPAPER,* MARCH 2, 1873. © CORBIS.

serves the meal. The household might bring out a special set of matching crockery or "dinner service," especially when guests are in attendance. A succession of courses is served that often centers on a meat dish—most impressively, turkey, prime rib, or spring lamb—and some occasions conclude with a dessert course.

Beyond immediate family gatherings, a dinner can be elaborate, involving written invitations, keen anticipation (or dread) on the part of the guests, and requiring toasts and speeches. On such formal occasions, diners wear special clothing, such as a dinner jacket or tuxedo for men. As it is maintained by dedicated food-and-wine societies, dinner extends through many courses of exquisite foods and matching drinks. Courting couples become acquainted over restaurant dinners and cook together for newly shared friends. Homecomings, departures, graduations, new jobs, business deals, and the like are ready excuses for a dinner date, often outside the home.

In the language of anthropologist Mary Douglas in her essay "Deciphering a Meal," dinner is a "stressed" event. She found her everyday, culinary pattern to be "one element stressed accompanied by two or more unstressed elements" (p. 67), that is, she cooked one main meal (dinner) and two minor meals (breakfast and lunch). Further, dinner tended to comprise one main and two minor dishes, and each dish had one centerpiece food and two accompaniments. This approach to dinner was no more than the pattern within a "certain segment of the middle classes of London" when Douglas wrote in 1972.

Meals are highly culturally variable, with one, two, three, four, or more meals per day being quite common. Meals vary considerably in timing and format, with fixed hours being a modern obsession. The daily meal routine differs among town and country settings, social classes, and between the sexes. In ancient times, monarchs dined behind screens as the gods had done; then they came to sit in full view or "in state." Women and men have dined apart in many cultures, perhaps in separate rooms or with the men going "out," leaving women and children at home. Women and men have also alternated flirtatiously around tables as "roses and thorns." The patterns of dining of present-day diners and their immediate forebears have remained constantly in flux.

Given the difficulty of establishing general principles of dinner, let alone transferring the concept to other cultures, this entry concentrates on a recognizable Western tradition that took shape in the nineteenth century. During that time, wealthy families agreed on smaller evening dinner parties, while working-class families gathered in their homes for dinner after a hard day at work or school. Much gastronomic attention has been devoted to this central social occasion, yet as meals are always evolving, questions arise regarding dinner's survival.

The Invention of Dinner

Throughout history, city dwellers tended to dine later and longer. Also, many travelers made the evening meal their main meal, as this was the time when they and their horses generally settled into an inn. In agrarian communities, however, where work began at daybreak, the first and principal meal occurred in the middle of the day. In medieval Europe, this midday meal was ideally eaten at the ninth hour after sunrise or "none," from which the word "noon" derives its meaning. This meal might have been taken in the fields and, especially in hotter climates such as the Mediterranean, been followed by a siesta.

President Thomas Jefferson illustrated the typical routine of an eighteenth-century rural gentleman. During his retirement at his home Monticello, he had two main meals per day: breakfast at around 9:00 A.M. and dinner at around 4:00 P.M. In a letter to Thaddeus Kosciusko on 26 February 1810, Jefferson described this routine: "My mornings are devoted to correspondence. From breakfast to dinner I am in my shops, my garden, or on horseback among my farms; from dinner to dark, I give to society and recreation with my neighbors and friends; and from candle-light to early bed-time I read."

Consuming two substantial meals—a late breakfast and a dinner (around 3:00 or 4:00 P.M. in the country and as late as 6:00 P.M. in town)—was also the pattern in England. During the nineteenth century, however, Arnold Palmer indicates that mealtimes became very uncertain. Eventually 8:00 P.M. became fashionable for dinner, a move that was in response to the longer business day and later parliamentary and court sittings. Workplaces were increasingly located at a greater distance from households, making it harder to return home for a main meal before work ended. This change was not a problem, as the evening meal was more easily lit with gas and electricity rather than the candles of the previous centuries. A more substantial luncheon occurring around 12:30 or 1:00 P.M. eventually filled the emerging hole in the middle of the day.

Confirming a similar pattern in the United States, Harvey A. Levenstein claims in *Revolution at the Table* that a new fascination with sophisticated food helped move dinner well into the evening. Before the 1870s, dinnertime was usually in the early or mid-afternoon, followed by tea and supper. In the last quarter of the nineteenth century, however, "upper-class males liked at least to appear to be engaging in productive activities during the day" and wanted their main meal afterward (p. 17).

Meanwhile, the emerging working class settled into their principal meal immediately after work, which was generally around 6:00 P.M. In the new world of highly differentiated production and consumption, social reformers and others, often with religious motivations, depicted the ideal family around their humble but sufficient table—the husband having put food there through his honest labors and the good woman through her thrifty shopping.

A similar movement occurred in France and was detailed in "Food Allocation of Time and Social Rhythms" in the journal *Food and Foodways*. The social elite used the same words for meals for several centuries, but they fluctuated in times, content, and relative importance. Most strikingly, each meal gradually moved later in the day until it replaced the next one. In particular, dinner (*dîner*) shifted from around 10 A.M. in 1550 until it reached late afternoon around the time of the Revolution, finally replacing supper (*souper*), which had previously been shifted from late afternoon to evening (p. 268). As a further complication, the schedule differed between social classes so that, according to a mid-nineteenth-century account, "the people déjeune, the bourgeoisie dines, the nobility sups. A man's stomach gets up earlier or later depending on his distinction" (p. 210). The French word *déjeuner* has been left untranslated rather than choosing between "breakfast" and "lunch."

A second major change in the wealthy European table contributed to the emergence of a recognizably modern dinner. This was the replacement of a series of grand tableaux of dishes, which servants would offer around, called *service à la française* (French service), with the succession of individually plated dishes, often served at smaller tables. This type of service was termed *service à la russe* (Russian service).

"Dinner, being the grand solid meal of the day, is a matter of considerable importance; and a well-served table is a striking index of human ingenuity and resource," extolled Isabella Beeton in 1861 in the long-lasting English "bible," the *Book of Household Management in London* (p. 905). In her sample "Bills of Fare," breakfasts warrant a mere half-page, although this is twice as much as luncheons. Three pages are devoted to "Ball Suppers" for sixty persons. In comparison, dinners occupy forty-seven pages. This section lists each month's menus, which are divided into five successive sets of dishes: "First Course" (soups and fishes); "Entrees" (various "made" meat dishes, such as pork chops and lobster ragout); "Second Course" (impressive meats such as roasts, hams, and pies); "Third Course" (game "removed" or replaced by sweet dishes); and "Dessert" (fruits and ices). Diagrams show

how each course is to be arrayed on the table around the central vase of flowers.

In deference to the direction in which dinner was heading, Beeton's book has a few concluding suggestions on *service à la russe*. The menus run through a simplified version of the *service à la française* progression that would become the standard dinner, namely, soup, fish, meat, and dessert. (Evocatively, the four courses make an evolutionary ascent from the primordial stew to the ethereal.) Yet confusion rules because, to cite one small complication, the British and Australian "entrée" precedes the main dish, which is the "entrée" for Americans. Cheese is a common additional course, before dessert in the French system and after dessert in the English.

In addition, Beeton's monthly suggestions conclude with "Plain Family Dinners," where she gives two menus for each day of the week. These comprise either two dishes (a meat dish plus sweet pudding) or, more often, three (with the addition of preliminary soup or fish dish). In the early twenty-first century, three-course dinners remain standard. For example, in the American classic *Joy of Cooking*, the successors to Irma S. Rombauer suggest lunch and dinner menus, both possibly with only two courses, whereas dinner usually has three (pp. 22–23). Lunch is lighter and more likely to include something obviously ethnic, particularly Italian (for example, minestrone). Dinner perhaps opens with soup (Greek lemon soup), salad, or fish, followed by a meat dish (lamb chops with roast garlic and cognac) accompanied by perhaps two vegetable dishes (pommes Anna, turnip purée) or rice or sometimes bread. Both lunch and dinner conclude with a tart, cake, or other dessert (such as apple spice cake).

The gastronomic literature that blossomed in the early nineteenth century promoted the intimate bourgeois supper that became the modern dinner. Writers of this period stressed the dependence on a good cook, the host's responsibility for the well-being of guests, the guests' responsibility to be punctual, and the optimum number at table in order to preserve "general" (that is, shared) conversation. Instead of large, aristocratic gatherings, the ideal number of guests became "not fewer than the graces [three] nor more than the muses [nine]."

Jean Anthelme Brillat-Savarin, who published *The Physiology of Taste* in 1825, assumed that a dinner (*dîner*) could be the "last affair of the day" and should conclude between 11:00 P.M. and midnight. Brillat-Savarin's "Meditation 14" includes twelve rules to optimize the "pleasure of the table," such as a room temperature between 13–16 degrees Réaumur (around 60–68°F), a progression from the most substantial foods to the lightest, and from the simplest wines to the most heady, and so on. Guests had to number "no more than twelve, so that conversation may always remain general," although he plainly enjoyed even smaller dinners that met just four conditions: "food at least passable, good wine, agreeable companions, and enough time" (1949, pp. 192–193).

A decade later, in London, Thomas Walker wrote about "aristology," or the art of dining, in his weekly newspaper *The Original*. In urging that dinner invitations make clear who is attending and what will be served, Walker included: "we shall sit down to table at half-past seven," yet he preferred the old system of an afternoon dinner (with male colleagues) and a separate supper as an opportunity for "wit, brilliancy and ease." As for guests, he stated: "Eight I hold to be the golden number, never to be exceeded without weakening the efficacy of concentration."

Walker's enthusiasm was not restricted to simplifying the dinner of the wealthy. As a police magistrate, he believed that the cure for poverty was self-dependence, which required the cultivation of domestic economy. In the "cheerless home," he wrote, the wife was absent or intoxicated, and possessions were often taken to the pawnbrokers. Coming home to angry words, then blows, the husband fled to the public house, where the wife came to collect him but also tended to stay herself. Meanwhile, in the "well-ordered" home, the returning husband found a "kindly woman, a cheerful fire, quiet children, as good a meal as his means will allow, ready prepared, every want anticipated."

The ideal of the modern dinner—ranging in style from the elegant dinner party to the virtuous, homely repast—was in place before the twentieth century. The advocates of this ideal helped set the stage for the "proper meal," to which British diners became committed, as evidenced in surveys such as *Women, Food, and Families* by Nickie Charles and Marion Kerr. People expected a hot course of "meat and two veg," which would be cooked by the mother or wife. However, dinner's relatively stable form was already breaking up again.

Disintegration

In the early twenty-first century, Sunday dinner has been giving way to more casual alternatives, notably brunch. Except for the exceptional "dinner party," the evening meal has become less rigid in expected fare, manners, and even attendance. Where morning newspapers had once intruded upon breakfast, prime-time television now interrupts dinner conversation. With both parents having to work, children often turn into individualistic snackers.

The conventional dinner has been perhaps an unnecessarily private refuge of the nuclear family or a showplace for privilege, with items such as fabulously expensive wines. The expansion of the food-service industry with street outlets, informal cafés, and restaurants has opened up an often more pluralistic, democratic marketplace that has restored the street life of the past. Yet many studies have demonstrated that family dinners assist in the socialization of children; psychological research has found that children who share meals are better adjusted and do better at school. At the same time, epidemiological studies (some of which are summarized in the article by James S. House and colleagues) have suggested that people who share meals with others live longer than solitary eaters. Treating late twentieth-century meal trends as alienating, Australian gastronomic author Michael Symons argues in *The Shared Table* for more "authenticity," in the sense of meals that bring people closer to each other and their physical world; that is, dinner makes us human.

These are not trifling particulars, as Thomas Walker, in *The Original* on Wednesday, 9 September 1835, maintained:

> Dining is an occurrence of every day of our lives, or nearly so, and as our health and spirits depend in great measure upon our vivid enjoyment of this our chief meal, it seems to me a more worthy object of study than those unreal occupations about which so many busy themselves in vain.

See also **Breakfast**; **Etiquette and Eating Habits**; **Lunch; Meal**; **Table Talk**; **Tea (Meal)**.

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Michael Symons

DISEASE: METABOLIC DISEASES.

Metabolism may be defined as those changes in liver cells that provide energy for vital processes. "Metabolic diseases" is a term that includes a vast array of genetic disorders whose effects may be exacerbated or ameliorated by diet. Several groups of these are recognizable and treatable.

One group of metabolic diseases is concerned with errors in the body that fail to preserve equilibrium of the water and salts. Dehydration results from excess water loss compared to intake. Normally, this is compensated for by thirst and the subsequent ingestion of water. Diseases result from loss of the thirst mechanism; excessive water is lost with diseases of the kidney or of the pituitary gland (diabetes insipidus). Diseases of the sweat glands may result in excessive loss of salt. Shock due to low salt in the circulation may occur as a normal blood pressure is not maintained.

Cystic fibrosis of the pancreas is a severe metabolic disease caused by an abnormality of a gene on chromosome 7. Infants may be born with obstruction of the intestine, develop severe diarrhea and/or chronic lung disease, or fail to grow properly. At present, treatment includes special easily absorbable formulas, large doses of vitamins, supplements of enzymes that are made in the pancreas, and frequent administration of specific antibiotics to treat or prevent lung infection.

Salt is lost in patients with the genetic disease cystic fibrosis, an error in one aspect of the function of the pancreas. Loss of function or destruction of pancreatic islet cells, another part of the pancreas, causes type 1 diabetes mellitus, one of the severe common metabolic diseases. The islets of the pancreas are the source of insulin, a hormone responsible for the metabolism of sugar. Without insulin, sugar (glucose) rises in the blood and is excreted in the urine together with excessive water and salt (sodium and chloride). Dehydration results in loss of excess sodium (a base or alkali) and results in the tissues becoming acidotic and the body is in "acidosis." Treatment requires administration of fluids and an excess of sodium compared to chloride (chloride functions as an acid in the body). Because insulin functions in fat metabolism, patients with diabetes may develop atherosclerosis, heart disease, and other complications due to abnormal deposition of fat. The amount of carbohydrate, protein, and fat in the diet must be regulated even in those receiving regular amounts of insulin.

In addition to the pancreas, disturbed function of any of the endocrine glands may result in metabolic disease. For example, the pituitary gland secretes growth hormone. Excessive growth hormone results in gigantism and acromegaly (i.e., overgrowth of parts of the body or the whole body, e.g., progressive enlargement of hands, feet, and face). Deficiency of growth hormone results in dwarfism. The thyroid gland secretes thyroxine, a hormone that controls metabolic rate. Excessive thyroxine results in excessive burning of calories, and affected children fail to thrive (Graves's disease). Insufficiency results in hypothyroidism. In the baby, this may be called cretinism (physical shortness and mental deficiency), and in the older child, myxedema (form of inelastic swelling of the connective tissue). If not treated, these children may be mentally retarded and fail to grow properly. The adrenal glands secrete hormones for maintaining blood pressure. Lack of adrenal function may result in shock. The adrenal glands also are important in sugar metabolism and lack of function may result in low blood sugar (hypoglycemia). Abnormalities of the fetal adrenal glands result in abnormalities of the development of the sexual characteristics and in hypotension or low blood pressure. The parathyroid glands are essential for normal bone function and metabolism. Abnormalities may result in a ricketslike syndrome, or in low blood calcium that may cause seizures. Abnormalities of the ovaries or testes result in abnormalities in sexual development. Abnormalities due to endocrine deficiencies may be corrected by replacement hormones. For those with excessive hormone secretion, surgery or treatment with drugs to inhibit the secretion of the hormone may be effective.

Vitamins

Inappropriate vitamin intake also causes metabolic disease. Vitamin A deficiency results in blindness; night blindness is due to lack of a specific metabolic product, rhodopsin, of vitamin A. Excessive vitamin A may result in increased intracranial pressure due to abnormalities of metabolism of cerebral spinal fluid. Thiamine is necessary for carbohydrate metabolism, and lack of thiamine results in beriberi, a very severe disease involving edema and heart failure. Some people with thiamine deficiency develop central nervous system abnormalities. Niacin is necessary for carbohydrate metabolism. Deficiency results in pellagra, a condition marked by diarrhea, abnormal coloration of the skin, central nervous system abnormalities, and death. Pyridoxine, vitamin B_6, is necessary for nerve and other functions. Deficiency results in seizures, abnormal sensation in the hands and feet, and anemia. Biotin is necessary for protein and fatty acid metabolism. Deficiency of biotin results in abnormalities of the hair and skin. Deficiency may occur in those who eat significant amounts of raw eggs. Deficiency of folic acid results in anemia. Deficiency in a pregnant woman results in a fetus with abnormalities of the spinal cord (e.g., spina bifida, myelomeningocele). Vitamin B_{12} deficiency results in abnormalities of nucleotides that are essential for gene replication and transcription. Clinically, vitamin B_{12} deficiency manifests as pernicious anemia, which, in addition to anemia, includes abnormalities of the central nervous system. Vitamin C (ascorbic acid) is necessary for the metabolism of interstitial (collagen) support substance. Deficiency results in bleeding, bone pain, and scurvy. Vitamin D is necessary for calcium metabolism. Deficiency results in abnormal bone formation and rickets. Deficiency also may result in secondary hypoparathyroidism, low serum calcium, and seizures. Excess may result in abnormal deposition of calcium in the kidneys and brain resulting in kidney failure and brain abnormalities. Vitamin E participates as an antioxidant. Vitamin K functions in clotting mechanism and bone metabolism. Treatment of any of the vitamin deficiencies or excesses requires control of intake, unless due to primary metabolic diseases that may inhibit absorption of the vitamin or its proper metabolism.

Minerals

Of the sixteen minerals said to be essential to humans, several are of special importance. Sodium, already discussed, is essential for acid-base homeostasis (maintenance of a steady state). Potassium is essential for nerve transmission and its importance is noted in maintaining heart rate regularity. Chloride is essential for water homeostasis and acid-base balance. Low sodium and chloride may result in hypotension, and elevated sodium chloride, in hypertension. Calcium and phosphorus participate in bone metabolism and in nerve transmission. Low serum calcium may result in seizures. Iron and copper are necessary for hemoglobin formation. Copper is also important in protein formation. Iodine is essential for thyroid metabolism. Zinc participates as a cofactor for many of the liver enzymes. Other trace minerals have been suggested as essential elements. Deficiency or excess of any of the minerals may be prevented by appropriate dietary intake unless, like the vitamins, metabolic errors due to genetic abnormalities may relate significantly to ranges of intake needed to avoid deficiency or excess.

Organs

Any of the organs may participate in metabolic disease. Two are especially prominent, liver and kidney. The liver enzymes participate in protein, carbohydrate, and fat metabolism. Low protein intake may result in edema due to lack of serum albumin. Liver enzymes help maintain glucose homeostasis, and levels of vitamin and fat metabolism. Common metabolic diseases seen with liver failure include albumin deficiency, hematologic disease, hypoglycemia, abnormalities of vitamin D metabolism, abnormalities of fat metabolism, and metabolism of some of the minerals. The liver also is essential for acid-base homeostasis. The liver enzymes are most responsible for detoxification of various chemicals. Liver failure may manifest itself by high serum ammonia levels and ammonia intoxication. Liver scarring (cirrhosis) may be the end result of several insults. Dietary treatment usually includes a low-protein diet that helps avoid ammonia toxicity and may help hepatic healing. Dietary supply of those substances that cannot be produced because of deficient liver metabolism may mitigate deficiencies partially.

The kidney is important in excreting and conserving water. If the body is alkaline, the kidney secretes base; if the body is acidotic, the kidney secretes acid. The kidney regulates secretion of small proteins, amino acids, and glucose. Kidney disease (nephrosis, where body swelling is related to the loss of serum protein, or nephritis, due to inflammation of the kidney) may result in loss of protein. The kidney is active in the metabolism of vitamin D, and deficiency results in abnormalities of bone and parathyroid metabolism. Kidney disease may result in retention or excess of normal products such as ammonia and urea, or excretion of essential substances such as water. Lack of control of water excretion is renal diabetes insipidus (excessive urine due to kidney abnormality), in contrast to pituitary diabetes insipidus (excessive urine due to pituitary abnormality, resulting in a deficiency of the antidiuretic hormone).

"Inborn errors of metabolism" was a term first used by Sir Archibald Garrod in his Croonian lectures published in 1908. He defined these inborn errors as blocks in metabolic pathways causing genetically determined diseases. He developed the concept that certain diseases of lifelong duration occur because an enzyme governing a single metabolic step is reduced in activity or missing completely, based on his observations of patients with alkaptonuria (urine that turns black upon exposure to light due to the presence of an amino acid breakdown product), albinism (lack of pigment in body tissues, such as hair, due to a lack of enzymes associated with melanin), cystinuria (excessive amounts of the amino acid cystine in urine resembling a form of kidney stone), and pentosuria (abnormal excretion in the urine of pentose, a form of sugar not utilized by humans).

When Garrod diagnosed these patients, most were adults who had been asymptomatic in infancy and childhood. Moreover, he noted that these conditions occurred in families and in many of the families more than one sibling was affected. Parents and other relatives usually were normal. A high incidence of intermarriage was common among affected families.

Following Garrod's work, others began to look for distinguishing characteristics in related families. For example, in 1934, Folling was working in an institution for the mentally delayed. He tested urine with a chemical, ferric chloride, and found a number of severely retarded children and adults whose urine turned purple upon that reagent's addition. The cause of the color change was found to be due to phenyl ketone. He and others determined that the phenyl ketone resulted from an error in the metabolism of phenylalanine, an amino acid found in nearly all proteins (Jervis). Many patients were identified with phenylketonuria (PKU) over the next twenty years, but little could be done to prevent mental delays that accompanied this condition.

Though chromatography was invented in Russia at the end of the nineteenth century, it was a technique used mainly for identification of complex substances. In the early 1950s, a number of investigators, particularly Armstrong and co-workers (Armstrong et al.), developed a technique to remove phenylalanine from milk proteins and the ability to diagnose this condition in growing infants became available. A formula with low phenylalanine content was developed at about this time. This formula was prescribed for those diagnosed with PKU and is very similar to the formula that is fed infants with phenylketonuria today. Though the infants with phenylketonuria progressed better than previously and indeed some progressed normally, a large number continued to experience delays in mental development. It was not until the Guthrie test was developed in the mid-1960s (Guthrie) that the diagnosis of phenylketonuria could be made almost at birth. This permitted the diet to be started at a much younger age. Many patients treated from birth progress normally.

Phenylketonuria is due to a disorder of the phenylalanine hydroxylating system. The gene for phenylalanine hydroxylase has been localized. Phenylalanine hydroxylase converts phenylalanine to tyrosine. Excess phenylalanine may be toxic or may convert to other toxic substances, or lack of the product tyrosine may be detrimental. Attempts to treat PKU only with added tyrosine did not completely correct the condition.

Newer instrumentation, gene analysis, and dietary control permit screening of the newborn for a large number of amino acid and other abnormalities; thus, many inborn errors of metabolism can be identified in the newborn and for some of these effective or palliative treatment is instituted. The studies of PKU are a model for many of the errors of amino acid metabolism (Barness and Barness). Each of these inborn errors of metabolism may present as a medical emergency, particularly in the newborn. One group of amino acids, termed branch-chain amino acids because of their chemical structure, improperly may form substances that smell like maple syrup. The disease is called maple syrup urine disease. Its treatment requires adjusting the intake of the branched-chain amino acids. Another group of branched-chain amino acids results in severe acidosis and depression of the bone marrow when inadequately metabolized. Two disorders are relatively common, methylmalonic acidemia and propionic acidemia. Some of these individuals respond to diet manipulation and large doses of vitamin B_{12}. Some patients present with an odor of sweaty feet due to a defect in the metabolism of leucine, one branched-chain amino acid. Decreasing dietary protein may ameliorate some of the worst signs of this disease.

One group of infants with amino acid and metabolic error may present with the odor of ammonia. They may become comatose rapidly. They have errors related to the breakdown into urea of one of the five amino acids. They cannot make urea from ammonia. Urea is a benign substance easily excreted in the urine. Affected infants are treated with a low-protein diet and frequently must also be treated with dialysis and ammonia-binding drugs to prevent catastrophic effects to the nervous system (Brusilow et al.).

Fatty acid metabolic disorders are causes of several muscle weakness diseases. Some patients affected by these conditions present with high blood ammonia, heart abnormalities, and coma. Liver disease may be a complication (DeVivo). These are divided according to the size (length) of the implicated fat. Many of the affected fats normally are excreted conjugated to the amino acid carnitine. Some of the worst effects of these disorders respond to the administration of carnitine and to limited intakes of the implicated fatty acid. Symptoms are aggravated by fasting, and intravenous glucose may be required.

Mason and Turner in 1935 reported a reducing substance identified as galactose in the urine of a number of children who were delayed markedly in development. The substance was found to be galactose and its source was human or cow's milk. Very young infants with the abnormal urinary substance were identified by this test. If allowed to drink milk, these infants frequently had seizures, became jaundiced, and vomited perniciously. They did not grow well. When milk was removed from the diet, they seemed to thrive. They experienced improved growth when they were fed with a soybean-based formula that contained no lactose, the principal sugar found in milks, human and other. Lactose is normally digested to galactose and glucose. The condition is called galactosemia because of the abnormally elevated galactose concentration in the blood.

Since the discovery and treatment of galactosemia, other errors in the metabolism of carbohydrates have been recognized. Some children cannot utilize fructose and develop symptoms similar to those experienced by untreated galactosemics. Children with hereditary fructose intolerance are interesting in that they consume breast milk and infant formulas made with lactose without difficulty. However, when given any food with table sugar, their symptoms become frightening. They quickly learn to avoid sugar or any food containing the fruit sugar, fructose. They grow normally and have wonderfully noncarious teeth. Other diseases of carbohydrate metabolism result in liver, heart, and kidney abnormalities. Some are accompanied by physical abnormalities.

Pauling and colleagues (1949) studied hemoglobin structure and found a specific mutation causing an alteration in the structure of hemoglobin. This led to the discovery of the errors in sickle cell disease. Subsequently, other genetic abnormalities have been identified as responsible for many hereditary anemias.

A common disease in adults is arteriosclerotic heart disease. Genetic abnormalities in cholesterol metabolism are believed to be responsible for atherosclerotic heart disease in some who suffer from this condition. Dietary manipulations and exercise beneficially affect a large percentage of these individuals. Others require drugs. Another group of patients with heart disease demonstrates a defect in metabolism of the amino acid homocystine. Treatment of the elevated homocystine with the same agents used for the treatment of the inborn error homocystinuria may reverse the condition.

Over four hundred inborn errors of metabolism have been diagnosed. Future genetic studies may reveal many more. Many carbohydrate, amino acid, and fatty acid abnormalities have yielded to effective treatment that must be maintained lifelong—a form of treatment is available for approximately forty to fifty of these conditions, with a similar number having experimental approaches. Some complex abnormalities, particularly those related to body structures and muscle diseases, await gene modification for effective therapy. Although each of the inborn errors, excluding the more common hematologic ones, may occur in only 1 in 4,000 to 1 in 100,000 live births, cumulatively they account for more than 1 in 1,000 of live births. Early diagnosis may prevent severe disabilities in progeny.

See also **Health and Disease; Microbiology; Proteins and Amino Acids.**

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Lewis A. Barness

DISGUST. Some philosophers doubt that there is such an emotion as disgust, yet in spite of the concept's overlap and fuzzy edges, there is a learned discourse about disgust defined as a feeling of revulsion. The prime example is in the context of food. Disgust may cause shock, faintness, even vomiting, or at the least it may dull the appetite. Not only to taste, but also to smell putrefying flesh, to touch excreta or slime, or even to set eyes on an open wound may provoke disgust. As a form of strong rejection, disgust is not the antithesis of desire; its effects are too immediate, even unexpected and uncontrollable, like an instinctive reaction. Why should humans be equipped by nature with this capability?

Training

A social explanation of disgust focuses on nutrition and the need to train children to avoid known poisons. Babies are taught by their parents' expressions of disgust not to eat noxious things. From the classifying of foods as edible or disgusting, the idea is extended to reprehensible behavior and despised classes of people. The ascription of filthy doings to outsiders accords with theories about the construction of ethnic identity. This approach allows for local differences due to training: some people reject snakes, worms, live grubs, or mud as food, but others relish them. Cannibalism evokes widespread disgust except among cannibals.

The limitation of the social training explanation is that the things commonly regarded as disgusting are not especially harmful. The people who habitually eat what others call disgusting would seem to enjoy as much good health as their critics. Furthermore, if early training in discriminating nutritious food explains disgust, the training is inefficient: it lets pass a lot of poisonous plants, roots, and living organisms.

Hygiene

The work of Louis Pasteur (1822–1895) and Joseph Lister (1827–1912) on microbial infection gained new relevance to disgust through the revival of Darwinism. An approach via hygiene starts from finding a strong convergence of evidence across the world to show that disgust is a direct response to waste products of the human body, including feces, slime, spittle, pus, mucus, and phlegm, which may carry infection. The same feeling of revulsion is extended to eating similar products of other living organisms and to anything that suggests these body wastes, like snails, slugs, and bugs. Evolutionary biology suggests a genetically inherited disgust mechanism that protects from infectious diseases.

Both the social training argument and the biological argument are open to the objection that the risks of disease from eating sick animals are only probabilities. House flies, mosquitoes, rats, and lice are dangerous to the same degree of probability, but they provoke more annoyance than disgust in those they afflict. Many deadly poisons are not slimy and are quite unlike body wastes, and comparative evidence is missing.

The evolutionary approach invites interesting comparisons. Animals may feel disgust, but the theory of genetic inheritance needs to take account of the exceptions. Many female mammals habitually dispose of afterbirth, smelly, sticky, and slimy as it is, by eating it. Hares and other coprophagous ruminants eat their own feces as part of the normal process of digestion. Sows are known to eat their young. Carnivorous animals do not discriminate between the best cuts and the messy-looking entrails, and some species subsist mainly on carrion.

These two approaches to human disgust conflict, and each side can reproach the other for using selected evidence. The social theory focuses on what the biological theory regards as exceptional, and the biologists focus on the common behavior, discounting the exceptions. Obviously, inherited feelings of revulsion can be overcome by training. Cannibals are trained to surmount disgust at eating human flesh, as are those who enjoy mucus-like turtle soup, slimy innards, snails, live grubs, and sticky buns. If no evidence against the thesis is allowed to count, the argument must come to a standstill.

Both arguments are causal and teleological. Both downgrade the importance of this emotion, taking it to be designed (inefficiently) to achieve a limited objective. Neither explains why the onset of disgust should be so sudden or so violent, liable to rack the whole body. Apart from causal thinking, there is analogy.

Analogy

A new direction in brain sciences challenges the separation between mind and body (Damasio). In continuous interaction, physical and intellectual energies sift through a succession of images and order them by creating analogies. Instead of looking for specific functions, analogists look for interactions between a system and its parts. Instead of starting with nutrition, analogists start with the body-mind relation and ask how disgust responds to pressures from the cognitive system.

Analogy maps similarities, checks similar patterns for structural consistency. It is a precarious process of reasoning, like trying to hold a pattern steady in a shifting kaleidoscope. The number of possible analogies for any one pattern is infinite, and the pattern always threatens to dissolve. Only repeated enactment entrenches an idea. Entrenchment needs to be fortified by a mechanism of rejection that protects the established pathways from slippage. The digestive organs are the root for making sensations of disgust analogous to other contexts of rejection and for extending disgust to moral or social contexts. Disgust churns the stomach and produces nausea and a cold sweat. Interacting with the cognitive system, its various vivid analogies are a team of watchdogs protesting against changes that, if adopted, would tumble the edifice laboriously constructed by experience.

One of the side effects of disgust may be to reduce the risk of infectious food. Its main function is in the body-mind system, where it limits conceptual slippage. Disgust warns against concepts threatening dangerously to slide between categories.

See also **Acceptance and Rejection; Aversion to Food; Pasteur, Louis; Sensation and the Senses; Taboos.**

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Mary Douglas

DISTRIBUTION OF FOOD.

The distribution of food in the United States can be as short as the distance from a farmer's or a consumer's garden to his or her kitchen table or as long as the journey from vineyards in South Africa to homes in South Dakota. Typically, the distribution of food moves along a complex supply chain that starts with chemical, seed, and feed companies in the agricultural input or agribusiness sector and ends on the consumer's plate at home or in a restaurant. This discussion, using corn as an example, follows food along a few relatively simple food distribution channels to reveal the many paths it takes as it travels from farm to fork.

Corn (maize) is one of the most widely produced grains in the world. In the United States, corn represents more than 40 percent of all grains produced. Four times more bushels of corn than bushels of wheat or soybeans were produced in the year 2000 (U.S. Department of Agriculture, 2001). For decades, university researchers and seed company scientists designed hybrid corn varieties that increase yields and improve quality. In tandem, chemists in public and private laboratories formulated fertilizers and pesticides to further enhance crop yields. In the late twentieth century, many seed and chemical companies merged and redefined themselves as life science companies to reflect advances in biotechnology. The application of genetic science to create new types of seed for corn, soybeans, and other crops touched off a controversy around the world about the safety and efficacy of the new seed supply and the food it produced. The link between the life science companies and consumers leapfrogged over the entire food distribution network as consumers protested this new and relatively untested technology that they perceived as a threat to their health and environment. While the controversy continued, food safety agencies in developed countries struggled with safety and labeling issues surrounding foods made from genetically modified ingredients. Life science companies and other agribusiness firms meanwhile continued to supply farmers with the seed, chemicals, and equipment needed to produce their chosen agricultural commodity, in this case, corn.

Once a farmer harvests the corn crop for the year, distribution of the raw commodity begins. At least two basic types of corn are produced, sweet corn for direct food consumption and field corn for food ingredients and animal feed. Each type has numerous varieties, brands, colors, and end uses. A small portion of fresh sweet corn might be sold at a roadside stand or in a farmers' market. In smaller communities, a farmer may deliver some sweet corn directly to a local grocery store or restaurant. Most of the new sweet corn crop is sold to commercial food processors, where it is canned or frozen.

Corn designed to be used as seed, animal feed, ingredients for food, or industrial products is sold to a local grain elevator. The choice for the farmer is to store the field corn on the farm and wait for the best market price over the course of the next year or to sell it to a grain elevator immediately. Some grain elevators are independent businesses, and some are owned by large food or feed companies that collect grain from across the land. At the elevator, corn is usually mixed and matched to achieve the quality demanded by the next buyer. Occasionally an elevator may handle only one type of corn grown by a few farmers who have contracted with a large food or feed company to supply a particular quality and quantity of grain. In this case, the identity of each type of corn is preserved. With bioengineered corn and other new varieties, the issue of identity preservation became a major issue. Traditional farming methods and grain elevator operations were incapable of keeping all varieties of corn separated and identified throughout the food distribution chain.

At the beginning of the twenty-first century, however, the development of technology and methods to preserve the identity and origins of all types of food was under great pressure to succeed quickly. Tagging and following foods from their origins to the point of retail sale was considered important for consumer choice and as a way for superior foods to capture higher market prices. It would also permit foods proven unsafe or undesirable to be traced back to their sources.

After leaving the grain elevator, about 20 percent of the corn was exported to a foreign country in 2000 (U.S. Department of Agriculture, 2001). The rest was sent to a feed mill or to a food processing or manufacturing plant. Some went to industrial plants that produce products like ethanol or plastics. At a feed mill, corn is further mixed with other grains and additives on its way to being fed to animals, such as hogs or chickens, many of which are later slaughtered for food. In fact, the bulk of the corn produced is used as animal feed. Corn used for human food usually goes directly to a food processing plant that specializes in producing basic ingredients, such as corn oil, starch, or flour. These ingredients are sold to food manufacturers, who use them in manufactured foods for consumers to eat. More complex food products, like taco shells, corn flakes, or corn bread, generally use ingredients purchased from food processors.

At the food manufacturer, major research and development departments create and test the safety and efficacy of food ingredients, flavors, and additives. They also experiment with new recipes, new packaging, and new ways to use corn in foods. Much attention is paid to the image of the food, its safety, its shelf life, its nutrition, and labeling. Several hundred new corn products are introduced to grocery shelves each year in an attempt to meet consumers' preferences and to capture part of their food dollars. This is also true for foods from other raw commodities, like rice, milk, eggs, and wheat. The average annual number of new food products introduced during the 1990s was 12,700, peaking in 1995 at 16,863 (Food Industry Institute, 1999; Food Industry Institute, 2000). Less than 5 percent of these new products were still on the grocery store shelves two years later.

Food products designed for the food service distribution channel also undergo extensive development and market research before going to market. These foods need less elaborate packaging and labeling and less advertising. They are designed to solve problems in a restaurant kitchen, problems of consistency and fail-safe cooking. Food service firms, such as quick service chains, purchase large and predictable quantities of food, often tailored to their specific needs. The distribution channel to food service firms was growing while the grocery channel was stable to declining at the end of the twentieth century. In any case, by the time the food product containing corn leaves the food manufacturer's warehouse, corn represents less than 20 percent of the value of the product. By the time a consumer purchases that product, corn represents less than 5 percent of the value (Elitzak, 2000).

The Grocery Channel

When a consumer food product leaves the manufacturer's plant for a grocery store, it has three channels through which it may travel. One is through a wholesaler's warehouse, where it is stored until a grocery store orders it. A traditional way of doing business is for the manufacturer to discount large quantities of freshly made food products to entice a wholesaler to "forward buy" the product. The wholesaler then stores it, marks it up, and sells it to a grocery store, making a profit on the difference in price. The costs of holding large inventories of food drove the industry to find more efficient ways to distribute food. With low inflation and fierce price competition at retail stores, wholesalers could not mark up their products enough to make reasonable profits. The quest to decrease distribution costs led to a consolidation of wholesale and retail firms and to the adoption of new information technologies.

Trade associations of retail food companies and manufacturers, such as the Food Marketing Institute (FMI) and Grocery Manufacturers of America (GMA), have long led the industry in adopting information technology. In the early 1970s, with the high cost of labor amplified by price inflation, the grocery store industry saw great potential in automating pricing activities. The Ad Hoc Committee on Universal Product Codes was established with representatives from major retailer and product manufacturing associations to develop a set of standards for identifying products that both the retailers and manufacturers could agree upon. Two years later the committee decided to adopt a ten-digit Universal Product Code (UPC) as its standard (Kinsey, 2000). The ubiquitous bar codes were born, and in 1974 a supermarket in Troy, Ohio, became the first to implement scanning. The first grocery store chain to implement scanning chainwide (Giant Foods) did not do so until 1980 (Walsh, 1993). By 2000 virtually every supermarket used scanners, though they were not widely adopted in convenience stores. At the time, scanners were still not widely used in the food service sector due in part to a lack of standardized products and packages for food service buyers.

Food Distribution Systems in Countries Other than United States

The food distribution system used in the United States is similar to that used in most of the westernized world (Europe, Australia, New Zealand, Japan). It requires good transportation and telecommunication systems and a modern food processing/manufacturing sector. In the United Kingdom there are few broad-line wholesalers, since the retail sector is more consolidated and handles its own distribution through tighter relationships with food manufacturers and producers. In other countries, large supermarket chains and chain restaurants receive food in much the same way as those in the United States, but there are a larger number of small retailers that procure their food directly from farmers or through third-party specialty wholesalers. In lower-income and emerging economies, the distribution of food is developing along the lines of the system used in the United States. Some level of household income and urbanization must emerge before supermarkets will become part of the retail food scene, and roads and communications need to be in place before a third-party distribution system can develop. For example, in China in 2002, Western-owned food manufacturers provided their own delivery to large supermarkets like Wal-Mart in the absence of a wholesale sector in the supply chain.

Globally, a few very large retailers are appearing around the world; their buying power tends to drive the delivery system and the types of food being purchased for retail sale. As these large retailers become more prevalent, the delivery system gets more consolidated, more responsive to consumers, and less open to small producers and farmers.

Using the information in banks of scanner data can give retailers valuable information with which to forecast sales, design customer loyalty programs, and con-

The Red Cross distributes food during a food shortage in Zaire. © SABA PRESS PHOTOS.

trol inventory. When Wal-Mart appeared as a major competitor with the most sophisticated information and distribution system yet known to retailers, it became obvious that those in the retail food industry would have to learn how to do business in the same fashion. In 1992 an industrywide program called Efficient Consumer Response (ECR) was developed to solicit conversion to electronic technologies and sharing of retail data with suppliers. By 1999 this program was declared dead by industry leaders partly because it had outlived its usefulness, partly because only the largest chains were able to invest in the technology and talent that would make it work, and partly because many ECR activities had already been adopted under separate names, such as category management and activity-based costing. By the end of the twentieth century, however, developing systems that would allow business-to-business, electronic-commerce methods of sharing information about final sales at retail stores with wholesalers and manufacturers became an industry goal. With real time sales data, manufacturers could adjust production and shipment of new products to match the flow of sales and accomplish continuous replenishment and lower distribution costs.

Wholesalers were vulnerable in this new distribution system since retailers could bypass them by using their own distribution centers. To keep their retail customers, wholesalers developed new services, like helping stores with their billing, merchandising, inventory management, and a number of other tasks. Wholesalers make it possible for small stores to carry a large number of items even though they may sell only a few of some specialty items each year. Some wholesalers specialize in particular types of foods, such as organic food, imported food, or fresh produce. Those who handle the whole line of groceries are called broad line wholesalers. Shipping food from manufacturers to wholesalers and from wholesalers to retail stores involves a large number of trucks, many of which need to be refrigerated to keep cold and frozen foods at a consistent and safe temperature. One of the difficulties in transporting food is the attention that must be given to temperature and the time the product will last before its quality or safety deteriorates.

The third party, broad-line wholesaler channel declined in size with the rise of large grocery chains like Wal-Mart and Kroger. Large chains have their own distribution centers in which to aggregate, store, and ship foods to their own stores. In this case, manufacturers sell food products directly to supermarket chain's distribution centers. In 2000, forty-five of the largest fifty supermarket chains in the United States were self-distributing chains.

A third channel by which food reaches grocery stores is called "direct store delivery." In this case, manufacturers have their own delivery trucks and sales representatives who deliver products to individual stores, stock the shelves, remove out-of-date products, and promote their products in stores. Most beverages and salty snacks are delivered directly to stores by manufacturers' trucks and personnel. At the beginning of the twenty-first century, each of the three distribution channels carried roughly one-third of the volume of food to grocery stores.

In 1999 about 127,000 grocery stores operated in the United States, of which 25 percent were supermarkets and 45 percent were convenience stores. At that time a supermarket was defined as a retail store that carries a full line of groceries, meat, milk, and produce and has over $2 million in sales per year. Supermarkets captured 77 percent of all retail food sales, while convenience stores had only 6 percent. About 70 percent of the food eaten was purchased at some type of grocery store, where consumers spent about 53 percent of their food dollars in the late 1990s (Carlson et al., 1998).

With the advent of large and efficient supermarket chains, the propensity for grocery chains to build long-term relationships directly with manufacturers increased. The sharing of sales forecasts based on large volumes of computerized sales data facilitated these relationships. Knowledge about customers' preferences and shopping habits gained through analysis of sales data made it possible for large retail chains to negotiate for bargain prices as they placed orders that matched what they needed, when they needed it. In some cases this eliminated the need for "slotting fees," the price retailers charge manufacturers to place new products on their shelves. Computerized scanner data and Internet communications made it possible to integrate the supply chain between manufacturers and food retailers and to streamline the inventory in distribution centers. Sharing sales data and mutual tracking and analysis made it possible to substitute information for inventory, cutting costs in the distribution channel. It became possible to match deliveries more closely to the time of sales, converting the food distribution channels into a semblance of just-in-time delivery. The adoption of business-to-business e-commerce, a new way to do business for retail food stores and their suppliers, focused mostly on ways to save labor costs and to speed up ordering, delivery, and invoicing. The goal was to move products through the system as freshly and as quickly as possible.

Food Service Channel

The food that goes to food service establishments (restaurants, fast-food places, cafeterias) goes through a separate distribution channel. Here again are broad-line wholesalers, specialty wholesalers, and some distribution companies dedicated to a large retail chain like McDonald's or Burger King. This complex distribution channel links over 740,000 food service locations with more than 2,600 distributors. Consolidation among broad-line wholesalers was rapid around the beginning of the twenty-first century. They distributed about half of the food to various food service places (Friddle et al., 2001). Over 30 percent of the food eaten in the United States went through the food service channel. Consumers spent almost half of their food dollars in food service places.

Food service is divided into commercial and noncommercial enterprises. The noncommercial segment comprises about 10 percent of the food service sector and includes schools, hospitals, prisons, and the military. The commercial food service sector includes bars and restaurants, travel and leisure, vending machines, and take-out (ready-to-eat) food from grocery stores and various types of restaurants. Restaurants and bars comprise about 62 percent of all food service sales and are further defined by the type of service they provide. Quick service (fast food) restaurants captured thirty-three percent of consumer expenditures at food service places, while full-service restaurants captured 28 percent. Full-service restaurants are further classified by whether the average size of the check is over or under $10. The lower-priced full-service restaurants were growing in importance as a proportion of food service sales in the late 1990s. These restaurants also represented the largest consolidation of individual units into national and international chains.

Summary

Food is distributed from retailers to consumers primarily through grocery stores or take-out food places. For the most part, consumers shop and take home their own food. Home delivered food experienced a resurgence with the rise of Internet food companies in the 1990s and beyond. Online shopping and home delivery made up less than 1 percent of all food purchased for home consumption but was a persistent phenomenon in some neighborhoods. Food distributed through food service became ubiquitous by the end of the twentieth century. Food and beverages could be purchased from vending machines, street-side stands, drive-through eateries, office cafeterias, shopping mall food courts, and home delivery.

When consumers finally eat the food that has traveled all the way down a long supply chain, few think about the corn delivered to a grain elevator or the canning plant months earlier. Corn oil is in their salad dressing, their soft drink sweetener, and their taco shell, but it is largely taken for granted. It is assumed that it is fit to eat, nutritious, and safe. Few think about the hundreds of people involved in producing and transporting the final food product or the plethora of food regulatory agencies that license, monitor, and inspect the process. Food distribution is a long and complicated journey, but somehow an army of scientists, truck drivers, forklift operators, computer specialists, government scientists and inspectors, and many others make the system work.

See also **Biotechnology; Consumption of Food; Food Supply and the Global Food Market; Green Revolution; Marketing of Food; Political Economy.**

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Jean D. Kinsey

DIVISION OF LABOR. Division of labor, the parceling out of work based on various categories of identity, is understood commonly as a division made on the basis of gender. Indeed, food production, preparation, and even consumption are often differentiated on the basis of gender: men do some tasks and women do others. For example, cooking is widely recognized as an essentially female task (Murdock and Provost, p. 208). However, division of labor can apply to class, ethnicity, and age as well, and these categories also intersect with how people produce, prepare, and consume food.

Food Production

The division of labor begins when food production begins, which is a pattern rooted in the history of humanity.

The earliest humans tended to divide their work by category, where men hunted and fished and women gathered vegetable foods (fruits, vegetables, grains, and nuts). Among foraging societies, women still take on the greater portion of food-preparation tasks, such as grinding, pounding, boiling, and otherwise processing gathered and hunted foods into edible meals. For the few societies that still procure their food in the hunting-and-gathering strategy, a large percentage of the diet is made up of nonmeat foods, with meat functioning as a much-desired and prized treat (Lee, pp. 256–258).

As societies adopted farming as a means of food production, dividing food production by gender persisted, yet much of this division was based on cultural understandings of gender rather than a physical advantage on the part of men or women. For example, among the Maring of New Guinea, numerous agricultural tasks are divided on the basis of gender: men and women together clear gardens, but only men fell trees. Both men and women plant crops, but weeding is a primary female occupation. At harvest time, men harvest above-ground crops and women harvest below-ground crops (Rappaport, pp. 38–40, 43). These are categories based on cultural understandings, similar to how grilling and barbecuing are identified as male tasks in many Western societies.

An extreme case of agricultural specialization is found in much of sub-Saharan Africa, where subsistence agriculture is a predominantly, sometimes exclusively, female task. Agricultural economist Ester Boserup notes that in sub-Saharan cultures, the shift to a more urbanized society often reduces women's status, for although rural farm women may not be socially equal to their husbands, their work on farms is recognized and valued. A shift into a more "Westernized" work pattern can eliminate what power such women do have (pp. 53–63). However, agricultural work patterns vary widely. In societies where plow agriculture is common, women are often likely to process food in the home, while the actual farm labor falls to men; yet even in those societies, women may weed and harvest or keep kitchen gardens. In the United States, women's farm participation varies from negligible to great. The publication *Marketing to Women* notes that although the number of women farmers in the United States is on the rise, women tend to own the smallest farms. At the same time, women are far more likely to own their farms: fully 80 percent of women farmers are farm owners, in contrast to the 58 percent of male farmers who own their farms.

Preparing Foods

Food preparation, particularly that which occurs in the home and family, is most strongly associated with women and women's work. This is a pattern that has been documented widely. Journalist Laura Shapiro and food writer Ruth Reichl outline the history of this development in the United States in *Perfection Salad*, their account of the "domestic science" movement. As a result of this movement, women's work came to be viewed as professional, and cooking and other domestic activities were elevated to a woman's highest calling. (See also Cowan. Numerous works from a range of disciplines document this pattern. Among them are works by Sherrie A. Inness and the U.S. sociologist Arlie Hochschild.)

Similar patterns have emerged in other societies, although the underlying cultural ideals may differ. Anne Allison describes the great attention that Japanese mothers give to the preparation of their preschool children's boxed lunches. Young children attend preschool from three to six years of age, where they bring elaborately prepared lunches with them. Mothers organize other family meals around lunch preparation and spend as much as forty-five minutes each morning preparing lunch for their preschoolers. Men never prepare such lunches, and no adult that Allison interviewed could ever recall their father preparing a lunch. Indeed, the elaborate and beautifully presented lunch reflects well on the mother and signals her devotion to her children in the eyes of other mothers and of the preschool staff.

The association of women and domestic food preparation is sufficiently strong that men's cooking requires explanation. In some societies, men prepare special or ritual meals. The ethnographic film *The Feast*, by Timothy Asch, shows Yanomamo men preparing and eating a ritual meal, which is unusual in this strongly patriarchal Amazonian society.

Other Types of Divisions

However, gender is not the only way that labor is divided. This is true for food preparation, as it is for many other types of labor. Class or rank is a major category of division. For example, among the affluent in society, in modern times as well as in the past, servants often prepare food for the household. Also, certain kinds of foods might only be prepared or consumed by people of specific social classes. Archaeologist Christine Hastorf's work in Peru traced the preparation and consumption of corn, in the form of corn beer, through the pre-Incan and Incan periods. Using a sophisticated array of techniques, Hastorf compared the presence of corn pollens among different house sites and throughout neighborhoods. Over time, the presence of pollen, generally found in the patios and yards where women prepared food, was concentrated in the house sites of elite classes. The preparation of corn slowly shifted from most women to elite women. Further comparisons of this type showed that over the same period of time, women's consumption of corn decreased overall, while men's consumption increased in elite neighborhoods. Hastorf hypothesized that with the rise of the Incan Empire, elite women became increasingly specialized corn-beer producers and elite men became the beer's main consumers.

Perhaps the most striking change in U.S. food preparation is that most people do not prepare their own food.

An increasing number of people pay to eat food that is prepared elsewhere, whether they pick up burgers at a drive-through restaurant, order pizza, or buy prepared meals in markets. This pattern has been noted for much of the past twenty years (see Gonzales) and continues to intensify.

See also **Gender and Food; Preparation of Food; Time**.

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Robin O'Brian

DURIAN. The durian is a tropical fruit encased in a spherical or ovoid spiny hard shell, which can be quite large—a single unhusked durian can be the size of a football. Within the shell are five or six segments of golden or cream-colored custardy pulp, the flavor of which is reputed to be so delectable that it is commonly known in Southeast Asia as the "king of fruits." But perhaps even more notable about the durian than its taste is its remarkably foul odor.

Origin of the Durian

In Africa, on the Indian Ocean island of Zanzibar, there grows a stand of durian trees near the site of the former slave market. Two stories account for its origin. One is that Arabs had brought back the durian from Indonesian explorations in the eighteenth century. Another story is that the British colonial governor of the 1850s decided to plant every tropical fruit in this garden, but it was the durian that took root and predominated. The durian is beloved by the Zanzibari (although mainland Tanzanians find it repulsive).

Nasal Nightmare or Palate Pleasure?

Sir Stanford Raffles, doughty founder of modern Singapore, proudly told friends in 1819 that whenever he caught a whiff of the fruit, he would "hold his nose and run in the opposite direction." The distinguished nineteenth-century naturalist Henri Mouhot found it relatively easy to trudge boldly through the Cambodian jungles when he discovered Angkor Wat, but give him a durian, and his delicate French olfactory senses would be offended to a point of desperation. "On first tasting it," he reported in his diaries, "I thought it like the flesh of some animal in a state of putrefaction."

What makes the durian both hostile and iconic is the thick rind of the fruit. As cleavers chop through it, an aroma propels upward, inspiring unsavory images: old unwashed socks, subway bathrooms, carrion in custard, fetid cheese. How nearly unimaginable that the taste of this source of nasal distress could evoke such imaginative and savory descriptions as "a bouquet of wild honey with a hint of smoked oak" or "bittersweet butterscotch." But such is indeed its reputation. The flavors of durian varieties range from nutty (the common Thai *chunee*, or "gibbon" durian) to butter-almond (the *maung thong*, or "golden pillow" durian) to crème brûlée (the newly crowned king of flavors, *daan yao*, or "long-stem" durian).

A Cultural Identity

While no festival is devoted to the durian, its Thai devotees crowd the ten-cent ferries from Bangkok to the province of Nonthaburi, where the finest durian grow, from April through July. There, along the port, the laughter of appreciation, the sounds of thick spiky rinds being chopped open, and a pervasively acrid aroma float and mingle together over the Chao Phrya River.

DEFENDING THE DURIAN

It has been said that Asians enjoy pricking the somewhat constrained food preferences of foreigners by offering them durian and watching the knee-jerk negative reactions. Usually the results are harmless and amusing, but sometimes when the untrained nose meets the noisome fruit, the culture clash can be more antagonistic than amicable. Some years ago in Thailand, where durian is a matter of national pride, a Thai lady from Bangkok's red-light district was accused of slashing an American's face with the sharp spines of the durian. Her excuse was that she had been innocently dining on the durian in the back of a bar, when the American stormed in to castigate the revolting smell coming from the fruit. What choice did this woman have but to claim durian rights and defend the fruit? The Thai magistrate, a patriotic durian eater himself, found the assault was, alas, criminal. But in deference to the noble durian, he penalized the woman the equivalent of a mere five dollars and, as if to underscore the virtue of her actions, paid the fine himself.

In 2000, Hong Kong filmmaker Fruit Chan wrote and directed *Durian Durian*, a movie that explores the lower classes of Hong Kong's steamy tenement district of Mongkok. The two durian in the title represent the story's two vulgar, ambitious women, who, like durian the fruit, are repulsive to outsiders but charming to their own society. And, like the Malays (who say "when the durian falls, the sarong falls"), the Chinese consider durian an aphrodisiac.

Botanical Profile

The durian (which the French dub "cheese-vending tree") is a member of the bombax family (Bombacaceae), a diverse family of trees that includes the thick-trunked baobabs of Africa and Australia, the fast-growing balsas of tropical America, and the kapok-yielding ceibas of Africa and tropical America. The durian (specifically *Durio zibenthus*) probably originated in Borneo, and today its numerous varieties are cultivated primarily in Malaysia, Thailand, Indonesia, and the Philippines. The durian tree, resembling the American elm, is of majestic height, reaching up to 120 feet. For its first five years, the trees are delicate, requiring humid climate and protection from fruit borers and leaf-cutters. From its fifth year, it begins to bear approximately forty fruit; by the tenth year, up to 200 fruits. Each of the spiky green fruits can weigh up to eight pounds, so during the harvesting season, it is most inadvisable to walk under a tree, since, upon beginning to ripen, the fruits fall from their lofty branches.

Humans are by no means the only eager consumers of the durian. According to a Thai maxim, "the first to note the malodor is the elephant, which shakes the tree to bring down the fruit. After the elephant noses open the fruit with its tusks, the tiger fights the elephant for the fruit. Rhinoceros, wild pig, deer, tapir, monkey, beetle, and ant follow the tiger. The human must be very quick to get the durian."

The Marketplace

Assuming no frugivorous animals have broken the husks, durians are trucked to market, where the durian buyers make their selections. As an iconic fruit, social status is important here, and only the most desperately poor will be satisfied with the lowly *chunee*. Others will look for the more desirable—and more costly—*maung thong* pile.

Which are the best in the pile? Some Western writers claim that the odor is the hallmark of a good durian, but in fact the husk is so tough that only a scintilla of the smell can pierce through the young fruit, which takes two or three days to ripen fully after falling. Those experienced in the durian trade know that it is sound, not scent, that identifies an acceptable specimen. The durian merchant will hold the durian by the stem, while the buyer lightly taps on the top of the fruit with a hand or (preferably) a carved teakwood stick. The other hand is held behind the buyer's ear to catch the resonance of the tap, much as a conductor will catch the timbre of violins in an empty auditorium. If the sound from the durian is a thud, the fruit is touching the husk and not ripe enough. If the sound is hollow, then it is overripe and mushy. Something between a thud and hollow, therefore, is ideal.

The export market for durian is limited, since no airline allows the transport of fresh durian (even in the luggage compartment, the aroma can seep up to within sniffing range of the passengers). Nonetheless, the de-

TABLE 1

Durian: Nutritional Information

Components	Per 100-gram portion
Calories	153.0
Moisture	64.1 g
Protein	2.6 g
Fat	3.4 g
Carbohydrate	27.9 g
Minerals	103.9 g
Beta-Carotene	140.0 mg
Vitamin B_1	0.1 mg
Vitamin B_2	0.13 mg
Vitamin C	23.2 mg

SOURCE: Ministry of Agriculture Malaysia at www.agrolink.moa.my/comoditi/durian/durian.html mand for this "king of fruits" among Western consumers is on an increase. To be sure, canned durian brought some 30 million dollars in exports in the year 2000, with the United States comprising one-third of this market.

Preparation and Consumption of the Durian

Slicing the durian open with a sharp cleaver offers a dissonance of reactions. The smell is indeed fetid, but the compartments within contain generous servings of pulp that is solid (but not dry) and creamy (but not milky). The fruit can be consumed by hand or spoon, extracting the chestnut-sized seeds embedded in the pulp. Fresh durian pulp can be wrapped in foil and stored in a freezer but inevitably loses its delicate taste.

Different cultures use the durian in a variety of ways. In Borneo, the indigenous Iban boil or salt unripe durian, using it as chutney on their sticky rice. In mainland Malaysia, the seeds are roasted or fried and eaten like popcorn. In Sri Lanka, where durian grows wild, farmers will take durian pulp and mix it with curdled buffalo milk, sugar, and sometimes cinnamon or cloves.

Other variations, like durian jam and candy, are made for those who want a taste of durian without the effort of the aroma. Among the most popular recipes is durian ice cream: chunks of the fresh fruit are blended into a puree, mixed with pineapple or orange syrup, and poured onto the ice cream. Fresh durian is also used for a durian "cake." This Malaysian treat is made with durian pulp and sugar, slowly boiled together and wrapped in palm leaves. These cakes keep up to one year in the freezer. Incidentally, consuming durian, in any form, with liquor is strictly avoided. It is a long-standing belief that fermenting the fruit in the stomach with alcohol can be lethal.

See also **China; Southeast Asia.**

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Harry Rolnick

E

EASTER. Easter, the Christian festival commemorating the resurrection of Christ, was the earliest feast day decided upon by the ancient Christian Church. Like its Jewish predecessor Passover, it is a movable feast, based on the lunar calendar rather than falling on the same Sunday every year.

The complicated dating for Easter was set in 325 at the Council of Nicaea, which scheduled the festival to be celebrated on the first Sunday following the full moon occurring next after the vernal equinox (about March 21); however, if the full moon occurs on a Sunday, Easter will be celebrated the following Sunday. Hence, the date of Easter can fluctuate between March 22 and April 25. Because the Western churches (Catholic and Protestant) now follow the Gregorian calendar, the Eastern churches, which follow the unrevised Julian calendar, celebrate Easter (and other Church holidays) on different dates. In the Orthodox Churches, Easter marks the beginning of the ecclesiastical year.

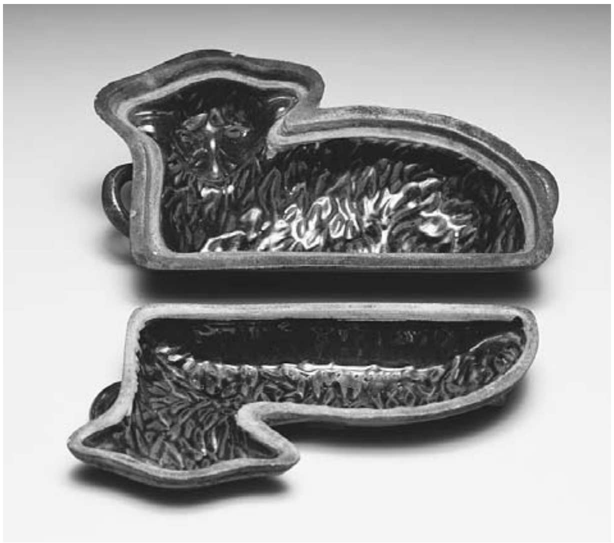
Like many other Christian feasts, the celebration of Easter contains a number of originally pagan or folk-religious elements tolerated by the Church. Among these are customs associated with the Easter egg, Easter breads and other special holiday foods, and the European concept of the Easter hare, or, in America, of the Easter rabbit, which brings baskets of candies and colored eggs during the night.

The pagan roots of Easter involve the spring festivals of pre-Christian Europe and the Near East, which celebrate the rebirth of vegetation, welcoming the growing light as the sun becomes more powerful in its course toward summer. It is significant that in England and Germany the Church accepted the name of the pagan goddess "Easter" (Anglo-Saxon *Eostra*—her name has several spellings) for this new Christian holiday. In Mediterranean Europe (Italy, Spain, and France), Christianity adopted *pascha*, a word derivative of Passover, from which comes the adjective "paschal" for things pertaining to Easter, such as the Paschal Lamb.

Aside from the fact that Easter Sunday officially ended the long fast of Lent, one of the most distinctive food elements of the Easter celebration is the Easter egg. In earlier times, Easter eggs were much more a part of the formal culture than they are in America today, where individual families determine the range of the custom. In the European village context, Easter eggs were once used as part of one's tithe to the landlord, or given as festive (and expected) gifts to the village pastor, the schoolmaster, the sexton and bell-ringer, the parish gravedigger, and even the village shepherd. Of course, they were hospitably presented to visitors, bestowed as favors upon servants, and, above all, given to children. Courting couples exchanged them as tokens of love, and godparents usually regaled their godchildren with gifts of decorated eggs.

The Easter rabbit (Easter hare in Europe) is not documented before the seventeenth century. While the Easter hare is the major egg supplier in European Easter celebration, there were other runners-up in the form of egg birds, Easter hens, cranes, storks, even foxes and other creatures. With its late origin, scholars are still debating the reasons for the association of the rabbit with Easter custom and lore. It is generally thought that, like the Christmas tree—and the recent development of Easter egg trees—the custom first emerged in the cities, then filtered down into the country villages. Among the theories of the origin of the Easter rabbit belief, the most plausible (although still not without difficulties) is that it may be connected in some way with the so-called March Hare of folktale. The Easter rabbit was believed to actually lay the eggs; hence, children went to elaborate lengths to build attractive "nests" for the elusive egg layer, who was summoned by whistling or by saying a charm.

The elaborate decoration of Easter eggs became a major form of home-produced folk art both in Europe and America. Among the Pennsylvania Dutch, who produced an elaborate Easter culture, eggs are dyed with onion skins, producing a rich reddish-brown color, or with other natural dyes. These eggs are then scratch-carved with designs, dates, names, or even religious verses, or elaborately decorated by winding the pith of a reed around the egg to create patterns. The Pennsylvania Dutch also make Easter birds out of large goose or duck eggs, furnishing them with wings, beaks, and tails. These are hung from the ceilings of farmhouse kitchens as festive seasonal decoration.



French ceramic mold for baking Easter bread in the shape of a Paschal lamb, circa 1850. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

In areas of Canada and the United States where Russian and Ukrainian Orthodox Christians as well as Poles and other Eastern Europeans settled, unusual methods of egg decoration are found. Such Easter eggs are generally referred to as *pysanka* (plural *pysanky*). In Eastern Europe, egg decoration is an ancient folk craft treasured in families and passed down from generation to generation. In Czarist Russia, this craft was elevated to such a degree that it was even imitated by such famous jewelers as Fabergé. Whether created with gold leaf and sapphires or just homemade dyes, the designs involve a variety of standard motifs—geometrical, animal, and floral. The geometrical motifs are probably the oldest, and range from simple horizontal and vertical lines to sectionalize the egg to sun symbols like the tripod, or to the "endless line" forms. Some of the most complex patterns incorporate stars and rosettes. Animal and bird designs are the rarest; the reindeer is said to symbolize wealth and prosperity, while the hen, or the feet of a hen, symbolizes fertility and fulfillment of wishes. Butterflies, fish, and horses are also occasionally included in the design repertoire. From the plant world, pine trees are drawn to symbolize eternal youth and health. Many of the Slavic methods of decoration are similar to those used by the Pennsylvania Dutch, but the range of motifs is different, the colors more striking, and the designs richly elaborate. Background colors are often red or black, although green and yellow are also popular, but multicolored designs seem to be the most popular.

In the family and community of all the various Christian denominations, Easter Sunday has always been a day of joyous celebration. In the Middle Ages it was often chosen as the day to crown kings since Easter feasting was, and remains, quite elaborate, especially in the Orthodox tradition. Since the day marked the official end to forty days of the Lenten fast, many special foods were prepared to mark the occasion. Easter breads have been researched widely and form a huge genre of ornamental foods made especially for this feast. Among the Greeks, lung soup is very much associated with Easter cookery, while in America baked ham seems to be one of the most common features of the Easter dinner. Many games were played with Easter eggs prior to or following Easter dinner, such as egg picking, where the player forfeits his or her egg if it cracks during the picking, egg eating contests, and egg rolling contests. In Europe and in parts of colonial America, Easter was often extended into a two-day celebration, with feasting, gaming, and other secular entertainments continued into Easter Monday.

Easter has undergone further evolution in more modern times, especially since the latter half of the nineteenth century. The confectionery trade began to commercialize Easter during the 1870s, with the introduction of an entirely new line of sweets employing Easter themes. Chocolatiers in particular discovered that candies once only sold as luxury foods for Christmas could become just as lucrative when transformed into rabbits and similar gift items. Today Easter is one of the most important seasons for selling confectionery, from chocolate bunnies, marshmallow chicks, and jelly beans, to music box coconut eggs, spun sugar tulips, and edible crucifixes filled with brandied fruit.

The most concise reporting of Easter customs in Europe occurred at a symposium on Easter organized by Robert Wildhaber of Switzerland. Wildhaber edited the papers and published them in 1957 in the *Schweizerisches Archiv für Volkskunde*. The papers cover Eastertide as cel-

The blessing of food at Easter is an important rite in the Orthodox Church. A priest of the Donskoi Monastery in Moscow is shown blessing food during Easter 1998. AP/WIDE WORLD PHOTOS.

ebrated in Switzerland, Germany, Austria, France (especially Alsace), Slovenia, the Czech Republic, Slovakia, Poland, Hungary, Rumania, Bulgaria, and Greece. The majority of the contributions deal with Easter eggs, their history, function, decoration, role in folk medicine, and in riddles. Several contributions treat Easter foods, especially Easter breads and other baked goods. Venetia Newall's *An Egg at Easter* (1971) is the most expert introduction in English to the history of the Easter egg and its place in ecclesiastical and folk culture.

See also **Bread; Christianity; Folklore, Food in; Judaism; Lent; Passover; United States: Pennsylvania Dutch Food; Shrove Tuesday**.

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Don Yoder

EASTERN EUROPE. *See* **Balkan Countries; Central Europe; Russia.**

EATING: ANATOMY AND PHYSIOLOGY OF EATING.

"Eating is the action of taking solid foods in the mouth in order to nourish oneself: this action is carried out by insertion [of the foodstuff] in the mouth, followed by mastication, swallowing, and digestion." This is the definition of "eating" proposed by Diderot in his famous Encyclopedia. He goes on to say that eating is specifically not the ingestion of non-food substances such as clay, chalk, stones, and charcoal, but only the ingestion of materials that can be conceived of as foods proper for nourishment. As a result, they also exclude such potential foodstuffs as blood and urine. In the present article, we follow the lead of our predecessor in adopting this definition.

Taking in nourishment is necessary for survival, and this usually involves eating. The following chapter provides an overview of the anatomy and physiology of eating, including the major nutritional processes that take place during digestion.

Eating can be divided into the following processes: eating proper, or ingestion, whereby food enters into the body; and digestion, the process through which nutrients from food are extracted in the gastrointestinal tract. Digestion is followed by absorption, the process through which nutrients are passed through into the blood stream; and by excretion, through which indigestible and unabsorbable products from food are eliminated.

Anatomy

The ability to eat and digest food hinges on an intricate, complex, and coordinated system known as the digestive system, all under control both of the central nervous system (brain and spinal cord) and of digestive system's own intrinsic nervous system, which is sometimes called the body's "second brain." The digestive system comprises two main groups of organs: the organs of the alimentary canal, also known as the gastrointestinal (GI) tract, and the accessory digestive organs.

The GI tract is a continuous tube that runs from the mouth to the anus. The organs of the gastrointestinal tract include the mouth, pharynx, esophagus, stomach, small intestine (consisting of duodenum, jejunum, and ileum), and large intestine. It is within the GI tract that food is chewed or masticated, then broken down into still smaller fragments, and absorbed into the blood.

The accessory organs of the digestive system are the teeth, tongue, salivary glands, liver, gallbladder, and pancreas. The teeth and tongue allow for chewing, tasting, and rasping of food. The other accessory organs of the digestive system produce secretions that aid in digestion. In embryonic life, these organs develop as outpouchings from the primitive GI tract, and their secretions travel into the GI tract via ducts.

In order to understand eating and digestion, it is important to imagine what the body needs to do when you think about food, eat food, swallow food, when food lands in your stomach, and when food makes it way through the small and large intestines. The digestive system is designed to prepare the body for eating and digestion before the first piece of food passes our lips. Once food is ingested, this system is designed to efficiently extract and absorb nutrients while it rids the body of waste products.

Preparation for Eating

In order to understand how the body prepares for eating, it is important to realize that eating and digestion require that our body maximizes blood flow to the digestive organs, in order to both supply oxygen and energy to these organs, and to carry away the nutrients that have been absorbed.

Blood flow to the digestive system is controlled primarily by the autonomic nervous system (ANS). The

ANS has two anatomically and functionally different subdivisions, the sympathetic nervous system and the parasympathetic nervous system. The sympathetic nervous system is designed to stimulate the body to prepare for and engage in activities and behaviors that are highly arousing, for example, "fight or flight reactions," while the parasympathetic nervous system is designed to prepare the body to engage in activities and behaviors that are relaxing.

Eating and digestion require the body to be relaxed, to allow for blood to be shunted away from the muscles to the digestive system. In fact, from an evolutionary point of view, the process of eating requires us to stand still or (preferably) to sit or lie down, and concentrate on taking apart the food item and ingesting it, rather than running around. Thus the processes involved in eating are antithetical to moving about, either to get somewhere or to escape danger.

As a consequence of this organization, the body cannot appropriately engage in relaxing behaviors if the sympathetic nervous system is activated, and it cannot engage in arousing behaviors if the parasympathetic nervous system is activated. In other words, if you feel stressed, or you are engaged in physical activity, or you must flee from danger, you will not be able to eat and digest food, and vice versa.

Both mental stress and aerobic exercise involve activation of the sympathetic nervous system. You may have noticed that if you try to eat while you have been highly stressed, or while you are "on the go," or after you have exercised aerobically, your mouth may have been dry, making it difficult to moisten, taste, and swallow food. You may have also experienced stomach cramping and pain upon ingesting food. These responses occur because your sympathetic nervous system is stimulated. Your body is worried about maximizing its ability to fight or run; it is not ready to eat a meal.

If, however, you are in a relaxed state, the thought of food, the sight of food, or simply making a mental association with food, sets into motion a series of events that prepares the GI tract for incoming food. Upon sensing that eating is imminent, the parasympathetic nervous system prepares the GI tract via signals sent though three cranial nerves that exit from the brainstem: the vagus nerve (cranial nerve X), the trigeminal nerve (cranial nerve V), and the glossopharyngeal nerve (cranial nerve IX).

Preparation in the mouth. In the mouth, food must be wetted by saliva, so you can taste it, chew it, begin to break it down into smaller particles, and swallow it. When your parasympathetic nervous system is stimulated, cranial nerves V and IX stimulate the salivary glands to release saliva into the mouth. The average person produces about 1500 ml of saliva each day.

Once food is wet, it can be tasted. Tasting food is critical for identifying it, receiving pleasure if it tastes good, rejecting it if it tastes bad, and for signaling to the body that food is indeed about to be ingested. There are five primary tastants: sweet, sour, salt, bitter, and umami, which is the taste of the amino acid glutamate, a major ingredient of monosodium glutamate (MSG). Tasting is accomplished by taste receptors, which are located in structures called taste buds. Taste buds are housed in small bumps on the tongue and the roof of the palate called papillae. Fungiform papillae house the taste buds located on the anterior surface of the tongue, foliate papillae house taste buds that are located toward the back and side of the tongue. Circumvallate papillae, which form the chevron-like pattern in the back of the tongue, house very large numbers of taste buds. In addition, there are a scattering of taste buds in the palate, the posterior oropharynx, and the esophagus. It is interesting to note that the ideas that only sweet can be tasted at the tip of the tongue, only sour and salt can be tasted on the sides of the tongue, and only bitter can be tasted at the back of the tongue are myths. In fact, all taste buds are capable of tasting all tastants; however, they do so at varying levels of sensitivity.

Another reason for wetting food in the mouth is that it makes food easier to masticate and swallow. Furthermore, once food is chewed, it can be acted upon by salivary enzymes, which are compounds that work to chemically break down food into its molecular components. For example, saliva contains the enzyme salivary amylase, which begins the breakdown of carbohydrates, and lingual lipase, which begins the digestion of fat.

Preparation in the stomach. Food needs to be mixed with fluid in the stomach as well. Therefore, upon the initial cue that the arrival of food is imminent, cranial nerve X (the vagus nerve) stimulates the stomach to release the gastric juices that will be necessary for digestion. Contained in the gastric juices are water, hydrochloric acid (HCl), and pepsin, an enzyme that breaks down proteins in the stomach's acid environment. Water is necessary to keep food liquified. Hydrochloric acid serves several purposes: it signals further digestive events to occur; it dissolves food into smaller particles; it kills many microorganisms that may have been ingested; and it denatures proteins, causing the proteins to lose their structure so that they can be further digested.

In response to parasympathetic activation, the stomach also produces a protective coat of mucus. There are two types of mucus, visible mucus and soluble mucus, consisting of highly glycosylated proteins, called mucins. Mucous neck cells that surround the openings of the stomach's acid-producing glands (called gastric or oxyntic glands) produce visible mucus, which continuously forms a protective coat on the surface of the stomach. As the gastric gland sends out hydrochloric acid and enzymes, soluble mucus, formed by the cells that line the upper part of the gastric pits, is secreted ahead of it, and also covers the surface of the stomach. Together, the two types of mucus form a protective coat, called the glycocalyx. This coat is soluble in alcohol, while aspirin prevents the formation and secretion of mucin. Therefore, alcohol abuse, or excessive use of aspirin, can permit hydrochloric acid to attack the stomach lining, which leads to bleeding. In addition, individuals who are highly anxious do not experience proper parasympathetic activation when eating, and consequently do not produce sufficient mucus. Therefore, given the presence of other triggers for ulcer formation (and specifically infection with bacteria of the *Helicobacter* species), anxious individuals are often susceptible to peptic ulcers.

Preparation by the pancreas. Cranial nerve X stimulates the pancreas to release insulin from its beta cells. Insulin is the hormone responsible for moving glucose and amino acids out of the blood and into cells so that they can be used for fuel and for forming new or renewed tissue. Insulin is needed once food is digested and absorbed, because the concentration of glucose and amino acids in the blood then increases. Cranial nerve X also stimulates the pancreas to release bicarbonate into the small intestine, which will be used to neutralize the acid coming from the stomach. This process will be discussed in more detail in a later section.

Ingestion: The Mouth and Esophagus

Once the digestive system has properly prepared itself for its incoming meal, food is ingested. Food is wetted by saliva, tasted by the tongue and palate, and chewed or masticated by the teeth. Once the food is mechanically broken down into small enough pieces, it is ready for swallowing, or deglutition. Swallowing is actually a complicated process that requires coordinated activity of the tongue, palate, pharynx, and esophagus, over twenty-two muscle groups in all, controlled by separate regions of the brain. This activity requires strict control to guarantee that the food makes its way into the esophagus and not the trachea. If food is swallowed into the trachea, breathing is blocked and choking ensues. Once food enters the esophagus, the tongue blocks the mouth, the palate rises to close off the nasopharynx, and the larynx rises so that the epiglottis, a muscular flap, covers its opening into the respiratory passageways. Food is subsequently squeezed through the pharynx and into the esophagus by wavelike peristaltic contractions.

At the bottom of the esophagus is the cardiac or lower esophageal sphincter. The esophageal sphincter acts like a valve controlling the entry of food into the stomach. With each peristaltic contraction, the esophageal sphincter opens and a bolus of food lands in the stomach. The esophageal sphincter is also designed to stay closed while the stomach contracts, so that the acid from the stomach cannot reflux into the esophagus. The burning a person feels when acid refluxes into the esophagus is commonly known as heartburn.

Breakdown and Digestion: The Stomach

The act of eating, and some of the psychological pleasures connected with it, are captured in this photograph of a teenage girl nibbling her way through a cupcake. © LARRY WILLIAMS/CORBIS.

The stomach is responsible for a large proportion of both the mechanical and chemical breakdown of food. Once it accomplishes its goal, it delivers the resulting material (called chyme at this point) into the small intestine, at a rate that is dependent upon the mixture it digests.

The stomach is anatomically designed to stretch to accommodate the entry of food, and to churn and mix food thoroughly so it may be acted upon by stomach secretions and enzymes. At the top of the stomach is the fundus, a dome shaped section where the majority of hydrochloric acid is secreted. Below the fundus is the body of the stomach. The body of the stomach and the antrum of the stomach are separated by the incisura. Below the incisura is the antrum, which narrows and terminates at the pylorus. The pylorus opens into the duodenum through the pyloric sphincter, a muscular valve that controls the emptying of chyme into the duodenum.

When food arrives in the stomach. When food arrives in the stomach, the esophageal sphincter closes; the stomach muscles relax, with the result that the pressure inside the stomach decreases. These two actions prevent food

China and Eating: Taoist Five Elements

The Chinese healing tradition is centered on a fundamental concept—balance—and three fundamental ways of delineating the elements involved in this balance: yin and yang, or the principle of opposites that are complementary and mutually dependent; the Taoist concept of the five elements or five evolutions; and the concept of *qi*, or "intrinsic energy." Daily eating should promote a harmonious balance among these systems, while eating in times of disease should be managed in order to restore balance.

Traditional Chinese knowledge of the anatomy of the digestive organs is reasonably accurate. However, the physiological concepts based on the ideas outlined above differ considerably from their Western counterparts. All parts of the body, and actions of the body, have either a yin or a yang quality. Eating is yin, while bodily activity is yang. Thus overeating causes an excess of yin, and can only be compensated for by increasing yang, for example, by exercise. Foods themselves have yin or yang qualities, so that a properly balanced meal is one where foods are chosen in order to balance their yin and yang qualities.

The organs of digestion are each either yin (liver) or yang (stomach, small and large intestine, gallbladder). Emotions affect the balance of function of these organs, so that, for example, anger affects both the liver, the organ corresponding to yin, and the gallbladder, corresponding to yang, leading to dysfunction of both.

The Taoist five elements (wood, fire, earth, metal, and water) can be used to classify the organs of the digestive system, as well as tastes and smells, the orifices and tissues of the body, the emotions, and natural phenomena such as the seasons. The order of the elements also provides directionality, in the sense that the Elements follow each other in the order of their corresponding seasons, and the function of one organ is dependent on the good function of the organ preceding it in the sequence. Furthermore, this scheme functions in parallel with the yin/yang system, so that, for example, both the liver, a yin organ, and the gallbladder, a yang organ, correspond to wood, and anger, being associated with both of these organs, corresponds to wood as well.

As the "intrinsic energy" of the body, *qi* is critical to the processes and transformations that move food to its appropriate location in the body, and transform it into nourishment. Each food provides its quota of *qi* or activation of *qi,* or, if toxic, depletes or stagnates *qi.* In health, foods can help *qi* move downward through the "triple burner," consisting of the three divisions of the torso: the upper burner, devoted to respiration and containing the lungs and the heart; the middle burner, devoted to digestion and containing the spleen, stomach, liver, and gallbladder; and the lower burner, devoted to elimination, and containing the kidneys, bladder, and lower intestines. For example, radishes are thought to help *qi* move downward and thereby promote digestion and good health.

Thus these three interlocking systems serve to organize and direct eating behavior by providing a scheme for balancing the perceived characteristics of each food eaten and each health condition experienced.

from refluxing back into the esophagus. The stomach's relaxation reflex is also designed to accommodate the increased volume and develops in response to the stretching of the stomach's walls. Note that this relaxation reflex can be "trained." When a person regularly eats large meals, relaxation is greater, and when a person eats small meals, the relaxation reflex is less vigorous. This less vigorous reflex is why people feel their stomach "shrinks" when they go on a diet.

Hydrochloric acid is secreted by parietal cells in glands of the fundus of the stomach. As a result, the pH in the fundus can be on the order of 1–2. With this low pH, pepsinogen, secreted by chief cells, also located in these glands, is converted to pepsin. Pepsin breaks down protein-containing foods in the fundus into peptides and amino acids, and calcium and vitamin B_{12} are released. These food components arrive in the antrum, where they induce the production of the hormone gastrin. Gastrin travels via the blood to the fundus to increase hydrochloric acid secretion. Incidentally, due to this signaling function of protein in the stomach, it is nutritionally important to consume some protein with each meal. Gastrin also enhances closure of the pylorus and esophageal sphincter. Local histamine secretion sensitizes parietal cells to the effects of activation the vagus nerve and of gastrin. These three processes form a carefully coordinated system that is designed to maximize hydrochloric acid secretion and retention of material in the stomach so that it is properly mixed with each wave of contraction.

To prevent dumping of the stomach's contents into the duodenum, the pylorus closes, so that only about one-tenth of the amount of food that entered the stomach actually reaches the duodenum immediately after ingestion. As the pylorus closes, the area around the incisura contracts; this provides a narrow round opening separating the antrum from the body and fundus of the stomach. The antrum then contracts, shooting the food back through this narrow opening into the fundus, a process known as retropulsion. As mentioned above, the fundus secretes hydrochloric acid, so the food, the hydrochloric acid, and the enzymes become thoroughly mixed. At the same time, fats are broken down into small globules through this churning process. The incisura then relaxes, and the food mixture is propelled forward into the antrum. This process repeats itself time and time again.

Digestion in the stomach. As noted earlier, proteins are first digested in the stomach by an enzyme called pepsin. Pepsin breaks down protein into smaller molecules called peptides or polypeptides, which make their way into the small intestine for further digestion and absorption.

The digestion of fat begins in the stomach as well, through emulsification by churning and retropulsion. Fats that we consume are mostly in the form of triglycerides. A triglyceride is a molecule that has a glycerol backbone and 3 fatty acid chains attached to it. Fats are not water soluble ("oil and water do not mix") and therefore need to be packaged for absorption into the blood. One process that aids in the digestion and packaging of fat is emulsification. Emulsification increases the surface area of the fat that is available for enzymatic action in the duodenum.

Finally, the stomach secretes intrinsic factor, which is required for vitamin B_{12} absorption in the intestine. Vitamin B_{12} is a large molecule, and requires intrinsic factor to protect it from destruction by the stomach, and to enable its absorption through a specific receptor in the ileum.

Reflexes designed to clear out the lower GI tract. Before chyme can adequately make its way into the small intestine, there is a series of reflexes that are designed to prepare the lower gut (small and large intestine) for digestion. The result of these reflexes is that the lower gut gets cleared of old material so that there will be room for the new material coming down.

One reflex is known as the gastrocolic reflex and is due to stretching of the stomach after food lands in it. This reflex moves fecal material into the rectum, so you have a desire to defecate. This is why you may need to go to the bathroom after eating, especially after breakfast.

Gastrin is involved in the gastro-ileal reflex. This reflex clears chyme from the ileum, the furthest point of the small intestine, moving the chyme into the colon. Finally there is a duodenocolic reflex that is brought about when chyme enters the duodenum. This reflex also brings fecal material into the rectum in preparation for defecation.

Digestion and Absorption: The Small Intestine

After the chyme is thoroughly mixed in the stomach, it moves into the small intestine. The small intestine is the primary site for the chemical digestion and the absorption of food. The small intestine has three subdivisions: the duodenum, the jejunum, and the ileum. The duodenum, which connects to the stomach, is the point of entry for the secretions from the pancreas and from the liver via the gall bladder. The jejunum is the longest section of the small intestine and is the site where the majority of nutrients are absorbed. The ileum is the third division and connects to the beginning of the large intestine.

The small intestine is anatomically designed for efficient nutrient absorption. Not only is it very long, but it also has three structural modifications which further amplify its absorptive area: plicae circulares, villi, and microvilli.

The plicae circulares are deep folds of the intestinal mucosa which force the chyme to spiral through the lumen of the intestine. This effect slows the movement and increases the mixing of the chyme, thereby creating time for maximal nutrient absorption.

Villi are fingerlike projections that lie on the surface of the plicae. These projections increase the amount of contact between the surface of the intestine and the chyme, and they make absorption more efficient because they each contain a dense capillary bed and a lymphatic capillary called a lacteal, which act to transport nutrients into circulation. Lacteals are essential for fat absorption.

Finally, at the end of each villus cell are tiny microscopic projections called microvilli, which form the intestine's brush border. The microvilli dramatically increase the absorptive surface area of the small intestine. Moreover, there are enzymes that reside on the brush border that complete the final stages of chemical digestion of carbohydrates and proteins.

When chyme arrives in the duodenum. Chyme must enter into the duodenum at a rate the duodenum can handle. Furthermore, the acidic mixture must be neutralized so that it does not damage the duodenum. Finally, the digestion of the chyme must continue, and the process of nutrient absorption must begin.

It is important to note that the hormones and nerve activities discussed below are usually responsible for more than one of these above processes, and that more than one hormone or nerve activity is involved with each of these processes. In other words, the digestive system has in place a number of checks and balances to ensure that each responsibility is met during intestinal digestion and absorption.

Gastric inhibitory peptide (GIP), released by the small intestine, is one such hormone. As its name suggests, GIP inhibits gastric motility, thereby slowing down the delivery of chyme to the duodenum. In addition, GIP is responsible for helping tissues prepare for an influx of glucose, by causing release of insulin from the beta cells of the endocrine pancreas.

Other ways in which the flow of chyme is slowed enough to accommodate digestion and absorption are through intrinsic nerve signals from the gut, through a decrease in the activity of the vagus nerve or an increase in sympathetic activity, through the hormones secretin and cholecystokinin-pancreozymin (CCK-PZ), which are secreted by the duodenum in the presence of chyme. Not surprisingly, these hormones also have several other functions, discussed below.

In order for the digestive enzymes of the small intestine to be activated, they have to be in an alkaline environment. Neutralization of stomach acid is accomplished by secretions from the pancreas and from Brunner's glands, which line the duodenum. Both secretions are rich in bicarbonate, a basic compound that neutralizes stomach acid. The process of secretion for both of these systems begins with activation of the vagus nerve, which itself begins with the thought of food, as noted earlier. Secretion is further enhanced by secretin and CCK-PZ release from the duodenal wall in response to fat and amino acids in chyme. Vitamins and minerals do not require digestion for absorption.

Fat digestion and absorption. In the small intestine, fat is further emulsified by bile, a fluid that is produced in the liver and stored in the gallbladder. The release of bile into the duodenum is induced by contraction of the gallbladder, which propels the bile into the common bile duct, and from there into the pancreatic duct. The sphincter of Oddi relaxes, letting the bile and pancreatic juices flow into the duodenum. Contraction of the gallbladder, relaxation of the sphincter of Oddi, and release of pancreatic juices are all induced by cholcystokinin-pancreozymin (CCK-PZ), produced, as noted above, by the duodenal wall in response to the presence of fat and amino acids.

Once fat is emulsified by bile, it can be acted upon by enzymes called lipases, which break down fat. Pancreatic lipase requires a high pH for activation, which is accomplished through secretion of pancreatic bicarbonate. Pancreatic lipase breaks off fatty acids from the triglyceride's glycerol backbone, leaving a monoglyceride and two fatty acids. Bile acids then join up with the monoglycerides and fatty acids to form mixed micelles. Bile salts need to be present at or above the proper concentration—the critical micellar concentration, or CMC—in order for micelles to form.

Mixed micelles are shaped like hockey pucks, with bile salts forming the outer ring of the micelles, and the hydrophilic (water-soluble) ends of the fatty acids and monoglycerides forming the circular surfaces. Because of this packaging, the micelles can cross the water layer at the surface of the cells of the small intestine. It should be noted that long-chain triglycerides (>12 carbons) require both breakdown by lipase and incorporation into mixed micelles in order to be absorbed, while medium-chain triglycerides (with 8–12 carbons in each fatty acid chain) only require breakdown by lipase, and not micelle formation, because they are more hydrophilic.

Bile acids are recovered from the chyme in the terminal ileum, and returned to the liver for re-use. Note that the terminal ileum is also where vitamin B^{12} is absorbed. No other part of the intestine can compensate for these functions should the terminal ileum be diseased or lost, although absorption of other nutrients can occur successfully with loss of a considerable length of jejunum.

Carbohydrate digestion and absorption. Carbohydrates are also digested and absorbed in the small intestine. They are hydrophilic compounds, and therefore do not require complex packaging to be absorbed. Carbohydrates in our diet exist as monosaccharides, which are one sugar unit long (simple sugars: e.g., glucose, fructose, and galactose); disaccharides, which are two sugar units long (e.g., sucrose, lactose, and maltose); and polysaccharides, which are long complex strings of sugar units (e.g., glycogen and starch).

The majority of carbohydrates are consumed as polysaccharides, either as starch or glycogen. It should be noted that fibers, either soluble or insoluble, are types of polysaccharides that cannot be digested because we lack enzymes capable of chemically breaking them down.

Carbohydrates that can be digested begin to be broken down into small sugars in the mouth by the enzyme salivary amylase (noted earlier). You may have noticed that a piece of bread that you keep in your mouth for some time begins to taste sweet because the amylase in your saliva breaks down complex sugars into sweeter-tasting simple sugars.

The majority of carbohydrate digestion takes place in the small intestine via enzymes that are secreted by the pancreas. Pancreatic enzymes break polysaccharides down into oligosaccharides (2–8 sugars long), which are then acted upon by enzymes of the intestinal brush border. Within the brush border, oligosaccharides are further broken down into glucose, fructose, or galactose, depending on their initial composition. Glucose is the primary source of fuel used by cells in the body, and fructose and galactose can be converted into glucose via biochemical mechanisms.

Protein digestion and absorption. Protein digestion in the small intestine is accomplished by pancreatic enzymes as well. The large polypeptides created by the action of pepsin in the stomach are broken down into small peptides and amino acids by the pancreatic enzymes trypsin, chymotrypsin, and carboxypeptidase, as well as by peptidases in the brush border. Amino acids, the smallest functional unit of proteins, and small peptides are then absorbed into the blood, where they can be transported to cells for protein synthesis or for fuel.

The Large Intestine: The End of the Journey

The undigested portion of food that does not get absorbed by the small intestine passes on into the large intestine. The large intestine is responsible for reabsorbing the water added by the stomach and the small intestine to keep the chyme fluid, for fermentation of undigested products by bacteria, and for packing waste products into feces for excretion. The subdivisions of the large intestine are the cecum, appendix, colon (ascending colon, transverse colon, and descending colon), rectum, and anal canal.

Bacteria normally live in the large intestine. These bacteria either make their way into the large intestine by surviving the journey through the stomach and small intestine, or via the anus. These bacteria break down the fiber that is consumed, releasing gases, as well as the very smelly short-chain fatty acids that provide the major source of fuel for the wall of the large intestine. In addition, these bacteria are capable of synthesizing some B vitamins and vitamin K.

Once the contents of the colon are moved along via contractions, they reach the rectum, which otherwise is usually empty. Stretching of the rectal wall initiates a defecation reflex. This reflex is mediated by the parasympathetic nervous system and causes the walls of the sigmoid colon and the rectum to contract and the anal sphincter to relax. Once feces are forced into the anal canal, the stretch sends a signal to the brain informing us of the need to defecate. Under normal circumstances, the defecation response is under voluntary control.

Such a complex process as eating, in which each step is predicated on the preceding one, is prone to large variations in normal function. Specifically, the timing and efficiency of each of the steps described here show wide variability both from person to person, and for different food choices and consumption patterns. Some people have rapid intestinal transit time, and some slow nutrients are more easily digested and absorbed from some diets than from others. However, the basic scheme outlined here holds true for all healthy people.

See also **Appetite; Sensation and the Senses**.

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EATING DISORDERS. *See* **Anorexia, Bulimia; Eating: Anatomy and Physiology of Eating; Obesity.**

ECOLOGY AND FOOD. Naturalists and geographers have commented on human, food, and natural-resource relationships throughout history. Religion and politics have influenced their ideas. Once, many societies strongly valued community and balance between nature and humans. With industrial modernization, the philosophy changed to conquering or controlling nature via education, "objective" science, new technology, and new ideology emphasizing individualism. Education in the fields of agriculture, soil science, genetics, and food science greatly expanded to explore and promote new methods for increased food production, processing, storage, and distribution. While tractors, machinery, chemical fertilizers, and pesticides sharply increased food production for a growing population (hailed in the 1960s as the "Green Revolution"), some pointed to the limits of natural-resource use and "progress."

Ecology, Science, and Modernization in Food Production and Distribution

Ecology—or *Ökologie*, as coined by German biologist Ernst Heinrich Haeckel in 1911—was largely a twentieth-century development. In this perspective studied in the natural sciences, the world is an interrelated system where changes in one part of the system affect everything else. The sun's energy and the earth's minerals nourish a cycle of plant "producers," herbivore "consumers," carnivore and omnivore "consumers," and bacteria, fungi, and parasite "degraders" that return the organic waste of the producers and consumers back into the system. The plant producers, animal consumers, and microorganisms are all food to each other, with humans generally being among the omnivores. Overall population of plants and animals is limited by the resources available to consume, as well as the ability to adapt to environmental stressors such as extreme weather, disease, or toxic waste. Ecological systems are more stable, or in balance, when a large number or diversity of plant and animal species is present, rather than few species in any location. Hence, forests or prairies are more diverse and stable than hog farms or cornfields, whose single species are highly susceptible to environmental stressors. Intercropping and crop rotation allow some diversity, even though the plant varieties are nevertheless limited.

Human systems studied through anthropology or geography gave rise to cultural ecology, human ecology, and political ecology, as understanding of ecological complexity grew. Cultural ecologists studied human cultures around the world as a product of desert, grassland, temperate forest, rain forest, mountain, or tundra environments in which people live. Each human culture was characterized by its particular foods and processes for daily living that were particular to the environmental qualities and limitations of these different habitats. Viewed within the industrial modernization paradigm emphasizing specialized technology, cultural evolution was measured by how much energy was harnessed from the environment per unit of human caloric input for hunter-gatherers, early small-scale cultivation and animal

FOOD PRODUCTION COSTS AND BENEFITS

The tremendous nonhuman energy fuel inputs in the more technological modern societies demonstrate ecological imbalance. The United States, for example, has one-twentieth of the world's population, but uses one-third of the world's fuel resources. Growing one calorie of food requires three calories of fossil fuel input for machinery, electricity, and fertilizer, and at least nine calories of fuel when processing and market transportation are included. This still excludes building the transportation vehicles, roads, and factories.

Genetic breeding of high-yield seeds and animals has led to more monocropping and less genetic diversity in the globalized cash-crop agriculture. Often the seeds are hybrids that do not reproduce new seeds to grow crops, so farmers must purchase each year's seeds from the agricultural industry. Nor are the high-yield seeds adapted to environmental stressors in diverse habitats without purchased chemical fertilizer and pesticide inputs. While new chemical pesticides are less immediately toxic than old arsenicals, cyanide, or nicotine, DDT (dichloro-diphenyl-trichloroethane) fatally weakens birds' eggs nearby, and there have been strong suggestions of a link between pesticides (particularly DDT) and the tumors, reproductive problems, and cancer that occur among farmhands who have direct and repeated contact with the chemicals. Thus pesticides' long-term safety to consumers and the environment is questioned by those such as biologist Rachel Carson, who in 1962 exposed the dangers of pesticides in her seminal book, *Silent Spring*.

Also, farmers receive much less income for their food-production efforts compared to others in the overall marketing system. The twentieth-century Green Revolution that was to produce volumes of food for global markets also produced environmental and cultural degradation as traditional food-production practices, decision-making, and locally adapted seed and animal varieties were replaced. Since Neolithic times, increased crop volume has not necessarily produced better nutrition, since food distribution, access, and nutrient quality of the ensuing diet are frequently inadequate. High food volume allows high population density, increasing the risk of infectious disease because of waste management problems and peoples' proximity to each other.

husbandry, more advanced agriculture of state societies, and then global industrial society. Animal, mechanical, transportation, and fossil-fuel inputs were often overlooked so that technological modernization was perceived to produce great volumes of food and caloric energy for the exponentially growing population.

Human ecologists further examined ecological interrelations of humans, food production, and consequent health status in different habitats. Calculating detailed energy flow of food and fuel calories in particular groups' ecological systems illuminated the limits of the natural environment, and the adaptiveness of people's physiology and behavior to particular environments, foods, and climate. Human ecologists, like Michael Watts, defined the causes of severe droughts and food shortage in sub-Saharan Africa in the mid-1970s and 1980s. Since drought is cyclical, human ecologists investigated how traditional populations avoided famine via many traditional strategies to modify, buffer, distribute, resist, avoid, or conform to the perturbation. Food storage techniques, crop diversity, and irrigation are prime examples of buffering, distributing, or modifying environmental stressors. Continued use of such indigenous knowledge was recommended. Researchers also began to understand how the limits of natural-resource accessibility have been controlled by local, regional, and global politics and economic market forces throughout history. Political and economic decisions made by new groups resulted in short-term gains, which often disrupted the longer-term environmental sense of traditional practices that had permitted people to survive over time. Hence, political ecology became the study of these combined factors, to improve food production further.

Environmentalism and Scientific Ecology

Some argue that the conservation movement arose through scientific application of ecological concepts so as to rationally plan economic development, thus replacing the public's or business's inefficient, shortsighted use of natural resources. Others believe that conservation occurred in reaction to modern industrialization's political grip over nature and people. Nevertheless, the environment has been known through an emotional, spiritual relationship of people who identify with their natural surroundings. Academic ecology initially had the premise that, by understanding ecological relationships, one could better control the parts of the process. "Objective" science and technology was the tool of industrial modernization's goal: controlling nature and other humans. Many public environmental movements identified with earlier religious and political philosophies oriented to the beauty and balance in nature, whereby taking too much from the system sends it into imbalance and ecological disaster.

Environmentalism has various forms that consequently advocate different philosophies and strategies for maintaining a balance among humans and the natural environment. Radical environmentalism includes deep ecology, social ecology, and ecofeminism. Radical environmentalism suggests eliminating the current political economic system to reach a more environmentally sound existence, whereas "surface" ecology advocates tinkering within the current system to direct it toward more sustainable or lower-impact options. Contrasts in environmental approaches have long existed, as reflected in John Muir's transcendental philosophy and Sierra Club in the early 1900s, versus Chief U.S. Forester Gifford Pinchot's scientific resource management of agriculture, forestry, livestock, and mining lands during Theodore Roosevelt's administration (1901–1909). Other environmentalists would emulate Aldo Leopold, who in the 1930s departed from scientific resource management to more spiritual approaches. Many scientific ecologists also gain insight from philosophical teachings and select career objectives that will serve the needs of humans and nature.

Sustainable Agriculture and Globalization

The counterculture of the 1960s and 1970s heightened interest in "health food" and food co-ops. This, and returning to organic farming, bioregional marketing, and sustainably "living off the grid" were reactions to capitalist globalization, vertical integration, and concentration in the food industry. Vertical integration involves ownership of the entire process of food production, processing, shipping, and marketing by a corporation or set of related corporations. The corporation may subcontract the riskier lower-profit aspects of the process to a separate small business that coordinates the farmers to meet the corporation's demand for specific qualities and timing of crop or livestock production. Concentration involves controlling entire food types (for example, pork, chicken, or flour) by only a few corporations. Contrastingly, community-supported agriculture and local farmers' markets feature direct marketing between the farmer and consumer.

Radical Environmentalism: Deep Ecology, Social Ecology, Ecofeminism

The term "deep ecology" was coined in the late 1960s by its leading proponent, Arne Naess, Norwegian mountaineer and teacher of Eastern and Western philosophy. Bill Devall and George Sessions, as well as David Foreman (founder of the radical group Earth First!) are more recent promoters. According to deep ecologists, the natural world is understandable through deductive subjectivity and consciousness raising. Examples of nature's value are gleaned from many religious philosophies. Population control and the biocentric valuing of plants and animals are deep ecology's hallmarks, rather than an anthropocentric orientation based on human needs. This has disturbing political implications when applied by elite classes or countries to the global system, since wildlife preservation is promoted over human needs in poverty-stricken areas. Neglect of these human needs becomes, therefore, population control.

Murray Bookchin pioneered the idea of "social ecology" in the 1960s as a means to address social inequity and sustainability by arguing for a more equitable decentralized political economic system using more alternative technology. But social ecology's Marxist and German Greens influences are often contrary to the philosophy and practices of the modern global market system. According to Bookchin, the natural and human ecological system develops through an educative, mediated, cumulative approach, versus the deductive understanding of nature, or the mechanistic evolutionary continuum of modernization found in deep ecology.

"Ecofeminism," promoted especially by female social scientists, notably Carolyn Merchant, explains environmental degradation and means for balance based on historical inequity of male and female social relations and decision-making. However, numerous evolutionary, structural, and political economic paradigms are confounded in selection of examples, much as deep ecology muddles religious philosophy from stratified and egalitarian social systems. According to ecofeminists, ritual, myth, and intuition are among methods of women's knowing, versus authoritative knowledge of male-centered "objective" science, business, and politics.

The U.S. Food and Drug Administration (FDA) began as the "Division of Chemistry," created in 1862 as an agency of the Department of Agriculture and charged with the responsibility of regulating toxic food additives, preservatives, quack drugs, and insecticides. However, the FDA (so named in 1930) has become associated with industrial pharmaceutical business, authoritative curative medicine, and health-insurance interests by those preferring self-directed disease prevention with "health" foods and herbal and vitamin supplements. Vegetarian and organic products are often selected for reasons philosophical (to protect animals) or environmental (to eat chemical-free or low on the food chain). Europeans react strongly against genetically modified food because of possible harm to others in the food chain, and against large-scale animal-husbandry practices that increase infectious disease, such as animal foot-and-mouth disease or "mad cow" disease—also feared for suspected neurological problems in humans. Yet the health-food market is subsumed by the corporate vitamin and supplement industry; the industrialization and mass marketing of "organic," "natural," or "health" food (a world market worth more than twenty-two billion dollars annually); more chain stores; and the U.S. Department of Agriculture's national organic standards of December 2000. Previous standards varied among regional organic farming associations, some being so strict that industrial organic farming would be prohibitive.

Interestingly, industrial and alternative agriculture claim overlapping goals, although careful examination reveals very different ideals behind those goals. Industrial corporations see a sustainable food system as ecologically sound, economically viable, and socially acceptable. When asked to identify their visions of a food system, supporters of alternative agriculture use such terms as ecologically sustainable, knowledgeable and communicative, proximate, economically sustaining, participatory, just and ethical, sustainably regulated, sacred, healthful, diverse, culturally nourishing, seasonal and temporal, economically value-oriented, relational. Conventional, industrial agriculture—centralized, dependent, competitive, specialized, and exploitative—attempts to dominate nature and the enterprise. Alternative agriculture is decentralized, independent, community-oriented, and restrained, with an emphasis on diversity and harmony with nature. The former maintains company profits; the latter attempts to maintain broader sociocultural and biological integrity of the local community and ecosystem.

See also **Additives; Environment; Food Politics: United States**; **Food Safety**; **Food Waste**; **Green Revolution**; **Herbicides**; **Organic Agriculture**; **Organic Food**; **Pesticides**; **Political Economy**; **Toxins, Unnatural, and Food Safety**; **Water: Safety of Water**.

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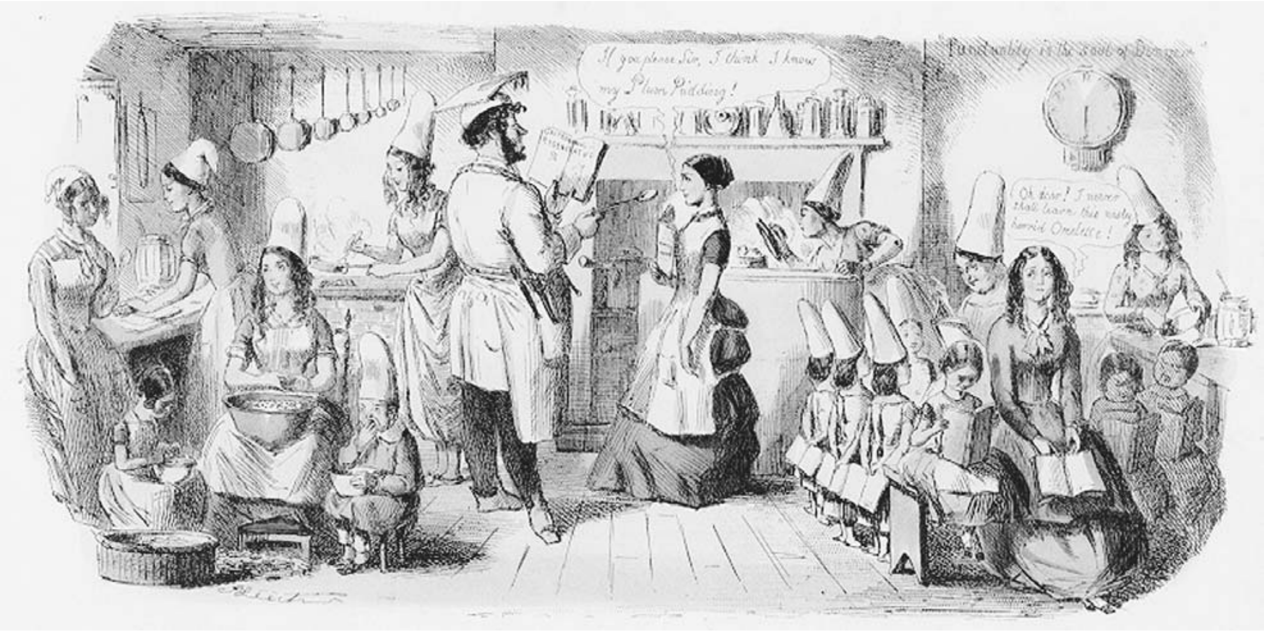
EDUCATION ABOUT FOOD. Traditionally, chefs' proprietary interest in their culinary knowledge has hindered their efforts to educate successors. Before the late eighteenth century, culinary education meant apprenticeship in private—or royal—kitchens. To some extent, it still does mean that, although modern kitchens are more commonly commercial. Today, culinary education other than apprenticeship occurs in two primary forms: formal and independent, each subdivided into professional and domestic training.

Formal Study

In the late eighteenth century, chefs began to seek the respect accorded to other professionals. Recognizing that formal education is required for professional status, E. Kidder opened the first school for chefs in England in 1781. It was not until 1874, however, that the prestigious London Cookery School emerged. The pioneer French culinary school, École Professionnelle de Cuisine et des Sciences Alimentaires, debuted seventeen years later, but was short-lived (1891–1892). Le Cordon Bleu (1895), the first truly successful professional cooking school, became the prototype for most subsequent culinary programs.

Outside the United States, culinary schools generally issue certificates, not degrees. Since the end of World War II, many American chefs have been educated in collegiate culinary programs, receiving degrees from Cornell's School of Hotel Administration (1922), The Culinary Institute of America (1946), Johnson & Wales University (1973), or dozens of other colleges.

Cooking schools for domestic (primarily female) cooks began earlier than those for professionals. The first American cooking school, Mrs. Goodfellow's, opened in Philadelphia around 1820. Its anonymous textbook *Cookery As It Should Be* (1853) was reprinted in 1865 as *Mrs. Goodfellow's Cookery As It Should Be*.


If you please Sir, I think I know my Plum Pudding!
"Punctuality is the Soul of Business"
Oh dear! I never shall learn this nasty horrid Omelette!

The learning experience of a cooking school for young ladies is the subject of this John Leech caricature in 1851. The student in the center is curtsying although holding her ground: "I think I know my plum pudding!" On the right, another student bemoans that she will never learn how to make a proper omelet. From John Leech's *Follies of the Year* (London, 1864). ROUGHWOOD COLLECTION.

The Boston Cooking School (1878) was the most influential of the early cooking schools, resulting in the publication of *Mrs. Lincoln's Boston Cook Book: What To Do and What Not To Do in Cooking* in 1884. Fanny Farmer's *The Original Boston Cooking-School Kitchen Cook Book* (1896) applied scientific structure and principles in the home kitchen—foreshadowing Auguste Escoffier's *Le Guide Culinaire* (1903), which attempted to do the same for the professional kitchen.

Independent Study

Early professional cookbooks—written by and for men—such as Apicius's *De Re Coquinaria* (first century) or the *Viandier of Taillevent* (fourteenth century) were simply collections of recipes. They did not attempt to teach technique because they were intended for professional cooks who—presumably—understood their vague, missing, or abbreviated instructions. Charles Carter's cookbook, *The Complete Practical Cook: Or, A New System of the Whole Art and Mystery of Cookery* (1730), was typical of early cookbooks in that it was written for the management of wealthy households, but it consciously strove to educate the reader in the "most useful and noble Mysteries of their Art."

Most early home cookbooks, such as Torquatto Tasso's *The Householders Philosophie* (1588), were intended for women. They featured cooking instruction as just one of the duties comprising home economics or "domestic science." Home economics was envisioned—especially in the late nineteenth and early twentieth centuries—as a way to modernize—and professionalize—women's household work with "scientific" respectability. The Boston Cooking-School's textbook (1887) was such a treatise on "domestic science."

The earliest professional magazines for chefs and bakers—*L'Art Culinaire* (not the *L'Art Culinaire* available today), *Le Progrès des Cuisiniers*, *L'Étoile* and *Le Progrès Gastronomique*—first appeared in the 1880s. Today, there are hundreds of trade magazines for food professionals in almost every imaginable language. Even more food magazines are targeted at home cooks, and almost every major newspaper carries at least a column—and, more often, an entire section—devoted to food preparation.

Televised cooking lessons have grown in popularity and sophistication since Julia Child's *The French Chef* (1963). An entire network is now devoted to food programming—although it is intended largely for amateur cooks. The Culinary Institute of America and the California Culinary Academy (1977), however, produce series for public television that teach professional techniques for home use.

The Internet is a major supplier of culinary information for both home and professional cooks, offering recipes, reviews (of books and restaurants), nutritional data, links with TV cooking shows, and dozens of specialized culinary discussion groups.

Food Studies

Aside from cooking instruction, "Food Studies" is beginning to be recognized as a legitimate scholarly subject in its own right. Today, one can earn a master's degree in gastronomy at Boston University or the University of Adelaide, or a doctorate in Food Studies and Management from New York University.

Professionals in food science and nutrition have long had academic societies, but more recently scholars working in food studies have formed such groups. The Oxford Symposia on Food and Cookery (1981) provide opportunities for scholars from diverse backgrounds to share their research. The Association for the Study of Food and Society (1986) and the Agriculture, Food and Human Values Society (1987) promote research and scholarship on food-related issues, drawing on disciplines as diverse as anthropology, sociology, geography, literature, nutrition, and history.

Excellent culinary libraries—including the Arthur and Elizabeth Schlesinger Library on the History of Women in America (Radcliffe College); the James Beard Foundation Archive and Library (New York); the Conrad N. Hilton Library (Culinary Institute of America); Culinary Archives & Museum (Johnson & Wales University); Foundation of Chinese Dietary Culture (Taipei); Foundation B. IN. G. (Bibliothèque Internationale de Gastronomie, Italy); and Bibliothèque Municipale de Beziers, Bibliothèque Municipale de Dijon, and G. Sender (France)—inform food scholars.

The American Institute of Food & Wine (1981) and the James Beard Foundation (1985) spread awareness of gastronomic excellence through education, publications, scholarships, and events. Oldways Preservation & Exchange Trust (1988) and Italy's Arcigola Slowfood (1986) are preserving the knowledge and practice of traditional foodways.

Several societies of professional culinary educators have been organized to enhance respect for chefs. The American Culinary Federation (1929) awards the culinary equivalent of a doctoral degree—Certified Master Chef (CMC)—and accredits over one hundred American culinary education programs. Similar groups include the Council on Hotel, Restaurant, and Institutional Education (1946) and the International Association of Culinary Professionals (1990).

Les Dames d'Escoffier (1976) and Women Chefs and Restaurateurs (1993) were formed specifically to advance the professional status of women in the food service industry, successfully doing for professional female culinarians what the domestic science movement attempted to do for home cooks.

See also **Beard, James; Child, Julia; Cookbooks; Escoffier, Georges-Auguste; Food Studies; Gastronomy; Goodfellow, Elizabeth; Taillevent.**

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Gary Allen

EGGS. Eggs have been known to, and enjoyed by, humans for many centuries. Jungle fowl were domesticated in India by 3200 B.C.E. Records from China and Egypt show that fowl were domesticated and laying eggs for human consumption around 1400 B.C.E., and there is archaeological evidence for egg consumption dating back to the Neolithic age. The Romans found egg-laying hens in England, Gaul, and among the Germans. The first domesticated fowl reached North America with the second voyage of Columbus in 1493.

Eggs are a staple of the diet in most of the world. They are used as main dishes or served as garnish with other parts of the meal. Barer-Stein points out that Austrian and Croatian cuisines are rich in eggs. In Africa eggs are regarded as a symbol of fertility and accompany yams in many festive dishes.

While most discussions of eggs and egg nutrition refer to bird's eggs, it should be borne in mind that many other animal species also lay eggs. Among mammals the echidna and the duck-billed platypus lay eggs. Reptiles, among them lizards, chameleons, and the tuatara of New Zealand, lay eggs, as do toads and frogs. Mollusks and

TABLE 1

Proximate composition of a large raw egg

(59 g shell, 33.4 g white, 16.6 g yolk)

Nutrient	Whole egg (g)	% in yolk
Water	37.665	21.5
Protein	6.245	44.5
Carbohydrate	0.61	48.4
Fat	5.01	100.0
Ash	0.47	57.9

crustaceans lay eggs that appear in a variety of forms. The eggs of fish offer a wide range of number and form; for instance, salmon eggs are deposited in a trough prepared by the parent, while eggs of perch are adhesive and stick to water plants.

The number of eggs laid by fish varies widely but increases with age and weight. The salmon may produce 1,000 eggs for every pound of weight. The sturgeon lays about 7,000,000 eggs, whereas the herring and sole produce 50,000 and 134,000 eggs, respectively. The number of eggs laid is proportional to the risk of destruction or loss.

The greatest knowledge of eggs, their physiology and chemistry, comes from observing hens. The hen's reproductive system consists of the ovary, where the yolk develops, and the oviduct where the egg is completed. At birth the female chick has a fully formed ovary containing several thousand tiny ova, or future yolks. The ova begin to develop, one at a time, when the chick reaches sexual maturity. Each yolk is enclosed in its own sac or follicle. The follicle contains a system of blood vessels that supply nourishment to the developing yolk. At ovulation the follicle ruptures, thus releasing the yolk into the oviduct. The yolk passes into the infundibulum (funnel), where fertilization could occur. After about fifteen minutes the yolk passes into the magnum, where, in a period of three hours, albumen is deposited around the yolk. The yolk next passes into the isthmus where two shell membranes are formed in about seventy-five minutes. The egg has now achieved its full size and shape. It now passes into the uterus, where, over a period of nineteen to twenty hours, it acquires its shell, shell color, and outer shell coating. After a few minutes the egg is released via the vagina, cloaca, and vent. During formation the egg moves through the oviduct small end first, but just before laying, it is rotated and laid large end first. It takes the hen twenty-four to twenty-six hours to produce an egg. Within fifteen to thirty minutes after laying, the hen starts the process all over again.

The egg is designed to support life (to bring a chicken into the world) and has been called nature's ideal food. The yolk comprises about one-third of the weight of the egg. The albumen or white of the egg is primarily protein and water. The yolk of a large egg contains fifty-nine calories and the albumen carries about seventeen calories. See Table 1 for the proximate composition of a large raw egg.

Protein is required for synthesis and maintenance of muscles, body organs, nerves, bones, and blood. Protein quality is measured by how efficiently it is used for growth. Only mother's milk has higher quality protein.

Egg protein contains different amino acids, including all the essential amino acids (essentiality of a nutrient means that it cannot be synthesized by humans and must be obtained from the diet).

Fat (lipid) comprises about 10 percent of the total weight of a large egg. The lipid composition of the egg is presented in Table 2.

Saturated, monounsaturated, and polyunsaturated fatty acids comprise 37.5, 46.0, and 16.5 percent of the total, respectively. Oleic acid (18:1) represents 40 percent of egg yolk fatty acids. There is a nutritional ambivalence with regard to eggs. Although the superior quality of egg protein is acknowledged, there is concern regarding the cholesterol content, this despite evidence that moderate intake of egg yolk is generally not harmful. Since polyunsaturated fats reduce plasma cholesterol levels, efforts have been made to increase their presence in the yolk. Feeding laying hens high levels of polyunsaturated fats such as corn or soybean oil will raise the level of their component yolk fatty acids to a slight degree. "Polyunsaturated" eggs are commercially available, but there is little evidence regarding any sustained hypocholesterolemic effect. There are also efforts to increase levels of antioxidant vitamins and fish oil

TABLE 2

Yolk lipids of a large raw egg

(59 g shell, 33.4 g white, 16.6 g yolk)

Fatty acids	G
Total	4.43
Saturated	1.59
Myristic (14:0)	0.02
Palmitic (16:0)	1.14
Stearic (18:0)	0.40
Monounsaturated	1.95
Palmitoleic (16:1)	0.15
Oleic (18:1)	1.78
Eicosenoic (20:1)	0.01
Polyunsaturated	0.70
Linoleic (18:2)	0.59
Linolenic (18:3)	0.02
Arachidonic (20:4)	0.07
Docosahexaenoic (22:6)	0.02
Cholesterol	0.21
Lecithin	1.11

Floating island was one of the most popular meringue desserts in eighteenth-century English and American cookery. It is still popular in England today. Egg whites whipped with wine are shown here floating in a creamy Madeira sauce. The "island" is garnished with crystallized violet petals and toasted almonds. © MICHAEL BOYS/CORBIS.

fatty acids in egg yolk and those products, too, are available to the public.

Hen's eggs are the most common source of egg nutrition. In 1989 the three largest egg-producing countries were China (140,900 × 10^6 eggs), Russia (84,600 × 10^6 eggs), and the United States (67,042 × 10^6 eggs). However, eggs of other avian species are eaten around the world. Hen's eggs contain less fat and less cholesterol than those of the duck, goose, quail, or turkey. The amount of fat in a yolk is partly a function of the size of the embryo and its future requirements. Caviar, for instance, contains almost 18 g of fat per 100 g of edible portion, but its cholesterol content is only 38 percent greater than that of the hen's egg. The major fatty acids of all the yolks are palmitic and oleic.

The egg is an easily available, inexpensive source of high-quality nutrition. It is an especially important source of nutrition for young people, old people, and sick people. Starting about forty years ago, as the relation between blood cholesterol and the risk of coronary heart disease was unfolding, the egg came under fire because of its cholesterol content. The assumption was that eating cholesterol-rich foods led directly to elevations in blood cholesterol and hence in risk of disease. That elevated blood cholesterol presents a risk for heart disease is fairly well established, but a direct link between dietary cholesterol and levels of blood cholesterol is not. Many other aspects of the diet influence blood cholesterol to a greater extent than does dietary cholesterol; principal among them are the amount of saturated fat in the diet and the type and amount of fiber in the diet. There are dietary prescriptions limiting the permissible amount of cholesterol in the diet. These are easy to follow, but are based on relatively little hard data. The emphasis on cholesterol has overshadowed the greater impact of saturated fat. The fat of the egg is relatively unsaturated, or the raw yolk would be solid. A calculated iodine value (measure of unsaturation) of egg yolk is about 72, which is not much below that of olive oil.

The relation of dietary cholesterol to blood cholesterol levels has been studied for many years. In the early 1950s it was demonstrated that while cholesterol levels of subjects with coronary disease were significantly higher than those of control subjects there was no relation to the level of cholesterol in the diet. In 1970 the subjects in the Framingham Study, both men and women, were segregated by serum cholesterol level under 180 mg/dl, over 300 mg/dl, and 181–300 mg/dl. The study found no correlation of serum cholesterol with any dietary component. The Framingham Study also showed that ingestion of one or nine eggs per week had the same influence on serum cholesterol. A study conducted by the NIH over twenty years ago attempted to correlate dietary factors with actual heart attacks in three large studies—Framingham, Puerto Rico, and Hawaii. At no location were there differences in cholesterol intake between those subjects who had suffered a heart attack and those who had not.

Epidemiological studies of dietary cholesterol have to be aware of possible confounding by other dietary factors. Many foods high in cholesterol are also high in saturated fat. High-fat diets are often poor in fiber. Since saturated fat intake has been linked to coronary disease and fiber appears to be protective, both must be considered when evaluating the role of dietary cholesterol.

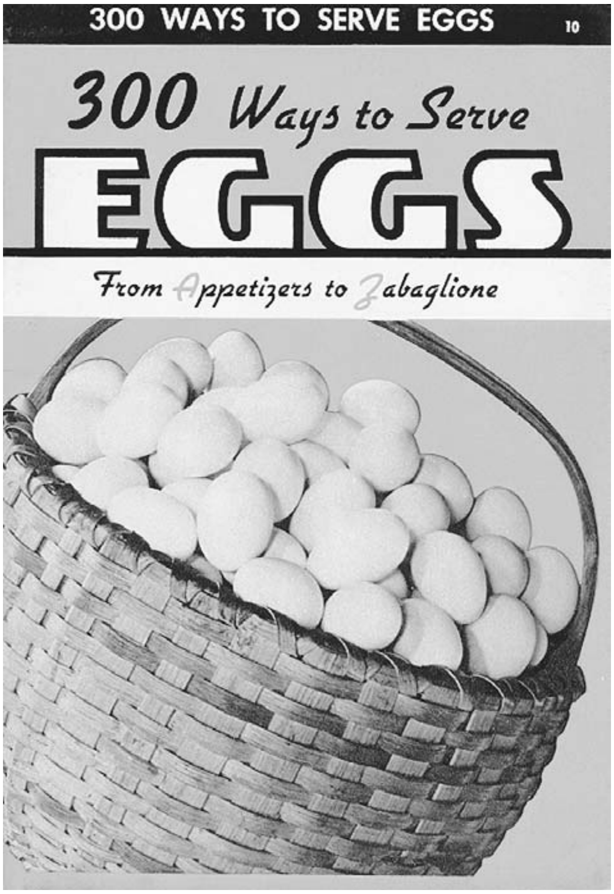
Data relating dietary cholesterol to heart disease are available. A study of middle–aged men in the Netherlands showed no significant relationship between cholesterol intake and coronary death after ten years. A positive relationship appeared after twenty years of follow-up but was not significant after adjustment was made for standard risk factors, occupation, and energy intake.

More pertinent to the discussion is the relationship, if any, between egg consumption and coronary disease. A study of women in Italy found no association between egg consumption and nonfatal myocardial infarction. A study among Seventh Day Adventists in California found no association between egg consumption and risk of cardiovascular disease, whereas a study of vegetarians in Oxford, England, found a significantly greater risk in those consuming six or more eggs a week than in those eating less than one egg per week.

One study, conducted at Harvard University, was aimed at investigating an explicit relationship between egg consumption and risk of cardiovascular disease. The authors addressed data derived from ongoing studies of more than eighty thousand female nurses and more than forty-three thousand male health professionals. After adjustment for age, body mass index, cigarette smoking, parental history of heart disease, vitamin intake, alcohol use, hypertension, physical activity, energy intake, bacon consumption, and in the women, menopausal status and postmenopausal hormone use, there was no association between egg consumption and coronary heart disease in either group.

The diet-heart hypothesis holds that a diet high in saturated fat and cholesterol and low in polyunsaturated fat leads to hypercholesterolemia and subsequent development of atherosclerosis. Addition of eggs to the usual diet of free living subjects does not affect cholesterolemia. Addition or deletion of eggs in the diet leads to other changes in diet that must be evaluated and corrected for. The Framingham data suggest that addition of eggs to the diet does not affect serum cholesterol levels. The egg is a source of a number of essential nutrients; that, plus its high-grade protein and low price, make the egg a desirable food, especially for the very young, old, and infirm. The presence of a high level of cholesterol in the egg has led to suggestions that it not be included in healthful diets since elevated blood cholesterol is a risk factor for cardiovascular disease. Data are accumulating which show that dietary cholesterol has a minimal effect on blood cholesterol levels. Epidemiological data also show little association between eggs and risk of cardiovascular disease. Eggs can be an important part of the diets of healthy persons.

See also **Cholesterol; Combination of Proteins; Lipids; Poultry; Proteins and Amino Acids; Sea Birds and Their Eggs.**



Published in 1940 by Ruth Berolzheimer, director of the Culinary Arts Institute in Chicago, *300 Ways to Serve Eggs* was both a booster for the egg industry and a novel attempt to make egg dishes the focal point of the menu. The rustic country basket on the cover is intended to imply farm-raised and down-home goodness, although no egg grower would pile eggs that high—they would crush one another. ROUGHWOOD COLLECTION.

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EGYPT. *See* **Middle East; North Africa.**

ELECTROLYTES. Electrolytes are molecules that, in solution, dissociate into positively charged ions (cations) and negatively charged ions (anions). Principal ions in body fluids are sodium, potassium, and chloride. A 70 kg adult has a body content of approximately 100 g sodium, 140 g potassium, and 95 g chloride. To maintain a stable body content, the amount of principal ions lost must equal the amount consumed. During growth and during pregnancy, the amount accreted for tissue formation also must be considered.

Physiological Functions

Sodium is the predominant cation in fluids outside the cells (extracellular fluid), whereas potassium is the predominant cation in the intracellular fluid. Chloride is the major anion of the extracellular fluid. Sodium plays a central role in regulating body fluid balance and distribution of fluid between the extracellular and intracellular compartments. As sodium is the major osmotically active particle in the extracellular fluid, sodium and its accompanying anion determines the osmolar concentration, or osmolarity, of this compartment. An increase in sodium concentration will increase the osmolarity of the extracellular fluid, thus causing water to move out of the cells into the extracellular compartment. It will also cause water retention by stimulating the thirst mechanism and by decreasing urine flow. The opposite occurs when sodium concentration is decreased. Thus, sodium plays a central role in regulating body fluid balance and the distribution of fluid between the extracellular and intracellular compartments.

Potassium is necessary for normal growth and plays an important function in cell metabolism, enzyme reactions, and synthesis of muscle protein. Both sodium and potassium are involved in maintaining proper acidity (pH) of the blood and in maintaining nerve and muscle functions. Normal resting membrane potentials of nerve and muscle cells range between −50 and 100 mV, with the inside of the cells negative with respect to the outside. These resting membrane potentials are maintained by the chemical gradient of potassium across cell membranes. Activation of excitable cells alters their membrane permeabilities to sodium and potassium, leading to changes in their membrane potentials. A weak stimulus causes a small depolarization (the inside of the cell is made less negative) as a result of sodium influx along its electrochemical gradient via the voltage-gated sodium channels in cell membranes. This is followed by repolarization, which is a manifestation of potassium efflux. If the stimulus is sufficiently strong, large changes in the membrane potential occur, during which the membrane potential may change from −70 mV to +30 mV, and then repolarize back to its resting membrane potential. This action potential, cause by alternation of potassium steady-state potentials with pulsed sodium potentials, gives rise to a traveling wave of depolarization that is conducted along the nerve fiber to exert an effect on the effector cells it innervates (supplies with nerves). In muscles, action potential leads to muscle contraction.

Dietary sodium chloride in foods and beverages is absorbed mostly in the small intestine. Active transport of sodium out of the small intestinal epithelial cells across their basolateral membrane provides an electrochemical gradient for the absorption of sodium across the luminal membrane. Entry of sodium through carrier proteins can either transport other solutes against their concentration gradient in the same direction (co-transport) or in an opposite direction (counter-transport). A number of transporters have receptor sites for binding sodium and glucose, galactose, or amino acids. Therefore, entry of sodium across the luminal membrane also brings in a solute. Counter-transport mechanisms operating in the kidneys allow excess hydrogen and potassium to be excreted in the urine.

Consumption of Sodium, Chloride, and Potassium

Consumption usually exceeds the needs of an individual, although the amount consumed varies widely with dietary habits. Most natural foods contain high potassium content but are lower in sodium content (Table 1). American adults consume an average of 2.5 to 3.5 g of potassium daily. Individuals consuming large amounts of fruits and vegetables may have a daily intake of as high as 11 g. Sodium is consumed mainly as sodium chloride (table salt). A small amount is consumed as sodium carbonate, sodium citrate, and sodium glutamate. Intakes of sodium vary, averaging 2 to 5 g/day of sodium or 5 to 13 g/day of sodium chloride. Only about 10 percent of sodium intake is from natural foods, the rest from sodium salts added during cooking and at the table, and from salts added during processing of foods. In regions where consumption of salt-preserved foods is customary, intake of sodium can be as high as 14 to 20 g/day.

Under normal circumstances, about 99 percent of dietary sodium, chloride, and potassium is absorbed. Absorption occurs along the entire length of the intestine, the largest fraction being absorbed in the small intestine and the remaining 5 to 10 percent in the colon. Potassium is also secreted in the colon. Various homeostatic regulatory mechanisms, the most important of which is aldosterone, modulate the absorption of sodium and secretion of potassium.

Loss of Sodium, Chloride, and Potassium

Obligatory loss of fluids through skin, urine, and feces invariably causes loss of these ions. Minimal obligatory loss for an adult consuming average intakes has been estimated to be 115 mg/day for sodium and 800 mg/day for potassium. Over 95 percent of loss is in the urine. Under most circumstances, loss of chloride parallels that of sodium. Loss of these ions can increase greatly in diuresis, vomiting, and diarrhea. Loss of sodium chloride can also increase greatly from profuse sweating.

Recommended Intake. Daily minimum needs can be estimated from the amount required to replace obligatory losses (Table 2). The need is increased in infants and children, and during pregnancy and lactation. Estimated safe minimum intake levels are higher than the minimum requirements to account for the various degrees of physical activity of individuals and environmental conditions. Average intakes in the United States are higher than the estimated safe minimum levels of sodium chloride (1.3 g/day) and potassium (2 g/day).

TABLE 1

Food sources of sodium, chloride, and potassium (mg/100 g)

	Sodium	Chloride	Potassium
Natural Foods			
Beef, lean (ribs, loin)	65	59	355
Pork, lean (ribs, loin)	70	—	285
Chicken fryers (with skin)	83	85	359
Salmon, fresh	48	59	391
Milk (pasteurized, whole cow's)	55	100	139
Wheat flour (whole)	2	38	290
Rice (polished, raw)	6	27	110
Potatoes	3	79	410
Carrots	50	69	311
Beans (string, fresh)	1.7	33	256
Apricots	0.6	—	440
Dates (dried)	1	290	790
Oranges	1	3	170
Almonds	4	2	773
Processed Foods			
Bacon (medium fat)	1770	—	225
Beef sausages	810	1100	150
Smoked salmon	1880	2850	420
Cheese (Cheddar)	700	—	82
Butter (unsalted)	7	10	23
Bread (whole meal)	540	860	220
Potato chips	550	890	1190
Carrots (canned, drained solids)	236	450	110
Beans (string, canned, drained solids)	236	300	95

SOURCE: Lentner, Cornelius, ed. *Geigy Scientific Tables,* 8th ed., vol. 1.

TABLE 2

Estimated minimum requirement across the life cycle

	Sodium mg/day	Chloride mg/day	Potassium mg/day
Infants			
0–0.5 y	120	180	500
0.5–1.0 y	200	300	700
Children			
1 y	225	350	1000
2–5 y	300	500	1400
6–9 y	400	600	1600
10–18 y	500	750	2000
Adults			
>18 y	500	750	2000

SOURCE: National Research Council. *Recommended Dietary Allowances*, 10th ed.

The association of high salt intake with hypertension and the beneficial effects of potassium in hypertension has led to recommendations that daily intake of salt should not exceed 6 g and that of potassium should be increased to 3.5 g. This can be achieved by increasing intake of dietary fruits and vegetables.

Regulation of Sodium, Chloride, and Potassium Balance

Various mechanisms regulate excretion of these ions by the kidneys to maintain homeostatic equilibrium of body fluids. Urinary sodium excretion is controlled by varying the rate of sodium reabsorption from the glomerular filtrate by tubular cells, whereas potassium excretion is controlled by varying the rate of tubular secretion of potassium.

Abnormally low blood volume (hypovolemia) in sodium deficit increases renal sodium chloride reabsorption by increasing sympathetic discharge to the kidneys, and by stimulation of two hormonal systems, the renin-angiotensin-aldosterone and the antidiuretic systems. This results in the production of low urine volume with low sodium and chloride contents. Hypovolemia also initiates the thirst mechanism and increases an appetite for salt (or salt cravings).The presence of salt appetite in animals is to ensure an adequate intake of salt to protect the extracellular fluid volume from excessive loss of sodium due to sweating, diarrhea, pregnancy, or lactation. The development of salt appetite is of signif-

DIARRHEA

Daily, about 8 to 10 l of water and large amounts of ions enter the gastrointestinal tract; about 1 to 2 l are from the diet, the rest from secretions of the alimentary tract. The greater part of this fluid is absorbed by the intestinal cells so that only about 150 ml of fluid are lost daily in the stool of an adult. Stools contain a low content of sodium and chloride but a high content of potassium so that the daily losses averages 6 mmol for sodium, 12 mmol for potassium, 3 mmol for chloride, and 5 mmol for bicarbonate. Loss of this water and ions can increase greatly in diarrhea, and if extreme, several liters of fluid can be lost, leading to dehydration and electrolyte and acid-base disturbances.

Diarrhea is defined as an increase in stool liquidity and a fecal volume of more than 200 ml/day in adults. Clinically, the most common and important causes of diarrhea are osmotic and secretory. Ingestion of a poorly absorbable solute, such as magnesium sulfate, or malabsorption or maldigestion of a specific solute because of enzyme deficiencies, as seen in lactase deficiency, can cause osmotic diarrhea. The presence of these solutes increases the intestinal luminal osmolarity, causing water to be retained in the lumen.

Various viral and bacterial infections can cause secretory diarrhea. Enteroinvasive bacteria such as *Shigella* and *Salmonella* invade intestinal mucosa to produce ulceroinflammatory lesions resulting in a failure of normal absorption. On the other hand, bacteria such as *Vibrio cholerae* release toxins that increase secretion of sodium chloride and water. If the cholera is severe, up to 18 l of watery stools can be passed in a day. These stools contain ionic concentrations similar to that of plasma, so that large amounts of sodium, chloride, and potassium can be lost.

Dehydration caused by diarrhea ranges from mild to severe. The severity of dehydration can be assessed clinically by examining the patient for sunken eyeballs, skin turgor, mental status, blood pressure, and urine output. Fluid replacement is of utmost importance, especially in severe dehydration, to prevent circulatory collapse. Although diarrhea causes losses of sodium as well as potassium and bicarbonate, the immediate concern in treating severe diarrhea is to replace sodium and water to restore the circulatory volume. Dehydration in diarrhea can be reversed by oral or, in emergency, intravenous rehydration therapy.

The World Health Organization has recommended the use of oral rehydration therapy for treatment of mild to moderate cases of diarrhea. This program has been very successful in reducing mortality from diarrheal diseases, particularly in infants in developing countries. Oral rehydration fluid contains 3.5 g of sodium chloride, 2.5 g of sodium bicarbonate, 1.5 g of potassium chloride, and 20 g of glucose in 1 l of water. An alternative household remedy is to make a solution containing three “finger pinches” of salt, a “fistful of sugar” and one quart of water. Addition of sugar to the oral rehydration fluid helps to increase the absorption of sodium chloride through the sodium-glucose transporter system in the small intestine.

icance in the successful adaptation to a terrestrial life, especially in herbivorous animals. The need for salt can be satisfied by providing cattle and sheep with salt licks. Humans and other carnivores are less dependent on separate supplies of salt because dietary salt can be obtained from meat. However, they may develop a craving for salt when they are sodium deficient. This deficit-induced salt craving may be mediated by hormones acting on the brain and by changes in gustatory response. Abnormally high blood volume (hypervolemia) in sodium excess increases renal excretion of sodium chloride by suppression of sympathetic discharge to the kidneys, suppression of the renin-angiotensin-aldosterone and antidiuretic systems, and stimulation of the secretion of atrial natriuretic peptides.

Aldosterone is the most important hormone regulating secretion of potassium. Aldosterone secretion is triggered by angiotensin II, by high plasma potassium concentration, or by low plasma sodium concentration. Plasma concentrations of potassium and hydrogen also affect directly the secretion of potassium by the distal nephrons. The rate of potassium secretion parallels the plasma potassium concentration. Secretion of potassium in response to changes in acid-base balance (which affects plasma pH) is complex. In general, acute acidosis decreases secretion of potassium, whereas acute alkalosis increases secretion and loss of potassium from the body. Response to chronic acid-base disorders is varied.

Sodium, Chloride, and Potassium Imbalance

Acute excessive intakes do not normally result in retention of sodium, chloride, and potassium because of the capacity of the kidneys to excrete these ions. Retention occurs when kidney function is compromised. Dietary deficiency does not normally occur because normal consumption usually exceeds body needs.

THERMOREGULATION THROUGH PERSPIRATION

Heat is produced continuously by the body during metabolism, and it is also taken up by the body from the environment by radiation and conduction. Heat is lost from the body by radiation, conduction and convection, and evaporation. Even in the absence of perspiration, water is lost continuously from the body by evaporation from the upper respiratory tract and by passive evaporation from the skin. These insensible water losses amount to a total of about 0.6 l/day, of which slightly more than 50 percent is from the skin. For every liter of water that evaporates from the body, 580 kcal (2428 kJ) of heat is dissipated. During intense physical exertion or at a high ambient temperature, loss of heat from radiation, conduction, and insensible water loss are insufficient to prevent a rise in body temperature. Under these circumstances, heat loss is enhanced by the production and evaporation of sweat. Loss of heat by evaporation of sweat is an effective means of removing excess heat from the body, and it can be controlled by regulating the rate of sweating. When the body temperature rises above 98.6°F (37°C), stimulation of the temperature-regulating center in the hypothalamus causes sweating.

Sweat is produced by sweat glands by actively secreting into ducts a fluid similar in composition to that of plasma. As this primary secretion passes along the ducts of the sweat glands to the surface of the skin, sodium and chloride are absorbed in excess of water, resulting in the production of a dilute fluid that has a lower content of sodium and chloride. Sodium chloride content in sweat varies; it depends on the rate of flow. For a young adult, the average value is about 50 mmol/l for sodium and 30 mmol/l for chloride. The transport mechanisms for sodium and chloride are affected in patients suffering from cystic fibrosis so that their concentrations in the sweat are increased. For the purpose of diagnosis, the upper limit of the normal values for children and young adults are set at 70–80 mmol/l for sodium and 60–70 mmol/l for chloride (Lentner, ed.).

Rate of sweat production depends on the ambient temperature and humidity, and the degree of activity of the individual. For a 70 kg man doing light work at an ambient temperature of 84°F (29°C), daily loss is about 2 to 3 l. An unacclimatized individual who is performing hard physical activity in a hot, humid environment may lose, for a short time, up to 2 to 4 l/hour of sweat. As the duration of perspiration increases, the rate of production decreases to about 0.5 l/hour. Therefore, even at maximal sweating, the rate of heat loss may not be rapid enough to dissipate the excess heat from the body. Dehydration from excessive loss of water and sodium chloride stimulates the thirst mechanism, and if water intake is not increased, it can cause weakness and, if severe, circulatory collapse.

Adaptation to heat leads to physiological changes that include an increase in sweat production, an increase in plasma volume, and a decrease in concentration of sodium and chloride in the sweat and urine. These latter two effects are caused by an increase in aldosterone secretion as a result of dehydration and loss of sodium from the body. The decrease in the concentration of sodium and chloride in sweat and urine allows for better conservation of these ions in the body. An unacclimatized person who sweats profusely often loses as much as 13 to 30 g of salt per day for the first few days, but after four to six weeks of acclimatization the loss can be as low as 3 to 5 g a day.

There is a limit at which the body can lose heat even when perspiring maximally. The progressive rise in body temperature will affect the heat-regulating ability of the hypothalamus, resulting in a decrease in sweating. Therefore, a high body temperature tends to perpetuate itself unless measures are taken specifically to decrease the body temperature. When the body temperature rises beyond a critical temperature of 106°F (41°C), the person is likely to develop heat stroke. Symptoms include dizziness, abdominal distress, delirium, and eventually loss of consciousness. Some of these symptoms are exacerbated by a mild degree of circulatory shock as a result of sodium loss and dehydration.

Since the extracellular fluid volume changes in parallel with its sodium concentration, sodium retention in renal failure or congestive heart failure results in edema and possibly hypertension (Table 3). Excessive loss of sodium resulting in hypovolemia and hypotension can occur through diuresis, Addison's disease, severe vomiting, or diarrhea.

Changes in plasma concentration of potassium affects the excitability of nerves and muscle cells (Table 3). Retention of potassium causes hyperkalemia (plasma potassium concentration exceeding 5.0 mmol/l), and depletion causes hypokalemia (plasma potassium concentration less than 3.5 mmol/l). Retention of potassium occurs when there is a lack of aldosterone secretion, or a lack of responsiveness of the kidney to aldosterone. An important clinical manifestation of hyperkalemia is cardiac arrhythmia, which can lead to cardiac arrest. Depletion of potassium can occur through hyperaldosteronism, diuresis,

TABLE 3

Imbalance of sodium and potassium

Primary defect	Pathological causes	Clinical manifestation
sodium retention	congestive heart failure renal failure Conn's syndrome	edema, hypertension
sodium depletion	excessive perspiration Addison's disease diuretic therapy renal diseases prolonged vomiting diarrhea	orthostatic hypotension, muscular weakness and cramps, dizziness and syncope, circulatory shock
potassium retention	aldosterone deficiency	cardiac arrhythmias leading to cardiac arrest
potassium depletion	wasting diseases and starvation hyperaldosteronism metabolic alkalosis diuretic therapy renal diseases prolonged vomiting diarrhea	muscle weakness, impairment of neuromuscular function, cardiac arrhythmias

SOURCE: Palmer, Alpern, and Seldin; Rodriguez-Soriano; Toto and Seldin.

vomiting, or diarrhea. Manifestations of hypokalemia include depressed neuromuscular functions and, in more severe hypokalemia, cardiac arrhythmias.

Nutritional Considerations

Epidemiological and experimental evidence has implicated habitual high dietary salt consumption in the development of hypertension, but controversy remains regarding the importance of sodium salts in the regulation of blood pressure and the mechanisms by which salt influences blood pressure (Stamler, 1977). Intervention studies of dietary salt restrictions to lower blood pressure have produced mixed results. Nevertheless, various clinical trials indicate some beneficial effects of dietary restriction of sodium on blood pressure, and it may also decrease the incidence of stroke and ischemic heart disease.

High consumption of potassium, found in foods like oranges, apricots, and dates, on the other hand, appears to have a protective action against cardiovascular diseases, although the mechanism of action is not known. Epidemiological studies have demonstrated an inverse relationship of potassium intake with blood pressure, incidence of stroke, and other cardiovascular diseases (Young, Huabao, and McCabe). A direct relationship between blood pressure and the ratio of sodium to potassium in the urine has also been found (Stamler).

Repeated intake over a long period of salt from salted and smoked products is associated with atrophic gastritis and gastric cancer. However, experimental evidence indicates that salt alone is not carcinogenic; the high dietary salt content may enhance the initiation of cancer by facilitating the action of any carcinogen, such as polycyclic aromatic hydrocarbons, present in the diet (Cohen and Roe, 1977), or potentiating Helicobacter pylori–associated carcinogenesis (Fox et al., 1999).

See also **Minerals; Nutrient Requirements; Nutrition; Salt; Sodium; Thirst.**

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Hwai-Ping Sheng

ENERGY. Sufficient dietary energy is essential to the survival and health of all animals. For understanding the biology and health of humans, energy is particularly important for a number of reasons. First, food and energy represent critical points of interaction between humans and their environment. The environments in which humans live determine the range of food resources that are available and how much energy and effort are necessary to procure those resources. Indeed, the dynamic between energy intake and energy expenditure is quite different for a subsistence farmer of Latin America than it is for an urban executive living in the United States. Beyond differences in the physical environment, social, cultural, and economic variation also shape aspects of energy balance. Social and cultural norms are important for shaping food preferences, whereas differences in subsistence behavior and socioeconomic status strongly influence food availability and the effort required to obtain food.

Additionally, the balance between energy expenditure and energy acquired has important adaptive consequences for both survival and reproduction. Obtaining sufficient food energy has been an important stressor throughout human evolutionary history, and it continues to strongly shape the biology of traditional human populations today.

This article examines aspects of energy expenditure and energy intake in humans. How energy is measured is first considered, with a look at how both the energy content of foods and the energy requirements for humans are determined. Next, aspects of energy consumption and the chemical sources of energy in different food items are examined. Third, the physiological basis of variation in human energy requirements is explored, specifically a consideration of the different factors that determine how much energy a person must consume to sustain him- or herself. Finally, patterns of variation in energy intake and expenditure among modern human populations are examined, with the different strategies that humans use to fulfill their dietary energy needs highlighted.

Calorimetry: Measuring Energy

The study of energy relies on the principle of calorimetry, the measurement of heat transfer. In food and nutrition, energy is most often measured in kilocalories (kcal). One kilocalorie is the amount of heat required to raise the temperature of 1 kilogram (or 1 liter) of water 1°C. Thus, a food item containing 150 kilocalories (two pieces of bread, for example) contains enough stored chemical energy to increase the temperature of 150 liters of water by 1°C. Another common unit for measuring energy is the joule or the kilojoule (1 kilojoule [kJ] = 1,000 joules). The conversion between calories and joules is as follows: 1 kilocalorie equals 4.184 kilojoules.

To directly measure the energy content of foods, scientists use an instrument known as a bomb calorimeter. This instrument burns a sample of food in the presence of oxygen and measures the amount of heat released (that is, kilocalories or kilojoules). This heat of combustion represents the total energetic value of the food.

Basic principles of calorimetry are also used to measure energy expenditure (or requirements) in humans and other animals. Techniques for measuring energy expenditure involve either measuring heat loss directly (direct calorimetry) or measuring a proxy of heat loss such as oxygen consumption (O_2) or carbon dioxide (CO_2) production (indirect calorimetry). Direct calorimetry is done under controlled laboratory conditions in insulated chambers that measure changes in air temperature associated with the heat being released by a subject. Although quite accurate, direct calorimetry is not widely used because of its expense and technical difficulty.

Thus, methods of indirect calorimetry are more commonly used to quantify human energy expenditure. The most widely used of these techniques involve measuring oxygen consumption. Because the body's energy production is dependent on oxygen (aerobic respiration), O_2 consumption provides a very accurate indirect way of measuring a person's energy expenditure. Every liter of O_2 consumed by the body is equivalent to an energy cost of approximately 5 kilocalories. Consequently, by measuring O_2 use while a person is performing a particular task (for example, standing, walking, or running on a treadmill), the energy cost of the task can be determined.

With the Douglas bag method for measuring O_2 uptake, subjects breathe through a valve that allows them to inhale room air and exhale into a large collection bag. The volume and the O_2 and CO_2 contents of the collected air sample are then measured to determine the total amount of oxygen consumed by the subject. Recent advances in computer technology allow for the determination of O_2 consumption more quickly without having to collect expired air samples. One computerized system for measuring oxygen consumption, like the Douglas bag method, determines energy costs by measuring the volume and the O_2 and CO_2 concentrations of expired air samples.

Sources of Food Energy

The main chemical sources of energy in our foods are carbohydrates, protein, and fats. Collectively, these three energy sources are known as macronutrients. Vitamins and minerals (micronutrients) are required in much smaller amounts and are important for regulating many aspects of biological function.

Carbohydrates and proteins have similar energy contents; each provides 4 kilocalories of metabolic energy per gram. In contrast, fat is more calorically dense; each gram provides about 9 to 10 kilocalories. Alcohol, although not a required nutrient, also can be used as an energy source, contributing 7 kcal/g. Regardless of the source, excess dietary energy can be stored by the body as glycogen (a carbohydrate) or as fat. Humans have relatively limited glycogen stores (about 375–475 grams) in the liver and muscles. Fat, however, represents a much larger source of stored energy, accounting for approximately 13 to 20 percent of body weight in men and 25 to 28 percent in women.

The largest source of dietary energy for most humans is carbohydrates (45–50 percent of calories in the typical American diet). The three types of carbohydrates are monosaccharides, disaccharides, and polysaccharides. Monosaccharides, or simple sugars, include glucose, the body's primary metabolic fuel; fructose (fruit sugar); and galactose. Disaccharides, as the name implies, are sugars formed by a combination of two monosaccharides. Sucrose (glucose and fructose), the most common disaccharide, is found in sugar, honey, and maple syrup. Lactose, the sugar found in milk, is composed of glucose and galactose. Maltose (glucose and glucose), the least common of the disaccharides, is found in malt products and germinating cereals. Polysaccharides, or complex carbohydrates, are composed of three or more simple sugar molecules. Glycogen is the polysaccharide used for storing carbohydrates in animal tissues. In plants, the two most common polysaccharides are starch and cellulose. Starch is found in a wide variety of foods, such as grains, cereals, and breads, and provides an important source of dietary energy. In contrast, cellulose—the fibrous, structural parts of plant material—is not digestible by humans and passes through the gastrointestinal tract as fiber.

Fats provide the largest store of potential energy for biological work in the body. They are divided into three main groups: simple, compound, and derived. The simple or "neutral fats" consist primarily of triglycerides. A triglyceride consists of two component molecules: glycerol and fatty acid. Fatty acid molecules, in turn, are divided into two broad groups: saturated and unsaturated. These categories reflect the chemical bonding pattern between the carbon atoms of the fatty acid molecule. Saturated fatty acids have no double bonds between carbons, thus allowing for the maximum number of hydrogen atoms to be bound to the carbon (that is, the carbons are "saturated" with hydrogen atoms). In contrast, unsaturated fatty acids have one (monounsaturated) or more (polyunsaturated) double bonds. Saturated fats are abundant in animal products, whereas unsaturated fats predominate in vegetable oils.

Compound fats consist of a neutral fat in combination with some other chemical substance (for example, a sugar or a protein). Examples of compound fats include phospholipids and lipoproteins. Phospholipids are important in blood clotting and insulating nerve fibers, whereas lipoproteins are the main form of transport for fat in the bloodstream.

Derived fats are substances synthesized from simple and compound fats. The best known derived fat is cholesterol. Cholesterol is present in all human cells and may be derived from foods (exogenous) or synthesized by the body (endogenous). Cholesterol is necessary for normal development and function because it is critical for the synthesis of such hormones as estradiol, progesterone, and testosterone.

Proteins, in addition to providing an energy source, are also critical for the growth and replacement of living tissues. They are composed of nitrogen-containing compounds known as amino acids. Of the twenty different amino acids required by the body, nine (leucine, isoleucine, valine, lysine, threonine, methionine, phenylalanine, tryptophan, and histidine) are known as "essential" because they cannot be synthesized by the body and thus must be derived from food. Two others, cystine and tyrosine, are synthesized in the body from methionine and phenylalanine, respectively. The remaining amino acids are called "nonessential" because they can be produced by the body and need not be derived from the diet.

Determinants of Daily Energy Needs

A person's daily energy requirements are determined by several different factors. The major components of an individual's energy budget are associated with resting or basal metabolism, activity, growth, and reproduction. Basal metabolic rate (BMR) represents the minimum amount of energy necessary to keep a person alive. Basal metabolism is measured under controlled conditions while a subject is lying in a relaxed and fasted state.

In addition to basal requirements, energy is expended to perform various types of work, such as daily activities and exercise, digestion and transport of food, and regulating body temperature. The energy costs associated with food handling (i.e., the thermic effect of food) make up a relatively small proportion of daily energy expenditure and are influenced by amount consumed and the composition of the diet (e.g., high-protein meals elevate dietary thermogenesis). In addition, at extreme temperatures, energy must be spent to heat or cool the body. Humans (unclothed) have a thermoneutral range of 25 to 27°C (77–81°F). Within this temperature range, the minimum amount of metabolic energy is spent to maintain body temperature. Finally, during one's lifetime, additional energy is required for physical growth and for reproduction (e.g., pregnancy, lactation).

In 1985 the World Health Organization (WHO) presented its most recent recommendations for assessing human energy requirements. The procedure used for determining energy needs involves first estimating BMR from body weight on the basis of predictive equations developed by the WHO. These equations are presented in Table 1. After estimating BMR, the total daily energy expenditure (TDEE) for adults (18 years old and above) is determined as a multiple of BMR, based on the individual's activity level. This multiplier, known as the physical activity level (PAL) index, reflects the proportion of energy above basal requirements that an individual spends over the course of a normal day. The PALs associated with different occupational work levels for adult men and women are presented in Table 2. The WHO recommends that minimal daily activities such as dressing, washing, and eating are commensurate with a PAL of 1.4 for both men and women. Sedentary lifestyles (e.g., office work) require PALs of 1.55 for men and 1.56 for women. At higher work levels, however, the sex differences are greater. Moderate work is associated with a PAL of 1.78 in men and 1.64 in women, whereas heavy work levels (for example, manual labor, traditional agriculture) necessitate PALs of 2.10 and 1.82 for men and women, respectively.

TABLE 1

Equations for predicting basal metabolic rate (BMR) based on body weight (Wt in kilograms)

	BMR (kcal/day)	
Age (years)	**Males**	**Females**
0–2.9	60.9 (Wt) – 54	61.0 (Wt) – 51
3.0–9.9	27.7 (Wt) + 495	22.5 (Wt) + 499
10.0–17.9	17.5 (Wt) + 651	12.2 (Wt) + 746
18.0–29.9	15.3 (Wt) + 679	14.7 (Wt) + 496
30.0–59.9	11.6 (Wt) + 879	8.7 (Wt) + 829
60+	13.5 (Wt) + 487	10.5 (Wt) + 596

SOURCE: FAO/WHO/UNU, 1985

In addition to the costs of daily activity and work, energy costs for reproduction also must be considered. The WHO recommends an additional 285 kcal/day for women who are pregnant and an additional 500 kcal/day for those who are lactating.

Energy requirements for children and adolescents are estimated differently because extra energy is necessary for growth and because relatively less is known about variation in their activity patterns. For children and adolescents between 10 and 18 years old, the WHO recommends the use of age- and sex-specific PALs. In contrast, energy requirements for children under 10 years old are determined by multiplying the child's weight by an age- and sex-specific constant. The reference values for boys and girls under 18 years old are presented in Table 3.

Human Variation in Sources of Food Energy

Compared to most other mammals, humans are able to survive and flourish eating a remarkably wide range of foods. Human diets range from completely vegetarian (as observed in many populations of South Asia) to those based almost entirely on meat and animal foods (for example, traditional Eskimo/Inuit populations of the Arctic). Thus, over the course of evolutionary history, humans have developed a high degree of dietary plasticity. This ability to utilize a diverse array of plant and animal resources for food is one of the features that allowed humans to spread and colonize ecosystems all over the world.

TABLE 2

Physical activity levels (PALs) associated with different types of occupational work among adults (18 years and older)

	PAL			
Sex	**Minimal**	**Light**	**Moderate**	**Heavy**
Male	1.40	1.55	1.78	2.10
Female	1.40	1.56	1.64	1.82

SOURCE: FAO/WHO/UNU, 1985

TABLE 3

Energy constants and PALs recommended for estimating daily energy requirements for individuals under the age of 18

Age (years)	Males	Females
	Energy constant (kcal/kg body weight)	
<1.0	103	103
1.0–1.9	104	108
2.0–2.9	104	102
3.0–3.9	99	95
4.0–4.9	95	92
5.0–5.9	92	88
6.0–6.9	88	83
7.0–7.9	83	76
8.0–8.9	77	69
9.0–9.9	72	62
	PAL	
10.0–10.9	1.76	1.65
11.0–11.9	1.72	1.62
12.0–12.9	1.69	1.60
13.0–13.9	1.67	1.58
14.0–14.9	1.65	1.57
15.0–15.9	1.62	1.54
16.0–16.9	1.60	1.52
17.0–17.9	1.60	1.52

SOURCE: FAO/WHO/UNU, 1985; James and Schofield, 1990

Table 4 presents information on per capita energy intakes and the percentage of energy derived from plant and animal foods for subsistence-level (i.e., food-producing) and industrial human societies. The relative contribution of animal foods varies considerably, ranging from less than 10 percent of dietary energy in traditional farming communities of tropical South America, to more than 95 percent among traditionally living Inuit hunters of the Canadian Arctic.

Subsistence-level agricultural populations, as a group, have the lowest consumption of animal foods. Among hunting and gathering populations, the contribution of animal foods to the diet is variable, partly reflecting the environments in which these populations reside. For example, the !Kung San, who live in arid desert environments of southern Africa, have among the lowest levels of animal food consumption among hunter-gatherers. In contrast, hunters of the Arctic rely almost entirely on animal foods for their daily energy. Foragers living in forest and grassland regions of the tropics (for example, the Ache and the Hiwi) have intermediate levels of animal consumption.

Regardless of whether they are from plant or animals, the staple foods in most human societies are calorically dense. Indeed, one of the hallmarks of human

TABLE 4

Per capita energy intake (kcal/day) and percentage of dietary energy derived from animal and plant foods in selected human populations

Population	Energy intake (kcal/day)	Energy from animal foods	Energy from plant foods
Hunter-gatherers			
!Kung San (Botswana)	2,100	33	67
Ache (Paraguay)	3,827	56	44
Hiwi (Venezuela)	2,043	68	32
Inuit (Canada)	2,179	96	4
Pastoralists			
Turkana (Kenya)	1,411	80	20
Evenki (Russia)	2,617	31	69
Agriculturalists			
Quechua (highland Peru)	2,002	5	95
Coastal Ecuador	1,851	7	93
Yapú (lowland Colombia)	1,968	11	89
Industrial societies			
United States	2,095	27	73

evolutionary history has been humankind's success at developing subsistence strategies that maximize the energy returns from available food resources. The initial evolution of human "hunting and gathering" economies some 2 million years ago is an example of this. By incorporating more meat into their diet, man's hominid ancestors were able to increase the energy contents of their diets.

With the evolution of agriculture, human populations began to manipulate relatively marginal plant species so as to increase their productivity, digestibility, and energy content. Today, staple agricultural crops such as rice, wheat, and other cereal grains are calorically dense (more than 300 kilocalories per 100 grams), and are much richer sources of energy than the wild plants from which they evolved.

Novel methods of food processing also allow humans to increase the energy content and digestibility of their foods. The most fundamental of these techniques is the use of fire for cooking, a strategy adopted by man's hominid ancestors at least 400,000 years ago. Cooking makes plant foods more digestible by helping to break down complex carbohydrates. Recent work has shown that cooking can increase the energy content of starchy tubers (potatoes, cassava) by more than 70 percent.

Another interesting example of processing food to raise its energy content is seen among populations living in the high Andes of South America. Here, small potatoes are left outside for several days to be repeatedly frozen during the cold nights and then dried under the intense daytime sun. The resulting product, called *chuño*, can be stored for many months and has an energy content more than three times that of a fresh potato (330 kilocalories per 100 grams versus 90 kilocalories per 100 grams).

Human Variation in Energy Expenditure

Humans also show considerable variation in levels of energy expenditure. Recent work by Allison E. Black and colleagues indicates that daily energy expenditure in human groups typically ranges from 1.2 to 5.0 times BMR (i.e., PAL = 1.2–5.0). The lowest levels of physical activity, PALs of 1.20 to 1.25, are observed among hospitalized and nonambulatory populations. In contrast, the highest levels of physical activity (PALs of 2.5–5.0) have been observed among elite athletes and soldiers in combat training. Within this group, Tour de France cyclists have the highest recorded daily energy demands of 8,050 kcal/day (a PAL = 4.68)!

Table 5 presents data on body weight, total daily energy expenditure, and PALs of adult men and women from selected human groups. Men of the subsistence-level populations (that is, foragers, pastoralists, and agriculturalists) are, on average, 20 kilograms (45 pounds) lighter than their counterparts from the industrialized world, and yet have similar levels of daily energy expenditure (2,897 versus 2,859 kcal/day). The same pattern is true for women; those from subsistence-level populations are 12.5 kilograms (28 pounds) lighter than women of industrialized societies, but have higher levels of daily energy expenditure (2,227 versus 2,146 kcal/day).

Thus, daily energy needs are expressed relative to BMR; it is found that adults living a "modern" lifestyle in the industrialized world have significantly lower physical activity levels than those living more "traditional" lives. Among men, PALs in the industrialized societies average 1.67 (range = 1.53 to 1.84), as compared to 1.90 (range = 1.58 to 2.38) among the subsistence-level groups. Physical activity levels among women average 1.63 in the industrialized world (range = 1.48 to 1.69) and 1.78 (range = 1.56 to 2.03) among the subsistence-level societies.

The differences in daily energy demands between subsistence-level and industrialized populations are further highlighted in Figure 1, which shows daily energy expenditure (kilocalories/day) plotted relative to body weight (in kilograms). The two lines denote the best-fit regressions for both groups. These regressions show that at the same body weight, adults of the industrialized world have daily energy needs that are 600 to 1,000 kilocalories lower than those of people living in subsistence-level societies.

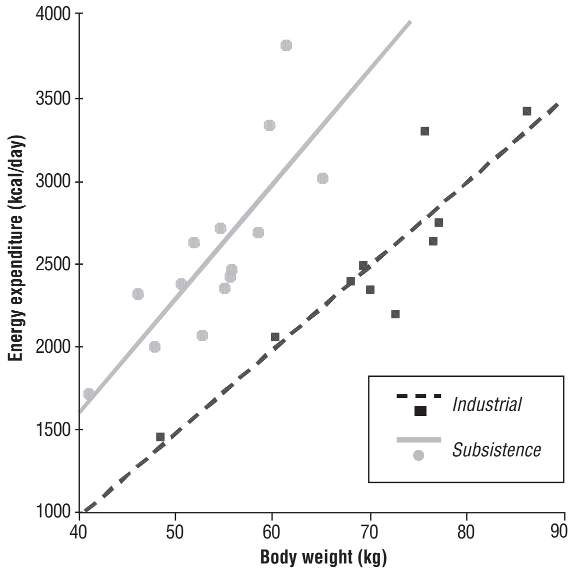
It is these declines in physical activity and daily energy expenditure associated with "modern" lifestyles that are largely responsible for the growing problem of obesity throughout the world. In the United States, rates of obesity have increased dramatically over the last twenty years, such that now over half of the adult American population is either overweight or obese. Equally disturbing has been the emergence of obesity as a problem in part of the developing world where it was virtually unknown less than a generation ago. In some sense, obesity and other chronic diseases of the modern world (diabetes and

TABLE 5

Weight (kg), total daily energy expenditure (TDEE in kcal/day), basal metabolic rate (BMR in kcal/day), and physical activity level (PAL) of selected human groups

Group	Sex	Weight (kg)	TDEE (kcal/day)	BMR (kcal/day)	PAL (TDEE/BMR)
Industrialized populations:					
18–29 years	M	75.6	3,298	1,793	1.84
	F	69.2	2,486	1,480	1.68
30–39 years	M	86.1	3,418	1,960	1.74
	F	67.9	2,390	1,434	1.67
40–64 years	M	77.0	2,749	1,673	1.64
	F	70.0	2,342	1,386	1.69
65–74 years	M	76.4	2,629	1,650	1.59
	F	60.2	2,055	1,267	1.62
75 and older	M	72.6	2,199	1,434	1.53
	F	48.3	1,458	980	1.48
Average	M	77.5	2,859	1,702	1.67
	F	63.1	2,146	1,309	1.63
Subsistence-level populations:					
!Kung San foragers	M	46.0	2,319	1,383	1.68
	F	41.0	1,712	1,099	1.56
Ache foragers	M	59.6	3,327	1,531	2.17
	F	51.8	2,626	1,394	1.88
Inuit hunters	M	65.0	3,010	1,673	1.80
	F	55.0	2,350	1,305	1.80
Evenki pastoralists	M	58.4	2,681	1,558	1.75
	F	52.7	2,067	1,288	1.63
Aymara agriculturalists	M	54.6	2,713	1,355	2.00
	F	50.5	2,376	1,166	2.03
Highland Ecuador, agriculturalists	M	61.3	3,810	1,601	2.38
	F	55.7	2,460	1,252	1.96
Coastal Ecuador, agriculturalists	M	55.6	2,416	1,529	1.58
	F	47.8	1,993	1,226	1.63
Average	M	57.2	2,897	1,519	1.90
	F	50.6	2,227	1,247	1.78

FIGURE 1



cardiovascular disease, for example) represent a continuation of trends that started early in man's evolutionary history. Humans have developed a diet that is extremely rich in calories while at the same time minimizing the amount of energy necessary for physical work and activity. Ongoing work in nutritional science is attempting to better understand the biological and environmental factors that influence patterns of energy consumption and expenditure to promote human health and well-being.

See also **Assessment of Nutritional Status; Body Composition; Hunting and Gathering; Inuit; Nutrition Transition: Worldwide Diet Change**; **Physical Activity and Nutrition.**

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ENGLAND. *See* **British Isles.**

ENRICHMENT. *See* **Additives; Vitamins.**

ENTERAL AND PARENTERAL NUTRITION.

The ascent of enteral and parenteral nutrition into a major therapeutic advance in the clinical care of critically ill patients as well as those with temporary or permanent loss of gastrointestinal function only occurred during the last thirty years of the twentieth century. Enteral tube feeding was first employed in the 1600s and was made popular in the medical profession by the famous English surgeon John Hunter at the end of the eighteenth century.

Three important developments accelerated the widespread acceptance of invasive feeding by tubes in the gastrointestinal tract (enteral nutrition) or in veins (parenteral nutrition). Milton Winitz and his colleagues developed chemically defined diets that provided all the essential nutrients in their predigested form. Protein and carbohydrates were provided as their basic building blocks, amino acids and glucose, with minimal amounts of fat sufficient only to meet basic requirements along with all the essential vitamins and minerals. Originally intended as low-residue diets for the American space program, they were made available, particularly by Henry Randall, via a feeding tube to surgical patients who could not be nourished with regular food by mouth. Later formulas were made more complex with protein present as peptides, which contain a number of linked amino acids, more complex carbohydrates, and larger amounts of fat. Subsequently Stanley Dudrick, Douglas Wilmore, Harry Vars, and Jonathan Rhoads administered similar predigested nutrients in concentrated form into large veins of six beagle puppies, who tolerated them well and experienced normal growth and development. Similar successes in a human infant and in malnourished surgical patients with gastrointestinal dysfunction led to widespread adoption of this life-saving and sustaining technique. Parenteral fat became available for intravenous administration as a component of parenteral formulas several years later. Finally, scientists recognized that protein calorie malnutrition (PCM) affected from one-quarter to one-half of all hospitalized adults and children (Bistrian et al., 1974; Bistrian et al., 1976), that PCM had a major impact on morbidity and mortality from an underlying disease, and that nutritional support by enteral or parenteral means could improve outcomes in malnourished or stressed individuals.

Initially a few interested individuals employed these techniques mainly in academic centers. However, enteral and parenteral nutrition have become essential components of care in critical care units, important adjuncts for many patients recovering from major abdominal surgery, and lifesaving methods for tens of thousands of individuals with permanent impairments of intestinal functions.

During the late twentieth century investigators developed a greater understanding of why PCM occurs, better methods and formulas for providing enteral and parenteral nutrition, and improved techniques for identifying the patients most likely to benefit. Whereas primary PCM develops as a consequence of inadequate intake of protein, energy, and often other essential nutrients, the PCM seen in hospitalized patients is largely due to the underlying primary disease. A process named the systemic inflammatory response develops following any major tissue injury, infection, or inflammatory disorder, such as inflammatory bowel disease or rheumatoid arthritis, and is a part of the body's innate defense system that supports the immune system and fosters healing. However, the response has potentially harmful side effects, including muscle wasting and severe PCM, if it is prolonged or severe, as when anorexia and gastrointestinal dysfunction limit the spontaneous dietary intake of food and increase the protein breakdown that are parts of the systemic inflammatory response.

The well-nourished individual can tolerate up to one week of illness without requiring invasive nutrition to avoid complications, usually infections or poor wound healing, from PCM. When malnutrition is a problem at the outset, feeding is helpful within three to five days. In the severely malnourished patient, defined by an unintentional weight loss of 20 percent or more, or the severely ill patient, especially one with a closed head injury, a major skeletal trauma, severe body burns, or a severe infection, feeding begun early can improve the outcome. The American Society for Parenteral and Enteral Nutrition developed specific guidelines for the roles of enteral and parenteral feeding that incorporate these principles (Klein et al.).

An important recognition that feeding critically ill patients, particularly if done incorrectly, could be harmful soon followed its broader application. The primary complications of parenteral nutrition include lung collapse, vein clots, infections related to the tube or as a consequence of poorer blood sugar control, or metabolic complications related to introducing all essential nutrients directly into a vein without modification by the gastrointestinal tract and the liver. With enteral nutrition the primary complication is intestinal intolerance as reflected in vomiting, diarrhea, or aspiration pneumonia. Although some have asserted that enteral feeding is more efficacious than parenteral feeding, a close look at the evidence suggests that they are probably equally effective but that enteral feeding would be preferred whenever possible. The potential complications of both modes of feeding can be minimized by assuring that trained, skilled individuals and teams use them only when indicated.

Subsequent developments included immune-enhancing diets with oils, such as fish oil and certain vegetable oils like flaxseed, containing omega-3 fatty acids; the amino acids arginine and glutamine; and nucleotides. Usually provided in combination, these nutrients, when added to a standard enteral formula, seem to improve outcomes by reducing infection rates and shortening hospital stays after major abdominal surgery for malnourished patients, patients with major traumas or burns, and patients in critical care units (Beale et al.). In addition the placement of feeding tubes by endoscope dramatically increased the number of patients who can receive enteral feeding. Placement into the upper small bowel improves tolerance to enteral feeding among critically ill patients, and placement into the stomach or small bowel with exit of the tube through the abdominal wall avoids surgical placement in less severely ill patients who need chronic feeding. The development and wide application of enteral and parenteral feeding was one of the major medical advances of the twentieth century.

See also **Health and Disease; Medicine; Nutrients; Nutrition.**

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Bruce Ryan Bistrian

ENVIRONMENT. People farm Earth's biosphere to produce food for the sustenance of the human species. Thus, human food systems are part of Earth's complex ecological systems. All of these systems begin with interactions with the sun, which is the ultimate energy source. Sunlight enables plants to manufacture carbohydrates through the process of photosynthesis, in which chlorophyll converts sunlight into chemical energy, synthesizing organic compounds from inorganic compounds. Plants take carbon dioxide, water, and inorganic elements for this conversion process from the air and soil. Humans obtain their nourishment directly from plants, or from animals nourished directly or indirectly by plants. Thus humans ultimately rely on air, soil, water, and sunlight for sustenance.

Humankind has a strong interest in not fouling the environment, as contaminants in the air, water, or soil can end up in the plants that people or their food animals eat. An extreme example of such contamination was the 1986 Chernobyl nuclear power plant explosion in the Ukraine. Although hundreds of thousands of people fled the area that was immediately affected by the explosion, as many as three million people still live in contaminated areas in this farming region. As a result of the ecological devastation from this disaster, enormous amounts of money have been and continue to be spent in an effort to relocate communities and decontaminate the rich farmland.

Environmental Progress and Challenges for Agriculture

Agriculture and food systems play a major role in the ecological health of Earth, including the number and

URBANIZATION AND DEVELOPMENT: THE GREATEST THREAT TO AGRICULTURAL LAND IN THE UNITED STATES

Between 1992 and 1997 more than 3.2 million acres of prime farmland were converted to developed land, at an average rate of 645,000 acres of prime farmland per year. From 1982 to 1997 approximately 30 percent of newly developed lands were converted prime farmland. Conversion of farms and farmland to the scattered and fragmented development of "urban sprawl" also causes the loss and fragmentation of other farm, pasture, and rangelands, as well as forests, wetlands, and other important habitats.

In *Farming on the Edge*, A. Ann Sorenson and others reported that 21 percent of prime or unique farmland conversions occurred in twenty major land resource areas that make up 7 percent of the U.S. land base. These most threatened land resource areas are part of or adjacent to expanding population centers and produce some of the highest value agricultural crops and products.

Shorelands and wetlands lose the buffering provided by farm- and forestlands, and non-point-source pollution from storm water runoff increases. Wetlands are a vital natural resource that provide flood protection and enhance water quality, wildlife habitat, and air quality. According to the 1997 National Resources Inventory, nearly 59 percent of wetland acreage is on forestland and 16.5 percent is on agricultural cropland, pasture, and land in the Conservation Reserve Program.

diversity of life forms that inhabit it. Half of the land mass of the United States, excluding Alaska, is privately owned crop, pasture, and range land. As noted in *America's Private Lands: A Geography of Hope*, the farmers and ranchers who manage these 907 million acres play a key role in maintaining the abundance of these natural resources for present and future generations.

Driven by changing economic and demographic trends, agriculture has become more consolidated, intensified, and specialized. At the same time, there has been increased scientific and public awareness of the detrimental environmental impacts of some agricultural activities, such as the problem of soil erosion. However, by adopting new practices and working with government conservation cost-share and technical-assistance programs, farmers are significantly reducing many of those detrimental impacts. Although soil erosion threatens the future productivity of 29 percent of cultivated acres in the United States, farmers reduced soil erosion on U.S. farmland by 38 percent from 1982 to 1997. Much of this reduction was accomplished by changing from traditional plowing to no-till or minimum-tillage systems that disturb the soil less and leave a protective layer of crop residue. The United States Department of Agriculture (USDA) programs, such as the Conservation Reserve Program and Wetland Reserve Program, take marginal or fragile croplands out of production and assist landowners with plantings or practices to buffer stream banks and enhance wildlife habitat. Wetlands, including productive yet fragile ecosystems like prairie potholes, have been restored, and the nesting success of ducks has increased.

Many livestock farmers and ranchers have improved grazing management to benefit livestock productivity as well as soil, water, and wildlife resources. For example, the United States and several western European nations are addressing the problem of excess manure in areas with high concentrations of livestock. Farmers are developing nutrient-management plans to make the best use of fertility-building resources in manure and to prevent excessive field applications or run-off into waterways.

Problems with water quality and water supply due to agricultural practices persist in some areas and have recently emerged in others, such as in the northeastern United States, where the water supply has not been a problem historically. Water quality also affects both freshwater and saltwater fisheries (discussed in more detail below). Careful management of agricultural production is critical in maintaining the ecological health of many estuaries (nurseries for fish and shellfish stocks and food webs). Efforts to improve nutrient management and agricultural conservation practices in the extensive watershed of the U.S. Chesapeake Bay are evidence of the growing awareness of the ecological links between farming and fishing.

Developed countries in North America and western Europe use a combination of technical assistance, incentives, and regulatory approaches to address environmental problems associated with agriculture. However, a lack of human and economic resources limits the ability of developing countries to address environmental problems associated with agriculture or other human activities. The clearing of forests in Brazil continues to accelerate in an effort to develop agricultural production for export. Land is cleared for crops and cultivated pasture, much of it to expand livestock and crop production for export markets. The USDA's *Agricultural Baseline Projections* February 2002 report (Westcott) predicted that the conversion of undeveloped land into arable land in Brazil's interior will gain momentum over the next decade. Brazil's share of the world soybean market is projected to grow from 28 to 35 percent by 2011.

In his 2000 Nobel anniversary lecture, agricultural researcher Norman Borlaug noted that irrigated agriculture uses 70 percent of global water withdrawals, covers

17 percent of cultivated land (about 679 million acres), and accounts for 40 percent of world food production.

Loss of genetic diversity in crop plants and livestock—driven by market rewards for high yield, cost-efficiency, and product uniformity—is increasingly recognized as an environmental concern for agriculture. Other concerns include agriculture's effects on biodiversity and health of critical habitats. Working agriculture can be a positive or negative factor in all these areas of environmental concern, depending on local site conditions and management practices.

World Fisheries and Food Security

Fisheries contribute to world food security, especially since fish are a major source of protein for some of the world's poorest populations. Per capita fish consumption varies among countries, depending on economic wealth, cultural traditions, and fisheries resource base. According to the United Nations Food and Agriculture Organization (FAO), world per capita fish consumption has been increasing since the 1960s, a trend that has been accompanied by increasing incomes. Global trade in fish and shellfish continues to grow and gain importance in developing countries. However, a practice of over-fishing now threatens fisheries around the world. Consumption of fish has been increasing quite dramatically for at least half a century, and stocks have been severely depleted. Too many fish have been harvested with too little thought or provision for protecting the resource base so that it can continue to produce sustainably. U.S. efforts to protect fisheries from over-fishing are showing some results. For example, some long-threatened resources, such as cod and haddock stocks in New England, have begun to recover after decades of decline. However, achieving international cooperation to protect coastal and estuarine environments and to manage and sustain world fisheries remains a challenge.

THE AQUACULTURE RUSH IN CHINA

Asia produces 90 percent of the world's aquaculture output, with China alone producing more than two-thirds of the total. Europe, North America, and Japan combined produce just over 10 percent of the total, but these areas consume most of the internationally traded farmed seafood. Excluding mainland China, world fish supplies from aquaculture grew from 3.5 pounds per capita per year in 1991 to 4.7 pounds in 1998. During the same period, according to the United Nations Food and Agriculture Organization (FAO), the per capita supply of aquaculture products in mainland China nearly tripled, growing from 13.2 to 37.4 pounds. Fish consumption in China is strongly correlated with economic growth, and freshwater aquaculture is responding rapidly to market stimulus. Many Chinese aquaculture enterprises are family and cooperative farms, often using integrated multiple-species systems to produce lower value, herbivorous species for household subsistence and local markets. As competition increases for land and water resources, more operations are intensifying, and some are producing higher value carnivorous or omnivorous species such as shrimp for export.

The FAO expects aquaculture to continue to grow in Asia, but it also expects the rate of growth to slow when China becomes a member of the World Trade Organization and thus more open to food imports. China may become a market for cultured fish produced in other Asian countries.

Toward a More Sustainable Aquaculture

Aquaculture, often promoted as a solution to over-fishing, has expanded dramatically in Asia for domestic and export markets. As with agriculture, the environmental impacts of aquaculture can vary greatly over the range of management systems and practices. The article "Effect of Aquaculture on World Fish Supplies," by Naylor et al., describes the paradox of aquaculture as both a possible solution and a contributing factor to the collapse of fisheries stocks worldwide.

In the late twentieth and early twenty-first centuries, capture fisheries provided a decreasing share of world food fish, while the share that aquaculture provided surged—nearly tripling from 10 million metric tons in 1987 to 29 million metric tons in 1997. World capture fish harvests leveled off at around 85–95 million metric tons per year, with the catch shifting from larger, higher value carnivorous species of fish to smaller, lower value fish used to make feed for farmed fish. Four of the top five capture fish species were used in feed production for the aquaculture and livestock industries.

Alteration of habitat—especially the large-scale transformation of mangroves and coastal wetlands in Asia into fish- and shrimp-farming ponds—also harms wild fish nurseries and the ecological health of coastal wetlands, coral reefs, and related marine habitat. Other factors that diminish wild fisheries are the collection of wild seed stock, food-web interactions (e.g., over-fishing of small fish species that form the food supply for marine predators, including valuable fish species consumed by humans), introduction of exotic species and pathogens, and nutrient pollution from fish farms.

Aquaculturists farm more than 220 species of fin-fish, shellfish, and crustaceans. Raising carnivorous species such as salmon, which consume wild fish for feed (producing one pound of farm-raised salmon takes eight pounds of wild fish), can create problems such as interbreeding of wild fish with escaped farmed fish. But some aquaculture benefits estuarine and marine ecosystems, such as filter-feeding oysters, mussels, clams, and some carp, all of which help purify water. A range of fish and shellfish farming systems are being developed for different species, locations, and conditions. Naylor et al. (pp. 1021–1023) offered four primary goals for the sustainability and continued growth of the aquaculture industry: (1) expand farming of smaller, lower feeding-level fish; (2) reduce use of fish meal and fish oils in feed; (3) develop integrated farming systems; (4) promote environmentally sound aquaculture practices and resource management.

Food and Ecosystems: Linked since the Rise of Civilization

Humans have always interacted with their environment in order to obtain food. Local ecosystem characteristics, such as the types and quantities of edible plants and plants eaten by food-producing animals, have significantly affected the evolution and development of human societies and cultures. In his Pulitzer-Prize-winning book *Guns, Germs, and Steel: The Fates of Human Societies*, Jared Diamond traced many of the outcomes of human history, including the comparative advantages of different societies and the availability and relative abundance of different types of plants and animals. For example, a hospitable growing environment with deep, fertile soil, adequate rainfall, and moderate temperatures provides people with a food-producing advantage. (Examples are the traditional "breadbasket" regions of the world: the midwestern United States, the pampas of South America, the plains of central Europe and the Ukraine, and China's river valleys.) However, through ingenuity, skill, and careful stewardship of resources, humans have produced ample food supplies in challenging environments such as the mountains of Switzerland, the Nile Valley, and arid parts of Australia.

In his book, Diamond also links the development of civilizations to people's ability to produce abundant food supplies in an environment. For example, settlements could become permanent only when people no longer had to wander in search of food, and when they learned to protect and replenish the soil so that they did not have to abandon exhausted farming sites. A sustained and ample food supply enabled societies to develop technology, writing, and political systems, all of which advanced agriculture even further. Highly developed farming systems were the cornerstone of the rise of the Roman Empire and the unification of China. The ancient Romans understood, and wrote extensively about, the practice of sustainable agriculture. They improved plants and animals through selective breeding, and they emphasized the use of manure and composts to replenish and enrich the life-giving capacity of farmed soils.

Lessons from Famines and Ecological Disasters of the Middle Ages

Cycles of disaster and famine in medieval Europe offer an instructive study in the interplay of agriculture and the environment. A series of extreme natural disasters including floods, crop failures, and epidemics among humans and livestock culminated in the Great European Famine of the early 1300s. In the mid-fourteenth century, another wave of natural disasters, which included the spread of bubonic plague, resulted in the loss of about one-third of the population of Europe, with death rates as high as 60 percent in some communities. These famines and ecological disasters most likely resulted from a complex combination of causes. Bruce M. S. Campbell discussed several theories about the famines in "Ecology Versus Economics in Late Thirteenth- and Early Fourteenth-Century English Agriculture," in *Agriculture in the Middle Ages* (pp. 76–97). The floods were most likely part of a period of climate change to cooler, wetter weather, accompanied by storm surges in the North Sea.

Medieval agriculture lacked the dynamism to keep pace with the demands of growing urban populations. In response to food shortages, marginal lands that had been used for livestock, hay, and pasture were now used to raise crops for human consumption. However, reducing livestock numbers not only reduced the quantity of foods produced from animals, but also the supply and use of manure on cropland, which ultimately lessened crop yields.

Lack of technical progress in agriculture, nearly continuous wars, and the extractive feudal economic system made the bad situation worse. Campbell explained (p. 94) that warfare wreaked ecological havoc on the food and agriculture system through physical destruction of crops, livestock, stock, equipment, and physical structures. Burdensome taxes levied to finance warring armies and the expropriation of stock, crops, equipment, and marketing and transportation systems also weakened the existing agricultural systems.

This pattern of famine during and after periods of war or civil strife, often coinciding with epidemics and disastrous droughts or floods, recurs in most modern famines, such as those afflicting Africa since the 1970s. Modern famines show how the ecological, economic, and social destruction of war disrupts the production and distribution of food and, subsequently, a society's ability to feed itself.

From Renaissance to Agricultural Revolution

Significant changes in farming systems that began in parts of Europe during the later medieval period brought about major changes in the ecological health and productivity of the land. Farmers began to combine and integrate crops and livestock in ways that promoted soil quality and fertility and that boosted production. They adopted more intensive and flexible crop rotations, as well as new crops such as oats, turnips grown for animal feed, and nitrogen-fixing legumes. These innovations eliminated the need for fallowing (idling) of land, adding further to sustainable production gains. Campbell found (p. 92) that farmers adopted these systems most readily in areas with natural resource advantages, access to markets, or fewer institutional constraints such as feudal servile tenure or common property rights.

The enclosure of common lands across England in the 1700s and early 1800s transformed agriculture and the English landscape. Well over six million acres, or one-fourth of the cultivated acres in England, were converted from communally held and farmed lands to lands that were privately owned and managed. This conversion enabled farmers to integrate livestock and crops, using manure and crop rotations to restore and improve depleted lands that were formerly pastured or cultivated continuously. The dramatic gains in productivity and prosperity reflect the key role of private property and free enterprise in resource management.

The large amount of available land in the midwestern and western United States lured families to seek new land when the soil became depleted. As a result of this, President Theodore Roosevelt called for a national sense of duty to the land during a 1908 White House Conservation Conference. However, it was not until the dust bowl disaster of the 1930s that major efforts to protect soil and water finally emerged.

The Agricultural Revolution of 1750–1880 improved yields and adaptation of crops and livestock to local conditions around the world. This period of innovation also set the stage for unprecedented scientific and technical progress in the latter half of the twentieth century. In his Nobel address, Borlaug also noted that in 1940 U.S. farmers produced 56 million tons of corn on 77 million acres of land. In 1999 U.S. farmers produced 240 million tons of corn on 71.7 million acres—a greater than four-fold increase in yield per acre, reaped from hybrid seed, fertilizer, and weed control. The Green Revolution of the 1960s and 1970s applied these techniques to rice, wheat, and other crops in the developing world.

Biotechnology and Questions for the Future

In a response to critics who questioned the environmental effects of advances in agricultural science and technology, Borlaug noted that without the dramatic gains in yields brought about by those advances, three times as much land of equal quality would have been required to match food production in the world at that time. Much of that additional 4.4 billion acres of land would have to come from more marginal and environmentally fragile lands.

By the late twentieth century, biotechnology was yielding new adaptations of crops and animals for food and medicine. U.S. farmers quickly adopted new genetically modified crops. According to the USDA National Agricultural Statistics Service 2002 report *Crop Production—Prospective Plantings*, U.S. farmers intended to plant genetically modified seed on 74 percent of soybean acreage, 71 percent of cotton, and 32 percent of corn grown for grain in 2002. Most first-generation genetically engineered varieties were designed to reduce pesticide use or to allow use of more benign chemicals.

Proponents maintain that through biotechnology people will find new ways to increase yields, nutritional and health values, and environmental sustainability of food production. Still, controversy persists about environmental impacts, consumer concerns, and access to the new technology for impoverished people and nations. Some people question the new methods of genetic manipulation on philosophical grounds. Despite his strong support of biotechnology, Borlaug said that national, regional, and world policymakers must resolve serious issues raised by the dominant role of proprietary companies in biotechnology investment and research. He questioned how resource-poor farmers in developing countries could obtain products of biotechnology research and what amount of time product patents should last. Thus, in policymaking processes, societies, governments, and international agencies need to make policy decisions based on credible information about how best to meet human food needs from the land and water while safeguarding valuable resources, ecological integrity, and future productivity.

See also **Agriculture since the Industrial Revolution; Aquaculture; Biodiversity; Biotechnology; Crop Improvement; Ecology and Food; Genetic Engineering; Green Revolution; High-Technology Farming; Pesticides; Population and Demographics; Sustainable Agriculture; Toxins, Unnatural, and Food Safety.**

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EPICURUS. Epicurus, a Greek philosopher (341–270 B.C.E.), has involuntarily given his name to the fastidious pursuit of pleasure. Born on the Greek island of Samos, Epicurus lived and taught mainly in Athens, where he was a precise contemporary of the playwright Menander. The Epicurean school of philosophy, which he founded, centered on his house and garden in Athens. He and his pupils, who included slaves and women, followed a secluded and austere lifestyle there.

Epicurus taught that the gods have no effect on human affairs, that the universe was created by the random swerve of an atom, and that pleasure is the goal of a happy life. His definition of pleasure is, however, a rather negative one, the removal of disturbance and pain. Since pain is caused by unsatisfied desire, one must reduce one’s desires to the minimum. The unavoidable demands of instinct must be satisfied; philosophical study is the best way to conquer all desires beyond that point.

Epicurus is not an ideal choice as a spiritual patron of gastronomes or hedonists. Yet he invited this view of his philosophy with such pronouncements as, “The beginning and root of all good is to make the stomach happy: wisdom and learning are founded on that” (Athenaeus, *Deipnosophists* [Professors at dinner], 546 ff.). The belief that Epicurus favored sensual pleasures can be traced to his contemporaries, and to their understandable misinterpretation of his own words.

See also **Greece, Ancient**.

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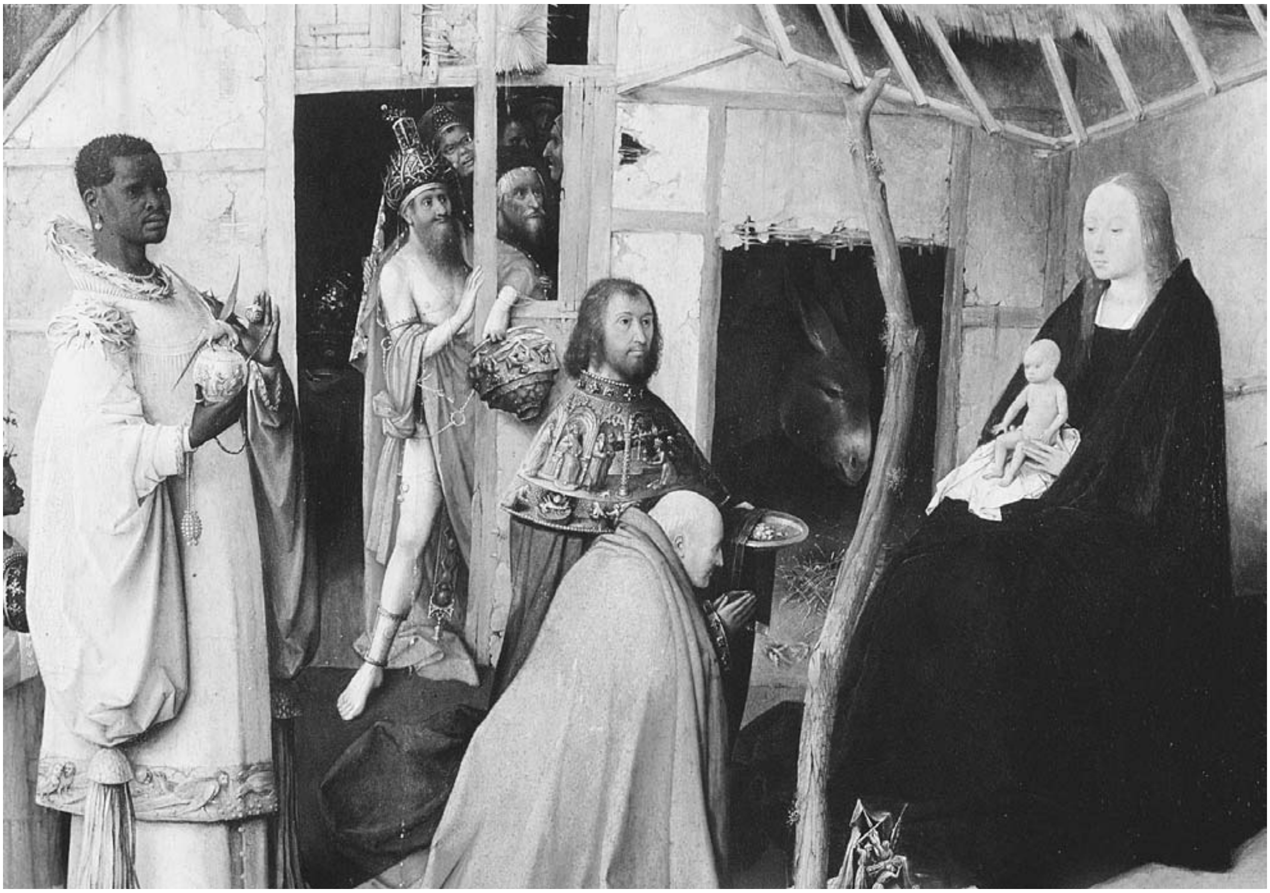
A few short writings by Epicurus survive. See Eugene Michael O’Connor, trans., *The Essential Epicurus: Letters, Principal Doctrines, Vatican Sayings, and Fragments* (Amherst, N.Y.: Prometheus Books, 1993), and Brad Inwood and L. P. Gerson, trans., *The Epicurus Reader: Selected Writings and Testimonia* (Indianapolis, Ind.: Hackett, 1994). His beliefs are eloquently explained in a Latin poem by Lucretius, *Lucretius on the Nature of the Universe*, translated by Ronald Latham, with an introduction by John Godwin (London: Penguin, 1994; first published 1951). The papyrus rolls found at Herculaneum in the eighteenth century had come from the working library of an Epicurean teacher of the first century B.C.E. and include some of Epicurus’s works. For the *Deipnosophists* of Athenaeus, quoted above, see vol. 5, pp. 477–481, of C. B. Gulick’s translation (London: Heinemann, 1933; New York: Putnam, 1933).

Andrew Dalby

EPIPHANY. Epiphany (from the Greek word for ‘manifestation’) is the Christian festival that commemorates the revealing of Jesus Christ to the Gentile world,

Epiphany Parade at Tarpon Springs, Florida, 1990. Epiphany parades are popular among Greek Orthodox Christians, and the event serves as a community focal point among immigrants. © NIK WHEELER/CORBIS.



Detail of the *Triptych of the Epiphany* by Hieronymus Bosch, showing the Adoration of the Magi. Collection of the Museo del Prado. © FRANCIS G. MAYER/CORBIS.

as personified by those “wise men from the east” who came “to worship him” (Matthew 2:1–2). In Britain it has another, more prosaic, name, Twelfth Day, because it falls on 6 January, twelve days after Christmas. Over time, the plain gospel account of this momentous encounter became richly embroidered with learned commentary and loving speculation. The “wise men” stepped from the shadows and were deemed to be three in number, each one a mighty king who knelt in turn to pay homage and present his gift to the greatest king of all. The festival formed the end and climax of the Christmas season, marked by a joyful and elaborate church service and much cheerful celebration, with parties and presents, fine feasting, and a favorite game. In this game, played in many parts of medieval Europe, a mock-king was selected to reign over the party, be toasted by loyal subjects, and, sometimes, enjoy the doubtful privilege of paying for the wine downed in his honor. He was chosen not on merit but by the chance that was hinted at in his official title, “King of the Bean.” A bean had been hidden in a cake, and the lucky man who found it became king of the company. The woman who pulled out the corresponding pea was hailed as his queen.

This traditional game remained popular, but in Britain a variation was developed during the late seventeenth century. Guests still enjoyed their cake, which was dark, dense, packed with dried fruit, and often crowned with almond paste and white icing. However, instead of choosing their king and queen by bean and pea, they drew paper lots. The new custom became a craze, and was elaborated until every slip or card bore the name of some character. Each person present thus had a part to play, and the monarchs mingled with such farcical figures as Sir Tunbelly Clumsy and Miss Flirt, Captain Tearaway, and Lady Racket. The character cards might be homemade or bought at any bakery or toy shop during the Christmas season.

In the eighteenth and early nineteenth centuries, the Twelfth Night cake and characters were enormously enjoyed, so much so that the custom found its way to those parts of America, such as Virginia, that were strongly influenced by British taste.

But the fashion that flared so brightly for a while had burned itself out by the end of the nineteenth century. Twelfth Day became just an ordinary date in the British calendar, and its cake was absorbed into the Christmas Day festivities. In France, however, and, incidentally, in Louisiana, where French traditions are strong, the Bean King still reigns. Bakery windows display tempting versions of the "Galette des Rois," made of sweet brioche or puff pastry, and in each a bean or, alternatively, a tiny porcelain baby Jesus, is concealed, a guarantee of instant pleasure for children.

See also **Christianity**; **Christmas**; **Christmas Drinks**; **Easter**; **Feasts, Festivals, and Fasts**; **Lent**; **Shrove Tuesday**.

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ESCOFFIER, GEORGES-AUGUSTE.

Georges-Auguste Escoffier (1846–1935) was born in Villeneuve-Loubet in France, a village located between Nice and Cannes. During his lifetime he was proclaimed "the finest cook I ever met" by César Ritz of the world-famous Ritz Hotels. Kaiser Wilhelm of Germany praised Escoffier's exceptional culinary talent, telling him "I am the emperor of Germany, but you are the emperor of chefs." Escoffier was more than just a great chef. He is credited with simplifying the complex French haute cuisine of the day—he favored less elaborate dishes, prepared lighter sauces, and used more seasonal ingredients. His reorganization of the professional kitchen eliminated duplication of efforts and resulted in more efficient operation.

Growing up, Escoffier's chief interest was art; he loved to draw and yearned to be a sculptor. However, his grandfather and his father, who was a blacksmith and also grew tobacco, decided otherwise; they said he needed a trade, and they arranged his apprenticeship at age thirteen in his uncle's Restaurant Français in Nice.

Photogravure portrait of Escoffier dated 1907. ROUGHWOOD COLLECTION.

At age eighteen, Escoffier was cooking at the Hotel Bellevue in Nice and making an impression on those who ate his food. At nineteen, he became *commis rôtisseur* and then *saucier* at the Petit Moulin Rouge in Paris. At the outbreak of the Franco-Prussian War, Escoffier was drafted into the military and became *chef de cuisine*, first at the headquarters of the general of the Army of the Rhine in Metz, and then for a variety of other regimental commanders. Five years later, he was appointed head chef at the Petit Moulin Rouge, where he fed such dignitaries as the Prince of Wales and Sarah Bernhardt. At the age of thirty, he opened Le Faisan Doré in Cannes.

Escoffier's experience in the military taught him the importance of preserving food, and he began working on methods of canning meats, vegetables, and sauces, and developed a way to preserve tomato sauce in champagne bottles. In his restaurant cooking, he experimented with techniques for simplifying meals and sauces and encouraged the use of seasonal foods. Other accomplishments included helping to found the successful review *L'Art Culinaire* (Culinary art). In this publication, he reflected on problems of feeding the military, published an item about portable stew for soldiers, and wrote about other artistic and practical matters.

In 1884, César Ritz invited Escoffier to become *chef de cuisine* at the Grand Hotel in Monte Carlo in the winter and at the Grand National in Lucerne in the summer. While at these hotels, he designed many things including serving-dishes, some of which bear his name. In 1885 he published *Le Traité sur l'Art de Travaille les Fleurs en Cire* (Treatise on the art of creating wax flowers). In time, Ritz moved on and managed hotels in Cannes and Baden-Baden, while Escoffier stayed behind and thought more about large, complex kitchens. At this time, he also started collecting, recording, and making available his recipes for cooks and headwaiters to use.

In 1890, César Ritz took over the management of Richard d'Oyly Carte's Savoy Hotel in London and invited Escoffier to develop an elegant restaurant there. The Savoy's restaurant quickly became the delight of its clientele, including the Duke of Orleans, one of the hotel's first royal residents, and the Prince of Wales, a frequent guest. Escoffier and the Savoy became known worldwide, and it was there that Escoffier perfected the codification of French haute cuisine. One of the dishes he invented was *pêche Melba*, created in 1894 for Australian opera diva Nellie Melba, who lived at the hotel while singing at Covent Garden. Another was cherries jubilee, invented three years later to celebrate Queen Victoria's Diamond Jubilee.

Escoffier also wrote many books that became bibles in their field, including *Le Guide Culinaire* (1903), a compendium of about five thousand recipes, *Le Carnet d'Epicure* (1911), and *Le Livre des Menus* (1912). In 1920, Escoffier retired to his family home in Monte Carlo where he continued to write many books, including *Le Riz* (1927), *La Morue* (1929), and *Ma Cuisine* (1934). That same year, he was awarded France's Legion of Honor.

See also **Cookbooks; Kitchens, Restaurant; Places of Consumption; Restaurants.**

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ESKIMOS. *See* Inuit.

ETHNICITY. *See* National Cuisines, Idea of; United States: Ethnic Cuisines.

ETHNOBOTANY. Ethnobotany is the study of the relationship between people and plants. This interdisciplinary field includes studying plants as wild foods and as agricultural crops; as constructs for houses and modes of transportation; as baskets, pottery, and art; as clothing and types of weaving; as medicines and alternative methods for healing; and in the context of cultural myths and religious ceremonies. Research topics address more complex issues, including the cultural consequences of the extinction of a particular plant species on the diet of a culture, impacts of acculturation on a culture's uses of plants, and the transmission of ethnobotanical knowledge from one generation to the next.

Ethnobotanists study all types of cultures, from the past to the present, from indigenous communities in the Amazon Basin to complex plant usage by immigrants in New York City. This field incorporates techniques and research from many fields, especially anthropology, archaeology, biology, botany, chemistry, entomology, geography, history, linguistics, medicine, and zoology.

How Does Ethnobotany Study Culture?

Ethnobotanists study culture by examining how plants were used in the past as well as the present. By studying farming practices of the past or examining fossilized plant or human remains, researchers are able to determine what plants were used by ancient civilizations.

Anatomically speaking, modern human beings (*Homo sapiens*) have existed for approximately 150,000 to 200,000 years, but have practiced widespread cultivation for only a fraction of that time. Evidence that agriculture was practiced includes abundant fossilized remains of plants known to have been cultivated or of tools used for preparing soil, cultivating, or harvesting food.

Human skeletons can provide information about the kinds of plants eaten and the ways in which food was pre-

Bora man is shown cooking coca leaves to prepare a paste that he and other members of his tribe will use to enable them to hunt for days without rest and food. © JAY DICKMAN/CORBIS.

Plants That Stand between Survival and Starvation

There are at least twelve plant species that have had an enormous impact on cultures throughout history. Without them, humankind could not have developed past single a hunting-and-gathering lifestyle.

In the grass family [Poaceae], four plants have been instrumental in the survival of human culture. These plants include wheat (*Triticum aestivum*), which was cultivated more than eleven thousand years ago in the Middle East as a staple grain and today has more than seventeen thousand varieties. Wheat is one of the staple crops of the United States since it is the primary ingredient in bread. Corn (*Zea mays*) was domesticated five thousand years ago in Mexico and Central America and ultimately became dependent on people for its reproduction. Corn has thrived with the assistance of humankind for so long that it can no longer effectively reproduce itself in the wild. Rice (*Oryza sativa*) was cultivated in Southeast Asia by many different cultures as long as five thousand years ago and is a staple in much of Asia and Latin America. Finally, sugar cane (*Saccharum officinarum*) was the staple crop of the indigenous peoples of New Guinea undergoing domestication about five thousand years ago. Nowadays, sugar cane is highly prized as a sweetener.

Two types of potatoes were also considered staples throughout history: the common potato (*Solanum tuberosum*) [Solanaceae] and the sweet potato (*Ipomoea batatas*) [Convolvulaceae]. These tubers actually come from different plant families and are unrelated to each other despite the fact that both are cultivated in South America and both are called potatoes. The common potato was cultivated before 5000 B.C.E. primarily by the multitude of cultures living in the Andean highlands. Hundreds of varieties now exist worldwide. The sweet potato also grows in the mountains, but was more commonly found in the tropical regions of South America and cultivated by Amazonian cultures.

The common bean (*Phaseolus vulgaris*) and the soybean (*Glycine max*)—both members of the Fabaceae bean family—have also been instrumental in the survival of cultures in Latin America and Asia, respectively. Beans were cultivated at least five thousand years ago in Mexico and Peru and often used in combination with corn, providing essential proteins. Soybeans originated in northeast China around the same time and eventually spread worldwide. Soybean production has now shifted from China to the United States, where more than 52 percent of world production occurs.

Coconuts (*Cocos nucifera*) [Araceae] and bananas (*Musa sapientum*) [Musaceae] are often touted as the world's most perfect foods. Although the origins of coconuts are unclear since their fibrous seeds can float in salt water for more than eighty days, researchers believe this important food plant originated in the Indo-Pacific region or possibly Southeast Asia. Bananas also originated in the tropical regions of the Pacific Islands and Southeast Asia more than five thousand years ago and are rich in potassium. The fruits from both of these plants provide high levels of carbohydrates. Sap from banana plants is used as medicine, while their leaves are used in wrapping food for cooking. The husks from coconuts provide strong fibers for weaving, while the fronds of the trees are used as thatching for homes.

Cassava, also known as yucca or manioc (*Manihot esculenta*) [Euphorbiaceae] is a tuber similar in consistency to the common potato and is very starchy. This plant originated in South America and its cultivation began around 5000 B.C.E. Hundreds of varieties now exist of two different types: bitter cassava that contains poisonous cyanogenetic glycosides and sweet cassava that is sold today in marketplaces around the world. Generally, cultures that were more sedentary raised bitter cassava because they were reliant on one garden and therefore would suffer more if herbivorous predators destroyed their gardens. Seminomadic hunter-gardeners would often plant two or three gardens that they could visit throughout the year so damage to one garden was not felt as sharply.

Perhaps the most recent example of a cultivated and important food plant is the sugar beet (*Beta vulgaris*) [Chenopodiaceae]. Beets were cultivated in the eighteenth and nineteenth centuries in Europe. These tubers contain large amounts of sugar and have long been highly prized in Europe, the Mediterranean, and Russia.

pared. Grasses have a ratio of two stable carbon isotopes (C12 and C13) different from that of most other plants eaten by people. Changes in the ratio of these isotopes in human skeletons over time from grass ratios to that found in grains can indicate a shift to grains as a primary source of food. Similarly, the consumption of large amounts of grains can be documented by examining patterns of wear on the teeth of archeological skeletons.

Do Plants Have Cultural Roles?

It is easy to think about plants as being used for food or medicine, or even as a source of technology, for example, in the making of spears or blowguns by Amazonian peoples or the furniture in your own house. But, how many people associate a particular plant with a particular culture? Plants had cultural roles in ancient civilizations, are tied to historical events, and can be important identifiers in modern-day cultures.

South and Central American cultures such as the Aztecs, Maya, and the Inca were often associated with particular types of food. For instance, the Aztecs were well known to have cultivated *Amaranth* sp. [Amaranthaceae], a high-protein grain that was considered sacred by its cultivators. The Maya people were linked to the production of corn, as were many other smaller tribes scattered across South and Central America, and Mexico. The Inca were known to cultivate potatoes and quinoa, a high-protein grain that is still grown by the Quechua and Aymara Indians, descendants of the Inca. North American natives used various dye plants to produce unique colors for weavings that symbolized their particular tribe, family, and sometimes their ethnolinguistic identity.

Plants That Made History

Historically, plants have been known to make or break a culture (see sidebar, Plants That Stand between Survival and Starvation). In addition to plants being food staples in societies, many plants are integrally linked to a culture because they improved or adversely affected its history. The tea tree (*Camelia sinensis*) [Theaceae] has huge cultural significance in many Asian cultures. Elaborate methods to cultivate and prepare tea began in China and later spread to Japan, where the tea ceremony became linked with Zen Buddhist beliefs. Egyptians are credited with inventing paper by pressing together strips of papyrus (*Cyperus papyrus*) [Cyperaceae], but real paper, made by separating plant fibers and matting them together in a thin sheet, was invented by the Chinese using paper mulberry (*Broussonetia papyrifera*) [Moraceae].

A darker side of history includes two plants integrally linked to slavery: cotton (*Gossypium* sp.) [Malvaceae] and sugar cane (*Saccharum officinarum*) [Poaceae]. Both plants were big money crops in the Americas and required significant labor, resulting in the enslavement of many African cultures and their transport to the United States and Central America.

Some may argue that the apple tree (*Malus domestica*) [Rosaceae] also had a hand in shaping world history from the moment Eve took that first bite. Few people realize that the intoxicating drug derived from the opium poppy (*Papaver somniferum*) [Papaveraceae] was one of the main reasons China shut down its borders to all outside trade after the establishment of the People's Republic of China in 1949. Production of the opium poppy has increased in present-day Afghanistan in an effort by terrorist groups to raise money in combatting U.S. military presence. Finally, spice plants in general led Christopher Columbus to search for a new trade route to India, but resulted in his discovery of the Americas in 1492.

IMPORTANT SPICE PLANTS

Common Name	Scientific Name
Anise	*Pimpinella anisum*
Basil	*Ocimum basilicum*
Bay leaves	*Laurus nobilis*
Caraway	*Carum carvi*
Cardamom	*Elettaria cardamomum*
Celantro	*Coriandrum sativum*
Celery	*Apium graveolens*
Chervil	*Anthriscus cereifolium*
Chives	*Allium schoenoprasum*
Coriander	*Coriandrum sativum*
Cumin	*Cuminum cyminum*
Dill	*Anethum graveolens*
Fennel	*Foeniculum vulgare*
Fenugreek	*Trigonella foenumgraecum*
Garlic	*Allium sativum*
Horseradish	*Amoricana rusticana*
Leek	*Allium porrum*
Marjoram	*Origanum majorana*
Mustard	*Brassica alba, B. nigra*
Onion	*Allium cepa*
Oregano	*Origanum vulgare*
Parsley	*Petroselinum crispum*
Peppermint	*Mentha piperita*
Rosemary	*Rosmarinus officinalis*
Sage	*Salvia officinalis*
Savory	*Satureja hortensis*
Shallot	*Allium ascalonicum*
Spearmint	*Mentha spicata*
Star anise	*Illicium verum*
Tarragon	*Artemesia dracunculus*
Thyme	*Thymus vulgaris*

The Future of Ethnobotany

The future of ethnobotany lies squarely in conservation of both plant species and the cultures that know how to use them. As scientists who work directly with cultures and their natural resources, ethnobotanists are in a unique position to promote strategies for conservation. Ethnobotanists of the future need to develop methods that empower the people with whom they work.

For much of the last century, ethnobotanists have spent their time documenting uses of plants and in finding ways to apply the knowledge of one culture for the benefit of another. They must look beyond this and find ways to safeguard the rights and knowledge of the people with whom they study as well as analyze more complex issues relating to interdisciplinary applications of cultural knowledge and uses of plants.

Ethnobotanists must develop methods to convey important information to the communities with which they work, treating indigenous collaborators as coauthors and establishing contracts with communities or tribal groups to ensure that a percentage of any future profits are returned to those cultures which originally held such knowledge.

See also **Agriculture, Origins of; Biodiversity; Botanicals; Herbs and Spices; Horticulture; Paleonutrition, Methods of; Prehistoric Societies.**

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ETHNOPHARMACOLOGY. Although the medicinal uses of plants can be traced to earliest human history and many modern pharmaceuticals are based in botanicals (about 30 percent), Western scientists have been reluctant to extend credibility to the therapeutic potential of plants from other cultures. During the last quarter of the twentieth century, however, attitudes about botanical sources of pharmaceuticals and other medicines shifted dramatically in the West. Renewed interest in plant medicines is substantiated in ethnopharmacology, the study of the chemistry and physiologic actions of (primarily plant) medicines used by native populations. *Ethno* denotes cultural group, and *pharmacology* refers to the science of drug sources, activities, and uses (Etkin, 1996; Rivier and Bruhn, 1979; Rivier and Anton, 1991). Scholarly journals that publish research and reviews on the topic include the *Journal of Ethnopharmacology*, *Pharmaceutical Biology*, *Economic Botany*, *Planta Medica*, *Phytotherapy Research*, and *Fitoterapia*.

Ethnopharmacologists represent diverse academic traditions, most prominently anthropology, pharmacology, and botany, and some commercial domains, including the pharmaceutical industry and the rapidly expanding market for "herbal" (botanical) medicines and medicinal foods. Given the diversity of contributors to ethnopharmacology, the field has considerable breadth in objectives and approaches. At one end of a continuum, anthropologists and a small percentage of ethnobotanists link the ethnography of health and illness to the chemistry and physiologic action of plant medicines. This extends traditional ethnomedical research that addressed the cultural basis of therapeutics and the social relations of healing and that treated plants largely as cultural objects. Anthropological ethnopharmacology has come to include the biodynamic qualities of plants, to acknowledge that tangible attributes may be as important as symbols in the selection of particular species and the interpretation of their physiologic actions.

This biocultural perspective on ethnopharmacology takes into account that native peoples, like Western scientists, are keen observers of their natural environments who embellish the cultural meaning of plants by marking and managing bitter, wound healing, symptom mediating, and other physical attributes. Yucatec Maya populations, for example, distinguish medicinal from nonmedicinal species (including foods) by smell and taste, noting especially astringent, aromatic, and sweet characteristics. These culturally defined clues not only encode information about which symptoms a particular plant treats best but also juxtapose cultural salience to bioactivity. For example, constituents (polyphenols) present in the plants used by Yucatec Maya for digestive complaints are responsible for both astringent taste and efficacy in the treatment of intestinal disorders (Ankli et al., 1999; Brett and Heinrich, 1999). Anthropologists discern these subtleties through extensive field studies (ethnography) of indigenous peoples to understand the complex cultural and environmental circumstances that shape plant selection and use. They have observed that many medicinal species are used for other purposes as well, thus extending human exposure to pharmacologically active constituents.

Medicines overlap especially with foods, and some cultural groups, for example, the Hausa in Nigeria, acquire knowledge of some wild food plants through their experiences with those species as medicines (Etkin and Ross, 1994). In other circumstances the incorporation into cuisines of "novel" plants, such as unusually bitter, astringent, or otherwise unpalatable plants, takes advantage of the healthful effects of bioreactive species, some of which may later be used as medicine proper (Johns, 1994). The point is not to judge whether or not some indigenous group "got it right," that is, used pharmacologically active plants in a way consistent with the principles of biomedicine, but to apply the techniques of bioscience as one aspect of comprehensive research based in extensive field study.

At the other end of the continuum are ethnopharmacologists whose primary objective is drug development. Logically this is the perspective of researchers who do want to know whether or not some indigenous group "got it right" and if so how that lead can be pursued to discover new pharmaceuticals. Bioprospecting pharmacologists have begun to collaborate with botanists, who offer chemotaxonomic insights to guide the search for new sources of known drugs (on the principle that closely related plants have similar chemical profiles) and new plant compounds. For example, the potential to develop medicines for diabetes is suggested in plants that have insulin-stimulating effects, inhibit carbohydrate-digesting enzymes in the intestine, or increase glucose utilization (Raman and Skett, 1998). This research is primarily entrepreneurial (discovering products rather than indigenous knowledge) and necessarily involves only short-term field study with greater emphasis on laboratory and clinical phases. As such this version of ethnopharmacology is not as likely to uncover overlapping uses and the potential pharmacologic significance of certain indigenous food plants.

In the West the bioscientific perspective of ethnopharmacology is applied also to the study of foods. For example, researchers have found that the antioxidant lycopene, which gives tomatoes their red color, diminishes the risk of cardiovascular disease and cancers of the digestive tract and prostate (Rao and Agarwal, 1999). Similarly sulforaphane in broccoli has anticancer activity; hesperidin in grapefruit inhibits poliomyelitis, herpes, and influenza viruses; capsaicin in chili pepper lowers the risk of stomach cancer; sulfides in garlic and onion inhibit blood clotting; and glucaric acid in orange lowers serum cholesterol (Debrovner, 1993; Montanari et al., 1997).

These examples of healthful constituents in everyday (nonexotic) foods overlap the rapidly expanding public and scientific interest in complementary and alternative medicines (CAM), many of which are variably promoted as functional foods, medical foods, supplements, nutraceuticals, health foods, pharmafoods, phytofoods, and phytochemicals ("phyto-" denotes plant). Although the popularity of CAM has been primarily commercially driven, these products increasingly are subjected to scientific scrutiny. For example, studies suggest that constituents of saw palmetto protect against prostrate cancers and that dandelion extracts are diuretic. Pharmacologic studies of previously uncharacterized medicinal foods also reveal potential risks. For example, the blood-thinning and insulin-promoting actions of ginseng may act synergistically with drugs prescribed for the same effects; Saint-John's-wort decreases the effectiveness of some pharmaceuticals, including Indinavir (used to treat HIV/AIDS); and licorice may increase the side effects of oral contraceptives (Newall et al., 1996).

Ethnopharmacologists of all persuasions want to move beyond catalogs of plant use and action to address issues of context. How are the activities of plant components affected by preparation according to real instructions for use? What is the outcome when foods, medicinal foods, medicines, and other biodynamic substances are combined? These are complex questions. They are also the most interesting questions, and their answers will have the broadest implications for people who interact with biodynamic foods and medicines in their daily lives.

See also **Botanicals**; **Health and Disease**; **Health Foods**; **Medicine; Neutraceuticals**.

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ETIQUETTE AND EATING HABITS.

No society can survive or flourish unless its members accept rules governing food sharing and consumption. Mealtime manners, which govern the way food is eaten in the company of others, provide for giving and receiving small, vital, and constantly reiterated signs that these rules are in working order. Without them food would be hogged by the physically powerful, violence would frequently erupt during meals, civility in general would decline, and eventually society would break down altogether. Furthermore, the specific fashion in which a culture manages eating helps to express, identify, and dramatize that society's ideals and aesthetic style.

Civilized and considerate people the world over demand that meals shall be eaten with respect, not only for the food and the effort and good fortune it represents but also for the people in whose company it is eaten. Human beings normally eat in the company of others. The word "company" is derived from Latin, meaning "bread with," and therefore "those who share food." The act of sharing a meal becomes a symbol of every kind of relationship and of the acceptance of cultural values that may seem to have little to do with consuming nutrients. Since eating normally happens more than once a day, human beings turn meals into opportunities to learn and to practice "culture." Politeness at meals provides daily exercise in making socially desirable norms "second nature."

However, mealtime etiquette is not morality. It is convention, an agreement to behave, in the particular circumstances of mealtimes, as if one were virtuous. Like any convention it is liable to degenerate into a facade, which can be used as a barrier to protect power and class distinction.

Taboo

Eating rules exist mainly to ensure that meals shall be shared peacefully, the reason being that such an outcome is far from inevitable. People have killed, chopped, and submitted to fire what they are eating together; they are often armed with knives and certainly with teeth, primary human weapons. They are hungry, each looking out for his or her own interests, and they are sitting at close quarters. They might also be consuming alcohol, which lowers inhibitions. Mealtime rules provide not only the safety but also the predictability that allows eaters to relax.

Different societies have different ways of keeping violence out of the sacred eating space. In European and American cultures knives are on the table. Their blades are given rounded ends unless they are exceptionally competent "steak" knives. Rules insist on no pointing with knives, forks, or spoons. Diners should not impale their food on their knives to carry it to their mouths, or hold their knives in their fists (that is, too competently and therefore aggressively). They should direct their knives toward their plates with their forefingers, and they should lay down their knives with blades facing inward, not toward neighbors. Attempting to reduce the actual use of the knife, diners, when in doubt and if possible, use a fork or a spoon instead. North Americans traditionally cut their food then put aside their knives, blades facing in, and eat with their forks. Carving up a whole

Portrait of Emily Post, the American doyenne of good manners. PHOTO COURTESY OF THE LIBRARY OF CONGRESS.

joint or a bird in front of the assembled company would be, in many societies, an unthinkably barbarous act. The Chinese and Japanese, for example, have banned knives from the table altogether. They cut up everything in advance, far away and out of sight. The eating implements provided are blunt wooden sticks.

Mealtime manners usually work by keeping any thought of violence from occurring. Many myths, however, reveal the roots of the conventions by including a murder that is especially appalling because of its mealtime setting. The drama resides in the horror of that which good behavior while eating so successfully prevents. (An example is Homer's *Odyssey* 11: 409–420.) And because mealtime manners are a mild form of taboo, hearing about infractions, such as people flinging food about, wiping their mouths on the tablecloth, or grabbing food with their hands (especially where knives, forks, and spoons or chopsticks are the rule), causes shock or laughter.

During meals all mammals are extrasensitive to the possibility of enemies stealing their food or otherwise taking advantage of their concentration on eating. They are alert to tiny signs and abnormalities in the environment that otherwise they might let pass. For human beings, who normally eat in a previously prepared and protected area, this heightened attention is applied to the behavior of their eating companions. Strange table manners or an affront to a visitor's culturally formed expectations are often the subject of dramatic travelers' tales. Westerners, for example, might note with surprise and then find unforgettable the Arab custom of pouring tea into a glass until it overflows into the saucer beneath it. This is a sign in Arab cultures of magnanimity, but foreigners can misinterpret it as sloppy and incompetent behavior. On the continent of Europe, propriety enjoins diners to sit with both hands in full view of the company; most correctly, unused hands should rest on the table's edge, being visible only from the wrists. The Anglo-Saxon custom of permitting guests to sit with one hand hidden seems, to Continentals, at best a sad sign of naivete. Since mealtime etiquette is drummed into people so early and so thoroughly, its obedient practitioners rarely find it a matter for comment; they take it for granted. It is outsiders usually who report on the idiosyncrasies of a society's manners at meals.

Violence

To attack corn on the cob with as little ferocity as possible is perhaps the only direction to be given, since from the point of view of grace a series of ferociously snatching, teeth-bared bites that can be heard as well as seen, to say nothing of butter and corn fragments sprinkled on chin and cheeks, while delectable to the palate, is a horrible sight. (Post, 1937, p. 758)

The neighing sound that some people make when they laugh is … unseemly. And the person who opens his mouth wide in a rictus, with wrinkled cheeks and exposed teeth, is also impolite.… If something so funny should occur that it produces uncontrolled laughter … the face should be covered with a napkin or with the hand. (Erasmus, 1530)

Host and Guest

The diner who lets his *fan* (rice) bowl stay on the table and eats by picking up lumps of *fan* from the bowl is expressing disinterest *[sic]* in or dissatisfaction with the food. If he or she is a guest in someone's house, that is seen as an open insult to the host. (F. L. K. Hsü and V. Y. N. Hsü, "Modern China: North," in *Food in Chinese Culture*, edited by K. C. Chang, 1977, p. 305)

If you are fortunate enough, as a guest, to be given a piece of fruit by the ruler, you should suck the kernel clean and put it down the front of your robe, to show that you are not throwing any of his gift away. (*Li Chi,* compiled in the early first century B.C.E., translated by James Legge, 1967)

Noise and Talking

When eating refrain from speaking, lest the windpipe open before the gullet, and life be in danger. (Babylonian Talmud, c. 450 C.E.)

Certain hot foods are best when very hot. The technique for eating them is to draw in air over a narrow opening so as to hasten evaporation and diffuse the flavor. This is most effective when the air roughens the surface of the liquid. That is why hot soup, hot soup-noodles, hot congee etc. are best when sucked in with as loud a noise as possible. (Chao, 1956, p. 34)

[Do not mention at table] a rope in the house of a man who has been hanged. (Lord Chesterfield's letters to his son, no. 259, 1777)

Consideration for the Company

Other themes expressed by systems of mealtime manners worldwide include who dines with whom and when, and the solidarity of the dining group; consideration for the needs, fears, and sensitivities of the other people present; and cleanliness, which may have as much to do with purity and all its connotations as with health. These themes may be articulated in mealtime rituals that are common to many cultures, or behavior may be highly idiosyncratic yet witness to widely held meanings. Mealtime rules simultaneously express preferences that are culture specific.

For example, in modern Europe and America meals are eaten around a table, which expresses the oneness of the group. Solidarity established, the separateness and

Snobbery

[Etiquette is] the barrier which society draws around itself, a shield against the intrusion of the impertinent, the improper, and the vulgar. (*Manners and Tone of Good Society; or, Solecisms to Be Avoided,* 1879)

Nothing indicates a well-bred man more than a proper mode of eating his dinner. A man may pass muster by *dressing well,* and may sustain himself tolerably in conversation; but if he is not perfectly "au fait," *dinner* will betray him. (Agogos, *Hints on Etiquette and the Usages of Society,* 1834)

Delicatesse

Turn away when spitting to avoid spitting on or spraying someone. If any disgusting matter is spat onto the ground, it should … be ground under foot lest it nauseate someone. (Erasmus, 1530)

Withdraw when you are going to vomit; vomiting is not shameful, but to have vomited through gluttony is disgusting. (Erasmus, 1530)

If you happen to have eaten something that cannot be swallowed, you should discreetly turn away and toss it somewhere. (Erasmus, 1530)

Drinking much and long leads to unavoidable consequences. Will it be credited that, in the corner of the very dining room, there is a certain convenient piece of furniture, to be used by anybody who wants it. The operation is performed very deliberately and undisguisedly, as a matter of course, and occasions no interruption of the conversation. (Louis Simond, *Journal of a Tour and Residence in Great Britain during the Years 1810 and 1811,* 1815, vol. 1, p. 49)

self-sufficiency of each individual is stressed. The cutlery is laid out like a fence surrounding every "place." Everyone sits on his or her own upright chair. Portions are divided out before people begin eating and are served on separate dishes. Any crossing of the boundaries represented by the enclosed "place" is either a transgression (a "transgression," derived from Latin, means a "stepping over") or demonstrates great intimacy between people allowed to break this rule and transfer "tastes" from one plate to another. In this same culture it used to be thought polite and benevolent, therefore "good manners," repeatedly to pass food to one's companions. People are exhorted not to lean into someone else's space; not to reach across the table, let alone across a neighbor's plate; not to share the cutlery. Such insistence on the boundaries between the diners is different from the etiquette of people who eat from a common spread, taking from it with their hands, often sitting on the ground to do so.

Equality, Hierarchy, and Reciprocity

When equality is the overriding theme of a meal, meat is likely to be prechopped or minced and perhaps formed into cakes of equal sizes, or all the ingredients might be mixed in one dish so everybody eats the same thing (Watson, 1988). But hierarchy frequently cuts across commensal equality. It matters, for example, who gets served first. Where a whole bird, representing the oneness of the group, is carved up before the diners, the proceeding ensures that differences are expressed. No portion is exactly like any other, and differing values might be assigned to each piece. Carving, in the Western tradition, was once called "doing the honors."

The allocation of sitting spaces at a banquet is exceedingly important in many cultures and subject to specific rules. Often women, who usually have prepared the food, are not allowed to join the men in eating it. Written records of feasts in the European past frequently describe the seating of the guests while not bothering to say what it was they actually ate.

Hospitality, or accepting nonfamily members into one's house, has always been thought a difficult or dangerous proceeding, and for this reason is often the subject of rules and constraints. Hosts have to make guests "feel at home," yet guests must refrain from demanding different food, ordering the host's children about, or otherwise overstepping their essentially passive role. Hosts are at home, giving, while guests are away, receiving, and these roles are underlined in different ways, for instance, in some of the rules for seating.

Meals eaten with friends and acquaintances are widely thought of as helping to bind a society's members together, especially in cultures where familial solidarity is strong enough to create the potential isolation of people into family groups (Ortner, 1978). Such meals normally demand a repetition of the exercise at a later date, when the present guest will become the host. The imbalance created between hosts and guests demands to be righted and produces the highly desirable social virtue of peaceful reciprocity (Lévi-Strauss, 1969; Pitt-Rivers, 1977).

Teaching Children to Behave

In all cultures children have to be taught mealtime manners, which deliberately complicate the actions of taking and eating. They learn gradually not to grab, splash, or shout at meals. They practice giving and receiving in the manner acceptable to the culture, and they find they must ask for rather than demand what they want. Children may also become familiar with social hierarchies or elaborate kinship patterns in their rule-bound expressions at meals, that is, how and when to keep quiet, how to hear and apply admonitions, how to wait and to share (Raum, 1940; Read, 1959; Richards, 1932, 1939). Mealtimes, with clear needs, swift rewards, and adult examples on view, are perfect occasions for children to learn to talk. It is understood that little children, if they are allowed to join the commensal group, have not yet learned to "behave." They may be permitted to run around, beg for tidbits from adults, and otherwise break the rules. Their eventual admission to adult status at meals is a kind of initiation and a proof that they now are capable of self-control.

Noise

Different attitudes toward food are expressed by two types of mealtime manners as they relate to sound. For some groups the polite response to a meal is gratitude to the cook or the host for providing it and pleasure, which should be clearly dramatized. People are expected to express their delight verbally or to provide physical signs of it, like slurping their noodles and sighing with satisfaction. Contentedly burping after the meal may show a kindly abandon to the generosity of the host, who might be hurt if guests remain cool, detached, and apparently either unsatisfied or unimpressed by what has been offered them.

In other cultures people feel they should not be unduly interested in the food; they should at least appear to revel mainly in the company of the other people present. They refrain from exclaiming about the food, although a polite murmur of appreciation might be permitted. They must not look too enthusiastic for fear of seeming greedy. People are expected instead to concentrate on the conversation.

In some cultures talking during meals may be strictly undesirable. In others only certain people present are allowed to talk, or it may be deemed essential that everybody contribute to the conversation. The etiquette of eating from a common spread versus that of eating previously apportioned food interlocks with these preferences for either talking or keeping silent. The system in which each person eats from a separate plate divides the companions, and talk provides the needed interchange among them. People who take their food from a central dish or set of dishes necessarily interact in the process, so they concentrate on eating with fairness and consideration and tend to talk little. People who use chopsticks eat quickly because cut-up food, sizzling hot, could get cold if too much time is taken in chatting rather than eating. Talking for these last two groups tends to be done before the meal or afterward.

Complication

Politeness, which overlays "nature," is usually a complication of behavior deemed by other people to be "fitting" and "proper." In the modern West, for example, where conversation is a necessary part of the formal proceedings at dinner, well-behaved people must nevertheless eat with their mouths closed. To eat and talk but never to be seen opening your mouth with food in it is far from simple. Dining "properly" and remaining relaxed while doing so (showing uneasiness at mealtimes is always distracting and annoying for the other diners) has to be learned and then honed by constant practice.

Silver punch strainer, London, England, 1757. According to proper eighteenth-century etiquette, punch was strained of fruit pulp as it was poured into cups. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Not being mannerly, and effortlessly mannerly, can arouse irritation, unease, disgust, contempt, and finally rejection by other people. Manners, which are supposed to ease relationships, can be turned into a series of tests to sift out people who have not learned the niceties and therefore are kept outside the privileged circles of the "well bred." Here manners are no longer "for the sake of other people" but only for the complacency of some and the exclusion of others. Mealtime manners make a more draconian demand than most aspects of "proper" behavior because ignoring them can violate largely unexamined or unconscious taboos. People often use the differences between their own systems of manners and those of others to make derogatory judgments about those others. In the modern West people frequently shudder at or mock the behavior of their own ancestors, who, for example, ate with their hands.

Yet people who eat with their hands have just as many rules and elaborations as do the wielders of chopsticks or knives, forks, and spoons. People might, for example, always have to eat with their right hands (Needham, 1973) and might even have to restrict the number of fingers used on that hand. They must never reach for more food while still chewing and must never fill both cheeks or even fill one too full, which shows uncontrolled appetite. Hand washing is demanded before and after meals and sometimes during meals as well. No spilling or grabbing and no fiddling with the food is allowed, such actions being all too easy when eating with the hands. Eating gracefully, or the reverse, is defined, and rules establish how to take up a morsel and just how and how much to dip it into sauce. Restrictions govern general physical postures at meals, and the pressure is to offer delicacies to others. Rules such as these regulated eating

Closing the Mouth

Item, that he fil not his mouth so ful of meat as he cannot hold his lips together while he is chawing: for otherwise, men shal look into his mouth, and see the meat rowle by and downe while he is eating: which is a foule sight and loathsome: and for that cause, a man must forbear to speake with meat in his mouth, except he have so litle as hee bee sure to hide it in his mouth while he is speaking. (*The Court of Civill Courtesie,* translated from the Italian, 1591)

Complication

American manners [regarding the use of knife and fork] are, if anything, a more advanced form of civilized behavior than the European, because they are more complicated and further removed from the practical result, always a sign of refinement. (Martin, 1983, p. 124)

The expert removes the bones from his mouth with his chopsticks. (Chao, 1956)

behavior before the imposition of the set of cutlery now common in the West.

The History of Table Manners

Mealtime etiquette is a conservative force in all societies. Since it expresses culture, it resists deconstruction and alteration. Manners do change over time. But no matter how trivial it may seem, any modification in a traditional mealtime convention is likely to be a sign of a momentous shift in socially determined sensibilities.

Forks have become in the West part of every diner's eating equipment. Eating with the hands is permissible only in a restricted number of cases, such as eating artichokes, asparagus, or radishes, or on informal occasions. The difficult, unnatural, skill-demanding fork has replaced fingers at nearly all tables most of the time. It took eight centuries to accomplish this.

Before forks achieved general usage as eating implements, people had to devise flat, hard surfaces on which each individual diner could impale portions with forks and cut them with knives. Those surfaces then had to be accepted and made available to everybody. The new plates ("plate," derived from the French, means "flat") were first metal, then ceramic, making them more affordable. They gradually replaced the traditional bowls and hollows carved into the dining table and the "trenchers" or bread bases for supporting morsels of food eaten with the hands. Even after the general acceptance of the fork, polite people continued until the early twentieth century to feel free to carry their food to their mouths with their knives.

The provision of special implements for moving food from serving dish to plate also came about slowly. European manners gradually and unevenly changed from several people taking it in turns to dip the one shared spoon into the pot and to eat from it, to wiping the communal spoon carefully on a napkin before passing it on, to provision of a spoon for each person for dipping and eating, to wiping that individual spoon on a napkin after sipping from it before dipping it into the common dish again, to using a special spoon for serving and nothing else. A person must never forget and use his or her own spoon by mistake. All this purity required more and more cutlery.

The slow developments just outlined together with a growing restriction on bodily relaxation at table reflected an increasing desire for self-sufficiency and separateness in the culture. Ideally others should neither impinge nor need assistance. Such changes can be tracked in European and American history by studying surviving writings describing etiquette. These writings include pamphlets and lists of rules published from the medieval period down to the twenty-first century for people wanting to "polish" their manners, including their table manners, in order to become upwardly mobile. The sociologist Norbert Elias (1939) used these texts, especially those concerned with table manners, to show the development of Western inhibitions following the Renaissance, when Erasmus (1530) published the most accomplished and famous example and included in it a chapter on manners at meals.

The printing press helped disseminate books of etiquette, and learning mannerly behavior began to spread outside the narrow but innovative circles of the court first to the bourgeoisie, who became stricter than the nobility was about certain kinds of correct behavior, and then to everybody else. Elias chronicled not only the growth of separating "walls of restraint," underwritten by embarrassment, in Western culture but the gradual imposition of an insistence that people control and hide bodily functions, where once people were far more tolerant about such matters. In all cultures manners must have changed in analogous ways, even if the changes have not been recorded.

Formality and Informality

Mealtime etiquette governs settings for meals, the seating of hosts and guests, dishes, decorations, lights, napkins and washing facilities, eating implements and their placement in the eating area, the sequence in which food is eaten, how food is served, the correct ways of issuing invitations to dinner, what people wear when eating, and much else besides. Each of these customs and artifacts has a specific meaning and a history. When all these things are enumerated, however, the reference is to full, formal meals, the ones with the widest range and intricacy, where hospitality is offered to guests. Such meals are likely to be "feasts" on the occasion of events important for the community. People come together to eat when they wish to celebrate, especially when they are eager to express what is held in common (Douglas and Gross, 1981).

Feasts by definition are out of the ordinary, extravagant, complicated, often pointedly traditional, highly organized, and therefore commonly formal. The food itself is typically shaped or molded and prepared in elaborate, time-consuming ways, often requiring the efforts of many people. Preparing becomes part of the sharing. Ordinary eating is simpler, less copious, and takes less time; it is informal.

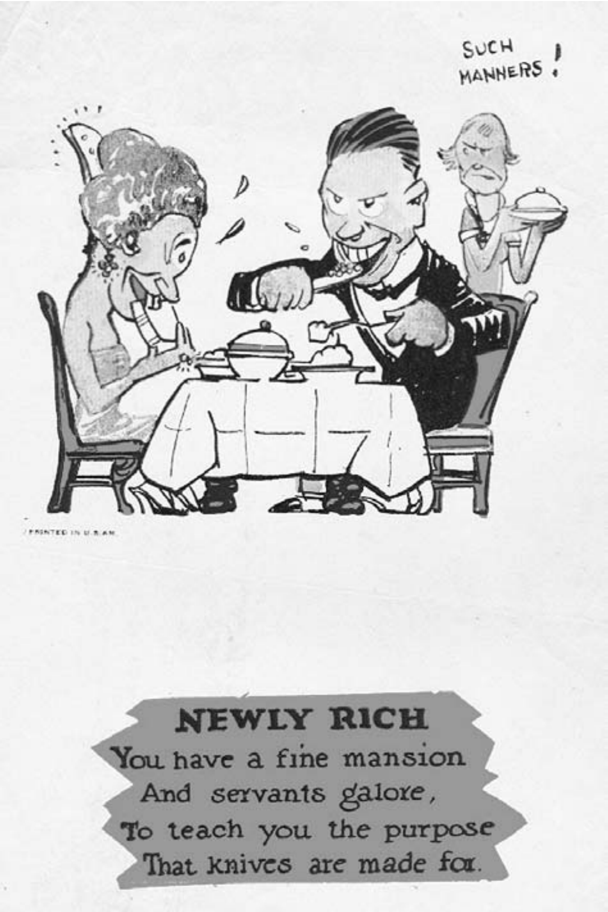
This does not mean that manners are less important at everyday family meals, but it does mean that decorum at these daily events is usually and deliberately lowered. Mealtime taboos are fiercely maintained (no one at a European or American meal puts his or her feet on the table, no one spits, or causes an uproar without disapproval), but formal flourishes are dispensed with. People might feel comfortable eating in silence, handle their food casually, or not clear the entire table before laying it for a meal. Membership in a high social class frequently entails relatively high decorum at ordinary meals. A deliberate lowering of decorum gives the strongest messages when the "full," formal model is previously understood.

Formality by design increases social distance; informality brings people closer. In the modern Western world being "casual" has come to be seen as nearly always de rigueur because of modern egalitarian ideals and because modern society has more than enough devices for keeping people apart. The insistence that people shall behave casually but in the prescribed manner is in itself a mannerly social convention.

Some Factors Informing Table Etiquette in Modern Europe and North America

Formality is a lot of work—work that has traditionally been performed with regard to meals mostly by women and by servants. In the course of the first half of the twentieth century, even upper-middle-class households learned to manage without live-in servants. The immediate result was the lowering of decorum, including that at the dinner table. Being served meals by people not part of the commensal group became part of the relatively unusual experience of dining in restaurants.

With the ongoing feminist revolution, women are no longer automatically expected to remain dedicated to the house and devoted to the maintenance of "polish." Once again formality at the family dining table has diminished, even where once it ruled. However, one of the principles of manners has always been "Do not improperly impose upon others." It is possible to accept a certain lowering of decorum at the dinner table as even more mannerly than formality once was. The rules of propriety are negotiated rules. Whatever is no longer thought proper is rude or at best ridiculous. Politeness at table as elsewhere has everything to do with the accepted conventions.


SUCH MANNERS!
PRINTED IN U.S.A.
NEWLY RICH
You have a fine mansion
And servants galore,
To teach you the purpose
That knives are made for.

Comic valentine from circa 1930 spoofing the bad table manners of the newly rich. ROUGHWOOD COLLECTION.

Formality is among other things the taking of time; elaboration takes time. In the "developed" world time has become part of the system of social constraints. People feel they have "no time." The immediate effect upon manners of this culturally induced perception is almost invariably, again, to simplify them. Eating meals can become not a pleasure but something done purely out of necessity and as quickly as possible to get it out of the way in favor of other activities. Preparing food is often foregone entirely, and prepared food is substituted. Eating "fast food," however, still conforms to the limits set by table manners. Predictability, equality, and cleanliness, all of them the concern of mealtime manners, are also assured by the fact that the food is always exactly the same, is served in similar surroundings, and is hedged about by a lot of paper wrappings and other signs that convey "cleanliness" and "control."

Manners, including mealtime manners, are at present undergoing change and renegotiation in many human cultures worldwide; this is a sign of important transformations underway. Such modifications must take time and occur neither smoothly nor evenly. People increasingly come into contact with systems of manners different from their own. They often have to endure unpredictable and annoying behavior from others and relatively weak social mechanisms for preventing or punishing transgressions. Many complain that others have "no manners." But as long as human society continues to function, manners will exist. And among the most fundamental of these are manners governing and involving eating.

See also **Meal**; **Table Talk**; **Taboo**.

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Margaret Visser

ETYMOLOGY OF FOOD. The words of a language can be traced to two sources. Some have been a part of that same language as far back as its history is known, although, since no language remains fixed, they will have gradually changed in form and sound. Others are loanwords, borrowed from another language with which the speakers of the first have been in contact.

Food words fall into both categories. Food and drink are necessities of life, basic elements of which are likely to remain fixed (and to retain the same vocabulary) through the centuries. Yet innumerable details will change (and demand new names) in response to taste, fashion, and the love of variety; also in response to the migration of peoples, the development of trade, and the transplanting of food species. Thus in English the names of foods and drinks mirror the cultural history of English speakers. Some names remain unexplained: no one knows the origin of "raspberry," "syllabub," or "toffee."

Some basic foods have had the same name in English and in its ancestral languages all the way back to Proto-Indo-European, an unrecorded, reconstructed language that might have been spoken some time between 5000 and 3000 B.C.E. in the southern Russian steppes. Such words include *water* (compare modern Russian *voda* [water] and *vodka*), *mead* (Sanskrit *madhu* [honey]), *barley* (Latin *far* [emmer wheat]), *milk* (Latin *mulgere* [to milk an animal]). Also from Proto-Indo-European come the names of certain basic preparation methods, *bake* (compare Greek *phogein*), *brew*, and *broth* (Greek *broutos* [a kind of beer]).

The names of some foods go back to the unrecorded Proto-Germanic language of the first millennium B.C.E. (the immediate ancestor of English, German, and others) but cannot be traced to any earlier stage. This applies to *meat*, *bread* (German *Brot*), *honey*, *eel* (German *Aal*), *egg* (German *Ei*). Some of these words may have been borrowed into Proto-Germanic from other unrecorded prehistoric languages of Europe.

Moving forward in time, some Mediterranean foods and luxuries were introduced to northern Europe by the Romans. Thus English uses words of Latin origin for important products such as *cheese* (from Latin *caseus*) and *wine* (from Latin *vinum*) and also for a few fruits and vegetables that were first planted in northern Europe by the Romans, such as *plum* (from Latin *prunum*) and *fennel* (from Latin *feniculum*).

Certain new foods came to England with the Norman conquest in 1066. During the period of English-French bilingual culture that followed, English cuisine changed and developed rapidly. Thus many terms relevant to food were borrowed into English from Anglo-Norman, the dialect of Old French that was spoken in Medieval England. Examples include *pear* (French *poire*), *chestnut* (French *châtaigne*; originally from ancient Greek *kastanea*), *salmon* (French *saumon*), *sausage* (French *saucisse*). Anglo-Norman was also the source of names for cooking methods, *fry* (French *frire*) and *boil* (French *bouillir*).

English has continued to borrow food concepts from other cultures and food words from other languages. *Steak* comes from Old Norse, the language of the Vikings; *lozenge* from Arabic by way of Old French; *pickle* from Dutch; *tomato*, *chocolate*, and *chili* from Nahuatl, the language of the Aztecs. In modern times, with the globalization of tastes, this kind of borrowing has become even more frequent. So we have *curry* from Tamil or Kannada of southern India, *toddy* and *chutney* from Hindi, *pasta* and *pizza* from Italian, *marzipan* from German (the word originated in Italian), *blini* from Russian, *tofu* from Japanese (the word originated in Chinese). Cooks and restaurateurs like to make the names of dishes evoke their origins by retaining an authentically foreign form, such as the French *coq au vin* and *tripes à la mode de Caen* (cockerel cooked in wine, tripe in the Caen fashion). They also like to use foreign names for methods of preparation, as in *chicken chasseur* (French *chasseur* [huntsman]).

Local specialities in food and wine mean that place-names often have a special food meaning. *Cheddar* is a village in Somerset, England (but cheeses with this name are now made in many countries). *Cognac* and *Armagnac* are towns in southwestern France. *Parmesan* is an English form of the Italian adjective *Parmigiano*, meaning 'from Parma', a town in northern Italy. *Sherry* is an English form of the Spanish place-name *Jérez* (*de la Frontera*); *Port* is an English form of the Portuguese place name *Porto*.

Since English is spoken so widely across the world, its vocabulary is astonishingly varied. Many foods have different names, and many food names have different meanings in Britain and the United States. *Cider* is apple juice in the United States; it is an alcoholic drink in Britain. *Corn* is maize in the United States, wheat in Britain. The spice called *turmeric* in Britain and the United States is known in South Africa as *borrie* (a loan from Malay by way of Afrikaans). The European spice known in Britain as *coriander* is called in Indian English *dhania* or *dhunia*; in the United States the fruit is called *coriander* but the leaves are called *cilantro*, a word borrowed from Spanish. The Afghan spice known as *hing* in Indian English is *asafoetida* in Britain and the United States, while it is *duivelsdrek* in South African English: this is a loanword from Afrikaans meaning literally 'devil's dung' (because that is what asafoetida smells like). The spice called *jeera* in Indian English is *cumin* or *cummin* in British and U.S. English. Indian English *methi* is British English *fenugreek*. Indian English *sitaphul* is known elsewhere as *custard-apple*. Indian English *alu* is U.S. and British English *potato* (also British *spud*). The fruit *okra* (this name is borrowed from the Akan language of Ghana) is also known regionally as *gumbo* (borrowed from Mbundu of Angola), *bhindi* (borrowed from Marathi of India), and *ladies' fingers*. The *chickpea* is also known as *chana* (borrowed from Hindi) and *garbanzo bean* (borrowed from Spanish). Even where the English names derive ultimately from a single foreign word, they may have different forms and connotations in different regions, like U.S. English *kabob* for British English *kebab* (a word that is Turkish in origin).

Corn

The English words *corn* and *grain* are linguistic doublets: both of them originate in a Proto-Indo-European word (of about 4000 B.C.E.) that may be reconstructed as *grnom*. This word meant 'cereal grain'. As the Indo-European languages grew apart, it took a different form in Proto-Germanic, in Latin, and in other early languages. In Proto-Germanic (about 500 B.C.E.) the form was *kurnam*: this became *korn* in Old High German and Old Norse and *corn* in Old English (Anglo-Saxon), and that is the immediate origin of the modern English word *corn*. In classical Latin, meanwhile, the form was *granum*. This became *grano* in Spanish and Italian and *grain* in French, meaning 'cereal grain', and the French word was borrowed into English. The French words *graine* (seed) and *grange* (barn) derive from the same Latin word.

What does *corn* mean? In British English it means 'cereal'—and usually it means 'wheat', the favorite cereal of Europe. When English speakers in the New World (the "Indies") encountered a cereal that was new to them, they invented a new name for it: *Indian corn*. In the United States, this name was eventually shortened to *corn*, which is why, in the United States, *corn* now means 'Indian corn'. Meanwhile, back in Europe, where Indian corn was soon transplanted, people came to know it under the name *maize* (a Carib word, transmitted by way of Spanish *maiz*). In South Africa it has a different name again, *mealie* or *mielie* (a word borrowed from Afrikaans and said to derive originally from Portuguese *milho* [millet]).

So what are *Corn Flakes* made from? Indian corn, of course, because they were invented and named in the United States; but British people often assume that they are made from wheat, because that is what *corn* means in Britain.

Sugar

Sugar, in ancient and medieval Europe, was a rare and costly spice. India was the nearest source of supply; sugar was shipped across the wide Indian Ocean, the Red Sea, and the Mediterranean to reach its European purchasers.

Sugar was originally traded as solid cakes. It was in India that granulated sugar was invented, perhaps about 200 B.C.E.; its ancient Indic (Pali and Prakrit) name, *sakkhara*, reflects this fact, because literally *sakkhara* (also *sakkara*) means 'gravel, grit'. This word reached the ancient West along with the sacks of sugar; it was adopted into classical Greek (*sakkhar*, later *sakhar*), Latin (*saccharum*), and early Arabic (*sukkar*). Medieval Russians got their sugar from the Greeks of Byzantium, so they called it *sakhar*. Medieval western Europe bought sugar from Arab traders, and therefore gave it names that resemble the Arabic: medieval Latin *succarum*, Italian *zucchero*, Old French *sukere*, modern French *sucre*.

Sugar must have been almost unknown in Britain until Norman times. The English name for it is borrowed from Norman French: the form is *suker* or *zuker* in thirteenth-century manuscripts, then *suger*, and finally *sugar*.

Cooking for William the Conquerer

The most familiar examples of food words borrowed into English from the Anglo-Norman form of French are names for the meat of the pig, sheep, and ox, the three major farm animals of medieval Europe. In the Anglo-Saxon (Old English) language, just one basic word existed for each of these three animals, alive or dead. So also in Old French; so also in modern French, in which the basic words are *porc* (pig), *mouton* (sheep), and *boeuf* (ox).

In Norman times, English borrowed those three French words, *pork*, *mutton*, *beef*. So, unusually, ever since then, English has had six basic words in this semantic field, three for the living animals and three for the meats. Why were the extra three words borrowed at all? Why were the borrowed words used in the special sense of ready-to-eat meats?

The likely answer is that because the English nobles of that period spoke French and ordered their food in French, others eventually thought it fashionable and classy to use French for the names of fine foods. In just the same way, after a successful hunt, the huntsmen demanded in French to be served with *la veneson*, meaning literally 'the game we just hunted', and that is why *venison* has its modern English meaning of 'deer meat'.

See also **Language about Food; Metaphor, Food as; Naming of Food; Symbol, Food as**.

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Andrew Dalby

EVOLUTION. Jean-Louis Flandrin, in his introduction to *Food: A Culinary History*, sets out many of the crucial questions basic to our understanding of the evolution of human diet:

> When and how did the eating behavior of human beings diverge from that of other animal species? Did humans distinguish themselves by the type of variety of foods they ate? By the fact that they prepared their food before eating it? By the ceremonial forms with which they surrounded the act of eating? Or by the conviviality of dining and its characteristic social forms? (p. 14)

These questions, as they relate to the evolution of human foodways, remain unanswerable. A major reason is the vast gulf that separates the living from earlier ancestors. Today, virtually all humans subsist on the products of agricultural activities, which include the raising of domestic animals for food. However, this way of life developed very late in the course of human evolution, with the domestication of plants appearing in several locations around the world at some point after 12,000 years ago; the domestication of food animals followed somewhat later. The vast earlier time, during which humans evolved from more primitive beings, was marked by other forms of subsistence. This time span, more than six million years in duration, witnessed dramatic changes in human biology, behavior, and adaptation. Although we have a treasure trove of fossil bones and archaeological materials that document much of this development, there is little in the record that can inform us of the precise dietary items consumed by these remote ancestors of ours, or enable us to answer the questions posed by Flandrin. There are, however, tantalizing hints of the ways of life followed by these earliest members of the human family, and in this essay, this record will be described, and the available evidence for the evolution of human foodways evaluated.

The data at our disposal for this investigation include the fossil bones and teeth of our ancestors, testaments to their evolving biological structures. There are also the residues of their activities, in the very earliest deposits often preserved as parts of natural accumulations of organic and inorganic remains, jumbled in with the fossil bones of very early human ancestors. Later in time, we find the archaeological remains of the actual living areas, where our ancestors slept, made tools, prepared and ate their food, and often buried or left their dead. All this varied information provides important insights about our evolutionary past, but it is very incomplete data for reconstructing dietary patterns. For example, very little in the way of actual food remains is found during archaeological excavations, and only relatively durable items like animal bones are preserved. This may provide some indication of the presence of meat in the diet, but it is not clear just how much it represents the total subsistence pattern and how much was composed of other foods, like vegetables and insects, which leave no archaeological traces. Similarly, the bones and teeth of our ancestors may preserve chemical and other traces of the sorts of foods that were emphasized in their diets, but these signs are often complex and must be carefully evaluated.

Given the difficulties in deciphering the actual residues, other, more indirect, sources of information have come to play an important role in reconstructing the foodways of our ancestors. These data come from the study of our closest living primate relatives, the chimpanzees, and observations recorded from the anthropological studies of those few modern human groups, called gatherers and hunters, who did not practice agriculture, but subsisted on an assortment of gathered vegetable foods, the collection of small animals, such as insects and small vertebrates, and the occasional successful hunting of larger animals. Comparisons with these living examples are often used to furnish clues to what sorts of foods our ancestors consumed. However, correlations of this sort have numerous limitations, and they must be used with caution. Chimpanzees and humans have had separate evolutionary pathways for at least six million years, and it is possible that during this time, chimpanzees have changed as much as humans in their biology and adaptation, making comparisons of living chimpanzees with our earliest ancestors tenuous at best (we have no fossil record of the specific evolutionary history of chimpanzees). Further, those few living gatherers and hunters who have been studied exist in environments that may be dramatically different from the locales of our ancestors. Finally, and perhaps most importantly, our early ancestors were neither bipedal apes nor humans in fur suits, but a series of biologically and behaviorally unique species whose way of life and biology are now wholly extinct.

Both modern chimpanzees and those gatherers and hunters who have been studied, and do not live in very specialized environments (like the Arctic, for example), have somewhat similar diets. The field research by Jane Goodall and her associates on chimpanzees living in the Gombe National Park in western Tanzania, as well as observations from other chimpanzee living-sites in Africa, indicate that these animals are overwhelmingly vegetarians, with a broadly based diet composed, at the Gombe, of the fruits, leaves, stems, blossoms, and gums of more than eighty different plants. Chimpanzees, however, emphasize a variety of fruits as the major part of their diet. Chimpanzees have also been observed consuming insects, sometimes using twigs, specially broken off and trimmed as tools, to obtain termites. Chimpanzees (often males), behaving together in a cooperative fashion, also deliberately hunt, kill, and eat a variety of small vertebrates, including bush pigs, monkeys, and antelopes. Meat, however, makes up a very small percentage of their total diet.

Human gatherers and hunters in tropical or subtropical areas also subsist on a diet that emphasizes a broad array of vegetable food sources, with smaller amounts of insects and vertebrate animals. The exact percentage of each of these elements differs seasonally or yearly, as well as varying between specific groups.

Like living gatherers and hunters, until the advent of agriculture, our ancestors probably lived an unsettled existence, regularly shifting their encampments to new locales in search of resources. Food storage would have been very difficult, and consumption of collected and hunted foods was probably immediate. Groups would have been small, with the social organization flexible enough to allow group size to fluctuate with the seasonal availability of food and other resources.

These comparisons provide only a very limited insight, and for more information, it is necessary to examine the direct evidence from the archaeological and fossil records.

Diet and Human Evolution

A variety of comparative genetic studies document that chimpanzees are our closest living relative. It has been estimated, for example, that humans and chimpanzees share about 98.5 percent of their genetic material. Calculations of the rate of genetic change over time indicate that humans last shared a common ancestor with this African ape between five and eight million years ago. This is the period when the evolutionary line that eventually led to living humans split from the line that led to chimpanzees, representing the beginnings of human evolution. The living and extinct members of this human evolutionary lineage are traditionally grouped into a biological family, the Hominidae, members of which are known as hominids.

We have no fossil or other evidence of the earliest members of the hominid family, just after they split off from the lineage leading to chimpanzees. We do not know what sorts of environments they lived in or what sorts of foods they ate. Because chimpanzees are native to Africa, and the earliest known hominid fossils are limited to Africa, it seems reasonable to place the homeland of the human family on that continent.

The Earliest Hominids

The recognition of Africa as the human homeland first came in 1924, with the discovery of the fossilized skull and jaw of a young child at T'aung, in the Cape Province of South Africa. Named *Australopithecus africanus* by its discoverer, Raymond Dart, hundreds of additional fossil specimens of this group, known collectively as the australopithecines, have subsequently been uncovered in south, east, and central Africa. There are now at least eight species of australopithecines, sometimes placed in other genera, like *Paranthropus* or *Kenyanthropus.* The australopithecines lived in Africa from about four million to perhaps as late as one million years ago. Like all members of the hominid family, they walked upright, allowing them to efficiently carry objects and food. Chimpanzees habitually walk on all four legs. However, the australopithecines were apelike in many of their biological features, possessing small, chimpanzee-sized brains in an apelike skull with a large, projecting face positioned out in front of the braincase. Their teeth were humanlike in form, but they possessed massive back chewing teeth, the premolars and molars, that were much larger than those of living humans. The australopithecines, like all hominids, possessed nonprojecting canine teeth. This is in marked contrast to the large, tusklike canines of the apes. Like gorillas, australopithecines also seem to have been sexually dimorphic in body size, with the males considerably larger than the females.

There are fossil bones found in East Africa of still earlier-in-time creatures, for example, *Orrorin tugenensis*, at six million years, possibly the earliest hominid yet discovered, and *Ardipithecus ramidus*, who lived about four and a half million years ago, but little is currently known about these creatures and their biology.

The fossil bones of the australopithecines are most often discovered in natural accumulations that are the result of various sorts of geological activities. These fossil bones may have been transported by water over long distances before they were deposited in their final location. They are only infrequently discovered in a context that represents the locale where they actually lived. Thus, little is known about the kinds of environments in which the australopithecines lived, or how the various australopithecine species may have differed in habitat usage or in food choice and general diet.

For many years after the initial discoveries of the australopithecines, there was a prevalent idea that these creatures lived on the open grasslands or savannas of eastern Africa. According to this theory, their habitat would have provided only a limited selection of foods, and was the selective factor responsible for the development of hunting and meat eating. More recent reconstructions, however, have revealed a much more complex environmental context for these early hominids, with evidence for the use of forests and woodlands. Just how important hunting and meat eating has been in human evolution continues to be debated, and its importance in the ultimate appearance of modern humans remains unclear.

Australopithecine fossil bones have been carefully examined in a number of ingenious ways, in order to learn more about their dietary patterns, but thus far with only limited success.

For example, on the basis of comparisons with the teeth of other mammals, it is clear that these early hominids were not specifically adapted to meat eating. As in modern humans, the chewing surfaces of the teeth are covered with thick layers of enamel. Some australopithecine species, known as the "robust" australopithecines, possessed truly massive back teeth, along with very large jawbones to house them, and large chewing muscles, sometimes so large that they formed a crest on the top of the skull. These general biological features of australopithecine jaws and teeth suggest that they emphasized the chewing of coarse vegetable food sources, but not the consumption of grasses, whose high cellulose content would have been very difficult for these creatures to digest.

Other studies of the dentition have attempted to determine more specific aspects of the dietary patterns of the australopithecines. One series of studies utilized scanning electron microscopy to examine the minute scratches and pits left by food particles on the chewing surface of the teeth. The results of these observations suggest that some of the australopithecines ate a diet rich in fruits, while others were consuming a more varied, but basically vegetarian, diet. One problem with these sorts of studies is that they tend to focus on the final meals the creatures ate before they died, providing a somewhat limited view of their overall diet, especially if they were seasonally exploiting a variety of different habitats and foods.

Other studies have examined the chemical composition of australopithecine fossil bones. One study employed the ratio of calcium and strontium in the fossil bones to determine whether the australopithecines were generally herbivorous, carnivorous, or omnivorous.

Another chemical analysis, based on staple isotopes including ^{13}C and ^{12}C, has reached a conclusion similar to that from the calcium-strontium analyses: some australopithecines, at least, were consuming animal foods, though the identity of these animals, and whether they were vertebrates or invertebrates, has not been determined.

These studies continue to support a variety of opinions about the dietary patterns of these early hominids, with some anthropologists suggesting a diet based primarily on fleshy fruits, nuts, and seeds, while others advocate a more broadly based diet, including some animal foods.

There is no direct evidence that the australopithecines collected foods to be brought back to some central camp to be consumed as part of a group activity. Rather, like chimpanzees, it appears likely that they consumed food continuously as they foraged in their environment.

The Evolution of the Genus *Homo*

Good evidence of the evolution of members of our genus, *Homo*, begins to appear around two million years ago at sites in East Africa. There was a dramatic increase in brain size, from the 500 ml common in the australopithecines to brains as large as 800 ml in these early humans (though still about half the size of those of living people). They also possessed smaller back chewing teeth. Chipped stone tools, first used about two-and-a-half million years ago, now became more common. These durable tools, made from water-rounded pebbles, are known as Oldowan tools. They were made by striking two stones together, knocking off chips to produce a cutting edge or point. Though crudely made, their development represented a major advance in the ability of the early hominids to exploit a wider variety of food sources. Hominids lacked sharp and hardened claws, as well as projecting and pointed canine piercing teeth, making them inefficient in dealing with many potential food sources. For example, without a digging tool or claws, many subterranean foods like insects, small burrowing mammals, tubers, and rhizomes, would have been impossible to obtain. The australopithecines are only rarely found in association with these chipped pebble tools, and most anthropologists believe the first stone tool makers were early members of the human genus *Homo*.

Also found at this time are animal bones, mainly from antelopes, with butchery marks made by a sharp stone edge. Although isotopic studies have indicated that the earlier australopithecines may have consumed animal foods, these cut marks represent definitive evidence of early meat eating. What is still being debated is the origin of these bones. They may have been the result of hunting activities, which is entirely reasonable given our knowledge of the cooperative hunting patterns of chimpanzees, but some scientists have suggested that they may also have been the result of scavenging activities. A safe way, it is said, to obtain bones with scraps of meat still adhering to them would be to claim animal bones from a predator kill after primary scavengers, such as hyenas and jackals, have finished with them. Thus, the initial meat eating in human evolution, according to this view, was to utilize stone tools to scrape off bits of rotting tissue from the bones of predator kills. One major flaw with this notion is that no primate is equipped with digestive mechanisms to protect them from the serious consequences of eating spoiled meat.

By about 1.8 million years ago, there are a number of different species of early *Homo* coexisting in eastern Africa. In addition, several species of robust australopithecines were also living at this time. What the possible dietary differences, if any, between all these hominids is unknown.

Expansion Out of Africa

At some point after 1.8 million years ago, in one of the most momentous events in human evolution, the hominids begin to move out of Africa. One site along the Jordan River Valley in Israel, dated at about one and a half million years old, is located along what must have been a major route into Eurasia. Along with stone tools similar to those from Africa were found numerous bones of African mammals, suggesting that the hominids were not the only creatures moving out of that continent.

Hominid sites in the Republic of Georgia and on the island of Java also testify to this dramatic increase in range. Although the reasons the hominids left Africa at this moment are unclear, one reasonable explanation is that stone tools enabled hominids to expand the range of dietary items open for exploitation, allowing them to move into new habitats.

During the course of the next million years, hominid brain size increased, so that by about 300,000 to 400,000 years ago, the volume of the braincase reached 1,200 ml, within the range of living humans. It may be that there was an associated increase in body size during this period as well. Increasing brain size would have required greater intakes of oxygen, as well as nutrients. It has been suggested that this brain size expansion relied on increased amounts of dietary fats. Hunted animals could have supplied these fats, but gathered insects, many of which are richly endowed with this nutrient (especially the essential fatty acid, linoleic acid), are equally likely sources. Larger body size also necessitated a greater number of calories.

The occupation of the European subcontinent appears to have taken place later than human expansion into more hospitable habitats in Asia. This is no doubt related to the presence of glaciers, which, beginning about two million years ago, periodically covered major parts of Europe. The earliest occupation site in Europe, dating to about 800,000 years ago, is located in northern Spain, near the present city of Burgos. From that time onwards, hominid presence in Europe was closely tied to the advance and retreat of the glaciers, with the continent relatively uninhabited during times of maximal glacial activity.

By 500,000 years ago, hominids, placed in the category *Homo erectus*, were intermittently occupying a large cave on the outskirts of what is now the village of Zhoukoudian, about twenty-five miles from Beijing, in northern China. Although there was no glacial activity in this part of Asia, winter would have been severe (Zhoukoudian is about as far north as Philadelphia). While it remains unclear if hominids actually wintered this far north, the earliest well-documented evidence of fire has been found here. Fire allowed hominids to use food sources that would be uneatable, or actually toxic, without cooking. Burned deer bones, as well as those with cut marks, testify to the use of meat by the inhabitants of the cave, but whether the meat was obtained by hunting or scavenging remains unknown.

From about the same time, a hominid skull was found in Ethiopia with cut marks on its frontal bone, suggesting skinning or scalping. Cannibalism has been documented at a number of other, later-in-time hominid sites; was the flesh a part of the diet, or was eating a dead friend or relative part of a ritual?

Modern Human Origins

The last 200,000 years of human evolution are much richer in data because actual living places have been located and excavated. Prior to this time, only a very few sites, like Zhoukoudian, represented the remains of an encampment, where the evidence of hominid activities are directly preserved. By about 115,000 years ago, our ancestors had begun the practice of the deliberate burial of their dead, thereby reducing the risk that the body would be destroyed by scavengers. Burying the dead resulted in a vast increase of ancient skeletons that have been preserved for study.

There continues to be debate about the precise way by which living humans emerged from our earlier ancestry. Some anthropologists suggest that modern humans evolved from these earlier hominids and, thus, are the culmination of a very long evolutionary history in various geographic areas. For example, living Asians are the descendants of ancestors who reached Asia more than a million years ago.

Most anthropologists support another theory, that all modern humans originated in Africa some 100,000 to 300,000 years ago and, subsequently, spread out from there to populate the rest of the planet, replacing the earlier hominids who were already living in these areas, descendants of the much earlier initial expansion.

One extinct fossil group that has figured prominently in these theories is the Neanderthals, a group of hominids who lived in Europe and the Middle East from about 130,000 to about 30,000 years ago, when they disappeared from the scene. Because they lived in Europe, where the most intensive archaeological investigations have taken place over the last 150 years, we have much more evidence about these creatures than about any other fossil hominids. This has provided a rich data source, but it also has a number of serious limitations. The most important is that emphasizing the Neanderthals gives a very Eurocentric view of human origins. The final glaciation occurred during much of the time Neanderthals were in Europe; this made major portions of the continent uninhabitable. Those parts that could be occupied by humans represented marginal environments that would have limited population density to extremely low levels.

Given the harsh environments of Europe in which the Neanderthals were living, vegetable foods were probably relatively scarce through much of the year, and meat was almost certainly a major dietary resource. This is confirmed by chemical analyses of their bones, which indicate that for some Neanderthals, fully 80 percent of their diet came from meat. The bones of numerous large animals, such as deer, aurochs, wild boar, and horses are preserved at Neanderthal sites, along with smaller animals. At sites along the Mediterranean, shells testify to the consumption of seafoods. Our evidence for the diet of peoples contemporary with the Neanderthals, but living in Africa and southern Asia, remains limited. At one site, located on the very southern coast of Africa, Klasies River Mouth Cave, there is abundant evidence of the use of a variety of food resources, including land and sea animals and shellfish. Because much of our current evidence comes from humans, like the Neanderthals, who lived in a harsh environment, the emphasis on hunting and meat eating that has come to characterize the diets of earlier hominids may represent a very biased picture.

Although the precise evolutionary relationships of the Neanderthals to living humans remain shadowy, excavation of their sites has revealed a complex picture. Often, living areas with hearths and signs of social areas around them have been uncovered. The bones of selected parts of animals, often with butchery marks on them, are scattered about. Clearly, Neanderthals, like living human gatherers and hunters, were carrying back to a central camp chosen pieces of animals. They may also have brought back other dietary items from their foraging and hunting activities, but the relative absence of small animal bones suggests that they may have been consumed immediately where they were found. It is quite possible that they sat around a fire sharing and consuming food, perhaps engaging in the uniquely human dinnertime interactions of storytelling and discussions of the day's activities. It is unclear, however, if the Neanderthals were actually able to use language, so this reconstruction remains a tentative one.

Sometime after 40,000 years ago, modern human-like peoples appeared in Europe, perhaps migrating there from their origins in Africa, or developing from ancestors already living in Europe. These modern humans brought with them new sorts of tool-making technologies, based on a broader array of raw materials, such as ivory, bone, and wood, with a wider assortment of beautifully made stone tools that show far greater sophistication than those made by the Neanderthals. The first artistic expressions also made their appearance at this time, with plastic art in the form of ivory and bone carvings of animals and people. Deep inside caves, they produced engravings and painted images of animals, and occasionally humans, some of them of great genius.

The sites occupied by these modern humans are littered with the bones of the same sort of animals, the earlier Neanderthals hunted, but the concentrations of bones indicate greater skills in hunting and a corresponding larger number of captured animals. This is also the case with much larger accumulations of shellfish along the coast.

These early modern humans continued this sort of hunting activity to the end of the last glacial period, about 12,000 years ago. In Europe, the retreat of the glaciers resulted in the spread of forests and a major change in dietary habits, with peoples hunting forest animals, like deer and rabbit, and utilizing to a much greater extent the riches of the sea. By this time, however, peoples in the Middle East and along the Yangtze River Valley in southern China were beginning to experiment with the cultivation of plants, which represented the beginnings of the agricultural revolution, and formed the foundations of settled urban life and the origins of civilization.

Although this sketch brings together much of our current knowledge of the evolution of human foodways, much clearly remains to be learned. For one thing, it tells us little about how human diet changed from eating what was necessary for nutritional needs to consuming what was enjoyable and pleasant to eat. Perhaps our ancestors always selected those foods that were enjoyable to eat, bringing about the basis of the consumption of food as a central focus in the social life of humans.

See also **Agriculture, History of**; **Cannibalism; Hunting and Gathering**.

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Alan Mann

EXTENSION SERVICES. Extension services extend information to users—farmers, growers, and homeowners. The Cooperative Extension Service (CES) is a publicly funded research and education network linking the resources of federal (U.S. Department of Agriculture), state (land-grant universities), and local (county) governments. The common mission—helping people to solve the problems that affect residents in U.S. communities—remains unchanged since its beginnings in the late 1800s.

Early in our government's development, George Washington and Thomas Jefferson advocated a national agency for teaching the agricultural sciences. Many years later, CES evolved from the needs of rural people for local education in agriculture, business, and home economics. In the 1800s, farmers needed help solving problems such as controlling insects or soil erosion or applying the right amount of manure to crops. Nonfarmers needed an education in business and trade. Housewives needed information on family nutrition and food preservation. In response, the Morrill Act of 1862 provided for the establishment of at least one college in each state. Under this act, many states established colleges of agriculture whose objective was to teach agriculture and the mechanical arts without excluding the classical studies.

In 1887, the Hatch Act established an agricultural experiment station at each land-grant college as well as a system of cooperative funding between the USDA and land-grant institutions. As a result, scientists and educators at experiment stations conducted research, published the results, and disseminated information to farmers. Several years later, in 1890, the second Morrill Act extended the land-grant provisions to the sixteen southern states and ultimately led to the establishment of land-grant universities for black students.

Seaman A. Knapp (1833–1911), a former professor of agriculture in Iowa, is credited with starting the agricultural demonstration method around the turn of the century. He conducted farm demonstration work in Louisiana and then served in the Department of Agriculture as a special agent to promote better methods of farming in the South. His work led to the development of the Farmers Cooperative Demonstration Work division, which he headed. The demonstration method proved effective and was copied by CES personnel throughout the country; it remains an important CES tool today.

The Smith-Lever Act of 1914 established the CES as we know it today—a partnership among federal, state, and local governments. Land-grant colleges and the USDA were directed "to work together to provide for the practical and liberal higher education of all Americans," reaching out to teach agriculture and home economics both in and outside of colleges. In 1925, the Purnell Act added agricultural economics, rural sociology, and home economics to the experiment stations' mission. The Extension Indian Reservation Program (EIRP) was authorized by the 1990 Farm Bill, and provided for the establishment of extension education programs on Indian reservations and in tribal jurisdictions.

Some states were early in recognizing the need for agricultural education. In 1857, the Agricultural College of the State of Michigan was founded. The Michigan Agricultural Experiment Station at Michigan State University, founded in 1888, was among the first stations created. The first county agricultural agent in New York State was hired in 1911 with funds provided by a Chamber of Commerce, a railroad, and the U.S. Department of Agriculture. New York was one of several states that went one step further, and by state legislation, created a partnership between the State Extension Service and the state itself. Alaska established its first experiment station in 1900.

The Cooperative Extension Service has kept pace with the farmer's search for ways to remain economically and environmentally viable. The Sustainable Agriculture Research and Education (SARE) program works to increase knowledge about—and help farmers and ranchers adopt—sustainable agriculture. To advance such knowledge nationwide, SARE administers competitive grants for research, education, and professional development. In other areas, CES offers programs to help children and their families cope with disasters and develop an emergency preparedness plan.

To contact a Cooperative Extension Service locally, check the government listing in your telephone directory for Cooperative Extension Service, or look under "Agriculture." Information about national programs can be obtained from the following address:

The Cooperative State Research, Education, and Extension Service
U.S. Department of Agriculture
1400 Independence Avenue S.W., Stop 2201
Washington, DC 20250-2201
Telephone: 202-720-7441
http://www.reeusda.gov/

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Patricia S. Michalak

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FADS IN FOOD. Food fads are interwoven with people's lifestyles, trends, and class aspirations. In all forms, fads are usually ideas that enjoy a quick popularity and soon disappear. Some fads, however, may actually become trends that develop into accepted style, indicating where society is moving. Fads in food are not a new occurrence. Ancient Roman recipes document demand for fattened snails and dormice as popular appetizers. During the 1700s, Americans craved ice cream, newly introduced from France, and lobster Newburg became fashionable in the 1800s. Lollipops were the rage in the 1920s. Current nostalgia for "retro" 1960s foods, such as fondue, accompanies a renewed interest in retrospective house and automotive design.

Health Food Surges in Popularity

Nutrition is often a rationale for food fads. In the late 1800s, Kellogg, General Mills, and other manufacturers created cereals from grains, in the interest of promoting a cleansing diet. Turning fad into substance, the interest in health food became entrenched in American diets over the succeeding decades, with foods like smoothies, meatless burgers, and whole wheat baked goods emerging in the marketplace. Fears of irradiated foods, the drive for organic, calorie-reduced foods, brand name diets, and multivitamins all contributed to the faddish style of healthy living. Vegan and macrobiotic diets, brown rice, tofu, and "live foods," now readily available, once were fads. Vegetarianism, seen as a fringe diet, has become mainstream, and organic ingredients are now basic supermarket fare.

The Orient and Other Ethnic Influences

America's fascination with the "exotic Orient" is an example of the pervasive influence of ethnic food fads. In the 1930s Chinese mah-jongg parties were popular among the socially style conscious. Accompanying food included *egg foo yung* and fried rice. Oriental themes characterized popular restaurants like Trader Vics, where diners could surround themselves with a sanitized Western version of exotic travel. Bars served unusually named Polynesian drinks with paper parasols. A Hawaiian craze followed, and backyard luau parties paralleled the emergence of Polynesian restaurants. Processed Spam with a sweet and sour sauce was a popular dish. Rumaki, a chicken liver, bacon, and water chestnut hors d'oeuvre, wowed guests. Japanese steak houses cooked sukiyaki and tempura before admiring diners.

Many other ethnic groups have contributed to fads in American cuisine. In the late 1960s the growth of the civil rights and Black Power movements led to the rediscovery of African-American roots, including southern soul food. Grits, collard greens, and ham hocks were served side by side with other American traditional foods. Interest grew in Zen Buddhism, Hinduism, transcendental meditation, and other beliefs of India and Asia, which emphasized the spiritual aspect of foods. The immigration of Latinos, Vietnamese, and Middle Easterners have added to foreign food interests. Immigrant grocers have introduced new foods to Americans, increasing demand for exotic imports. In the late twentieth century, fusion cooking, combining several cultural food styles, created a second wave of interest in Oriental "style" foods, popularizing sushi bars and sushi kits.

Travel and Tourism Contribute

Since the 1880s, immigrants and overseas tourism have influenced American cuisine. While some believe that GIs returning from World War II initiated the discovery of foreign food in postwar America, there is no strong substantive evidence to this effect. Sociologists theorize instead that, with an improved lifestyle, Americans had time and resources for travels abroad, from which they brought home cookware and ingredients. Hibachis enabled the suburbanite to barbecue Japanese style; fondue pots evoked trips to Zurich; copper pots decorated the French gourmet kitchen. Italian pizzerias and spaghetti houses sprang up to meet the demand for Neapolitan food. Chains of Italian restaurants and take-out pizza counters are their descendants.

Similarly, the popularity of Scandinavian design in the 1950s included appreciation of the smorgasbord, deli plates, and unusual drinks, such as Aquavit. European simplicity was not inexpensive. Stores featuring the high-end styling of Dansk, Braun, and later Crate and Barrel kitchenware changed the appearance of home kitchens and tables.

Haute Cuisine

Fashionable in the last century, haute cuisine restaurants featured haughty waiters and showy decor. Servers cooked flambéed dishes, such as crêpes suzette, tableside. At home, any recipe that evoked the Parisian food scene had style. Chiffon pies with meringue toppings suggested restaurant desserts. In her kitchen, the trendsetting housewife would use readily available preprocessed sauces for dishes, such as lobster Thermidor, beef stroganoff, and chicken divan, served in chafing dishes to recreate the fine dining of four-star restaurants.

Media Influence

Food magazines, epitomized after 1941 by *Gourmet* magazine, promoted food as fashion. *Sunset* magazine depicted the Western California scene, a sophisticated style of casual living, including football weekend tailgating, backyard cocktail parties, and barbecues. *Playboy* appealed to the urban bon vivant with a monthly column for the male chef, contributing to the craze for shish kebabs.

The chef as personality. The cult of personality chefs created through television programming resulted in the notion of the chef as star and creator of fancy cookbooks based on image, as well as in the exploding growth of fancy foods. One of the most significant personalities was *The French Chef*, Julia Child. She led the way for other television personality chefs to teach home viewers about good cuisine. James Beard, a food writer and chef, popularized classic American cooking. Paul Prudhomme, a Cajun New Orleans chef, demonstrated the "blackened fish" style of cooking. He used fiery spice rubs on fish, then seared them over high heat. There were many other food celebrities in the 1960s. In the 1990s, television's Food Network catapulted interest in the celebrity chef, professional techniques, and personalized ingredients. The growth in cooking stores and vocational cooking schools is a direct response to the cult of the personality chef. Through these chefs, recipes that made use of goat cheese, aioli, beurre blanc, and green peppercorns became trendy pantry staples.

Among the fads connected to food are political movements targeting agricultural practices. In the 1960s César Chávez led a boycott of grape harvests in California to advertise the plight of farmworkers. Bans on large tuna nets in order to save dolphins were an early precursor to contemporary concerns about overfishing.

Time Savers

As early as the 1900s, the goal of saving time created fashionable food fads. Refrigerators allowed homemakers to create quick, chilled desserts, epitomized by heavily sweetened marshmallow salads, fruit cocktails, and gelatin parfaits. The crock-pot, blender, and electric wok all promised to save time. One notable example that has faded is the 1980s "Impossible Bisquick Pie," in which preblended ingredients sink to the bottom of an egg custard to form the "crust."

Space-Age Influence

Fascination with the National Aeronautics and Space Administration (NASA) and the space race in the 1960s produced many fads. Even before the emergence of health foods and healthy planet foods, space technology influenced trends, especially snacks. TV dinners and other aluminum-clad, quickly prepared foods surged in popularity. After the astronauts appeared on American television, anything freeze-dried or dehydrated, previously associated only with military rations or camping, became food for the modern age. Space sticks, chewy rolls of power food flavored with vanilla or chocolate, predated today's energy bars. Tang, the sugar-powdered orange drink, was advertised as "drunk by astronauts."

A fad develops as a result of a social aim, interest in other cultures, and advances in technology that promise that the home cook can become a chef like Escoffier—or at least cook like a pro. Some, like space sticks, fade with time, while others, such as organic foods, have helped to change dietary and farming practices. Within an evolving lifestyle, food fads both reflect and change contemporary society.

See also **Beard, James**; **Child, Julia**; **Comfort Food**; **Escoffier, Georges-Auguste**; **Fast Food**; **Food, Future of**; **Food Politics: United States**; **Health Foods**; **Ice Cream**; **Kellogg, John Harvey**; **Kitchen Gadgets**; **Macrobiotic Food**; **Marketing of Food**; **Nostalgia**; **Organic Food**; **Take-out Food**; **Vegetarianism**.

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Terrie Wright Chrones

FAO (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS). The Food and Agriculture Organization of the United Nations traces its origin to the foundation of the International Agriculture Institute in 1905 under the pioneering work of David Lubin. This institute, which preceded FAO, consisted of forty member nations and sponsored the first World Agriculture Census in 1930, a census which has been undertaken every ten years since that time and which has become one of the responsibilities of FAO since 1950.

The Food and Agriculture Organization was born out of the Hot Springs Conference held by forty-four nations at the Homestead Hotel, Hot Springs, Virginia, in May and June of 1943. It was established as an agency of the United Nations on 16 October 1945 to assume the work of the International Agriculture Institute and is presently governed by the U.N. Conference of Member Nations. The Conference convenes every two years to review the work carried out by the organization and to approve its programs and budget for the next biennium. The director-general of FAO serves a six-year term. In addition to its headquarters in Rome, FAO maintains five regional offices (Africa, Latin America, Asia and the Pacific, the Near East, and Europe), five sub-regional offices, five liaison offices, and over seventy-eight country offices. The purpose of the organization is to serve as a neutral forum for all members of the United Nations through numerous international programs and initiatives. Due to this political neutrality, FAO has been able to act as a conduit for the completion of hundreds of international agreements covering food and agricultural matters.

One of FAO's activities involves the development of international codes and norms, such as the standards established for food processing in connection with Codex Alimentarius and the related conventions negotiated by the FAO/WHO Codex Alimentarius Commission and the Joint Expert Committee on Food Additives (JECFA). In a similar manner, FAO's Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) has provided the international framework for dealing with such agricultural plagues as the desert locust.

Another area of FAO activity is the gathering and dissemination of information on food and agriculture by means of databases organized under the umbrella of the World Agriculture Information Centre (WAICENT) in Rome. The center provides information to governments, research institutes, and universities, as well as to private individuals, using a wide range of media. This includes databases on soils and terrain (SOTER), information on soil and climate requirements for more than 1,700 plant species, domestic animal diversity information, lists of mutant plant varieties, a seed information system (SIS), a feed and forage database, a fertilizer yearbook, nutritional profiles of U.N. member countries, and vast amounts of material on food crops and crop shortages. FAO is also the world center for information on fisheries, aquaculture, and forestry.

The Food and Agriculture Organization has also become deeply involved in fighting world hunger and poverty by developing special programs for food security. This has involved a commitment to sustainable agriculture and rural development, the establishment of food cooperatives, seed saving programs at the small-farm level, land conservation, and an environmental agenda designed to better manage natural resources. FAO has taken this campaign to the public through its World Food Day programs in mid-October of each year. In 1997, FAO launched Telefood, a series of concerts and broadcasts designed to raise money for specific programs dealing with hunger and poverty. Money from these events, which are held in different places throughout the world each year, have funded over eight hundred small community-based projects in rural areas of such countries as Bangladesh, Somalia, Nepal, and Uganda.

See also **Aquaculture**; **Codex Alimentarius**; **Food Supply, Food Shortages**; **Government Agencies**; **International Agencies**; **Political Economy**; **Sustainable Agriculture**.

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William Woys Weaver

FARMERS' MARKETS. Farmers' markets are common facilities or areas where several producers gather on a regular basis to sell various fresh meat, fruit, vegetables, and other food products directly to consumers. They circumvent the middleman and provide small- and medium-sized producers with an immediate, convenient, and economical sales outlet for their agricultural products. They are also established for the benefit of the urban consumer who values quality, variety, and freshness in food.

Farmers' markets vary greatly in terms of their physical shapes and configurations. The simplest form is the open-air market, where shelter is provided by the producers themselves or by structures already in place, such as bridges, arcades, and elevated highways. A more complex form is the market shed, which provides minimal protection from the elements yet allows easy access from all sides. The fully enclosed market house offers still greater shelter and facilitates year-round selling. Market districts, the most complex form, combine elements of the open-air market, the market shed, and the market house with other facilities, services, and related businesses.

Farmers' markets are an urban phenomenon worldwide and they assume characteristics determined by the social, political, and economic factors particular to their locales. The environment, natural features of the landscape, cultural norms, and the historic relationship between the countryside and the town also contribute to a wide range of market types. For example, the Tsukiji ome markets open short-term retail space to local farmers in an effort to bring the producer and customer face to face. Amish armers in Philadelphia's Reading Terminal Market often rent tables on Saturdays to sell their produce during harvest season. HOTO COURTESY OF DAVID K. O'NEIL.

Market in Tokyo specializes in the wholesale and retail ish trade, with nearly 1,700 stalls covering a huge (54-cre/22-hectare) site. The market at Otovalo, Ecuador, ne of many open-air markets in South America, functions as a principal trading point for Indian farmers selling local produce and handicrafts. And the daily market t Campo de'Fiori continues the long tradition of food marketing in one of the oldest public squares in Rome. Regardless of types or locations, farmers' markets around he world create a vibrant environment where consumers nd producers are brought together for the benefit of the ocal community.

Although farmers' markets vary in terms of ownerhip and facilities, most operate by standard criteria in ccordance with traditional trading ethics and standards. Vendors are subject to environmental, health, licensing, nd other market ordinances and legislation. They must lso adhere to the market's own rules and guidelines, which typically establish days and hours of operation, the payment of rents, and other business matters. A market manager is usually engaged to oversee the daily activities of the market and to ensure that rules and guidelines are met.

The most important criteria for farmers' markets are that goods be locally produced and that vendors sell their own products. These criteria change over time and differ from place to place. "Locally produced" may be defined strictly in terms of the radius from the market, for example, thirty miles, but the actual distance depends on a number of circumstances. Farmers' markets near coastal areas may encompass a large radius that includes the source of locally caught fish. For markets in major urban areas, farms are of necessity some distance away, so the radius may be larger than that for smaller communities. Available transportation from farm to market as well as consumers' own perception of "local" may also influence definitions.

The other important criterion, that goods be the direct product of the merchant's labor, is again subject to different interpretations. In general it holds that fresh

Curbside farmers market in Dubuque, Iowa, circa 1900. COURTESY OF THE NATIONAL ARCHIVES.

meat and produce have been grown or finished on the producers' land. Cheese, honey, and processed meat products, such as sausage, are also produced on the vendor's land or at least within the defined radius of the market and with local ingredients. In general crafts and processed products using materials from outside the area of the farmers' market are excluded in favor of food products that have an entirely local origin. This restriction, however, is often lifted during winter months or when local products are not in season.

Farmers' markets belong to an ancient tradition of urban food retailing, in which the governing authority designated specific places for the exchange of life's necessities. Known as public markets, these places were intended to attract local and regional producers to the city to ensure citizens an adequate supply of healthful food at fair prices. They were critical to the survival of the town, because without them unbridled competition and unfair dealings in the sale of perishable food could jeopardize the public welfare. The local authority also maintained public markets to ensure a healthy population of workers, to prevent emigration, and to encourage agriculture near the city.

One of the most famous farmers' markets in nineteenth-century America was the city-owned High Street Market in Philadelphia. By midcentury this market consisted of a series of sheds in the middle of High Street extending from the foot of the Delaware River to Eighth Street and again from Fifteenth to Seventeenth streets, with breaks only at the intersections. Space in the market was divided by types of goods, including meat, fish, garden seeds, produce, roots, herbs, vegetables, meal, locally produced earthenware, and New Jersey produce. The market was demolished in 1859, when it was replaced by a series of large, off-street market houses owned by private companies.

The majority of farmers' markets in the United States were municipally owned and operated until the mid-nineteenth century, when the movement for privatization generated alternative food-marketing establishments, including private shops and market companies. As a result, farmers' markets may be owned and managed by a municipality, but more often they convene on public property and are sponsored by nongovernmental entities, which may be farmers' associations, chambers of commerce, cooperatives, or other community organizations.

A quasi-public corporation, the Pike Place Market Preservation and Development Authority, oversees Pike Place Market in Seattle, Washington, one of the most successful markets in the United States. Established in 1907, the market encompassed a nine-acre historic district by the year 2000, with more than 100 farmers, 150 craftspeople, nearly 300 commercial businesspeople, 50 performers, and various services for low-income residents. During the 1990s the historic district hosted approximately 9 million visitors per year, and annual gross sales were estimated at $9 million.

The number of farmers' markets has been growing steadily in recent years. Cities throughout the world are taking an interest in developing farmers' markets to add vitality to their public spaces, to redevelop their historic marketplaces, to revitalize neighborhoods, and to make fresh food available in areas underserved by supermarkets. In the United States, for example, the number of farmers' markets grew 63 percent in the last decade of the twentieth century, from 1,755 in 1994, when the U.S. Department of Agriculture began collecting data, to 2,863 in 2000. Other factors have contributed to their popularity. Most significantly, small farmers cannot afford to invest in the costly marketing systems required for mass food retailing and distribution. Direct access to the consumer therefore offers an alternative source of revenue and immediate cash flow.

Consumer demand for farmers' markets has also increased worldwide, primarily in response to the growing organic food movement and to public health disasters resulting from mass food marketing and production practices. Sophisticated consumers take a great interest in nutrition and wholesome eating habits, and they seek the sources of the foods they eat. As a result they view farmers' markets as healthy alternatives or supplements to supermarkets and other outlets of mass-marketed food. Farmers' markets devoted exclusively to the sale of organic food are abundant in France, one of the world's leading consumers of organic food. The demand for organic food markets, coupled with the larger international movement to resist the globalization of food marketing and production, will continue to foster farmers' markets as critical sources of fresh, healthful, and affordable food for the urban consumer.

See also **Food Cooperatives**; **Marketing of Food**; **Marketing of Food: Alternative (Direct) Strategies**; **Retailing of Food**.

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Helen Tangires

FAST FOOD. What is termed "fast food" in the United States today most commonly consists of hot, freshly prepared, and wrapped food items, served to customers across a counter or through a drive-up window. Known as both "fast food" and "quick-service food" in the restaurant industry, these items are routinely sold and delivered in an amount of time ranging from a few seconds to several minutes; they now vary widely in food type, encompassing virtually all kinds of meats, preparation methods, and ethnic cuisines. Inexpensive hamburgers and french fried potatoes are still the products most readily identified as fast food, but the list of items sold in the format continually increases. Fried fish and shellfish, hot dogs, chicken, pizza, roast beef, and pasta are commonly sold at quick-service outlets. In addition to these staples, many quick-service restaurants sell a broad menu of Americanized Mexican, Greek, and Chinese foods. Some fast-food outlets offer specialty items, such as sushi, clams, or ribs, and others even sell complete "home-cooked" meals over their counters. Though menus and delivery formats vary greatly, fast food's chief common denominators include immediate customer service, packaging "to go," and inexpensive pricing.

The precise origins of fast food are vague, probably predating written history. Hungry people are as old as civilization itself, as are entrepreneurs eager to satisfy their hunger. Food vendors in ancient cities sold prepared items to passersby on the street. The actual foods varied greatly, depending on period and culture, but they generally comprised simple, inexpensive fare sold to people of modest means.

Immigrants brought a variety of food styles to America, often preserving these for decades as a comforting connection with their ethnic past. Though many immigrant foodways were elaborate and ritualistic, most groups had one or two simple items that they consumed on a daily basis. As a rule, immigrant groups preferred their indigenous grains: corn from the Americas, rice from Asia, and wheat from Europe. Often these served as the basis for the "peasant" foods of their homelands. Pasta and flat breads came over with Italians; tortillas, beans, and tamales arrived with northbound Mexicans; and Germans brought dark breads, along with a variety of fatty sausages (which later mutated into the hot dog).

Asian immigrants continued to eat rice as the basis of their diet.

In the early twentieth century fast food remained primarily the fare of the masses. Vendors wheeled their pushcarts daily to factory gates, selling their wares to hungry workers. Often catering to the tastes of the particular factory's dominant ethnic group, they charged customers pennies for basic items such as sausages, meatballs, or stew. Though popular among male industrial workers, this pushcart version of fast food never became mainstream cuisine.

The urban diner was the transitional phase between the vendor's pushcart and modern fast food. Most early diners were small restaurants, with limited seating, sometimes constructed out of converted railway carriages or streetcars. They served simple foods to working-class customers on a "short-order" basis, usually cooking each meal individually when ordered. Menus varied, but fried foods were common. Though diners often emphasized speed in delivering food, customers routinely lingered before and after eating.

The hamburger still stands out as the single most important American fast food, though the precise origin of this meat sandwich is the subject of historical disagreement. People have eaten chopped beef throughout the ages, and it was long a fixture in many world cultures. The lineage of the American hamburger seems to point directly, as its name indicates, back to the German city of Hamburg. First appearing on American restaurant menus in the mid-nineteenth century, ground beef patties bore the title "hamburg steak." By the century's close, vendors regularly sold meatballs wrapped in slices of bread at county fairs and summer festivals. Regional legends attribute the invention of this snack to several different individuals, but its true originator remains a mystery.

The Rise of Modern Fast Food

Our modern image of the fast-food restaurant dates back to 1916, when Walt Anderson began selling "hamburger sandwiches" from an outdoor stand on a Wichita street corner. Anderson simply flattened a meatball and placed it between two halves of a bun. His sandwich quickly became popular, attracting long lines of hungry buyers. By 1921, Anderson had joined local insurance broker Edgar "Billy" Ingram to form the White Castle System. After opening several identical restaurants in Wichita during their first year, the partners quickly spread their business to neighboring cities, then to nine major urban areas throughout the Midwest and on the East Coast. What separated the White Castle System from earlier short-order restaurants was its very streamlined menu, comprising only hamburgers, coffee, Coca-Cola, and pie; a uniform architectural style; and strict standardization of food quality, preparation methods, and employee performance. By the close of the 1920s, White Castle's aggressive marketing and rapid spread had made the hamburger one of the most popular foods in America.

EATS
HAM 10
BAR-B-B'
COFFEE 5
CHILI 15
Coca-Cola
TAMALE
ICE CREAM
BARBECUE

Fast foods have generated their own type of architecture. To attract attention and customers, some buildings were quite whimsical, like this 1930s hot dog stand. © CORBIS-BETTMANN.

Other entrepreneurs soon noticed White Castle's success in the hamburger business. Very closely copying White Castle's products, architecture, and company name, competing new chains also thrived, carrying the hamburger craze across the nation to smaller cities and towns. The White Tower chain appeared in 1925, eventually challenging White Castle's dominance in several northern cities. Krystal's, opened in 1929 in Chattanooga, soon became the hamburger powerhouse of the southeastern states. White Castle's hamburger sandwich, along with its many imitators, became a daily staple for many working-class Americans. It proved so successful, in fact, that by 1930 the president of the American Restaurant Association identified the fast-food hamburger as the most important food item in the nation.

Hamburgers became even more a mainstream food during the 1930s. The larger restaurant chains began marketing their products to middle-class buyers, and even more Americans became burger lovers. Despite the harsh economy of the Great Depression, most fast-food chains continued to thrive, and in many cases grew considerably. Most continued selling the White Castle–style hamburger, but late in the decade the Big Boy chain spread east from California, introducing its new double-decker hamburger sandwich along the way. By the end of the Depression, America was a solidly hamburger-eating culture.

After prospering in the Depression, however, the fast-food industry suffered a serious setback during World War II. Shortages of necessary foodstuffs, such as meat, sugar, tomatoes, and coffee, meant limited menu offerings and often a significant loss of business. Attempting to continue providing meals to their customers, fast-food restaurants experimented with different items that were still in abundance, including soy patties, chili, and french fried potatoes. Even more damaging than commodity shortages was the very low unemployment rate, which meant that most workers bypassed the restaurant industry in favor of higher-paying work. Adjusting to this labor shortage, chains soon replaced their all-male workforce with women and teenagers, two groups who would become their most common employees. Despite attempts to find palatable alternative foods, and despite the shifts in workforce, much of the fast-food industry was a casualty of the war; by 1945, more than half of America's restaurants had closed down, including several of the major fast-food chains.

Rebuilding the fast-food industry after the war proved a slow process. No single chain emerged to claim dominance, and little innovation occurred. Individual companies struggled to restore their prewar prosperity, and new regional chains tried to gain a foothold. Suffering the effects of escalating costs and still under the threat of continued shortages due to unstable food supplies in war-torn countries, fast-food restaurants often had to double prices to remain in business.

As population shifted from America's cities to suburbia during the 1950s, the fast-food industry quickly followed. Early chains such as White Castle and White Tower, resisting moving to the suburbs, were quickly eclipsed by upstart franchised chains. Burger King and McDonald's outlets became common fixtures at suburban crossroads, selling burgers, fries, and shakes to hungry families. Burger King's Jim McLamore and McDonald's Ray Kroc each sought to build one of his restaurants in every American town, and they opened hundreds of new Burger Kings and McDonald's each year in the 1960s. To accomplish this rapid expansion, they relied heavily on franchise investors, enforced strict product uniformity throughout their chains, and aggressively advertised in every newly opened territory. With McDonald's and Burger King's success, Burger Chef outlets soon appeared nearby. Arby's, Kentucky Fried Chicken, and Taco Bell were not far behind. By the late 1960s, fast food no longer meant just hamburger restaurants, but had diversified to include quick-service pizza, roast beef, chicken, and tacos. To give an idea of the dimensions to which the fast-food industry has grown, in 1999 Americans consumed over 26 billion pounds of beef, much of it as hamburgers. In that year McDonald's alone had more than ten thousand restaurants in the United States, from which it grossed in excess of $13 billion in revenue.

Criticism of Fast Food

Despite the widespread popularity of fast food in modern American culture, critics abound. Since the 1930s, articles and books have condemned the industry, exposing allegedly poor sanitary conditions, unhealthy food products, related environmental problems, and unfair working conditions. Whether it warrants the attention or not, the fast-food industry is still regularly cited for exploiting young workers, polluting, and contributing to obesity and other serious health problems among American consumers. American beef consumption, and more specifically the fast-food hamburger industry, is often blamed for the burning of the Amazon rain forests to make way for more grazing lands for beef cattle. Early foes of fast food cited the deplorable filth of many hamburger stands, in addition to claiming that the beef ground for their sandwiches was either spoiled, diseased, or simply of low quality. In fact, many critics maintained that much of the meat used in fast-food hamburgers came from horse carcasses. The high fat content of fast food was also controversial. Despite deceptive industry claims about the high quality and the health benefits of their products, in the 1920s and 1930s concerned nutritionists warned the public about the medical dangers of regular burger consumption. This distrust and criticism of fast food continue today, extending even further to include dire warnings about the industry's use of genetically modified and antibiotic-laden beef products. Most major chains have responded to recent attacks by prominently posting calorie and nutritional charts in their restaurants, advertising fresh ingredients, and offering alternatives to their fried foods. Despite a few more health-conscious items on the menu, fast-food chains now aggressively advertise the concept that bigger is better, offering large "super-size" or "biggie" portions of french fries, soft drinks, and milkshakes. Critics point to this marketing emphasis as a reason for an excessive and greatly increasing per-capita caloric intake among fast-food consumers, resulting in fast-growing rates of obesity in the United States.

Increased litter is another problem that critics have blamed on the fast-food industry. Selling their products in paper wrappings and paper bags, early outlets created a source of litter that had not previously existed. Wrappers strewn about city streets, especially those close to fast-food restaurants, brought harsh criticism, and often inspired new local ordinances to address the problem. Some municipalities actually forced chains to clean up litter that was imprinted with their logos, but such sanctions were rare. Fast-food wrappers became part of the urban, and later suburban, landscape. Since bags and wrappers were crucial in the delivery of fast food, the industry as a whole continued to use disposable packaging, superficially assuaging public criticism by providing outside trash receptacles for the discarded paper. Years later, environmentalists again attacked the industry for excessive packaging litter, criticizing both the volume and the content of the refuse. By the early 1970s, the harshest criticisms focused more on the synthetic materials used in packaging, and less on the carelessly discarded paper. Critics derided the industry's use of styrofoam sandwich containers and soda cups, claiming that these products were not sufficiently biodegradable and were clogging landfills. Facing mounting opposition from a growing environmental movement, most of the major chains returned to packaging food in paper wrappings or small cardboard boxes.

Labor activists have criticized fast-food chains' tendency to employ inexpensive teenage workers. Usually offering the lowest possible wages, with no health or retirement benefits, these restaurants often find it difficult hiring adults for stressful, fast-paced jobs. Many critics claim that the industry preys on teenagers, who will work for less pay and are less likely to organize. Though these accusations may have merit, the industry's reliance on teenage labor also has inherent liabilities, such as a high employee turnover rate, which result in substantial recruiting and training costs. Companies have countered criticism about their use of teenage workers with the rationale that they offer young people entry-level work experience, teaching them: both skills and responsibility.

Despite the relentless attacks, hundreds of millions of hungry customers eat fast food daily. The media constantly remind American consumers about its supposed evils. Most are conscious of the health risks from fatty, greasy meals; most realize that they are being served by a poorly paid young worker; and if they choose to ponder it, most are aware that the excessive packaging causes millions of tons of trash each year. But they continue to purchase and eat fast food on a regular basis. Fast food remains central to the American diet because it is inexpensive, quick, convenient, and predictable, and because it tastes good. Even more important, Americans eat fast food because it is now a cultural norm. As American culture homogenized and became distinctively "American" in the second half of the twentieth century, fast food, and especially the hamburger, emerged as the primary American ethnic food. Just as the Chinese eat rice and Mexicans eat tamales, Americans eat burgers.

And fast food has grown even beyond being just a distinctive ethnic food. Since the 1960s, the concept has extended far beyond the food itself, with the term becoming a common descriptor for other quick-service operations, even a metaphor for many of the negative aspects of mainstream American life. Theorists and pundits sometimes use the term "fast food" to denigrate American habits, institutions, and values, referring to them as elements of a "fast-food society." In fact, "fast-food" has become a frequently used adjective, implying not only ready availability but also superficiality, mass-produced standardization, lack of authenticity, or just poor quality.

In the last two decades of the twentieth century, fast food gained additional economic and cultural significance, becoming a popular American export to nations around the world. Some detractors claim that it is even deliberately used by the United States, as a tool of cultural imperialism. The appearance of a McDonald's or Kentucky Fried Chicken restaurant on the streets of a foreign city signals to many the demise of indigenous culture, replacing another country's traditional practices and values with American materialism. In fact, the rapid spread of American fast food is probably not an organized conspiracy, rather more the result of aggressive corporate marketing strategies. Consumers in other countries are willing and able to buy fast-food products, so chains are quick to accommodate demand. Thought of around the world as "American food," fast food continues its rapid international growth.

See also **Cattle**; **Fish and Chips**; **Food Politics: United States**; **French Fries**; **Hamburger**; **Meat**; **Obesity**; **Packaging and Canning**; **Potato**; **Sandwich**; **Slow Food**; **Take-Out Food.**

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David Gerard Hogan

FASTING AND ABSTINENCE.

This entry includes four subentries:
Christianity
Hinduism and Buddhism
Islam
Judaism

CHRISTIANITY

Fasting or abstaining for a period from food and drink is common to various religions and is often an expression

Fasting was an integral part of Christian diet during the Middle Ages, but clever cooks devised numerous ways to create tasteful foods without meat or animal fats. These Polish fast-day dumplings are stuffed with mushrooms, a popular meat alternative. PHOTO BY ANDRÉ BARANOWSKI.

of penitence or mourning. Christian fasting and abstinence can be a purely personal matter or a social event at a special occasion, but it should be distinguished from the regular fasting that is prescribed by ecclesiastical authority and fixed on the Church calendar. The institution of fasting is a commandment for all Christians, and the Church's acceptance of it is thought to go back to Pope Calixtus I (217–222).

Fasting can be abstinence not only from food or drink, but also from sexual intercourse or other activities. This article focuses on food and looks at when Christians fast. Early monastic communities enforced abstinence from meat and wine, following in part the classical argument of Hippocrates and Galenus that warned against such "warm and humid" foods, which were thought to stimulate luxury. These strictures proved too severe—the religious lacked the energy to complete their daily tasks, and the laymen who worked outside the walls could not be expected to observe such stringent restrictions on food and drink.

By the tenth and eleventh centuries, the Roman Catholic Church had modified its rules for fasting, distinguishing between monastics and ordinary people, and regulating the severity of fasts on the Church calendar. The Church never prescribed total fasts (without food and drink) or even those allowing just water and bread during a whole day or longer. Instead, several forms of the discipline were practiced, the more severe of which is called "fasting" and the milder "abstinence."

During fasting periods, Christians were forbidden to eat the meat (and other products, such as milk and eggs) of quadrupeds and birds. Christians did not consider these animals and their products "unclean," as did the Jews (Acts 10–16), but eating them was proscribed by the Church during certain times of the year. At such times, Christians fed on seafood, fish (including hard and soft fish roe), grains, and other field produce. The prohibition on dairy produce and eggs, in particular, and the resulting lack of protein nourishment, placed an enormous strain on medieval people. Chicken eggs were replaced by hard roe and butter, lard, and bacon by vegetable oil. For the European countries north of the Alps, where olives and almonds could not be grown, there was a substantial rise in the cost of living. Those who could afford them obtained expensive olive oil or almonds from the Mediterranean, which were mashed into a binding agent for sauces and chowders. Dried fruits, including dates, figs, raisins, and currants, from the Mediterranean were highly sought in northern Europe, as were the indigenous walnut and hazelnut.

During the milder periods of abstinence, milk could be consumed. It was not clear whether the meat from birds could be consumed during these times, but their eggs were permitted. Late medieval household accounts (fourteenth to fifteenth centuries) show that Christians lived according to these rules, especially during the longest fasting period in the church calendar, the forty weekdays of Lent or the so-called *quadragesima* (Latin *quadraginta* = 40, hence *quadragesima*), which precedes Easter, when the faithful switched over to a fish-and-oil kitchen.

In addition to Lent, the Catholic Church had four fasting periods called Ember days during the year (Latin *quatuor tempora* = four times, corrupted to *quatember*, then to "ember"). These days, prescribed by Pope Gregory VII (1073–1085), correspond to the turn of the seasons: the Wednesday, Friday, and Saturday of the week after St. Lucia (13 December) at the beginning of winter; then the Wednesday, Friday, and Saturday after Ash Wednesday (therefore, part of Lent) at the beginning of spring; next, the Wednesday, Friday, and Saturday of the week after Whitsuntide (Pentecost) at the beginning of summer; last, the same days of the week after Holy Cross Day (14 September) at the beginning of fall. Because the Christian calendar, unlike that of the Muslims, has a solar year with twelve months of more than the twenty-eight days of the orbit of the moon, these so-called Ember days always occur in the same season. Unlike the Muslim Ramadan, which shifts through the year, the Christian *quadragesima* always occurs during the turn from winter to spring.

In contrast to the *quadragesima* and the Ember days in which the severe abstinence that we call "fasting" was observed, a milder abstinence was obligatory all other weeks of the year on Wednesday and Friday, or Friday and Saturday, depending on the diocese in which one lived. On those days fish, which might be served with butter, was consumed. Fishermen strove to bring fresh fish to the market on those days, knowing that they would find ready consumers. Long after the fasting prescriptions in Catholic Europe had been mitigated by the Protestant Reformation of the sixteenth century, the habit of eating fish on Friday or Saturday remained common.

Religious generally did not observe a more severe fasting regimen than lay people, but the duration of the fast was greater. Monks and nuns started the *quadragesima* ten days prior to Ash Wednesday, thereby making a *quinquagesima* of fifty days, and they also fasted on the Monday, Tuesday, and Wednesday before Ascension Day, the so-called Rogation Days. Advent, the four weeks before Christmas, formed a fasting period for them, not just the Ember days of St. Lucia that fall during this period.

The Rule of St. Benedict forbade the consumption of the meat of quadrupeds unless the religious was ill. The eating of birds was allowed, as was the consumption of eggs and dairy produce, except, of course, on fasting days. In this Rule it was stated that on fasting days, but not before Vespers, only one meal should be served that would be finished before dark. On other days, two meals were eaten, earlier or later depending on the season but always with daylight.

Mindful of the heresy of the Manichees and the Cathars, who taught that the body and the material world were the work of Satan and only the immaterial spirit was the work of God, Christians of the Western Church attempted to strike a balance between gluttony on the one hand and too rigorous an asceticism on the other.

The forty days of Lent referred to the forty years during which the Jews, under the guidance of Moses, had wandered through the desert before reaching the Holy Land (Deuteronomy 1:1–3), as well as to the forty days of Christ's temptation by Satan in the desert (Matthew 4:1–11, Mark 1:12–13, Luke 4:1–13). But this does little to explain the timing of the Lenten fast, which commences at the turn of winter into spring. There is no text in the Bible prescribing this particular fast period. Also, the other Ember days coincide with the turn of the seasons.

Perhaps a key can be found in the reference to the humoral system of Hippocrates and Galenus, which was used to condemn the consumption of meat and wine as a stimulus of luxury. In this system of thought, every season has its own qualities—dry or humid, hot or cold—and the human body, which also has humoral qualities, needs a little digestive pause to switch over to another season. So fasting might have served such a function. This reasoning was seldom explicit, but in one example, a Latin schoolbook of chronology from 1436 (*Computus Magistri Jacobi*), the comparison was made between the qualities of the seasons and the capital sins, from which the human mind should be cleansed by fasting.

However, not all questions concerning the Christian traditions for fasting and abstinence can be answered. Why was the longest fasting period the one from late winter to early spring? And why did the church not forbid the consumption of fish and seafood? Were there economic motives at stake—should eggs be allowed to hatch instead of being eaten by humans? Should the milk of animals be reserved for their newborn? Since Church authorities never clearly explained the reasons behind fasting and abstinence, we may never know the answers to these questions.

See also **Christianity**; **Lent**; **Middle Ages, European**; **Shrove Tuesday**.

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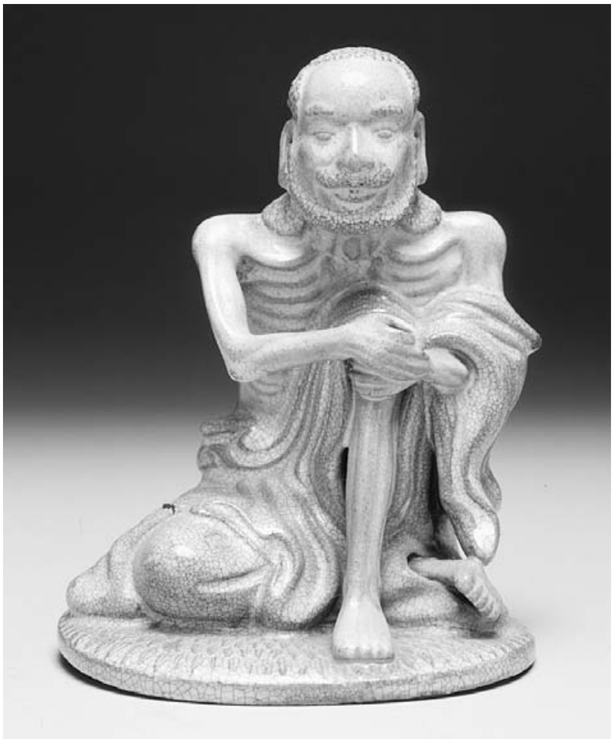
Johanna Maria van Winter

HINDUISM AND BUDDHISM

Hinduism

Food (in Sanskrit, *anna*) plays a very important role in the social and ritual life of the Hindus. Its importance is illustrated in a regular greeting at the Indian subcontinent: "Have you eaten?" is asked in the same way as people elsewhere might ask, "How are you?" Food is



Ceramic figurine of Chinese philosopher Lao-tse. Sung Dynasty, 960–1126 C.E. The bony, wasted body of Lao-tse, who flourished in the sixth century B.C.E., was a perennial symbol of abstinence and asceticism in Chinese culture. Roughwood Collection. Photo Chew & Company.

mentioned in the early Hindu sacred writings known as the Vedas (Sanskrit, "knowledge"). In the Taittiriya Upanishad it is written, "Food is life, therefore one should give food; eating is the supreme sacrifice." Hindus have hundreds of traditional health rules, most of them regarding food and the preparation of meals. A traditional Hindu housewife spends a large amount of time cooking. Also religious books—such as the Dharmaśātras, the ancient "law books"—treat food and all that is related to eating extensively. Caste borders were sharpened by the many rules on eating, or rather not eating, together. In Vedic times (1500–500 B.C.E.), people ate everything, including beef, but in later times, probably under the influence of Buddhism, meat eating became a taboo, as was the killing of animals, either for food or for a sacrifice. One could argue that many of these food taboos were instigated by climatic conditions and by ideas about hygiene. Different groups and castes developed their own food rules, although there were regional differences. The Vaisnava community classifies food according to the three qualities (*guna*) of the Sāmkhya philosophy: *sattva* food, which is pure; *rajas* food, which is energetic or exciting; and *tamas* food, which is impure. Only *sattva* food is allowed, which means no meat and fish, onions, garlic, specific fruits, and sharp spices.

Fasting in the sense of not eating for a specific time (*upavāsa*), or abstaining from specific substances during certain periods, is a well-established part of all Hindu spiritual practices. In the early times it was related to *tapas*, ascetic practices, and it is still a major aspect of the religious practices of many of the *sādhus* or "holy men" in India. Also, many ordinary Indians fast on specific days during the year, either by taking no food at all or by restricting their diet. For instance, Vaisnavas fast on the eleventh day of each half of the lunar month (*ekādaśī*), when they are only allowed to eat what has grown below the ground, along with dairy products. Before and during rituals, like sacrifices, but also before going on a pilgrimage, fasting and abstinence from certain food items are part of the practice of Hindus.

It is all part of the concept of *vrata* or religious vow. A *vrata* can be taken during a religious festival, or a pilgrimage, and also in conjunction with pursuing some goal in life, which may include material or spiritual well-being or success in business, love, or a good job. *Vratas* are applied following ritually significant and meaningful patterns, depending on which deity is addressed or which goal is pursued, or on a person's station in life. Fasting and abstinence lead to the attainment of religious merit, which is then "used" to achieve the desired goal.

There is, however, also a spiritual aim: the control of the physical body as well as of emotions and the mind, which may lead eventually to the ultimate goal of unconditioned consciousness or liberation from the cycle of rebirth, in union with the transcendent (either considered personal or impersonal).

Complete fasting, in its most radical form, can be pursued until death, in which case it is called *prāyopavista* ("one who sits down and quietly awaits the approach of death" by not eating). Suicide through starvation has been well documented in Jainism, a religion that originated in the sixth century B.C.E., but Jain customs regarding this kind of suicide may be based on Hindu practices from around the fourth century B.C.E. Elderly people, who feel they are of no use any more to the community or feel they are a burden to the family, can choose this way of ending their lives. Suicide by ending the cycle of rebirth (*samsāra)* through not eating is beyond mainstream Hinduism, which sees it as another attachment that will even bring a worse rebirth unless the person has already been detached of all worldly concerns. A person can fast for a specific period to attain some goal, thereby pressuring family or community members, as exemplified by the fasting of Mahātma Gandhi for political and humanitarian ends.

In the general practice of Hinduism, fasting and abstinence are not clearly distinguishable and are performed under the general concept of *vrata* or vow. The most common form of abstinence practiced by communities as a whole is vegetarianism. The consumption of substances that entail the killing of a living animal—in principle this also includes eggs—is considered to create demerit, which has to be avoided at all cost by people belonging to those communities. Many others also practice vegetarianism as a spiritual practice by personal choice, either all the time, or even just one day a week.

Certain other substances are also avoided when a person performs a vow, because they are known to stimulate the senses, and therefore are contrary to the goal of control over the body and the senses. In particular, onions and garlic are avoided. For some groups or individuals this restriction is followed all the time. For others these foods are only avoided on certain occasions that call for a stricter diet. Especially on days that are set aside for rituals for ancestors, onions and garlic are forbidden.

Vrata or spiritual vow has three main branches. The first one is called *nitya*, which means permanent or always. Persons undertaking this type of vow are usually seeking the grace and blessing of a particular divinity toward a particular wish or desire (such as a good job, success at exams or business, or a good marriage). Hindus sometimes abstain from certain foods permanently. Or, they fast completely during one day of the week or month.

The second form of *vrata* is called *naimittika*, which means occasioned by some particular cause. It pertains to people who experience remorse or repentance in connection with a sin they have committed. They practice a vow in order to be relieved from the karmic consequences of their sin. The third type of vow is called *kāmya vrata*, which means a vow for what one desires. This form of vow is performed in order to achieve property, popularity, wealth, or health. An example of this kind of vow is called *somavrata*, which involves complete abstention from food on Mondays.

Vows follow many diverse patterns, depending on which deity is beseeched for blessing, the nature of the objective, or the wish that the devotee wants to see fulfilled. Such vows can require not eating, eating less, eating only certain substances, or avoiding certain substances altogether. The choice of the days on which or the periods during which the vow is performed is regulated by the ritual calendar.

The days of the week are ruled by the planetary deities and are also indirectly related to the main deities of Hinduism. People may choose to fast, or abstain from certain substances like meat or fish, or also from onions and garlic, on the day dedicated to the deity they are addressing with their vow. Sunday, Ravivāra, is ruled by Sūrya, the sun, and is dedicated to the achievement of victory, as in the case of disputes and court cases, but also when starting Vedic studies or a journey. Monday, Somavāra, is dedicated to Candra, the moon, and to Śiva. Fasting on Monday is directed to all general spiritual purposes. Tuesday, Mangalavāra, is dedicated to Mars, and Kārttikeya, Śiva's son and the god of war. Fasting on Tuesday is directed toward victory, childbirth, and good health. Wednesday, Budhavāra, belongs to Mercury. It is said that fasting on this day has twice the value of other days. It is mostly dedicated toward education and success in business. Thursday, Brhaspativāra, is dedicated to Jupiter, ruler over education and scholarship. Friday, Śiukravāra, is ruled by Venus. Fasting on this day is dedicated to prosperity, marriage, and a harmonious family life. Saturday, Śianivāra, is ruled by Śiani or Saturn. Fasting on Saturday will give the blessing of Saturn and longevity.

Another aspect that is important to the ritual calendar is the phases of the moon. One pattern of fasting and abstinence, which relates to the phases of the moon, starts on new moon day, when the practitioner eats fourteen hands full of food. Then every next day one eats one handful less, until on the day of the full moon one eats nothing at all. During the waning moon one eats again one handful more each day, until the vow is completed on the next new moon day, when again fourteen hands full of food are eaten.

Generally, all kinds of vows of fasting and abstinence are practiced on the occasion of the many religious festivals celebrated during the course of the year, and also on the occasion of the Hindu rites, which are related to specific stages in life, such as birth, name-giving, first eating of solid food, puberty, the beginning of Vedic studies, marriage, and cremation.

On the other hand, certain foods are especially dedicated to certain deities. Such foods are regularly prepared at home and offered to the deity as part of certain festivals or during home worship, after which they are enjoyed by those present, and often also sent to relatives and friends. These special foods are also prepared and offered as part of the daily temple worship. After being offered to the deity, they are distrbuted as *prasāda* or sanctified food among the worshipers and visitors. Examples of such special food are rice prepared with black pepper and cumin fried in clarified butter or ghee, which is dedicated to Śiva; *laddu* or sweet balls for Krishna and Ganeśa; or rice prepared with tamarind, which is specially offered to Visnu. A person can also make a vow in connection with a certain deity to eat only the deity's special food for a period of time.

Some examples of this kind of *vrata* include twenty-one days of drinking only milk, or eating only the leaves of the bilva and banyan trees, after dipping them in water, a vow dedicated to Śiva. A fasting vow that is dedicated to Ganeśa is practiced from the day after the new moon in the month of Kārttika (October–November), through the sixth day of the waxing moon in the month of Mārgaśīrsa (November–December), which means complete fasting for three weeks. Those who follow this vow are given a yellow thread bound around their wrist, a *raksabandha*, worn on the right wrist for men and on the left for women. On the concluding day they give a donation of money to a priest as well as food, and then they eat again. A vow for the goddess Devī involves complete fasting on the Friday in the month of Caitra (March–April). During the day the practitioner meditates on the goddess. The person concludes by offering *jagari*, which is raw sugar from sugarcane. After this worship one eats again. A vow dedicated to Visnu is called Vaikuntha *caturdaśī* and involves complete fasting on the fourteenth day of the waxing and waning moon.

One other place where fasting is given great importance within the many traditions and practices of Hinduism is in Ayurveda and Siddha medicine. According to these traditional healing methods, fasting is considered one of the great medicines. Both apply fasting for the cleansing and balancing of the physical body, as well as for the emotions and the mind. Here three kinds of fasting are distinguished: purification fasts to clean the system; healing fasts to overcome a specific disorder; and austerity fasts, which are undertaken to deny the bodily urges on the way toward liberation from the cycle of rebirth.

Buddhism

According to the Buddhist tradition, Siddhārtha Gautama, the Buddha, lived between 560 and 480 B.C.E., although recent research indicates that he may have lived about a hundred years later. In that period northeast India was being transformed from a agricultural society to a more complex urban society. The ancient religious traditions of early Brahmanism no longer fitted the needs of society and of individuals. Therefore, many left society to find new religious ways, mostly by practicing asceticism. The Buddha was one of them. The Buddha used traditional ascetic practices including a very strict fast, reducing his intake of food to a few drops of bean soup a day. This starvation almost killed him, and he became aware of the fact that the body should not be ignored to arrive at man's spiritual core, but should be supported in a healthy and moderate way: no consciousness without a body; no experience of liberation or *nirvāna* without a body. After his "awakening" (*bodhi*) he formulated his "middle path," holding the middle between extreme asceticism and indulgence. This is the reason why fasting and abstinence in Buddhism are always placed within the context of the middle path.

In Asian as well as in Western Buddhist communities, certain traditions regarding food are followed in which there is a difference between the customs of laypeople and the stricter rules for monks and nuns. In general, Buddhists prefer to abstain from eating meat, since this involves the killing of living beings, although, even for the monks and nuns, there is no rule forbidding the eating of meat, unless the monk or nun, who is provided with a meal by a layperson, knows that the animal has been specially killed for the occasion. According to the monastic rules, the Vinaya, monks and nuns should have only two meals a day, in the early morning and before noon, and abstain from food for the rest of the day. One of the reasons is that meditation practice is considered to be difficult if the stomach is full. On festive days, especially at full and new moon, and during meditation retreats, laypeople regularly follow those rules too. In lay Buddhist practice, the Hindu custom of sharing "sanctified" food or *prasāda*, food that is pure (no meat or sharp spices) and has been offered to monks and nuns or to statues of the Buddha or Buddhist deities, is also followed.

In the Buddhist practices of the Newars in the Kathmandu Valley, one finds observances, *vrata*, similar to those of the Hindus, in which fasting takes a prominent role, for example, in the observances connected with full and new moon, but also in those directed to a specific deity; for example, on the eighth day after full moon the fasting is held to honor the bodhisattva Avalokiteśvara-Lokeśvara, the embodiment of compassion. During public or private ritual performances fasting is observed to maintain purity. And, similar to the Hindu custom, an observance is also a way to achieve a specific spiritual or material goal. Some examples include the fasting for Lokeśvara, which is supposed to cause the birth of a son; a fast for Tārā, which frees one from illness, dangers, pain, and untimely death; a fast for Hārītī protects against smallpox; and other deities are invoked by following rules of purity, including abstaining from sex, and fasting for good jobs, before an exam, or before going on a journey.

See also **Buddhism**; **China**; **Hinduism**; **India**; **Religion and Food**; **Southeast Asia**.

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ISLAM

The fast of the month of Ramadan is one of the five major obligations of individual Muslims (the other four being the pronunciation of the confession of God's Unity, the five daily prayers, the religious tax, and the pilgrimage to Mecca). The Qur'an, the holy book of Islam, charts a middle position—"Thus we have made you a community of the middle path" (2:143)—between the ascetic ideal of Christian monastic practices and the more materialistic style of Jewish religion. Islamic fasting during Ramadan is quite harsh by Western standards and includes a full month of total abstinence from food and drink during the hours between dawn and sunset, although the evenings are a time of joy and celebration. The period of fasting during Ramadan is not an individual religious exercise, but part of a great social event that binds individual Muslims collectively.

The Qur'an explains the significance of this time of prayer and abstinence. During the Medina period, which marked the last ten years of the life of the prophet Muhammad (570–632 C.E.), Muslims were instructed to join the Jews in prayer in the direction of Jerusalem, to the north. After the Jews of Medina refused to recognize Muhammad as a prophet and obstructed his ideal of an Islamic state, the Prophet received a revelation that his followers should turn to the Ka'aba of Mecca (to the south of Medina). The Qur'an (2:183–187) prescribes fasting during the month of Ramadan, but prior to Muhammad's revelation, followers observed the fast of the day of Atonement or Ashura, as did the Jews. The institution of the Ramadan fast marked a return to an older Arab tradition that included abstaining from warfare and blood feuds. (In the same chapter of the Qur'an a third Arab institution was restored and reinterpreted: the pilgrimage to Mecca [2:196–203].)

The fast of Ramadan was reinterpreted as an instrument for the forgiveness of sins. It was instituted in commemoration of the Prophet's first revelation, which occurred during that month (on the twenty-first, twenty-third, twenty-fifth, and twenty-seventh of Ramadan) and in awareness of God's decision about man's fate for the coming year. From dawn—in fact, from the moment when a black thread can be distinguished from a white one—until sunset nothing may enter the body through any of its parts. Therefore, not only are eating and drinking forbidden, but also the use of fragrant perfume and even sexual intercourse. Women who menstruate during this period are not allowed to observe fasting but must make up for the days they miss by fasting later on.

In the first generations after Muhammad the basis was laid for what is known as the *shari'a* or Islamic law. Scholars during the first century after Muhammad developed the rules for determining the beginning and end of the month of Ramadan. It is commonly accepted that some part of the new moon must be "seen" (physically or intellectually, i.e., directly observed or by calculation), although there is a divergence of opinion among Muslim communities concerning the correct method for defining the start and finish of the month of Ramadan. Travelers and those who are sick are excused from the fast, but even these exceptions are disputed, as are the various compensations for some days of fasting or the alms given to the poor.

In addition to the month of Ramadan, there are voluntary days of fasting for Muslims, such as the tenth day of Muharam (Ashura, a continuation of the Jewish day of atonement, although the Islamic lunar calendar does not coincide with the solar calendar of Jews and Christians). For the very pious there is a voluntary fast on all Mondays and Thursdays.

Bakers in the Old City of Jerusalem are selling holiday bread for Ramadan. PHOTO COURTESY OF AP/WORLD WIDE PHOTOS.

Fasting not only constitutes abstinence from food. Pious Muslim preachers stress that fasting is more an exercise of the mind than of the body. The prophet Muhammad said, "He is not a good Muslim who eats his fill and leaves his neighbor hungry" (Glassé, p. 112). The mystical theologian al-Ghazali (d. 1111) proposed a category of fasting that included "other parts of the body" (besides the mouth and the sexual organs): The eyes and the hands should be kept under control and prevented from evil. Attention must be given to the poor during the month of Ramadan, and the special "alms tax" (*zakat fitra*) or "gift of breaking the fast" consists of 2.5 kilograms of rice or the equivalent in money given to the poor. Slander and gossip in particular are forbidden during Ramadan, and a saying from Muhammad supports this admonition: "If one does not give up saying false words and doing false deeds in Ramadan, giving up eating and drinking means nothing to Allah" (Buitelaar, p. 22).

Some preachers suggest that the daily fast should be followed by a light meal only and by many prayers. A folk custom ends a day of fasting in the manner of Muhammad: Commonly, a Muslim eats a date first, following the example of the Prophet. In countries where fresh dates are not available, they are imported from abroad to facilitate this custom of the believers. It is also quite common for Muslims to invite friends and relatives to their homes on certain days so that they might experience this rewarding moment together after a full day of fasting: breaking the fast together with a first light meal (*iftar*, literally meaning the breaking snack), accompanied by the pious words of a preacher.

Local kitchens serve a great variety of dishes during the evenings of Ramadan. In the Indonesian province of

Aceh, known for its devout Islam, believers eat *beras tape*, a porridge of fermented sweet rice, as their first snack after a day of fasting. Because of the process of fermentation, this snack contains a significant amount of alcohol, but it is considered a traditional food, not a drink, and is therefore acceptable to pious Muslims. Fish is not considered a good choice for Ramadan meals because it is too light and does not provide a good base for the next day of fasting. A tomato soup (*harira*) that is prepared with a variety of vegetables and beef, buffalo, or lamb is much more substantial and provides longer-lasting nutrition. In countries of the Middle East it is closely identified with the celebration of Ramadan. Sometimes before dawn a heavy "breakfast" (*sahur*) is consumed in preparation for a full day of fasting. Buitelaar mentions (p. 47) a daily meal of rabbit that is eaten at 3:00 A.M. in Morocco.

After Ramadan, on the first day of the month of Shawwal, the so-called small festival is celebrated. A major festival also occurs on the tenth day of the month of the *hajj*, when the sacrifice of Abraham is recalled, but the end of Ramadan brings the greatest joy to Muslims: Relatives are visited and many types of sweets are consumed. In Turkey, this celebration is known as the sugar festival, a celebration also marked in recent decades in parts of Europe where Turkish migrants have settled.

Some mystical or local groups have developed special kinds of fasting, which are either not generally accepted or even denounced by other Muslims. In order to obtain special favors from God, Muslims in Indonesia, especially on the island of Java, practice the *mutihan*, or "white fasting." Muslims there only eat white rice and boiled eggs, and they drink plain ("white") water during a certain period, often to implement a vow. Members of the Khalidiyah branch of the Naqshbandiyah brotherhood practice *suluk* (spiritual travel) or *khalwat* (loneliness), a forty-day period of abstinence from meat and some other dishes; believers also refrain, as much as possible, from talking. Their opponents blame them for introducing a Christian habit (forty days of fasting, and abstinence from meat) into a well-defined Muslim regulation.

The Islamic rules on *haram* (forbidden) foods and drink, such as pork and wine, are not considered akin to the pious acts of fasting or abstinence, but rather are part of the regular observance of taboos and are therefore beyond the scope of this entry.

In many regions and during different periods of Muslim culture, ascetic and mystical movements have introduced elements of abstinence, some from sexual intercourse, others from various luxuries such as perfumes during certain periods. For the especially pious and for those who make special vows, milk and meat are avoided, and there are even vows of abstinence from sleep.

In modern Muslim communities, both in countries with Muslim majorities and also in the new Muslim diaspora in Western countries, the fast of Ramadan is one of the most carefully observed aspects of Islamic custom. Even among secularized Muslims, who do not say their prayers five times each day or who only very seldom join the Friday prayers, there is an attempt to keep the fast for part of the month of Ramadan, as a way of keeping in touch with their spiritual and cultural roots. As with those who are more devout, the festive moment in which the fast is broken is a central element. In 1963 Ahmad Hasan al-Zayyat, the editor of the journal of the Al-Azhar mosque and university in Cairo, commented bitterly on the way of fasting: "We do not have any more thirty days of fasting, but thirty days of breaking the fast" (Goitein, p. 108). This comment may reflect the general practice of fasting and abstinence found in Islamic culture, where a middle path has been found: between strict religious and cultural interpretation, between individual piety and communal belief. The middle path of Islamic fasting and abstinence lies between ascetism and pure materialism.

See also **Christianity**; **Feasts, Festivals, and Fasts**; **Islam**; **Judaism**; **Middle East**; **Ramadan**.

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JUDAISM

The phenomenon of fasting in the variegated history of Judaism has its roots in the biblical text. Though it is not entirely clear why and when this practice arose, it is certain that in ancient Israel, abstaining from food and drink on both the individual and communal level was considered an act of piety that one would (in most cases spontaneously) undertake as a means of entreating God's compassion or in the hope of averting divine punishment (Judges 20:26; 1 Kings 21:9, 27; 1 Sam. 7:6; 2 Sam. 12:16, 22; Jer. 14:12, 36:6, 9; Joel 1:14, 2:12, 15; Jonah 3:5; Ps. 35:13, 69:11–12; Esther 4:16; Dan. 9:3; Ezra 8:21, 23; Neh. 1:4; 2 Chron. 20:3) or as a sign of mourning and lament (1 Sam. 31:13; 2 Sam. 1:12; 12; Zech. 7:5; Esther 4:3; Ezra 10:6; Dan. 10:2–3; 1 Chron. 10:12).

Fixed Fasts

The four fixed fast days mentioned by the post-exilic prophet Zechariah relate to calamities centered about the destruction of Jerusalem and the Temple (Zech. 8:19): the fast of the fourth month corresponds to what is celebrated as the seventeenth of Tammuz, which marks the breaching of the walls of the city (in 2 Kings 25:4 and Jer. 39:2 the date is the ninth); the fast of the fifth month, the ninth of Av when the Temple was destroyed (in 2 Kings 25:8 and Jer. 52:12–13 the date is the tenth); the fast of the seventh month, the third of Tishrei when Gedaliah, the Babylonian-appointed governor of Judah, was murdered (2 Kings 25:25, Jer. 41:1–2); and the fast of the tenth month, the tenth of Tevet, which marks the beginning of the siege of Jerusalem by Nebuchadnezzar, king of Babylon (2 Kings 25:1–2, Jer. 52:4). The custom to fast on the thirteenth of Adar, the day before the holiday of Purim, which celebrates the downfall of Haman and the redemption of the Jewish people, does not commemorate a tragedy in Jewish history but rather stands as a reminder of a precarious moment when disaster was averted (Esther 4:16).

By contrast, the Day of Atonement, Yom Kippur (celebrated on the tenth day of the seventh month, which is enumerated as the first month of the new year), the one fast specified in the Pentateuch, is part of the afflicting of the body—according to later rabbinic law this comprises five forms of self-denial: abstention from eating, washing, anointing, wearing shoes, and cohabitation; Mishnah Yoma 8:1—that is a means of purification from transgression (Lev. 16:29–34, 23:27–32; Num. 29:7–11). From other verses we can deduce that refraining from eating and drinking was considered one of various methods of abstinence by which one could afflict the body, acts that were often accompanied by oaths and vows (Num. 30:2–16; Dan. 10:12). There is evidence to suggest that fasting was also practiced as preparation for communing with the spirits of the dead (1 Sam. 28:20). The narrative about Moses being with God for the forty days in which he wrote the tablets of law specifies that during that time he neither ate bread nor drank water, indicating that he was in a transformed state wherein the normal physical needs could be discarded (Exod. 34:28; Deut. 9:9, 18), a theme that is applied as well to Elijah when he had the theophany on Horeb, the mountain of God (1 Kings 19:8–12). In the case of Daniel as well, acts of prayer, which included fasting, were answered with a vision of the divine (Dan. 9:20–27, 10:7–21).

Abstention from food was considered one of the several typical acts of humbling oneself, which may have included renting one's clothes, lying in sackcloth, walking about in a subdued posture, sleeping on the floor, and not washing, anointing, or changing one's clothes (2 Sam. 1:11–12, 12:16–20; 1 Kings 21:27; Jonah 3:5; Ps. 35:13, 69:12; Esther 4:3; Dan. 9:3; Neh. 9:1). Fasting could also accompany weeping and the offering of sacrifices (Judges 20:26; Joel 2:12) or the confession of one's iniquities (1 Sam. 7:6; Neh. 9:2; Dan. 9:4), but on occasion it takes the place of the sacrificial cult (Joel 1:13–14). The purpose of fasting as a ceremonial expression of remorse and supplication is underscored in the prophetic pronouncements against those who would fast without the proper intent as if God demanded of the Israelites external forms of self-affliction without commitment to act justly (Isa. 58:3–7; Jer. 14:12). Indeed, according to the messianic declaration of Zechariah, the fast days in Israel commemorating past suffering centered around the destruction of Jerusalem and the Temple would be transformed into occasions for joy provided there would be love of honesty and integrity (Zech. 8:19).

Fasting without repentance is of no value. In the Second Temple period, abstaining from eating and drinking continued to serve as a primary means of atonement, but in addition we have evidence that on occasion it functioned as an ascetic regimen that served to purify the heart and bring one closer to God, and even in some cases to induce an ecstatic state wherein a supernatural vision was granted (2 Bar. 12:5, 20:5–6, 43:3; 4 Ezra 5:13–20, 6:35–36). There is evidence from the rabbinic corpus that select individuals similarly fasted excessively in order to have visionary experiences (Palestinian Talmud, Kil'ayim 9:4, 32b), a phenomenon attested as well in the Heikhalot literature, the magical and mystical texts that began to take shape roughly during the time that Judaism and Christianity began to emerge as distinct liturgical communities. We know little about the social background of the individuals responsible for these texts, but we can conclude with some degree of certainty that they adopted ascetic practices, primarily fasting and sexual renunciation, as preparation for dream-vision, angelic adjuration, or heavenly ascent. In the tenth century, a leading rabbinic figure, Hai Gaon, summarized these older practices by saying that anyone who wished to gaze at the chariot must "sit fasting for a specified number of days, place his head between his knees, and whisper to the earth many prescribed songs and hymns." It is likely that fasting or even a restricted diet (together with sexual abstinence) was viewed as means by which the human could be transformed into an angelic being, a prerequisite for the attainment of the visionary encounter with an angel or the glory.

Perhaps some of the rabbis developed a critical stance vis-à-vis fasting as an appropriate form of piety to combat such individuals and their anomian customs. Thus, a dictum is transmitted in the name of R. Yose: "An individual is not permitted to torment himself in fasting lest he fall upon the community and they will need to support him" (Tosefta, Ta‘anit 2:12). According to another statement attributed to Samuel, "Whoever sits in a fast is called a sinner" (Babylonian Talmud, Ta‘anit 11a). In the words of a maxim ascribed to Reish Laqish, "the scholar is not permitted to sit and fast for it diminishes the work of heaven" (Babylonian Talmud, Ta‘anit 11b). Finally, Rav reportedly declared that "in the future a man will have to give an account for everything that his eye saw but he did not eat" (Palestinian Talmud, Qiddushin 4:12, 66b).

An especially interesting concern for the rabbis was the abstinent woman whose constant fasting "causes her to lose virginity" (Palestinian Talmud, Sotah 3:4, 19a). Indeed, on account of the reduced intake of food she is called the "fasting virgin," a term that suggests that the challenge such a woman posed was that she disrupted the societal expectations by abdicating the domestic responsibility of child bearing. In contrast to early Christianity where virginity and fasting were considered virtuous acts of piety, the rabbinic sages castigated the woman who adopted an ascetic lifestyle with regard to sexuality and eating. According to one rabbinic ruling, the ascetic woman is enumerated among those who bring destruction to the world (Mishnah, Sotah 3:4), an expression meant to convey that female celibacy results in the breakdown of marital life and the bearing of progeny.

Additional Fasts

The basic approach to fasting was continued by the rabbis who, in their characteristic fashion, codified specific regulations to fashion the biblical references into binding rituals. In addition, the rabbis decreed additional fasts in the course of the calendar, generally associated with the fixed fasts and other calamitous events in biblical and postbiblical history. Yet, the rabbinic authorities were opposed to extreme forms of abstinence, including fasting, as we find, for instance, in the Therapeutaue community described by Philo, early Christian communities, and the individuals whose experiences are preserved in the Heikhalot texts. It must be pointed out, however, that the rabbinic sources themselves yield proof that some members of the academies were more positively disposed toward voluntary abstinence as a way to cultivate the highest form of piety. Thus, there is substantial textual evidence to indicate that sages (many from the third and fourth centuries) undertook excessive fasts as part of an ascetic lifestyle, to attain an extraordinary experience (usually of a visual nature), or for penance (Palestinian Talmud, Kil'ayim 9:3, 32b, Ta'anit 2:13, 66a, Nedarim 9:2, 40d; Babylonian Talmud, Pesahim 68b, Hagigah 22b, Qiddushin 80b, Baba Metsi'a 85a, Nazir 52b).

Additionally, there is verification that some rabbis preserved an ancient custom, apparently initiated in the land of Israel, to fast every week on Monday and Thursday (Palestinian Talmud, Ta'anit 1:6, 64c; Babylonian Talmud, Shabbat 24a, Ta'anit 12a), and there is as well confirmation of the fact that some considered fasting appropriate for Sabbath (Babylonian Talmud, Pesahim 68b, Beitsah 15b) even though others clearly thought the opposite and prohibited fasting on Sabbath (Palestinian Talmud, Ta'anit 3:13, 67a, Nedarim 8:10, 40d), maintaining that Sabbath is a day of joy and rest, the sanctification of which involves physical pleasure, encompassing eating and drinking (Palestinian Talmud, Shabbat 15:3, 15a; Babylonian Talmud, Berakhot 32b). A residue of the former orientation is found in the ruling that fasting because of a troubling dream (*ta'anit halom*) is allowed even on Sabbath (Genesis Rabbah 44:12; Babylonian Talmud, Berakhot 31b, Ta'anit 12b). Interestingly, the routine of fasting on Sabbath was revived in the twelfth and thirteenth centuries by figures like Judah he-Hasid, the leader of the Rhineland German Pietists (Hasidei Ashkenaz), who adopted an ascetic form of devotion, and we even have a report by Avigdor ben Elijah ha-Kohen that Judah fasted on Rosh Hashanah, the Jewish New Year, a practice followed by other rabbis connected to this group, such as Abraham Haldiq of Bohemia, though by no means accepted by everyone. Finally, there are rhetorical flourishes in rabbinic literature that assign supreme theurgical significance to fasting as a means of atonement. Perhaps the best illustration of this approach is the prayer offered by Rav Sheshet before God, which is predicated on the symbolic equation of fasting and sacrifices: "May it be your will to account my fat and blood, which have been diminished, as if I sacrificed them before you on the altar, and you should find favor with me" (Babylonian Talmud, Berakhot 17a).

In spite of the admonitions against excessive fasting, it must be said that an ascetic tendency is well entrenched in the classical rabbinic corpus, an orientation that served as the foundation for pietists and mystics at later stages of Jewish history. In particular, the Rhineland Pietists and the Provençal and Spanish kabbalists of the twelfth and thirteenth centuries cultivated ascetic practices to attain a state of holiness and removal from the bondage of the corporeal world, in part based on earlier mystical tracts. An especially important part of the pietistic regimen was fasting, which, together with sexual abstention, was viewed as the mechanism by which the mortal being could be transmuted into an angel. For example, Eleazar of Worms, another leading member of the Hasidei Ashkenaz, chronicles an elaborate ceremony for the transmission of the divine name, which involved ritual immersion, being clad in white clothes, and fasting. Acts of self-denial and self-affliction were considered to be the way of fulfilling the hidden will of God.

Kabbalistic Piety

In kabbalistic literature as well we find a central concern with fostering an ascetic piety predicated on acts of behavior that transform the human into an angel. Moreover, kabbalists articulated a contemplative goal of union with God, which is often described as the merging of the finite and infinite will, as we find in Azriel of Gerona, Jacob ben Sheshet, and the authors of the Zohar. The rabbinic analogy comparing fasting to sacrifice played a crucial role in shaping the mystical sensibility of offering one's heart fully to God and subjugating desire (Zohar 2:20b, 119b, 153a). From the symbolic vantage point endorsed by kabbalists, fasting is the instrument by which one becomes a sacrifice and is submerged thereby in the Godhead. In somewhat different terminology, but expounding a similar ascetic ideal, in zoharic literature the members of the mystical fraternity engaged in Torah study are said to partake of the spiritual food that angels eat, the "bread of the mighty" (*lehem 'abirim*) (Ps. 78:25), the overflow of divine wisdom, rather than the coarse food of this world (Zohar 2:61b). With this idea we reach the paradoxical reversal characteristic of mystical insight: abstention is genuine consumption.

Utilizing an older midrashic gloss (Leviticus Rabbah 20:10) on the verse "And they saw the God of Israel, and they ate and drank" (Exod. 24:11), the kabbalists affirm that this refers to an "actual eating," which does not entail physical ingestion, but deriving sustenance from basking in the visual presence of God, a state applied to the righteous and angels in the world to come (Zohar 1:104a, 2:126a). By fasting the kabbalist anticipates that condition in this world and thus has a foretaste of the food that is perpetually fulfilling.

See also **Buddhism; Christianity; Feasts, Festivals, and Fasts; Hinduism; Islam; Jewish Food; Judaism; Middle East; Religion and Food; Sin and Food.**

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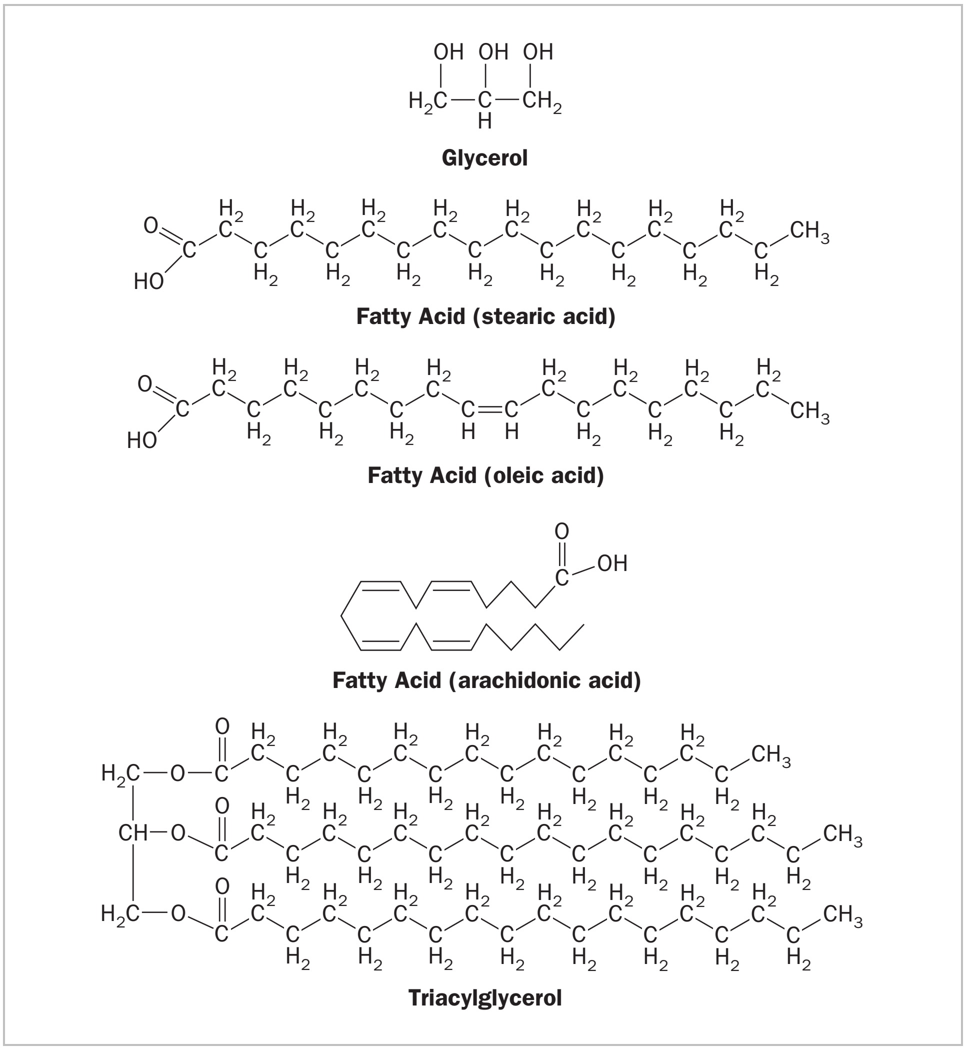
FATS. Fat is a generic term for triacylglycerols, which are a class of structurally similar chemical compounds that contain three fatty acid molecules that are linked or chemically esterified to one glycerol molecule (Figure 1). Mammals store triacylglycerol as lipid droplets in specialized cells referred to as adipocytes, which compose the white or yellow tissue known as adipose or neutral fat tissue. White fat has several functions in mammals. It is a reservoir for storing excess energy obtained from the diet. Fatty acids are a dense storage form of chemical energy in mammals. Adipose tissue also has an important role in padding and thereby protecting various organs throughout the body from temperature extremes and physical impact or trauma. Triacylglycerol, when converted to phospholipid, is a primary constituent of cell membranes and therefore is critical for all forms of life. Mammals also contain brown fat in various locations throughout the body including the neck, thorax, and abdomen. Brown fat functions to generate body heat and therefore it is an important tissue for energy expenditure, otherwise referred to as "burning calories." Brown fat can generate heat because it contains mitochondria with a unique and specialized function. In most other cells, mitochondria are the energy-producing compartments in the cell that generate adenosine triphosphate (ATP), which is a chemical form of cellular energy that is required for numerous cellular chemical reactions. In brown fat, the energy generated by mitochondria is used to generate heat. Brown fat cells contain an "uncoupling" protein that diverts energy away from ATP synthesis and toward heat production. Energy utilization by brown fat is tightly regulated by signals it receives from the sympathetic nervous system. Animals that are adapted to cold temperatures display increased heat production from brown fat, and brown fat is proportionally more abundant in infants than in adults.

Classes of Fatty Acids

Fatty acids are a diverse family of structurally similar carbon chains that contain a single carboxylic acid group (see Figure 1). Fatty acids differ from one another by their carbon chain length, which is usually an even number of carbons that can exceed twenty carbon atoms. Fatty acids are often categorized as short-chain, medium-chain, or long-chain fatty acids because each of these groups displays distinct physical properties. Short-chain fatty acids contain up to seven carbon molecules and are liquids even at cold temperatures. Medium-chain fatty acids, which contain between eight and twelve carbons, are liquids at room temperature but solidify when refrigerated. Long-chain fatty acids contain greater than twelve carbons and are solids at room temperature, but liquefy at elevated temperatures. Long-chain fatty acids are the most abundant fatty acids in plant and animal foods. Short-chain fatty acids are found in whole cow's milk, and medium-chain fatty acids are abundant in coconut milk.

Fatty acids also differ by the number and location of carbon–carbon double bonds, otherwise called the degree of saturation. Saturated fatty acids do not contain any carbon–carbon double bonds because all carbon molecules are "saturated" with hydrogen molecules. The most abundant saturated dietary fatty acids are palmitic and stearic acids, which are long-chain fatty acids found in foods derived from animals and are abundant in meat and dairy products (Table 1; see Figure 1). Monounsaturated fatty acids contain a single carbon–carbon double bond (see Figure 1). Oleic acid is a monounsaturated fatty acid and a common dietary component found in canola and olive oil. Polyunsaturated fatty acids contain up to six carbon–carbon double bonds that are always separated by

FIGURE 1



Glycerol

Fatty Acid (stearic acid)

Fatty Acid (oleic acid)

Fatty Acid (arachidonic acid)

Triacylglycerol

a methylene group (—CH_2—) (Figure 1). Polyunsaturated fatty acids that contain a series of double bonds that begins between the third and fourth carbon from the methyl or omega end of the molecule (see nomenclature system below) are referred to as omega-3 fatty acids. Linolenic, eicosapentaenoic (EPA), and docosahexaenoic (DHA) are omega-3 fatty acids and flaxseed oil, walnut oil, and fatty fish are good sources of omega-3 fatty acids. Omega-6 fatty acids are another class of polyunsaturated fatty acids that includes linoleic acid and arachidonic acid. They contain a series of carbon–carbon double bonds that begin between the sixth and seventh carbon from the omega end of the fatty acid. Linoleic acid is the most common omega-6 fatty acid in Western-style diets and is found in corn, safflower, and soy oils.

The fatty acid composition of triglycerols found in mammals is usually complex and is influenced by the fatty acid consumed in the diet and by the tissue where it resides. The most common fatty acids in humans are 16, 18, and 20 carbons in length, but longer-chain fatty acids are found in the central nervous system. Most diets contain mixtures of all types of fatty acids, but saturated and monounsaturated fatty acids constitute the vast majority of fatty acids that are consumed in a typical Western diet. A single triacylglycerol molecule rarely contains three identical fatty acids.

Essential Fatty Acids

Rodents placed on a fat-restricted diet are growth impaired, infertile, and develop lesions in the skin and kidney. These pathologies are not observed if the diet is supplemented with linolenic (omega-3) and linoleic acid (omega-6). The results of these studies indicated that mammals cannot synthesize these fatty acids and therefore that these fatty acids are essential components of a healthy diet. Human deficiencies of these essential fatty acids are rare but can occur in infants and children or as a result of intestinal absorption disorders. Human essential fatty acid deficiency compromises liver function, results in unhealthy skin, and impairs growth and development in infants including impaired cognitive function, visual acuity, and hearing.

Essential fatty acids are necessary to maintain the architecture of cell membranes and the integrity of the skin. They are also precursors for the synthesis of eicosanoids ("eicosa" meaning twenty carbons in length), which are bioactive, hormone-like compounds derived from linoleic and linolenic acid. The eicosanoids include prostaglandins, which elicit numerous and varied biological responses including induction of labor, regulation of the female reproductive cycle, and modification of pituitary function. Thromboxane is an eicosanoid that functions in platelet aggregation and blood clotting; leukotrienes function in the inflammation and allergic responses. The omega-3 fatty acid alpha-linolenic acid is also a precursor for eicosapentaenoic acid (EPA) and docohexaenoic acid (DHA) synthesis. Both DHA and arachidonic acid are important for nervous system and retina development. DHA may be an essential dietary fatty acid for preterm infants because studies indicate that it is not synthesized in sufficient quantities to meet the infant's needs.

There is no Recommended Dietary Allowance (RDA) for essential fatty acids. The minimal adequate adult intake of omega-6 fatty acids is estimated to be 2 to 4 g/day of linoleic acid. Americans normally consume about 10 to 15 g/day. The minimal adequate adult intake of omega-3 fatty acids is estimated to be 0.2 to 0.4 g/day, but intakes as high as 3 g/day may have added benefit. Omega-3 fatty acid intakes should be increased during pregnancy and lactation. The World Health Organization recommends an omega-6/omega-3 ratio of 4:1 to 10:1.

Fatty Acids Derived from Food Processing

Synthetic or unnatural types of fatty acids are also common components of Western diets and result from food processing. Fats are processed to increase their shelf life and to alter their physical properties. Monounsaturated and unsaturated fatty acids are chemically inert, whereas polyunsaturated fats are susceptible to oxidation. Polyunsaturated fatty acids degrade by oxidation and become rancid, thereby spoiling foods that contain these compounds. Therefore, products containing polyunsaturated fatty acids tend to have a reduced shelf life, but can be stabilized by converting the polyunsaturated fatty acids contained within these products to more stable monounsaturated and saturated fatty acids through the process of chemical hydrogenation. This processes converts carbon–carbon double bonds to single bonds (Reaction 1):

$$\text{—HC=CH—} \rightarrow \text{—2HCNCH}_2$$

(Reaction 1; Chemical Hydrogenation)

FAT AND HEART DISEASE

Risk for heart disease results from excess fat consumption and the type of fat that is present in the diet. Diets high in saturated fatty acids, especially those found in animal fat, increase the concentration of low-density lipoprotein (LDL) cholesterol or "bad" cholesterol. Elevations in serum LDL concentrations increase risk for arteriosclerosis. Consumption of *trans*-fatty acids, although only representing between 2 and 4 percent of calories in Western diets, also increases risk for heart disease, but the pathogenic mechanisms are not certain. *Trans*-fatty acids may be as efficient as natural saturated fat in increasing serum LDL concentrations, and their consumption replaces foods that contain beneficial unsaturated fatty acids. Consumption of omega-3 and omega-6 fatty acids, especially when they replace consumption of saturated fat, decreases risk for heart disease, in part by lowering LDL cholesterol levels. Omega-3 fatty acids are more protective than omega-6 fatty acids. Omega-6 fatty acids may lower serum HDL cholesterol, which is harmful because HDL protects the heart from disease. Omega-3 fatty acids may prevent heart disease by improving immune function, lowering blood pressure, and inhibiting the growth of plaques on blood vessel walls. Omega-3 fatty acids obtained from whole food sources such as fatty fish seems to be more beneficial than dietary supplements.

This process not only stabilizes food, but also changes its physical properties. For example, margarine is produced by the chemical hydrogenation of vegetable oils. This process produces a product that is more stable and solid than vegetable oil and mimics the consistency of natural butter. However, chemical hydrogenation of polyunsaturated fatty acids also results in the formation of "unnatural" *trans*-fatty acids, which are normally found only in trace quantities in foods from natural sources. *Trans*-fatty acids do not differ from natural fatty acids in their carbon chain length or degree of saturation, but differ in the orientation or stereochemistry of the carbon–carbon double bonds. Carbon–carbon double bonds can exist in both a *cis* (the hydrogen atoms that are attached to the carbon atoms that flank the double bond reside on a common plane) or *trans* (hydrogen atoms reside on different planes) conformation; this is a fundamental principle of organic stereochemistry. The double bonds present in fatty acids from natural, unprocessed food sources usually exist in the *cis* conformation (see Figure 1). *Trans*-fatty acids are abundant in foods that undergo chemical hydrogenation and their consumption may increase risk for disease.

Nomenclature of Fatty Acids

All fatty acids can be identified by their "trivial" names, such as oleic or linoleic acid, but these names do not contain information that is necessary to infer their structure or physical properties, that is, the length of their carbon chains or the number and location of carbon–carbon double bonds. Therefore, a nomenclature system has been devised that describes the precise chemical structure of the molecule (see Table 1). The carbon atom that constitutes the carboxylic acid of the fatty acid is referred to as the *alpha carbon* and is designated as carbon number one; the methyl carbon that constitutes the other end of the molecule is referred to as the *omega carbon*. Fatty acids are named by the number of carbons in the chain and the number and location of carbon–carbon double bonds. For example, oleic acid is referred to as *cis*-9-octadecenoic acid, or 18:1(9); the 18 refers to the number of carbons in the fatty acid carbon chain, the 1 refers to the number of carbon–carbon double bonds, and the 9 in parentheses refers to the position of the double bond counting from the carboxylate carbon that is in the *cis* conformation.

Fatty acids as membrane components and emulsifiers. Fatty acids and triglycerols are lipid soluble and therefore are hydrophobic molecules that do not dissolve readily in water (as evidenced by the appearance of distinct oil and water layers in many oil-based salad dressings). In aqueous environments, fatty acids aggregate and form ordered structures. All life forms have taken advantage of the hydrophobic properties of fatty acids to make cell membranes, which are semipermeable barriers that separate cells from their environment. Membranes delineate the boundaries of the cell, enable cells to retain water, and form specialized internal structures called subcellular organelles that include mitochondria, Golgi apparatus, and lysosomes. Cell membranes are lipid bilayers that are primarily composed of lipid and membrane-bound proteins. Fatty acids present in cell membranes are components of phospholipids, and phosphoglycerides are the most abundant phospholipids in membranes. Phosphoglycerides are similar in structure to triglycerols. They contain two fatty acid molecules and one phosphate molecule esterified to a glycerol molecule. The phosphate molecule has a hydrophilic amino acid or sugar molecule attached to it. Phospholipids are amphipathic molecules because one end of the molecule contains a water-soluble phosphate molecule, and the other end contains a lipid-soluble carbon chain of the fatty acids. Therefore, phospholipids are ideal components of cell membranes because the phosphate end can dissolve in water while the fatty acid end interacts with other lipid molecules to form a barrier that restricts the efflux of water.

TABLE 1

Classes of fatty acids

Trivial name	Systematic name	Numerical symbol
Saturated fatty acids		
Lauric acid	Dodecanoic	12:0
Myristic acid	Tetradecanoic	14:0
Palmitic acid	Hexadecanoic	16:0
Stearic acid	Octadecanoic	18:0
Monounsaturated fatty acids		
Palmitoleic acid	*cis*-9-hexadecenoic	16:1(9)
Oleic acid	*cis*-9-octadecenoic	18:1(9)
Polyunsaturated fatty acids (omega-6)		
Linoleic acid	*cis*,*cis*-9, 12-octadecadienoic	18:2 (9,12)
Arachidonic acid	All *cis*-5,8,11, 14-eicosatetraenoic	20:4 (5,8,11,14)
Polyunsaturated fatty acids (omega-3)		
Linolenic acid	All *cis*-9-12- 15-octadecatrienoic	18:3 (9,12,15)
EPA	All *cis*-5,8,11,14, 17-Eicosapentaenoic	20:5 (5,8,11,14,17)
DHA	All *cis*-4,7,10,13,16, 19-Docosahexaenoic	22:6 (4,7,10,13,16,19)

The amphipathic properties of phospholipids make them effective *emulsifiers*, which are chemicals that interact with both water and oils and prevent them from separating and forming two layers. Lecithin is a phospholipid that is synthesized by mammals and is found in high concentrations in eggs. It is also an effective emulsifier and a common food additive in margarine, salad dressings, chocolate, and a variety of baked items. Fatty acids are components of many household products including lubricants, cooking oils, soaps, and detergents.

Dietary and Biosynthetic Sources of Fat

Fatty acids found in mammals are derived from both dietary sources and intracellular biosynthesis. Humans can synthesize all of the necessary fatty acids with the exception of the essential fatty acids. Fatty acids are synthesized in most cells from excess dietary carbohydrate, amino acids, and from other fatty acids. Palmitic acid (16:0) is synthesized by mammals and is a precursor for the synthesis of all other nonessential fatty acids. The carbon chain of palmitic acid is extended by the sequential addition of two carbons to the carboxy terminal end of the molecule. This is an enzyme catalyzed reaction that uses acetyl coenzyme A (CoA) as a source of the two carbon atoms. Mono- and polyunsaturated fatty acids are synthesized by the desaturation of saturated fatty acids. The first double bond is formed between the C–9 and C–10 of palmitate or stearate to form palmitoleic or oleic acid. This is the first step in the synthesis of polyunsaturated fatty acids. This reaction is inhibited by dietary polyunsaturated fatty acids but activated by insulin and thyroid hormone.

Triglycerols are synthesized by most tissues from glycerol 3-phosphate, an intermediate in carbohydrate metabolism, and chemically activated fatty acids known as fatty acyl CoAs. This reaction occurs most frequently in the liver and white adipose tissue. In the liver, triacylglycerol synthesis is necessary for the assembly of lipoproteins, whereas triacylglycerol synthesis in adipose tissue functions to create long-term energy stores for mammals. Although a storage form of energy, fat is a dynamic tissue. Triacylglycerols constantly undergo hydrolysis and resynthesis in adipocytes. Newly synthesized triacylglycerol molecules remain intact for only a few days.

Digestion and Transport

About 90 percent of dietary lipid is in the form of triacylglycerols, and typical adults consume about 60 to 150 g/day. During digestion, dietary lipids aggregate and form water-insoluble particles in the gut that must be disrupted before absorption. Specific enzymes in the stomach, called gastric lipases, and in the intestine, called pancreatic lipases, bind to the lipid droplets and catalyze the hydrolysis or removal of fatty acids from triacylglycerols resulting in the liberation of free fatty acids, diacylglycerols, and monoacylglycerols. Fatty acids are also liberated from phospholipids by pancreatic phospholipases. The products of triglycerol hydrolysis are made soluble by bile acids, which are negatively charged detergents that are synthesized from cholesterol in the liver and secreted into the duodenum. Bile acids form micelles, which are disc-shaped particles with a negatively charged exterior that is water soluble and a hydrophobic center that sequesters fatty acids. During digestion, liberated fatty acids are continuously transferred from lipid droplets to micelles. Virtually all free fatty acids are transported from the micelles into intestinal epithelial cells by passive diffusion. Lipids that cannot be made soluble are not absorbed and are excreted.

Once absorbed into the intestinal cells, short- and medium-chain fatty acids are released directly into blood and taken up by the liver. Long-chain fatty acids are resynthesized into triacylglycerols and complex with apolipoproteins to form lipid globules known as chylomicrons. Chylomicrons travel through the lymphatic system and then through the venous plasma. Most triacylglycerol in chylomicrons is metabolized by lipoprotein lipase that is bound to the surface of adipose and muscle cells.

Metabolism of Fat

Most fat cells are derived in infancy and adolescence except in instances of severe childhood obesity. As fat stores accumulate, adipocytes increase in size but generally not in number. Normal fat stores provide sufficient energy to sustain humans for several weeks during total starvation. During fasting, fatty acids are catabolized or broken down to acetyl-CoA, which is an intermediate in the citric acid cycle. This reaction requires carnitine, a derivative of the amino acid lysine. The oxidative breakdown of fatty acids occurs in mitochondria through a series of reactions known as beta-oxidation. Fatty acids are rich sources of energy; 44 moles of ATP are generated by the complete oxidation of 1 mole of a six-carbon fatty acid, whereas only 38 moles of ATP are generated from 1 mole of glucose, a six-carbon sugar. During starvation, acetyl-CoA can be converted to ketone bodies, which include acetone, acetoacetate and alpha-hydroxybutyrate. These compounds are produced exclusively in the liver but readily enter the circulatory system by passive diffusion. The odor associated with the generation of these ketones becomes apparent in the breath and urine of individuals. Ketone bodies are an alternative energy source for glucose during starvation, and are utilized by the brain and other tissues. Normally, ketones are rapidly metabolized by the peripheral tissues and do not accumulate in blood. However, if the citric acid cycle is depressed by low glucose due to starvation, diabetes mellitus, or a high-fat, low-carbohydrate diet, ketones accumulate in serum and a state of ketosis can result. High concentrations of ketones in blood can lower its pH and result in metabolic acidosis, which can be fatal during diabetic ketosis.

Fatty Acid Regulation of Gene Expression

Polyunsaturated fatty acids and eicosanoids are informational or signaling molecules that can influence the expression of certain genes involved in lipid synthesis, breakdown, and transport. Omega-3 and omega-6 polyunsaturated fatty acids lower the accumulation of triacylglycerol in muscle by inhibiting triacylglycerol synthesis in the liver and accelerating the breakdown of fatty acids in the liver and skeletal muscle. Linoleic and linolenic acid, as well as certain pharmaceuticals, bind to and activate the transcriptional activity of a family of related nuclear receptors known as the peroxisome proliferator–activator receptors (PPARs). These receptors are transcription factors that can directly bind DNA and elevate the transcription of genes. The target genes are involved in the metabolism, storage, and transport of lipids, triacylglycerol, and fatty acids. These receptors also regulate the differentiation of immature adipocytes into mature fat cells.

Individual members of the PPAR family have different functions. In the fasting liver, PPAR-alpha activates genes that encode enzymes that metabolize lipids to ketone bodies and decreases expression of genes involved in fatty acid synthesis. As fatty acids are hydrolyzed from triacyglyceride, PPAR-alpha is further activated. PPAR-alpha activates the expression of genes in fat cells that are necessary for fatty acid uptake, triacylglycerol synthesis, and fat storage.

PHARMACEUTICALS THAT TARGET FAT METABOLISM

Many of the most prevalent diseases in Western cultures are related to excessive caloric intake and sedentary lifestyles, diseases that include obesity, hyperlipidemia, diabetes, and arteriosclerosis. These states often occur in combination, and are diagnosed as syndrome x. Pharmaceutical have been developed to manage these disorders. These agents either inhibit intestinal fat absorption or affect fat metabolism by manipulating the activity of PPARs.

Fibrates (gemfibrozil, bezafibrate, fenofibrate) are pharmaceuticals that target and inhibit the function of PPAR-alpha. Thiazolidinediones target PPAR-alpha. Fibrates are effective in the treatment of cardiovascular disease. They function to elevate HDL levels by increasing the expression of proteins necessary for its structure, and decreasing plasma triglyceride by accelerating fatty acid oxidation in the liver. TZDs are effective in the treatment of Type 2 diabetes because they have a hypolipidemic and hypoglycemic effect.

Nondigestible commercial lipids have also been developed to limit total fat intake. One product, Olestra, contains fatty acids linked to the sugar sucrose. These products replace natural fat in foods, and were designed to taste like natural fat. However, they cannot be hydrolyzed in the gut and therefore are not absorbed. Other pharmaceuticals target and inhibit pancreatic lipase, such that natural dietary lipids are not broken down to fatty acids and therefore are not absorbed.

Determinants of Total Body Fat

Fat is a storage form of energy, and as such only accumulates when energy intake exceeds energy output. Total body fat accumulation is determined by complex interactions among genes, environment, and behavior. The human body can adjust to a wide range of fat intake, but both deficiency and excess are associated with disease. In a normal, healthy individual, fat stores constitute 12 to 18 percent of total body weight in males and 18 to 24 percent in females. Excessive consumption of high-calorie foods and/or a lack of exercise elevate fat stores. In some cases, the genetic background alone can determine total body fat in the absence of strict dietary control. Children with obese parents are at higher risk of becoming obese, and studies of identical twins also indicate that risk for obesity has a strong hereditary component. Furthermore, more than 75 percent of the Pima Indians are obese, again indicating a strong influence of genetics on fat accumulation. Many genes have been identified that control weight gain. The products of these genes regulate energy balance and expenditure and are signaling hormones that regulate appetite and fat metabolism. Some studies indicate that genetic factors, and the metabolic signals they generate, balance energy expenditure and appetite to form an individual's "set point" that specifies body weight. These signals include the satiety hormones such as serotonin and leptin. The neurotransmitter serotonin is responsible for "cravings" that can increase consumption of particular food types. Leptin is a peptide hormone that is secreted by fat cells and signals the hypothalamus. Leptin secretion is proportional to fat cell size, and increased leptin concentrations in blood signal the brain to increase energy expenditure and decrease food intake. Mice lacking the leptin gene or the leptin receptor become obese. Human mutations in the leptin gene are rare but result in obesity.

Dietary Fat and Disease Risk

Lipids constitute about 33 percent of total energy intake in the typical North American diet, whereas Japanese diets have a lower fat intake (11 percent of energy from fat). Western-style diets are deficient in omega-3 fatty acids and contain excess omega-6 fatty acids. Some evidence indicates that prehistoric diets that were consumed through much of human evolution contained an omega-6/omega-3 fatty acid ratio that was near 1.0, whereas this ratio is about 20 in the typical Western diet. Vegetarian diets also tend to contain excess omega-6 fatty acids. Diets deficient in omega-3 fatty acids or diets that contain an elevated omega-6/omega-3 ratio may increase risk for cardiovascular disease and cancer.

Research over the past few decades has indicated that excess consumption of saturated fat increases risk for disease including heart disease (arteriosclerosis), obesity, diabetes, and certain cancers (see "Fat and Heart Disease"). Obesity is a clinical condition defined as having a body weight that is greater than 20 percent above a desirable body weight standard or a body mass index that exceeds 30 kg/m^2. Obesity occurs in epidemic proportions in the United States and other Western societies, especially in individuals from lower socioeconomic level. Its prevalence is rapidly increasing in developing societies that are adapting Western lifestyles. The combination of increased fat intake and sedentary lifestyle (otherwise referred to as excess energy intake) increases risk for overweight and obesity. Increased body fat, in turn, is an independent risk for heart disease, diabetes, and high blood pressure. Elevated fat intake can also increase risk for cancers of the colon, prostate, and breast. The incidence of cancers of the breast is high in populations with high intakes of either natural saturated fat or *trans*-fatty acids, but not diets rich in olive oil, which contains high levels of monounsaturated fatty acids. High polyunsaturated fat intake in the form of linoleic acid (omega-6) increases risk for breast cancer incidence in mice, compared to diets high in omega-3 fatty acids.

Cultures in which traditional foods have high concentrations of monounsaturated fats, products that include olive oil and fish, have lower incidence of heart disease compared to the United States. The prevalence of heart disease in Mediterranean countries is only 50 percent of that found in the United States, even when fat represents almost 40 percent of total energy intake. However, the decreased rates of heart diseases in these countries also reflects other dietary patterns including a high consumption of fresh fruits and vegetables and other lifestyle differences.

See also **Assessment of Nutritional Status; Body Composition; Cholesterol; Gene Expression, Nutrient Regulation of; Mediterranean Diet; Nutrition.**

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FAUCHON, AUGUSTE FÉLIX.

Auguste Félix Fauchon (1856–1939) was a Parisian grocer who founded Fauchon, the luxury food store in the Place de la Madeleine in the 8th Arrondissement in Paris. Fauchon, who was born in Calvados, left school and moved to Paris, where he bought a wagon to peddle fruit and vegetables outside La Madeleine. In 1886, he bought a small shop across from the church, where he began to specialize in high-quality foods including charcuterie, cheeses, poultry, confectionery, and wines, as well as produce.

Fauchon became more and more popular among the rich and fashionable of Paris along with its reputation for quality, luxury, and exclusivity. During Fauchon's lifetime, his shop sold only French products; importing exotic items from outside France remained the domain of the neighboring grocery owned by Fauchon's friend Ferdinand Hédiard.

Between the two world wars, Fauchon expanded his operation to include a catering service, a tea and pastry salon, and a food laboratory to prepare products such as confits and bottled fruit. After his death, the company added specialty items from around the world and continued to develop its own luxury products, including teas, honeys, jams, spices, pâtés, chocolates, and pastries.

Today, Fauchon includes several departments, including the tea salon, wine cellar, patisserie, charcuterie, produce shop, and épicerie for Fauchon-brand products, including teas, coffees, and spices.

See also **Hédiard, Ferdinand.**

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MM Pack

FAVRE, JOSEPH.

For the first half of his career, Joseph Favre (1849–1903) followed the traditional path of a chef. He was apprenticed as a teenager in his native Swiss canton of Valais, and thereafter moved around Europe serving in aristocratic households, grand hotels, and restaurants in Switzerland, Germany, England, Italy, and France. In Paris he was also employed by the fashionable caterer Chevet, whose shop was located in the Palais Royal.

Once he had received recognition as a chef, Favre turned his attention to promoting the welfare and status of cooks, founding a professional society and a trade journal. He also wanted to bring the best of French cuisine to the masses, a view which put him at odds with some of his fellow chefs.

Favre wrote prolifically on all sorts of culinary topics, and in 1894 his articles were gathered together into the four-volume *Dictionnaire universel de cuisine: Encyclopédie illustrée d'hygiène alimentaire* (The universal dictionary of cuisine: illustrated encyclopedia of food health). The *Dictionnaire* contained thousands of recipes, menus, profiles of well-known people in the field (including Favre himself), and a history of cooking that was pronounced "very interesting" in Prosper Montagné's *Larousse gastronomique.* Today, manufacturers of traditional foods included in the *Dictionnaire* continue to use the mention by Favre as an endorsement for their products.

See also **Chef**; **France**; ***Larousse gastronomique***.

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Alice Arndt

FEASTS, FESTIVALS, AND FASTS. A feast is commonly thought of as a lavish meal; in a religious sense, it is also a day of commemoration set aside for an important personage, such as a saint. The word "feast" also connotes sensual delight, often excessive, as in the expression "a feast for the eyes."

A festival is a period of celebration, often centered around a religious feast day or a holiday, such as Christmas, a period of holidays celebrating an event (such as the completion of harvest), or a season (e.g., a winter carnival). Also, a festival can mean an unusually intensive or exaggerated series of presentations, such as a film festival. Finally, a fast (when used as a noun) marks a period of abstinence, such as the Lenten fast for Christians or the Ramadan fast for Muslims.

The concepts of feast, festival, and fast are closely interconnected. A feast day, such as St. Patrick's Day, for instance, is often the center of prolonged festivities. In such cases, the religious rituals such as attending church and, perhaps, fasting, are components of a larger festival event that frequently includes feasting, in the sense of excessive eating or drinking.

Food and Festival

Food is a major component of festival. Often it is part of a ritualized exchange, as when Halloween trick-or-treaters are given candy or are invited in for doughnuts and cider, or when Christmas carolers are rewarded with cookies. Food is often present in a formal, sacred meal. For instance, the Roman Catholic mass centers around the sacrament of the Eucharist, the transubstantiation and eating of bread and wine as the body and blood of Christ. While individual communicants each partake of only small amounts of the host, the Eucharist is invariably described by Catholics and Orthodox Christians as a (sacred) meal. The ritual most probably derives from the celebration of the Jewish Passover, which is celebrated with the sacred meal known as the Seder. The Seder is generally celebrated in the home, but is no less sacred or ritualized for that fact. Traditionally, during the meal four questions are asked by the youngest male child present, and certain foods are present on the table, each with specific symbolic value. Wine is consumed on four occasions during the meal, and the proceedings can take on a very festive demeanor, but the Passover Seder is a religious, historical, and sacred feast. Conversely, Jews fast from sundown to sundown on the high holy day of Yom Kippur.

The American Thanksgiving holiday is also centered on a meal, a feast that is likewise symbolic, ceremonial, and formalized, but not specifically belonging to any particular religion or denomination. However, the occasion is frequently used to express religious sentiments. The Thanksgiving feast commemorates an early harvest celebration held among English Puritan settlers in Massachusetts and their Native American benefactors. The tradition became an officially proclaimed national holiday under President Abraham Lincoln, in 1863, during the Civil War. As such, Thanksgiving has always had a strong element of patriotism and nationalism associated with it. While not a religious celebration in any strict sense, Thanksgiving can still be said to be a sacred event, in the sense of a secular ritual, one with strong political overtones (Moore and Myerhoff, 1977).

The events above are all more than simply meals. They are highly elaborated performances done with reference to religious and political worldviews, and are usually carried out by a group. One can examine the role of food in other celebratory events along these axes of formal-informal, and sacred-secular, such as Emancipation Day picnics or house-warming potlucks. For instance, in the United States people frequently gather at a home to watch the Super Bowl, the championship game of the National Football League. This televised sporting event has been promoted as an unofficial American holiday, and it is said to be played on "Super Bowl Sunday." Since people gather together, food is served on these occasions, but generally there is no formal, sit-down meal. Frequently, it is a potluck, with the hosts providing a large and plentiful central dish such as chili or spaghetti. Very often, the food consists of store-bought goods such as submarine sandwiches, or pizza, and beer. Thus, the food served at the Super Bowl Sunday party is itself mediated—it is bought in supermarkets or ordered by telephone—as the game itself is mediated.

Michael Dietler (2001) defines "feast" as any meal marked as different from everyday domestic meals, or from the exchange of food without consumption. He emphasizes that it is a kind of ritual activity. Likewise, the concept of "fast" depends on a ritual context in order to distinguish the abstinence from food from a diet or an eating disorder. Idiosyncratic fasting is often done to signify devotion to a saint or deity, for instance, or to a cause, as when individuals go on hunger strikes to protest certain situations. Idiosyncratic fasting often becomes a badge of marginality. In this latter regard, Caroline Walker Bynum points out that in Europe in the Middle Ages it was far more common for religious Christian women to use the denial of food as a sign of sacrifice and devotion than it was for men, and she suggests that many of what are regarded as eating disorders in the present time are also overwhelmingly a female problem. That is, many aspects of feasts and fasts are gendered, including food preparation, consumption, cleanup, and disposal.

For the denial of food to be considered a "fast," both the faster and the scholar consider the denial of food and/or drink as occurring in response to a sacred calendar that proscribes the consumption of certain foods during certain ritual periods or holy days; or the individual decides to fast in order to fulfill a vow of some sort, to purify oneself, or to show intense devotion to a deity. Feast and fast represent the overrating and underrating of food, respectively—food as plenty and food as denial.

Feast and fast meet in the Islamic holy month of Ramadan. Muslims do not eat between sunrise and sunset, but break the fast every evening with a festive meal. Neighbors and friends routinely visit during these evening events, which feature special desserts to mark the occasion. The end of Ramadan is celebrated with the festival of Eid. With Ramadan a ritualized relationship, a rhythm, of feast, fast, and festival may be observed—periods of fast interspersed with periods of feasts. Each takes increased meaning from its juxtaposition to the other. Eid, as a celebration, is especially meaningful coming at the end of a holy month of fast and reflection, much as Mardi Gras and carnival precede the forty days of Lent in Christendom. Very generally, it is often thought that feasts usually occur during periods of plenty, particularly after a harvest is completed. Surplus is consumed in celebration, as well as stored against the winter, famine, or other periods of want. Indeed, many celebratory feasting events mark both the pastoral and the agricultural cycles: ox slaughterings, grape harvests, apple butter festivals. However, as cultural events, both feasts and fasts are more complicated than this.

How, for instance, might the various proscriptions against the eating of certain foods in various religions be explained? Mary Douglas has produced the best analysis of the Jewish dietary laws in her book *Purity and Danger* (1970). She argues against the standard interpretations of the taboos involved in keeping kosher, that the foods involved such as pork were likely to be unhealthy due to poor means of preservation available in the biblical period. Such an explanation, she points out, does not explain the continued existence of these laws. In her analysis, she demonstrates that each of the animals listed as "abominations" in the biblical Book of Leviticus are creatures that possess characteristics of other species, who therefore blur the boundaries and cultural categories, and that are therefore considered taboo. "The unclear is the unclean," she concludes. While this interpretation may or may not be universally valid, it does show the complexities of culture that are inherent in food, eating, and ideas of the edible (Long, 2000).

Holiday eating is a ubiquitous form of feasting, often with foods that are themselves symbolic. Many religious feast days are also secular holidays, such as Christmas; or, at least, many popular holidays have religious underpinnings to them. Some, such as St. Patrick's Day or Valentine's Day, are not governmentally recognized holidays. No days off from work or school are granted. Still, they are celebrated traditionally by large numbers of people. Likewise, Halloween is the Eve of All Hallows, or All Saints' Day, in the Roman Catholic Church. Most traditional holiday and celebratory occasions, including religious and ethnic events such as Hanukkah, or Passover, are marked with special foods. The American Thanksgiving typifies the feast as experienced by many people today. The celebration of Thanksgiving is traced to a harvest feast in Plymouth, Massachusetts, in 1621, even though there were many other religious services of thanksgiving, usually involving fasts rather than feasts, that preceded the Plymouth event in the New World. Many Native Americans today regard the occasion as a national day of mourning, since the indigenous peoples were thanked for their assistance to the early colonists by later policies of betrayal and genocide.

The *Ngusaba* or Volcano Festival celebrated by twenty-eight Hindu villages near the Gunung Agung Volcano at Duda, Bali (Indonesia). © ROGER RESSMEYER/CORBIS.

Nevertheless, Thanksgiving is thought by many to be an inclusive celebration. For the occasion, the foods are prepared not only to be consumed, but also to be displayed. They are appreciated for their appearance and for their abundance. The table setting is important—special china and silverware, rich in family history, may be brought out. The dishes and the foods are arranged aesthetically, with the turkey being the centerpiece (Long, 2000).

Many aspects of personal and social identity are displayed along with the foods. For instance, family relationships are indexed by the favorite dished prepared by members of the extended family—a cousin's stuffing or a grown sibling's apple nut cake. Ethnicity, too, may be present in the form of additional dishes such as lasagna. There are even vegetarian organizations that have a meatless Thanksgiving with a live turkey present. Likewise, regional background is manifested in the foods and the ways they are prepared (Long, 2000).

First Communion procession in the Duomo Square of Positano, Italy. The communion service is followed by large family meals. © Jonathan Blair/CORBIS.

Ritual Feasts and Ritual Fasts

Feasting done in ritual contexts or as rituals themselves (again, the Passover Seder, e.g., or even the Sunday dinner) is usually in some way festive. Even foods served during mortuary rituals (the eating and drinking during the Irish wake; the cold cuts served after a funeral) serve this socially integrative, generally light-hearted function. Fasts are thought to be "fasts," rather than "diets" or "eating disorders," precisely because they are carried out in reference to a sacred overarching symbolic system, usually religious, but sometimes political.

Ritual, festival, and celebration have in one form or another long been a source of great interest to folklorists and anthropologists. In fact, anthropology had its beginning in (the now largely repudiated) theories of Sir James George Frazer (originally published in 1911) concerning religion, belief, magic, and ritual, as well as the related work on belief by Edward Tyler from 1873. In 1925 Bronislaw Malinowski revolutionized the practice of anthropology in the twentieth century with his field studies of ritual, along with religious and magical beliefs and customs. The list can go on, but any such list will include the work of the French folklorist and sociologist Arnold van Gennep who, in the first decades of the twentieth century, provided systematic analysis of life cycle and calendrical rites of passage, and the later work of Victor Turner in the 1960s through 1980s. Both these scholars produced analyses and vocabularies that have become paradigmatic, not only in anthropology but in other disciplines as well. Scholars are widely familiar with Turner's ideas concerning communitas and liminality that, along with his phrase "betwixt and between," are regularly used to this day not only by anthropologists but also folklorists, ethnomusicologists, historians, and indeed anyone working with ritual materials. Van Gennep's term "rites of passage" has become part of everyday speech. Along with Mary Douglas, Turner put the study of symbols and symbolic action at the top of the research agenda for the second half of the twentieth century.

With the rise of cultural studies critiques that have engaged questions of politics, race, social class, gender, and power, newer approaches to the study of ritual have arisen that complement rather than entirely supplant the symbolic analyses inspired by Turner. After Stanley Tambiah's article "A Performative Approach to Ritual" was published in 1985, along with Turner's own growing interest in performance, a great many important recent studies of what folklorist Beverly Stoeltje (1993) calls "the ritual genres" came out of performance studies—a field influenced by Turner's work but also by more recent perspectives on feminism, postmodernism, and cultural studies, as well as earlier movements in rhetoric and theater.

At the same time, the emphasis on performance and performativity has led to an expansion of the materials of ritual studies. Felicia Hughes-Freeland says, "The focus on performance allows us to understand situations interactively, not in terms of communication models, but in terms of participatory ones" (p. 15). Parades, protests, and street theater generally are increasingly being referred to and studied as ritual or at the least as ritualized behavior, with the work of folklorist Susan G. Davis being particularly influential. Further, such events are compared and contrasted in other works to performances such as Jacobean theater or the mass media. National ceremonies, nationalizing events, and beauty pageants all take their place in the literature on ritual. In fact, people find the kinds of meanings scholars refer to under the rubric of "ritual" in a wide range of events and activities; that is, people invest certain actions with symbolic meaning or transformative power. That is ritualization, and it is up to the researcher to determine how people create this kind of dynamic. Likewise, feasting is emerging as a critical site for investigation within archeology, anthropology, and folklore. Foodways or food studies is a growing subfield within these disciplines, and is an important component of the study of ritual, festival, and celebration, as seen in works by Caroline Walker Bynum (1987), and Michael Dietler and Brian Hayden (2001).

The present author argues that ritual is not necessarily in opposition to festival (i.e., one confirms; the other subverts) but simply that ritual is a discrete form, distinctive from festival and celebration but frequently a component of these, much as game, sport, music, dance, food, story, and so on, are each discrete genres but also available as constitutive components of festival. Because festival and ritual are closely intertwined, because both often mark transitional points in the life cycle or recurrent, transitional, or important points in the year, festival is thought of as ritualistic. As has been seen, marking, commemorating, or celebrating something is not the same as causing it. However, these two features—celebration and performativity—are both capable of being potentiated in ritual, as well as in other genres such as festival and demonstration. It is not the scope of an event that makes it ritual. One may light a candle simply because one likes candlelight, or to ward off insects in the summer, and not think of these activities as special. However, lighting a candle at Christmas, even decoratively, is done because of the sense that it is a special time (another frame) and therefore may be felt to be ritualistic, despite the informality and secularity of the act. These continua—formal-informal, religious-secular—are self-evident. One may light Advent candles in the home before Christmas, a more formal and more religiously oriented activity, but not as formal or religious as the lighting of candles in church for Sunday or Christmas services.

Ritual, festival, celebration, holidays, public display events—what links these terms analytically is the combination of their performative and celebratory aspects, and the fact that rites of public display, like ritual, are performative. Food presentation and consumption—and the lack of it—are used to mark social time and establish social identity. Feasts precede and follow days or weeks of fast; they mark and celebrate periods of plenty after seasonal harvests or animal slaughterings. Fasts also indicate special days of the week, month, or year; may be used as part of life-cycle rituals such as coming-of-age; and are used by individuals to communicate being in a special state—denial as devotion to a deity or a cause (e.g., the Irish hunger strikers) or penance and suffering as a means to purification.

See also **Christmas; Fasting and Abstinence; Festivals of Food; Folklore, Food in; Kwanzaa; Lent; Metaphor, Food as; Passover; Ramadan; Religion and Food; Shrove Tuesday; Thanksgiving**.

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Jack Santino

FERMENTATION.

FERMENTATION. Fermentation is one of the oldest known food preservation techniques. Along with drying and salting, fermentation was a key method of extending the life of foods, allowing them to be available, and eaten safely, in times of scarcity or seasonal nonavailability. These methods helped allow the transition from hunting and gathering to organized food cultivation and storage, which took place some ten to fifteen thousand years ago in the Middle East.

Fermentation involves the action of desirable microorganisms, or their enzymes, on food ingredients to make biochemical changes, which cause significant modification to the food. Often lactic-acid bacteria convert the carbohydrate energy source of food, such as lactose in milk, to lactic acid; examples are yogurt and cheeses from milk, and pickles from fruits and vegetables. Alternatively, yeasts, often of the *Saccharomyces* species, may convert the glucose to ethanol and carbon dioxide in leavened breads, or the sugars in grain or fruit beverages to beers and wines. Molds also can be active in certain fermentations, such as Stilton cheese and soy sauce. It is estimated that about one-third of all the food we consume is fermented. World estimates for beer consumption are about 22 million gallons, and a total of 15 million tons of some one thousand varieties of cheese are eaten annually.

Fermented Beverages and Foods

Fermentation is often the key to the safe, enjoyable consumption of perishable food materials, as it changes their composition, flavor, and texture. For example, milk is a nutritious but highly perishable beverage. Originally, in the Middle East, milk carried in animal-skin containers, often on horseback, would sour naturally, to produce acidic fermented milk. The combined action of the two lactic-acid bacteria, *Streptococcus lactis*, producing lactic acid, and *Lactobacillus bulgaricus*, producing lactic acid and acetaldehyde, a major contributor to flavor, are involved in yogurt production. The Tartars of Central Asia used the milk of horses, donkeys, or camels to produce a fizzy, gray acidic and alcoholic drink, *kumiss*, in which yeasts were active.

In acid conditions, the milk protein, casein, denatures and is precipitated to form a curd, producing cottage and soft cheese. By stirring and pressing, whey is removed and a more solid curd is produced, which by ripening or maturation produces semi-hard or hard cheeses. Surface-active bacteria of *Brevibacterium linens* are active in producing the aroma of Limburger type cheeses, while the blue molds of the genus *Penicillium* give Stilton and Gorgonzola cheeses their character.

Sugar products are shown fermenting in an open tank at a rum distillery in Guadeloupe. © REINHARD EISELE/CORBIS.

The use of *Saccharomyces* yeasts has allowed the production of a range of fermented beverages, enabling safe consumption of liquid when fresh water supplies are not available. Lagers, the light golden, gassy beverage made by "bottom" yeast fermentation of cereal extracts, were first made in the regions of Germany and Czechoslovakia, but are now produced and consumed throughout the world. In Africa, a thick, sour alcoholic beverage is made from sorghum or millet, or sometimes maize or banana. These sorghum beers are important sources of nutrients, particularly B vitamins, to people on marginal diets in these regions. The Romans planted extensive vineyards in North Africa to harvest and ferment their grapes into wine, thereby producing a fermented beverage that could be readily stored, transported, and consumed when and where required.

Distillation of these alcoholic beverages, such as whiskey from beers, brandies from grape wines, or arrack from palm or rice wine, further extend our range of drinks and play important cultural roles in festivities.

Fermentation Vessels and Starter Cultures

Art meets science in the production of fermented foods. Traditional practices are passed down through generations of producers, often small in scale, and consumption patterns often have great cultural importance. In Scandinavia, traditionally the brides and mothers jealously guard their own supplies of sourdough starters, so that they can always make the desired bread for their partners and families. In West Africa, a homeowner keeps a supply of *dawadawa*, a dried fermented African locust bean paste (*Parkia* species); it is used to give everyday soups and stews the desired "meaty" flavor, while also providing important nutrients, such as riboflavin, the B vitamin that protects against blindness, which is endemic to the region due to nutritional deficiency.

In Korea, few meals are complete without *kimchi*, a pickled fermented cabbage, which may also contain fish and other components. The practice of every home having their own *kimchi* jars, often on their verandahs, originated as a way of preserving vegetables through the cold winter season, providing year-round vitamin C. *Kimchi* together with *kochujang*, the fermented red pepper paste, give Korean preparations a unique and characteristic attractive color and flavor.

Where food fermentation occurred naturally as conditions favored particular organisms, an important art arose to encourage the desired fermentation organisms, while preventing undesirable microorganisms from developing, for successful fermented food production.

Food storage often took place in earthenware vessels, whose semipermeable inner walls were difficult to clean completely. This allowed a biofilm of desirable microorganisms to remain, to initiate a successful fermentation of the next batch of food. Because of their significance, the vessels themselves were artistically designed and treasured. Interesting examples can be seen in museum collections, such as the Nezu Museum in Tokyo, Japan, and a museum dedicated to *kimchi* in Seoul, South Korea.

In Europe, the fermented meat producers, while using ceramic or metallic vats with smoother, more easily cleaned surfaces, developed the technique of "backslopping" to introduce a small quantity of the fermenting liquor from the previous batch of meat to initiate successful fermentation.

In many cases, dried grains or balls of the derived fermenting microorganisms on cereal or other substrates would be used to start fermentation. Baker's yeast may be used in this work. Kefir grains are used in North Africa, the Middle East, and Russia for production of kefir, *laban*, or *leben* fermented milks. *Ragi* is used in Indonesia and throughout East and Southeast Asia as *inoculum* for *lao-chao* and other fermented foods.

Cultural Diversity

The production, consumption, and enjoyment of different fermented foods reflects the diversity of cultures and cuisines that make up our varied world. In Chinese and Japanese cuisines, *shoyu*, or soy sauce, is added almost universally to dishes, while the Indian vegetarian diet depends on fermented cereals and legumes, often in combinations, as in *dosas* and *vadas.* The art and science of fermenting meat to a wide range of salamis are vital to the enjoyment of Eastern and Central Europeans, while Italian food market stall holders proudly display their mold-covered fermented sausages and traditional cheeses.

As people migrate, they normally carry their traditional fermented food practices with them. The range of fermented cheeses and meats in Latin America reflects the European origins of these populations, and the wineries of Chile were originally established by French families. Consumers of imported wine, chocolate, coffee, or tea are all beneficiaries of the internationalism and significance of fermented foods.

See also **Beer; Bread**; **Cheese**; **Meat**; **Microorganisms**; **Preserving**; **Spirits**; **Wine.**

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Geoffrey Campbell-Platt

FERMENTED BEVERAGES OTHER THAN WINE AND BEER.

Fermented beverages have been produced and consumed all over the world and over a very long time span. Man discovered that sugar solutions of different origins, if left standing rather warm, will start fermenting spontaneously into an alcoholic beverage that also often contains lactic acid. The requisite microorganisms, *Saccaromyces* yeasts and *Lactobacillus* bacteria, are abundant almost everywhere and will do their duty, producing alcohol and lactic acid. A similar fermentation process of animal and vegetable foods is the lactic-acid fermentation that yields, for instance, sour herring in Sweden, and sauerkraut.

Fermented beverages can be divided into two groups, wines and beers, broadly defined. Wines are fermented from various fruit juices containing fermentable sugars. Beers come from starch-containing products, which undergo enzymatic splitting by diastase, malting, and mashing, before the fermentable sugars become available for the yeasts and bacteria. The enzymatic splitting of the starch can also be performed either by human saliva, containing amylases, or by molds. Narrowly defined, beer is barley beer and wine is grape wine.

Detailed information on fermented beverages all over the world can be found in Hardwick and colleagues (1995, 63–68), Steinkraus (1979), Arnold (1911), and Campbell-Platt (1987).

Beer from Cereals

Bouza is produced in Egypt and is probably the forerunner of beer in Ancient Egypt. It is prepared from malt of

Old cider press at Happy Land near Ashton Keynes, England, 1934. Two hundred sacks of apples were pressed daily to make cider during the harvest season. English cider is fermented while Americans generally drink the unfermented juice, either raw or pasteurized. © HULTON-DEUTSCH COLLECTION/CORBIS.

milo (a grain sorghum that resembles millet) and crushed baked loaves of bread. Residue from an earlier fermentation is used as a starter and both lactic-acid bacteria and *Saccaromyces* are involved in the fermentation process to get this sour alcoholic beverage. *Talla* from Ethiopia is a very similar to *bouza* and can be produced from barley and wheat. The bread loaves are heated to give a roasted character, and the pots are fueled by olive wood to give a smoky taste. *Talla* can also be spiced with hop leaves and stems, and spices.

Wheat beer. Wheat beer—and rye and oat beer as well—are frequently made from mixtures of malt and the crushed grains of these cereals with barley. Often the beer is bottled with the yeasts for continued fermentation in the bottle. Wheat beer—which is top-fermented and thus, technically, an ale—is particularly popular in Bavaria and in Belgium and northern Germany, in varieties such as *lambic*, *Gueuze*, Wit beer, Trappist beer, and *Berliner Weisse*.

Rye beer. Rye beers such as *kalja* and *sahti* in Finland, similar beverages in the Baltic area, and *kvas* ("kvass" in English) in Russia are produced in northern and eastern Europe, where cultivation of rye is widespread. *Kvas* has been the basic beverage for the Russian people for centuries. Its importance is indicated by many proverbs such as "Eat cabbage soup with meat, but if you don't have it, eat bread and *kvas*." The use of *kvas* is documented from about the year 800. Traditionally it is spontaneously fermented. In a broad sense, *kvas* is any sour and alcoholic fluid made from honey, bread, cereals, birch sap, fruits, beets, or cabbage. Red-beet *kvas* should always be used to produce *borshch* ("borscht," in English—red-beet soup). In a narrow sense, *kvas* (that is, bread-*kvas*) is produced from rye malt with or without other cereals or sour-fermented rye bread as adjuncts, and the beverage is spiced with peppermint. Most of the consumed *kvas* is of low alcohol content, only some few percent.

Oat beer. Oat beer is today mostly used as an adjunct in certain stouts called oat stouts. A stout is a dark ale, made of roasted malt, which occurs in several varieties such as sweet and dry (Guiness). Oats have also been used in traditional Norwegian beer production.

Rice beer. Another type of cereal beers is made from rice, and these have been produced in all the rice-growing areas of the world. The best-known example is sake from Japan, which has a documented history of more than two thousand years. The principal difference from the malting of barley lies in the *koji*-process of rice. *Koji* is a culture of *Aspergillus oryzae*, which grows on steamed rice, and saccharifies the rice starch (that is, converts it to sugar) and decomposes the rice proteins. The sugar produced in the sake mash is later fermented by the already-present *Saccaromyces cerevisiae*. The mash is acidified either by adding lactic acid to it or by facilitating the growth of lactic bacteria to form the seed mash, *moto*. Sake is a clear, pale-yellow liquid with an alcoholic content of about 15 percent and a characteristic estery (artificially fruity) aroma. It is slightly sweet and slightly acidic and has a high amino-acid content compared to wine and beer. Other similar beverages from rice are known from other eastern and southern Asian countries such as China, Thailand, India, Malaysia, and the Philippines.

Another similar fermentation process is performed by the inoculum *ragi*, present in Southeast Asia. *Ragi* contains the mold *Amylomyces rouxii*, the yeast *Endomycopsis burtonii*, and sometimes *Hansenula* yeasts; it produces a pleasant alcoholic and acid beverage from rice or cassava, called *tape ketan* in Malaysia.

Sorghum and millet beer. Sorghum beers, known as kafir beers in Africa, are made from malt from sorghum (*Sorghum bicolor*) or from the related grain, millet (*Pennisetum typhoides* and *Eleusine coracana*). Often-used adjuncts are maize (corn), malted or unmalted sorghum or millet, and malt amylase. Lactic acid is used as a flavoring and preserving agent, and the alcoholic fermentation is performed by *Saccaromyces*. Nowadays, these traditional African beers are not only produced in tribal areas; they are also available in home-brewed urban and industrially produced versions. They are opaque, rather thick pinkish-brown liquids with an estery (artificially fruity) or fruity odor, and a sweet and sour taste.

Maize beer. *Tesquino* and *zendecho* from Mexico and Latin America are made from malted maize and spontaneously fermented by *Saccaromyces cerevisiae*. These beverages might be as ancient as the oldest beers of the Old World, dating back about eight thousand years. Another beer is *chicha*, made by Andean and Central American Indians. The starchy material is chewed into dough, which is dried and later placed into warm water where the amylase action is finished. Then a starter (a small amount taken from a prior fermentation) is added, and the lactic-acid and alcoholic fermentation begins. Today much of the chicha is made using a maize malt rather than saliva.

Beer from Starch Products

All kinds of starchy items, such as manioc (cassava), potatoes, beets, and various roots, are included in this group. To get fermentable sugars, the starch has to be split either by diastase in malt, by saliva, or by molds, as with rice. In South and Central America, almost all of the traditional beers were originally produced by chewing either the cereal maize or other starchy vegetables. One of the most popular has been the manioc, both the sweet and the bitter; sweet potatoes, mangabeira (*Hancornia speciosa*), cashew, Jaboticaba (*Myrciaria cauliflora*), pineapples, bananas, and algarroba pods have also been used. In the tropical forest tribes, the favorite manioc beer was prepared as follows:

> The roots, cut into think slices, were first boiled, then squeezed and partly chewed by young girls. The mass, impregnated with saliva, was mixed with water and heated again over the fire. The liquid was afterward poured into huge jars, half buried in the ground, covered with leaves, and left two to three days to ferment. A fire was built around the jars to warm the beverage before serving it. Each extended family manufactured its own liquor. When a bout was organized, drinkers went successively to each hut, exhausting the available supply. The women served the liquors in huge calabashes (Steward, vol. 3, 1948, p. 127).

An earlier popular American low-alcoholic beverage is root beer, which consists of an infusion of sarsaparilla, sassafras, spruce, wild cherry, spikenard, wintergreen, and ginger, with sugar and yeast. Today, it is a soft drink containing some of these ingredients at its best; otherwise, it is artificially spiced.

Wine from Fruit and Vegetable Juices

Fruit wine. Fruit wines are produced with almost the same technique as grape wines. Specifically-named fruit wines such as cider (from apples) and perry (from pears) are produced, as well as wines from other fruits. The technical difference between these two groups is the alcohol content—5 to 7 percent in the first group and up to 18 percent in the second group—which depends on sugar addition.

Tree-sap wine. Saps from various trees have been used to produce alcoholic beverages; examples include maple sap (from *Acer saccharum*, the sugar maple) in North America, and birch sap (from *Betula pubescens*, the downy birch) in northern Europe. The manifestation of the symbiosis of yeast and bacteria cultures, which looks like a jellyfish, on the wounds of spring birches has been used in Europe as a folk medicine and is called "*Volga-swamp.*"

Sugarcane wine. Wine made from the sugarcane, *Saccharum officinarum*, together with molasses, is distilled into rum.

Cactus-plant wines. The tall perennial plants of the genus *Agave*, which grow in Mexico and nearby areas, give a sweet, slightly bitter sap, called *agua miel* (literally, honey water), which is fermented into pulque, either spontaneously or through the use of an inoculum from a previous fermentation. The Aztecs were familiar with the product. Pulque is an important food beverage for the poor in the semiarid areas of Mexico. If pulque made from *Agave tequilana* is distilled, the resultant liquor is called tequila; if pulque made from another agave is distilled, it is called mescal. Before the contacts with the European settlers, only a few American Indian tribes north of Mexico made alcoholic beverages. They were the Akimel O'odham (Pima), Tohono O'odham (Papago), and the River Yuman peoples in southern Arizona and northern Mexico, and they produced wine from the saguaro cactus as well as from the agave and the mesquite. In the East, the Cherokees made wine from persimmons. During an important ceremony in July, the Papagos and the Pimas drank enormous quantities of the wine to induce rainfall in their desert areas.

Sugar-palm wine. Some examples of wines made from palm sap are *surra* from *Borassus flabillifer*, *toddy* and *temba* from the coconut palm *Cocus nucifera* (from which arrack is obtained by distillation), *malovu* from *Elaeis guineensis*, a kind of undistilled "rum" from *Hyphaene coriaca* and *Hyphaene critina*, *Phonix reclinata*, *Raphia pedunculata*, and *Raohia vinifera*.

"Wine" from Animal Sources

Mead. Honey is probably among the first foods gathered by *Homo sapiens* and its predecessors, and mead, the wine fermented from honey, may well be one of the oldest alcoholic beverages. Honey has also been much used as an adjunct to sweeten many kinds of beers over the centuries. Mead was the drink of the Nordic gods, whereas the people drank beer. The modern methods of production of mead are described by Andrej Jarczyk and W. Wzorek (1977).

Fermented milk. Only milk from human beings and horses has a relatively high concentration of milk sugar (lactose)—6.9 percent, in comparison with the 4.9 percent in cow's milk—which makes it easier to ferment milk from mares than that from cows. People from central Asia (Tajikistan, Uzbekistan, and Kazakhstan) and Mongolia have fermented mare's milk, making the alcoholic beverage *kumiss*, and it appears that milk from camels, sheep, yaks, and reindeer has been used similarly.

See also **Beer**; **Fermentation**; **Fruit**; **Spirits**; **Wine**.

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FERTILE CRESCENT. *See* **Mesopotamia, Ancient.**

FESTIVALS OF FOOD. Food festivals can celebrate one particular ingredient, single dishes, or entire culinary cultures. Their public display, orgiastic consumption, or their playful way of dealing with food provide us with illustrations of the fundamental importance of such festivals for the development of culture.

Prehistoric Roots

Alternating periods of malnutrition with certain occasions of extraordinary food consumption is typical for economies of penury. In the early phases of cultural development, therefore, the simple abundance of food was already reason enough for the celebration of a feast. Greenland’s Eskimo communities, for instance, had spontaneous feasts whenever a large animal like a whale was captured. In order to hunt game and gather fruits in a world perceived as filled with spirits (animism), hunting and gathering societies depended on the help of shamanic rites. These rites were intended to persuade faunal and floral spirits to release animals and plants for human consumption. Game was always divided among the hunters and their community according to a customary ratio of distribution. This ancient practice gave rise to a variety of ideas and rituals. Sacrifice was one of the most prominent. There have been attempts to deduce the principle of gift giving and the exchange of gifts

Pig roast at Atuona, Hiva Oa, French Polynesia, in 1998. Pig roasts are popular adjuncts to all sorts of public feasting in the islands. © Nik Wheeler/CORBIS.

from this primordial partitioning of food. Even though various disciplines have theorized and discussed the subject extensively, its original character has not developed clearly. The attempted explanations ranged from the sacrifice as an act of reciprocity to the sacrifice as a community at table, where gods and humans take part. Essential, however, was the fact that the food offered was consumed during the festive ceremony and only the inedible parts (bones, gall bladder) or minor pieces (fat) were offered to the higher beings. Bulk slaughtering, like that on the occasion of the "hekatomb" sacrifices in Greek antiquity, originally limited to the offering of one hundred head of cattle, became popular festivals with plenty of food for everyone.

Mass feeding in ancient societies certainly was an effective instrument for the manipulation of public opinion. In the case of Julius Caesar, it helped to create a dictatorship. He celebrated his victory over Gaul, Egypt, Pontus, and Africa in September 46 B.C.E. In order to outdo the triumphs of his predecessors, Caesar not only rewarded his soldiers, but almost the entire Roman citizenry. Approximately 320,000 people received a present of 100 denars and a special allocation of oil and grain. Meat also was distributed gratuitously and the Roman masses were entertained at 22,000 tables before viewing the games. The obligatory social mechanism behind this phenomenon was first described by Marcel Mauss as "potlatch" in his fundamental study on the "gift." Individuals who are offered a gift are obliged to reciprocate. This system, widely operating in traditional societies, could be seen in two different forms: the potlatch of gifts and the potlatch of destruction. Only the wealthy were capable of leadership because they could oblige others, upon whom they bestowed gifts. Even the deliberate destruction of goods or gluttony was a strong signal of the social segregation of the elite. So it is not surprising that feeding the poor became a customary social act among the European elites of the Middle Ages.

Charitable and Social Traditions

Byzantine emperors, for instance, invited the poor to their annual banquets on "vow day" (2 January). When an imperial prince was born, the event was celebrated by the distribution of *lochozema*, a "childbed soup," in Constantinople's main street. The ingredients, consisting of wheat flour, honey, butter, and sesame suggest the high prestige attached to this soup.

In many cultures, the birth of children or other rites of passage provide occasions for the public dispensation of food. Besides the wish to celebrate the happy event, elements of reciprocity also add to these customs. So, for instance, in eighteenth-century France it became customary for godfathers to throw "dragées" (sugar-coated sweetmeats), hazelnuts, almonds or aniseed among the children standing in front of the church. Yet these presents were eventually interpreted as the obligatory gift of the newcomer to those whose company they would share.

Some food festivals are of a religious nature. Every year the people of Morave, Slovenia, bring baskets of food into church to have them blessed for Easter. © CORBIS.

In the nineteenth century the custom was also integrated into wedding ceremonies. Another example of this reciprocal exchange is the *sihk puhn* feast (eating from the common pot) of the Cantonese ethnic groups in the rural suburbs of Hong Kong. For this feast, nine separately cooked ingredients, mostly luxury foods, are mixed in a big pot from which each guest, rich or poor, is invited to eat. Representatives of every single household and the village's elders are invited to the feast. Hence. the hosts symbolically feed the entire community. *Sihk puhn* banquets are the only way to legitimize social transitions, since any marriage or birth that is not celebrated with a *sikh puhn* is not considered legitimate. The annual appointment of the village guardsmen also depends on the *sihk puhn*. If a significant number of lineage elders refuse the food, the selection procedures must be repeated.

Some existing festivals are rooted in the pious traditions of the medieval period, for instance, the feast of the Holy Spirit in the Portuguese-speaking world, especially in the Azores. There, the entire local community shares in an enormous banquet, which includes the distribution of food and money to the indigent. During the festivities a child is crowned as the "Emperor of the Holy Spirit." The festival, now nearly extinct in Portugal, first appeared on the Azores during the fifteenth century. Its origins are closely connected to the ideas of the Calabrian monk Joachim of Flore (c. 1135–1202/5), who professed the arrival of the age of the Holy Spirit, an era of peace and prosperity.

Cockaigne and Carnival

In addition to these social and charitable aspects, the themes of utopia and carnival became important elements of medieval and early modern festival culture. Of course, the idea of a utopian terrestrial paradise in which the lazy

The Guelaguetza festival is held annually in Oaxaca, Mexico. Shown here are young girls in native dress holding pineapples. © Rose Hartman/CORBIS.

are rewarded and the diligent punished was already known to Greek and Roman authors like Lucian, Herodotus, and Strabo and was projected either onto foreign countries or the island of the blessed. But in the medieval and early modern period, the idea of a gastronomic utopia, the land of Cockaigne (Cuccagna, Schlaraffenland, Lubberland), developed in times of famine. This made an ideal theme for feasts of feeding. The "Cuccagna Napoletana" of the eighteenth century is a famous example. It was originally celebrated as the culmination of carnival in Naples with a procession of food carriages sponsored by the guilds of bakers and butchers. In 1746 the king ordered the food to be heaped up in front of the royal palace. For obvious reasons, the *cuccagna* had to be protected by guards until the king gave the sign from the balcony of his palace and the crowds were allowed to plunder the mountain of food. The *cuccagna* was conceived as a work of art, and all the victuals were displayed in the form of landscapes, gardens, or architectures. From 1759 a firm construction was used to drape the foodstuffs. The term *cuccagana* was also applied to more traditional forms of food distribution. So the disposal of food hanging from a wheel placed on the top of a post was called a *cuccagna* just as was the famous Carnival *degli gnocchi* of Verona. The latter is believed to date back to the year 1531, when the rich Veronese citizen Tommaso da Vico handed out flour, butter, and cheese to the starving masses of his hometown. Even though there is no documentary evidence for this festival prior to the eighteenth century, the event today is advertised as the "oldest carnival of Italy." Once the "gnocchi" were cooked and distributed, the sponsors of the festival, pompously dressed, took part in the procession of the "macaroni."

Numerous European festivals originate from charitable foundations or social obligations. An example of the latter is the Sindelfingen cake-ride in southern Germany, reflecting the millers' duty to deliver cakes and bread to the local authorities as well as to the pupils of the town. First mentioned in 1535, the annual delivery developed into a traditional horse race, until in 1837 "enlightened" officials abolished this custom. Nevertheless, the millers were obliged to continue the payment of a fee to the graduating pupils up until 1961. Only five years afterward, the cake-ride was reactivated as a tourist attraction and has been celebrated ever since.

Aspects of Economy and Amusement

Modern food festivals are generally characterized by the predominance of economic interests. There are few wine, beer, fruit, or vegetable festivals that originated prior to World War I. One of them is the Circleville Pumpkin Show (1903), in Circleville, Ohio. Despite its humble origins, this agricultural street fair soon developed into one of the largest festivals of the United States, attracting hundreds of thousands of visitors each year.

Countless agricultural festivals arose during the Depression of the 1930s. The intention was to promote consumption and to advertise products from certain areas. In the United States, such festivals were mainly founded by local voluntary associations like the Lion's Clubs, whereas in Europe the government played a more decisive role in their creation. For example, in 1930 the Italian ministry for agriculture ordered an annual countrywide celebration of a grape festival on 28 September. Nevertheless, the virtual mushrooming of food festivals is a recent phenomenon. The redefinition of ethnic and communal relations in a post-colonial and post-totalitarian world, as well as the revival of interest in regional foods since the 1970s, has contributed to this growth. Marketing also recognized the importance of festivals in providing firsthand experience with foods that would later be recognized by the potential consumer in the store. Yet, sheer human creativity still can lead to spontaneous festivities. The most spectacular food events of the present, the "tomatina" of Buñol, Spain, and the "battle of the oranges" at the carnival of Ivrea, Italy, are examples. Their key element is an orgiastic row, in which 55 tons of tomatoes and 350 tons of oranges are consumed, respectively, each year—and the numbers are rising. Food is used as a projectile and to soil others. The event of Buñol came into being in 1944/45, when a carnival parade got out of hand. In Ivrea the "battle of the oranges" dates back to around 1850 when upper-middle-class children practiced throwing oranges from the balconies of their houses. Today the contracting parties are organized in eight teams, each consisting of 100 to 300 members, who have to contribute to the festival's costs. Their main targets are the people on the thirty-two horse-driven floats moving through the masses. Here adults turn into children for a few hours. Georges Bataille explains this behavior as the most archaic element in festival culture and world economy. Since enjoyment of waste engenders the will for surplus production, excess is the essence of a festival, as Sigmund Freud writes in his essay "Totem and Taboo."

See also **British Isles; Christianity; Day of the Dead; Fasting and Abstinence; Feasts, Festivals, and Fasts; Halloween; Holidays; Metaphor, Food as; Shrove Tuesday; Symbol, Food as.**

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FIBER, DIETARY. In 1972 British physician Hugh Trowell defined dietary fiber as "that portion of the food which is derived from cellular walls of plants which is digested very poorly by human beings" (*Revue Européenne d'Etudes Cliniques et Biologiques*). Most of the current interest in dietary fiber stems from the efforts of Trowell and other researchers in the 1960s and 1970s to examine the differences in disease patterns between populations consuming diets high in refined foods (typical of developed countries) and populations consuming diets high in unrefined foods (typical of less developed or undeveloped countries). Populations with a higher intake of unrefined food, and thus a higher intake of dietary fiber, had lower risk of chronic diseases, such as heart disease, intestinal cancers, and gastrointestinal disorders, as compared to populations consuming highly refined, low-fiber diets. These observations stimulated a large number of research studies and, while the ability of fiber to prevent chronic disease is difficult to prove, the data gathered since the 1960s strongly supports the importance of dietary fiber for the health of the gastrointestinal tract and thus its importance in the general diet.

Definition of Dietary Fiber

In 2001 the U.S. National Academy of Sciences Institute of Medicine (IOM) recommended that "dietary fiber" be defined as the nondigestible carbohydrates and lignin that are intrinsic and intact in plants and that the term "added fiber" be used to characterize isolated, nondigestible carbohydrates that are added to foods or supplements. Defined as such, dietary fiber includes nonstarch polysaccharides (NSP) and oligosaccharides that cannot be digested in the small intestine by alpha amylase or any of the sugar-hydrolyzing enzymes in the gut. The most commonly consumed NSPs include cellulose, pectins, glucans, hemicelluloses, and gums. Inulin, a nondigestible carbohydrate of lower molecular weight than NSP, also is included in this definition of dietary fiber. The only noncarbohydrate component of dietary fiber is lignin; however, this is probably a minor component of most edible portions of plant foods since it is associated with tough or woody tissues. An important distinction of the IOM definition is that dietary fiber is the term applied to plant foods in which the nondigestible carbohydrates remain intact and part of the structure of the plant cells. Because of inconsistencies in the precise definition of dietary fiber within the research community, the methods to analyze the fiber fraction of foods have been controversial. Earlier food composition tables provided crude-fiber values; however, this value does not include most of the dietary fiber in foods and should not be used to estimate fiber intake. Food tables that contain data using the enzymatic total dietary fiber (TDF) method or that include analysis of NSP provide more accurate estimates of fiber intake.

Dietary fiber is characterized as soluble or insoluble depending on its extraction by one of the steps in the TDF analytical method. Originally it was believed that this characterization might predict physiological effects of different fibers; however, this has not been the case, and more detailed descriptions of chemical-physical properties are needed to understand the metabolic response to diverse sources of fiber. Some fibers that are categorized as soluble fibers, such as hydrolyzed gums or oligosaccharides, are not very effective in lowering cholesterol. On the other hand, fibers vary in their physical properties, which appears to be important in understanding how fiber can affect metabolism. Certain polysaccharides can become viscous or thick when mixed with water. Viscosity is associated with slowing gastric emptying, lowering plasma cholesterol, and reducing the increase in blood glucose due to consumption of digestible carbohydrates. NSPs that can become viscous include glucans, pectins, and gums. Nondigestible carbohydrates can be fermented by the microflora in the large intestine, and these carbohydrates are the primary substrates for their growth and metabolism. To be fermented by microorganisms, polysaccharides must have water-holding capacity (WHC) so that microbes can penetrate the fiber matrix. Those polysaccharides with relatively high WHC are degraded to a larger extent than those with low WHC. In addition to viscosity, fermentability, and WHC, dietary fiber provides bulk in the intestines, and some fibers may bind bile acids and increase their excretion. Most foods contain a mixture of different types of polysaccharides; however, certain foods are good sources of particular types of fiber. For example, oats and barley contain mixed beta-glucans, fruits provide pectins, wheat bran is high in cellulose and hemicelluloses, and dry beans are a source of viscous polysaccharides. Cellulose is the most abundant NSP in foods.

Fiber Content of Food

The table that follows provides values for some foods that are sources of fiber, including fruits, vegetables, cereals and grains, and dry beans and nuts. Based on the proposed definition from IOM, animal products contain no dietary fiber; it is derived only from plant foods. Some food products that are formulated with animal products could be a source of fiber if plant foods with dietary fiber or isolated polysaccharides are added in the preparation. The values in the table are reported as grams per 100 grams of edible portion so that it is easy to compare foods. Information is given in the conversion column so that the value can be converted to the foods as normally eaten. The table helps to illustrate how the handling and preparation of foods influence fiber content. As the data show,

TABLE 1

Fiber content of some foods

Food description	Dietary fiber	Water	Conversion information
	g/100 g of edible portion		
Fruits			
Bananas	2.4	74.3	1 medium = 118 g
Apples	2.7	83.9	1 medium = 138 g
Oranges	2.4	86.8	1 medium = 140 g
Orange juice	—	88.4	8 ounces = 248 g
Grapes	1.0	80.6	1 grape = 5 g
Plums, dried	7.1	32.4	1 dried plum = 8.4 g
Vegetables			
Tomatoes	1.1	93.8	1 medium = 123 g
Broccoli, cooked	2.9	90.7	1 spear = 37 g
Corn, cooked	2.4	76.7	½ cup = 82 g
Snap beans, cooked	2.8	89.9	1 cup = 124 g
Lettuce, romaine	1.7	94.9	½ cup = 28 g
Potatoes, baked without skin	1.5	75.4	½ cup = 61 g
Potatoes, French-fried, oven-baked	3.2	57.1	10 pieces = 50 g
Peas, cooked	5.5	77.9	1 cup = 160 g
Cereals and Grains			
Bread, whole wheat	4.3	37.1	1 slice = 25 g
Bread, white	2.3	36.7	1 slice = 25 g
Bread, rye	5.8	37.3	1 slice = 32 g
Rice, white, cooked	0.4	68.4	1 cup = 158 g
Rice, brown, cooked	1.8	73.1	1 cup = 195 g
Oatmeal, cooked	2.3	77.0	
Bran flakes	14.1	2.5	1 cup = 49 g
Corn flakes	2.8	3.2	1 cup = 28 g
Dry Beans and Nuts			
Kidney beans, canned	3.5	77.9	
Garbanzo beans, canned	4.4	69.7	1 cup = 240 g
Almonds, dry-roasted	11.8	2.6	1 cup = 138 g
Walnuts, English	6.7	4.1	1 cup chopped = 120 g
Peanuts, dry-roasted	8.0	1.5	1 cup = 146 g

SOURCE: Data obtained from the USDA Nutrient Database, release 13 at www.nal.usda.gov/fnic/foodcomp/

changing the water content of a food will change its fiber content. Dried plums have the highest fiber content for the fruits listed but also the lowest water content, due of course to the drying process. Likewise, the fiber content of potatoes is higher when the water content is lower. Cooking per se does not generally alter the fiber content of foods unless the water content is changed in the process. The cooking of vegetables will break down the cell wall structure and hence soften tissues; however, this does not remove the polysaccharides associated with the cell wall.

Food preparation methods that remove or separate parts of the food also can alter fiber content. Raw oranges and orange juice have similar water content, but no fiber is present in the juice because the process of squeezing the fruit extracts the watery fraction and leaves behind the fiber associated with the pulp. The milling of whole grains removes fiber, which is concentrated in the outer bran layers of the cereal grain. White rice has a lower fiber content than brown rice due to milling. Likewise, breads made with whole grains that have the bran layer intact will have higher fiber content than breads made with refined grains such as white wheat flour. In some starchy products the presence of resistant starch can contribute to the amount of fiber measured by the TDF method. Starch is digested normally by alpha-amylase in the intestine; however, some starch, because of retrogradation or the structure of the starch polymers, cannot be digested and passes into the large intestine as does NSP. Bran fractions are used in food product formulations to increase the fiber content of cereal products. A breakfast cereal made with wheat bran has a much higher fiber content than one made with a whole grain or a refined grain. Consumers can make quick assessments of such differences, as most food products are labeled with nutrition facts that give the per-serving fiber content.

Fiber Intake and Health

Because fiber is nondigestible by enzymes in the mammalian small intestine, it mediates its effects on metabolism by its impact on the functioning of the gastrointestinal tract. Although fiber has not been considered a nutrient from a traditional perspective, it appears to be essential for the normal function of the small and large intestines. Fiber-containing foods take longer to masticate and involve more chewing than do highly refined foods. Because of the WHC of certain polysaccharides, their presence will increase the amount of water in, and therefore the volume of, the gut contents. The presence of viscous polysaccharides, as well as an increased volume of contents, will slow the rate of gastric emptying. The rate of gastric emptying determines the rate at which nutrients are exposed to the digestive enzymes and absorptive surface in the small intestine and hence the rate of nutrient absorption. Within the contents of the small intestine, the presence of nondigested carbohydrates will expand the bulk phase of the contents; this type of dilution affects the mixing of gut contents and the process of digestion and absorption.

The net effect of these factors is that a diet high in fiber-rich foods is likely to slow the rate at which nutrients are digested and absorbed and cause digestion and absorption to occur along a greater length of the small intestine. Extending the period in which nutrients are available for absorption might result in a prolonged feeling of fullness and improve the satiety effects of meals. Because fiber is not digested in the small intestine, it passes into the large bowel, where it can remain undigested or serve as a substrate for the microflora that are normally present. Fiber is the only dietary component that increases stool weight. Its ability to improve laxation in this manner is either direct, by providing bulk as nonfermented carbohydrates, or indirect, by allowing growth of the microflora, which contribute to stool bulk. Scientific reviews have estimated that at least eighteen to twenty grams of NSP per 2,000 kilocalories should be consumed daily for adequate stool formation. Thus the properties of fiber result in a slower transit of food through the stomach and small intestine; however, transit through the large intestine may be shorter due to a high fiber intake. The net effect of fiber is to shorten total transit time through the gastrointestinal tract since residence time in the large bowel accounts for more than 90 percent of the total transit time.

Epidemiological or population-based studies have demonstrated that diets rich in plant foods are associated with a lower risk of chronic diseases such as cardiovascular disease, certain cancers, obesity, and Type 2 diabetes. The clinical and experimental studies to examine this relationship indicate that dietary fiber is one of the components of plant foods associated with reducing this risk. The ability of fiber to be protective relates to its functions within the gastrointestinal tract. Sources of viscous polysaccharides such as glucans, pectins, and gums reduce plasma cholesterol (and specifically LDL-cholesterol) levels by reducing absorption of cholesterol and bile acids, which are made from cholesterol. Viscosity helps to blunt the increase in blood glucose after a meal, which reduces the amount of insulin needed to clear glucose from the blood. Diets high in fiber-containing foods such as whole grains, fruits, vegetables, and dry beans tend to be lower in total fat and saturated fatty acids, which is a dietary pattern associated with a lower risk of cardiovascular disease and cancer. These foods also appear to be more filling and may help to regulate short-term appetite. Although fiber has not been proven to facilitate weight loss, its potential effects on appetite may help with weight maintenance. Because of fiber's importance to the microflora in the large bowel, there is considerable interest in its ability to protect against colon cancer. However, the primary evidence for this role of fiber is from epidemiology or experimental animal studies rather than from clinical studies. When microbes metabolize fiber, short chain fatty acids (SCFA) are produced. These SCFA are used by cells in the colon and have been associated with maintaining a healthy mucosal layer in the gut. Advancing our understanding of the role that these compounds play in the health of the gut and in prevention of bowel diseases continues to be an active area of research.

In summary, dietary fiber has specific attributes that promote the normal functioning of the gastrointestinal tract. In addition, actions of fiber contribute to the ability of plant foods to lower the risk of chronic disease; however, it is difficult to isolate the effects of fiber from the overall response to a diet rich in plant foods, which provides many compounds that contribute to a lower risk of disease. As a consequence most recommendations of dietary fiber emphasize the importance of consuming foods high in fiber rather than relying on isolated fiber supplements.

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Barbara O. Schneeman

FISH.

This entry includes three subentries:
Overview
Freshwater Fish
Sea Fish

OVERVIEW

When did human beings begin to eat fish? This question is an endless source of speculation. What can be said with confidence is that our very distant ancestors, if they lived near sea, lake, or river, would have picked up the idea quickly enough; watching the activity of diving birds, and finding fish trapped in rockpools or in naturally formed barriers in rivers, would have been sufficient prompts.

In prehistoric times, the availability of fish as food was distinctly limited. Of the marine species, only inshore ones ran any risk of being caught; deep-sea species, save for the occasional stranding on a beach, were not seen, much less caught and eaten. Even the most accessible of inshore species were relatively safe. So many fish, so few humans. And, to judge by archaeological evidence, humans found it easier to prize mollusks off rocks than to chase darting fish; witness the huge deposits of bivalve shells found in coastal Stone Age communities. Some of these deposits, for example those at Skara Brae in Shetland, are well known; but they are found in many parts of the world.

Freshwater fish enjoyed less immunity. Even before the arrival of nets and harpoons and fishing rods, they could be caught in fish traps made from simple, natural materials such as beavers used for making their dams.

Moving forward in time, it is clear that, at the dawn of recorded history, fishing and eating fish were well established practices. William Radcliffe's highly readable and wide-ranging *Fishing from the Earliest Times* (1926) shows that in most regions of the Old World—China, the civilizations of India and the Middle East, classical Greece and Rome—fish were a significant feature of the diet.

It is also abundantly clear that in early historic times the art of fishing and the scale of consumption developed rapidly. The works of early Chinese writers and of classical Greek authors, although some survive in mere fragments, exhibit a sophisticated range of specific fishing techniques and considerable discrimination among the species. Radcliffe observes that fishing techniques, at least for freshwater fish, have changed less over the centuries than corresponding techniques in, say, hunting (changed by the introduction of the gun); and that the spear, the line and hook, and the net remained preeminent fishing implements.

Special Attributes of Fish as Food

Early humans may have known instinctively that fish constituted a beneficial food. There are many reasons for this. One reason, which no one would have been likely to articulate until recent times, is that fish need a less elaborate skeleton than land animals, since their weight is supported by the water in which they live, providing them more flesh in relation to body weight. They are therefore an excellent source of low-fat protein. (Incidentally, not all species of fish have true, bony skeletons. The category of certain important groups, notably sharks and rays, as "non-bony" indicate they have a skeleton of cartilaginous substance, not bone.)

There are other ways in which fish are unique among the categories of food. First, they constitute by far the largest resource of wild food in the world. Second, the huge number of species of edible fish distinguishes them from other foods. Not even the citizens of Norway or

Fisherman hanging fish to dry in the sun at Sunderbans, Bangladesh, 1996. © TIZIANA AND GIANNI BALDIZZONE/CORBIS.

Singapore (the top two countries worldwide in per-capita consumption) could hope to sample them all.

In addition, humanitarian considerations have been applied only rarely and selectively to fish and other marine or freshwater creatures, in contrast to the land animals (especially mammals) and birds. True, it has recently become unseemly for anyone except the Inuit (Eskimos) to eat marine mammals, and concern is sometimes shown over how to kill lobsters and crabs painlessly; but compassion rarely extends to fish. Nonetheless there may be a gradual change of attitude on this matter; indeed the first signs have already emerged of campaigns to include fish in "animal rights."

This last point would fit in with the reverence that in many cultures has been accorded to fish, and with the symbolic importance they have enjoyed. It is common knowledge that a fish was the first symbol of Christianity, that several disciples of Jesus were fishermen, and that some of his best-known miracles involved fish as well as bread and wine.

In other religions and cultures too fish have had a special place. In ancient Egypt and elsewhere, fish were sacrificed for the gods. They could also take on the role of "scapegoats" or sin bearers. Thus in ancient Assyria people gathered on New Year's Day by a lake or stream and, if they found numerous fish, took this as an omen for the expiation of human sins, and cast their clothes into the water for the fish to bear away, and their sins with them.

Fish could also be used, in Babylon and classical Rome, for auguries and oracular responses, based on a study of their movements. However, it was in Christian cultures that the religious role of fish led to practical consequences. In medieval times the demand for fish, stimulated by the Christian Church's insistence on meatless days, combined with realization that abundant stocks of fish such as cod existed in northerly waters, stimulated voyages of exploration and the development of techniques for fishing in distant waters.

So, at least in Europe, fishing and trade in fish took a new turn as the medieval period began. Northerly peoples such as the Scandinavians emerged from relative obscurity. The powerful Hanseatic League, centered on the Baltic Sea, was based to a considerable extent on its near monopoly of the trade in salted and dried fish; these fish came from the huge stocks of the North Atlantic. Indeed, the subsequent colonization of North America was certainly stimulated—some would say largely caused—by the search for ever more effective ways of exploiting these stocks and by the competition between the maritime powers for them.

The effects of all this activity are still with us. The salted and dried cod of medieval times survives today as an important article of commerce, under Scandinavian names such as *klippfisk*. In many parts of the world people who now have better means of preserving fish, notably freezing, continue to eat these products because they have acquired a taste for them. The same applies to the famous lutefisk which Swedes, for example, devotedly eat at Christmas despite all the bother involved in preparing it. Indeed it applies to many kinds of cured fish, including the hundred and one forms of cured herring such as kippers and bloaters, red herring and rollmops.

All this activity implies a recognition of fish as a valuable food resource. Indeed in the Orient, the Chinese have a consistent record, stretching back for more than four thousand years, of recognizing the nutritional (and often the medical) value of most seafoods, and of honoring fish. Bernard Read in his invaluable "Chinese Materia Medica" comments that:

> Owing to its reproductive powers, in China the fish is a symbol of regeneration. As fish are reputed to swim in pairs, so a pair of fish is emblematic of connubial bliss. As in water fish move easily in any direction they signify freedom from all restraints, so in the Buddha-state the fully emancipated know no restraints or obstructions. Their scaly armour makes them a symbol of martial attributes, bringing strength and courage; and swimming against the current provides an emblem of perseverance. The fish is a symbol of abundance or wealth and prosperity, because they are so plentiful in the seas and rivers.

In the Western world, however, attitudes have been more ambivalent. Although the fish was a symbol of Christianity and prescribed as Lenten fare, opinions were divided on its merits, even on its suitability, as food. In Britain, for example, the evidence of eighteenth-century cookbooks indicates increased consumption of fresh fish from the sea, but the literature of dietetics shows a countervailing current among some medical authorities. As recently as 1835 the respected author of a manual on "modern domestic medicine" declared that fish "affords, upon the whole, but little nourishment, and is, for the most part, of difficult digestion, and this appears to be the general sentiment of intelligent medical men." One author even devoted a lengthy book to arguing that the fundamental cause of leprosy was "the eating of fish in a state of commencing decomposition." These examples remind us that it is only in the present century that seafood has been fully accepted in the West as an admirable source of nourishment. More specifically, it is only in recent decades that the importance of fish oils for health has been fully recognized. The recognition of fish as a valuable article in the diet has led to a flowering of books devoted to fish cookery. The prominence given by authors and by the media generally to fish as food, especially in the English-speaking world, is a new phenomenon which has its effect on demand.

The question arises: what are the future prospects for supplies of fish, and will they be adequate for the growing world population? There are many considerations involved here. Perhaps the most important is the development of aquaculture. Colin E. Nash has shown that there is a wealth of evidence from early sources in Egypt, China, and the Mediterranean region to show how the primitive origins of the industry led long ago to relatively sophisticated practices.

In classical Rome, for example, there were numerous *vivaria* (fish tanks), which served in part as status symbols for the wealthy but were essentially devoted to the production of food. Later, from the early Middle Ages onwards, fishponds became almost ubiquitous in Europe, particularly in association with religious institutions such as monasteries. It does not need a genius to perceive the benefits, and it is not surprising that there is an ancient and strong tradition of constructing and stocking fishponds in Asia also. These, of course, are for freshwater fish, especially carp and (more recently) tilapia. However, even in classical Rome there were *vivaria* for marine species and progress was already being made in taking advantage of saltwater lagoons and suitable parts of estuaries to create enclosures in which seafish could be raised to maturity. Carol Déry has demonstrated that the Romans had progressed amazingly far in this sort of activity, perhaps further than modern people until the last quarter of the twentieth century. Now, however, the pace is quickening. Techniques for raising salmon in sea lochs or similar environments and for dealing with the attendant risks (pollution, infections, etc) are constantly improved. The number of species involved is growing as trials show that more and more can be successfully brought to marketable size in protected surroundings. Atlantic cod are being raised in Norwegian fjords, catfish are brought up in "farms" in the southern states of the United States, and so on. The future looks promising.

As for the sea fisheries, it is difficult to be equally optimistic, since so many fishing grounds are now being exploited up to and beyond the sustainable limits, and some stocks, for example cod in the northwest Atlantic, have already been overfished to the point of extinction. Politics enter into the matter in a big way. To put it very mildly, not everyone in the fishing industry is willing to sacrifice short-term gains for long-term benefits. The same applies to consumers, and it is significant that at the beginning of the present century a new international organization, the Marine Stewardship Council, set about establishing a broad set of Principles and Criteria for Sustainable Fisheries. A system of "eco-labeling" is advocated, whereby special labels will indicate to people buying fish whether these are from an endangered source or not.

Progress may be slow but it is being made, and there is one comforting thought. Humans are now better equipped than ever before to harvest the waters, and also better informed about the ways in which harvests can safely be maximized.

See also **Aquaculture**; **Christianity**; **Crustaceans and Shellfish**; **Fishing**; **Mammals, Sea**; **Mollusks**.

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Alan Davidson

FRESHWATER FISH

Fish have been a major source of human food and of oil, fertilizer, and feed for domestic animals since the dawn of history. Efforts to propagate fish as a source of high-grade protein for human consumption have been more recent but still date to ancient China and the Roman Empire. In the twenty-first century, fish provide about 25 percent of the animal protein consumed by people in developing countries and as much as 75 percent in countries such as Bangladesh and the Philippines.

One reason for the long-standing popularity of fish as food is sheer numbers. More than 70 percent of the Earth's surface is covered with water, and well over twenty thousand different species of fish live in marine, fresh, and brackish waters, making them the most diverse of all the animals. Fish can live at temperatures ranging from below freezing in Antarctic waters to over 100°F (40°C) in hot springs. They range in size from the .5-inch (1.3-centimeter) dwarf goby of the Philippine Islands to the 45-foot (14-meter), 25-ton whale shark of the tropical oceans. The nutritional profile of fish is also outstanding. Rich in the essential omega-3 unsaturated fatty acids so lacking in other foods, fish are also high in protein yet low in calories, sodium, sugars, saturated fats, and cholesterol.

Biology

Scientifically speaking, fish are aquatic vertebrates with gills instead of lungs and fins instead of external limbs. In contrast to the higher animals, fish are also cold-blooded, that is, their body temperatures remain the same as that of the water. A few species, such as tuna, are able to maintain their body temperatures a degree or two higher than the water.

The chain of life leading to fish production begins with the microscopic diatoms and algae in lakes, rivers, and the ocean. These aquatic plants, collectively termed phytoplankton, use the energy in sunlight to convert carbon dioxide dissolved in the water into the organic matter that eventually becomes food for fish. Fish were the earliest animals with backbones to appear in the fossil record, evolving from more primitive forms over 500 million years ago. In turn, the terrestrial animals evolved from the fishes.

Biologists class the more than twenty thousand known species of fish into three main groups, the Agnatha (primitive jawless fishes, such as the blood-sucking lamprey), the Chondrichthyes (sharks, skates, and rays that have skeletons of cartilage instead of bone), and the Osteichthyes (fishes with a bony skeleton, such as salmon and trout). All of the fish important as food are members of this latter group.

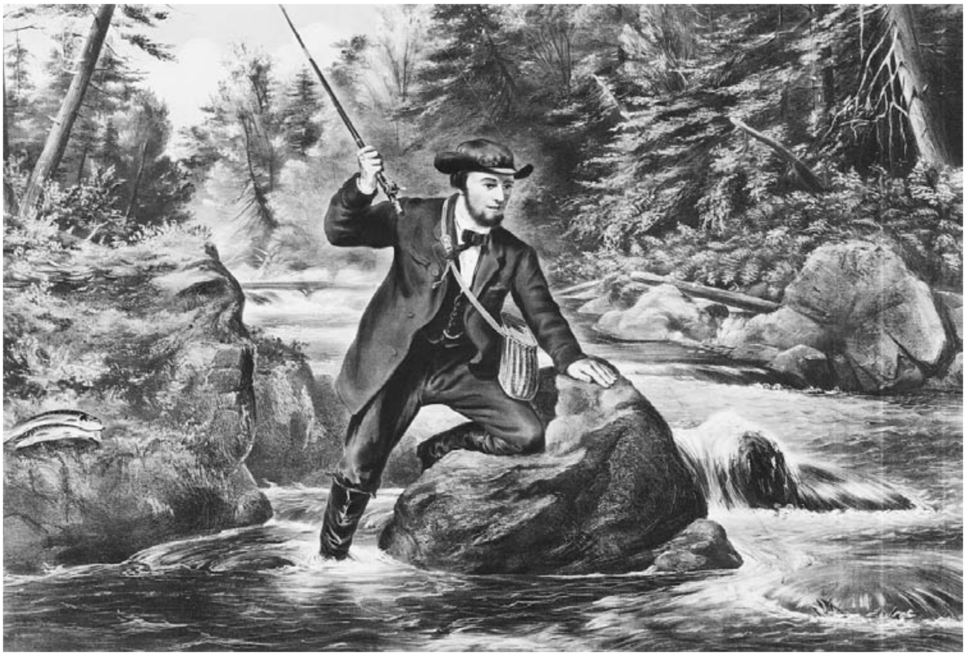
A typical bony fish is torpedo-shaped with a head containing a brain and eyes, a trunk with a muscular wall, and a postanal tail. Fish generally propel themselves through the water by undulating movements of the muscular trunk, using their fins to control direction. All have skins covered with a layer of mucus that decreases friction with the water, and nearly all are covered with an external layer of scales (catfish are one exception). Fishes also have a system of sensory organs along their sides, called the lateral line, that can detect pressure changes in the water caused by sounds. Fish obtain oxygen and eliminate carbon dioxide (breathe) by sucking water into the mouth and pumping it out over the gills. Oxygen dissolved in the water thus diffuses into the bloodstream, and carbon dioxide diffuses out. A few species (such as the African lungfish) also have air-breathing lungs as an additional means of respiration.

Most fish live in either saltwater or freshwater, but some important food fish are physiologically capable of migrating from one to the other. For example, Pacific and Atlantic salmon are hatched and reared in freshwater but then migrate to the ocean to grow and mature, returning to their natal streams and lakes to spawn. The eel has the opposite life history pattern. Thus eel and salmon may be thought of as either freshwater or saltwater fishes depending on age and season.

Over the years, a number of other aquatic animals have been given common names that include the term "fish," such as shellfish, but these do not resemble and are not related to true fish. Furthermore, some animals that have adopted an aquatic way of life, such as whales, seals, and sea snakes, superficially resemble fish and may even be called fish. But they are air breathers, and their anatomical structure is that of land animals.

Preparation and Food Safety

Fish are a highly perishable food product, and historically they had to be marketed live or preserved (cured) by smoking, salting, pickling, or a combination of these methods. Fish to be cured by any method are first cleaned, scaled, and eviscerated. They are salted by packing them between layers of salt or by immersion in brine. Smoking preserves fish both by permeation of smoke ingredients and by partial drying due to heat penetration. Fish can also be dried per se by carefully controlling temperature, humidity, and air velocity.



Freshwater fishing is idealized in this nineteenth-century engraving of a brook trout fisherman by James Merritt Ives. © FRANCIS G. MAYER/CORBIS.

However, dried fish are relatively unappetizing, and rehydration is slow. With the exception of smoked fish, the ready availability of ice and modern freezing and canning facilities has largely supplanted curing as a method of fish preservation. Fish are routinely shipped around the world either fresh or frozen. Fresh fish are shipped on ice and have an acceptable shelf life of about ten days. Frozen fish packaged in oxygen-impermeable plastic wrap, such as Saran, may be stored frozen at –20°F (–29°C) for up to six months with no appreciable loss in quality.

Fresh fish are almost always marketed as either whole fish on ice (viscera removed), dressed fish (head, fins, and viscera removed), fillets (sides cut lengthwise away from the backbone), or steaks (cut longitudinally into sections). Due to consumer demand, boneless cuts are increasingly available in the United States and Europe.

Fish is a naturally tender protein food, free of tough fibers that need to be softened by prolonged cooking. Thus fish products are best cooked using high-temperature, short-time methods. They may be deep-fat fried (325–350°F; 163–177°C), pan fried (sautéed) in a small amount of butter, broiled, poached (simmered, never boiled), or baked (400–450°F; 204–232°C). Pan frying or sautéing is one of the most widely used methods of cooking thin fillets in general. Microwaving is especially well suited to the high-temperature, short-time method of cooking fish. The advent of individually quick-frozen fish fillets has enabled timesaving cooking techniques, such as brushing marinades directly on the frozen product and grilling or oven roasting without the necessity of defrosting. Fish is generally ready to eat when cooked to a temperature of 140°F (60°C) and the flesh has turned opaque and flakes easily. Fish is eaten raw by some ethnic groups (such as Asians). Other ethnic specialty preparations, such as blackened fish (Cajun) or gefilte fish (Yiddish), are also popular.

To ensure food safety, fresh fish should be clean smelling, and the flesh should be firm and resilient when pressed. Fish should be kept wrapped and refrigerated at 40°F (4°C) or less and eaten within two days. Frozen fish should be rock hard, free of ice crystals, and have no white spots, visible drying, or browning around the edges. In the home, fish should be stored frozen at 0°F (–18°C) or below and for no more than three months. It should be thawed in a refrigerator, never at room temperature.

Freshwater Fish Commonly Used as Food

Historically, the human race has used literally thousands of different species of fish in its continuing search for sustainable sources of food. In the twenty-first century, the most popular in North America and Europe include carp, catfish, crappie, eel, lake herring, mullet, muskellunge, yellow perch, yellow pike, pickerel, salmon, suckers, sunfish, tilapia, trout, lake trout, and whitefish. In Indonesia, the Philippines, and Taiwan, milkfish have been used for food for centuries. In Asia, carp, ayu, and eel are important freshwater food fish. Some of the most interesting of these freshwater fish are discussed in more detail below.

Ayu. The ayu *(Plecoglossus altivelis)*, also known as sweet fish in Japan and aroma fish in China, is an extremely popular and economically important freshwater food fish in many Asian countries. Historically, it was caught by Japanese fishermen using trained cormorants with rings around their necks to prevent them from swallowing. In the twenty-first century, it is wild-caught in rivers by sport and commercial fishermen or raised commercially for both restaurant consumption and home use. Ayu are usually sold live, on ice in the round, or frozen. The food quality of wild-caught ayu is especially desirable, characterized by a sweet, delicate taste and an odor reminiscent of cucumber or watermelon.

Carp. Carp *(Cyprinus carpio)* are the largest members of the minnow family and can easily reach a weight of ten kilograms or more. Although greatly underutilized in North America, the common carp has always been a widely popular freshwater food fish in the rest of the world. History records that carp were grown in ponds for food in ancient China in the fifth century B.C.E. In Europe, carp were grown in monastery ponds as early as the sixth century C.E. so the monks would have something to eat during the many meatless fasting days prescribed by the church. By the late Middle Ages, carp had become a well-established food item for the general populace. In the twenty-first century, carp are wild-caught or grown for food in Russia, Ukraine, Hungary, Poland, India, China, Japan, Latin America, Egypt, Iran, Indonesia, and Israel, to name only the major consumer nations. The world's leading producer is China, where carp are often grown in rice paddies in rotation or even simultaneously.

The most common market forms of carp are fresh whole fish, dressed fish, or fillets. Gefilte fish, fish balls blended with egg and matzo meal and simmered in a vegetable broth, is an ethnic specialty item (Yiddish) traditionally made from carp.

Catfish. The channel catfish *(Ictalurus punctatus)*, native to warm water lakes and rivers in North America, is a traditional food fish in the southern United States. Consumer demand has moved from regional to national and even international. In the United States, the per capita consumption of catfish is exceeded only by that of tuna, shrimp, pollack, and salmon. To satisfy American consumer demand, several hundred thousand metric tons of channel catfish are produced by aquaculture each year in the southern United States.

Imported catfish from Vietnam has been marketed aggressively to restaurant chains and food service companies with considerable success. Advertised as delta-raised catfish, it is actually a catfish relative raised in the delta of the Mekong River. Another catfish species, the walking catfish, is a popular food fish in tropical regions and even in some European countries, especially the Netherlands.

Catfish is firm textured and has a mild, slightly nutty taste that complements a variety of flavors. It is a lean fish, and modern processing methods have eliminated bones. That, together with its lack of a fishy odor, gives it wide consumer appeal. Catfish were traditionally wild-caught and marketed as iced whole dressed fish. Modern farm-raised catfish are processed within minutes and shipped either on ice or as individually quick-frozen fillets, making it one of the freshest fish available. In addition to fresh or frozen fillets, steaks and nuggets (pieces) breaded or marinated with flavors and spices, such as Cajun spices or mesquite, are also common in seafood markets and restaurants and have even been introduced into school lunch programs. As Mark Twain once said, "The Catfish is a plenty good enough fish for anybody."

Eel. Although appreciated before the Civil War in North America, freshwater eels (primarily *Anguilla anguilla* and *A. japonica*) are a widely popular food item in Asian countries, particularly Japan, Korea, China, and Taiwan. Eels are also an important delicacy in Europe, particularly Italy, where they must be produced commercially by aquaculture to satisfy consumer demand. Overall, however, China produces more than 70 percent of the eels sold in the world, and many rice paddies have been converted to eel production. Japan is the world's largest eel consumer, where *kabayaki*, eel fillets grilled with a sweet basting sauce, is practically a national dish.

As mentioned, eel consumption in North America is minor. However, freshwater eel *unagi* is common in Japanese restaurants in the United States, where it may be served grilled with teriyaki sauce or used in sushi or *unadon* (eel over rice). In addition, each year many tons of market-sized eels are wild-caught by U.S. fishermen and exported to Europe, where it is eaten roasted or even jellied and baked into pies.

Eels have an interesting life history in that they live in freshwater rivers and lakes, where they grow to adult size, then they migrate into the ocean, where they swim long distances to the Sargasso Sea to spawn and die. The newly hatched young eels may then ride the ocean currents for several years until they reach coastal waters and swim back to freshwater rivers. There they grow to adult size and can be harvested for food.

Eels under a kilogram in size are the most tender. The rich, sweet, firm flesh of eel must be refrigerated and eaten immediately, so the best restaurants keep live eels in aquarium tanks. The skin and outer layer of fat are removed by the chef, and the fillets are either grilled or roasted. Eel is also available frozen, smoked, or jellied in cans.

Asian folklore holds that eel consumption confers strength and vitality, particularly in hot summer weather. Eels are amazingly rich in vitamin E and in the omega-3 fatty acids (DHA) that are essential to brain functions involving mood.

Milkfish. Milkfish *(Chanos chanos)* have been an important food fish for people in Southeast Asia for many

Traditional fish cage made of split bamboo and reeds (China, twentieth century). Fish were placed inside the cage, which was then submerged in water to keep them alive for market. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

centuries. Although they are an oceanic fish, milkfish spawn in shallow coastal areas, where fry and fingerlings are collected in nets and carried to freshwater or brackish water ponds for rearing to market size. Milkfish have been raised in this fashion for at least seven hundred years in the Philippines and Indonesia. Taiwan is also a major producer. Milkfish *(bangus)* is sold in Asian markets and restaurants either fresh, smoked, marinated, as fish balls, as fish sausages, or as fish nuggets. It is also exported frozen to North America, where *sinigang na bangus* (milkfish in sour broth) is a popular dish among ethnic Indonesians and Filipinos.

Tilapia. Although relatively new to North American fish markets, tilapia are actually a group of fish (cichlid) that traces its origins to North Africa and the Middle East. These mild, white, sweetly flavored fish have been wild-caught or pond-raised around the world for centuries. Called St. Peter's fish in many parts of the world, legend has it that the fish Jesus multiplied to feed the multitudes in the story of the seven loaves and fishes was tilapia (Matt. 17:24–27).

Because of their versatility, tilapia have been nicknamed "the aquatic chicken" and can be baked, broiled, fried, blackened, grilled, poached, or sautéed. Sautéing is one of the most popular methods of preparing thin fillets in general, and in most recipes tilapia can easily substitute for catfish or even sole and flounder.

Tilapia are grown in floating cages, ponds, or rice fields in temperate and tropical regions around the world. Only Chinese carp and salmon or trout exceed tilapia in total worldwide fish production. Although they are less popular in the United States, tilapia consumption has grown to rival trout among the commercially raised fish species. Since relatively modest numbers of tilapia are produced by U.S. aquaculture, large quantities of frozen fillets are imported from Indonesia, Taiwan, and Mexico to satisfy consumer demand. Many large U.S. cities report a significant demand for live tilapia delivered to ethnic Asian markets.

Trout. Many trout species have historically been used for food, but rainbow trout *(Oncorhynchus mykiss)* have been by far the most popular. Originally native to cold water environments in the north temperate zone, this prized food fish has been transplanted around the world and is well established in North and South America, Japan, China, Europe, Australia, New Zealand, and parts of Africa. Top trout-producing countries include Chile, Denmark, France, Italy, and the United States.

Most rainbow trout is marketed as head-on dressed fish, as fresh or frozen boneless fillets, or as smoked fish. Farmed trout are typically rich in the omega-3 fatty acids so essential to normal brain and eye function, while they are less expensive than most other fish products.

Walleye pike. Walleye *(Stizostedion vitreum)*, a member of the perch family with an excellent reputation for its food quality, is a widely sought cool-water fish mostly caught by anglers for home use but also available in fish markets and restaurants in much of the northern United States and Canada. In the United States, a limited commercial harvest comes from the Great Lakes. However, most of the commercial harvest is from Canadian fishing on Lake Erie and the inland waters of Ontario and Saskatchewan. The walleye is Canada's most economically valuable freshwater fish. Only a few commercial growers produce food-size walleye, but because of its reputation for excellent food quality (aroma, flavor, and texture), its name recognition, and its high retail price, walleye has considerable aquaculture potential. Traditionally, walleye are sold as scaled, skin-on fillets. A two-pound fish yields about two eight-ounce dinner-size fillets.

Whitefish. Lake whitefish *(Coregonus clupeaformis)* native to the deep cold lakes of North America are popular food fish in the United States and Canada. They are widely sold in restaurants, and some believe their flaky, non-oily white meat is the best tasting of all the freshwater fish. Early settlers claimed they could eat nothing but whitefish for days at a time and never tire of it. A large commercial fishery for whitefish exists in Lake

Superior and the other Great Lakes of the midwestern United States. In Canada, close to 600,000 kilograms of whitefish a year is caught and sold by tribal fishermen of the Great Slave Lake alone. Most whitefish is marketed frozen and sold in restaurants or supermarkets, but limited amounts are also available smoked or fresh. Whitefish eggs, termed freshwater or golden caviar, are sometimes sold as a less-expensive substitute for sturgeon caviar.

See also **Aquaculture; Fishing; Fish, Salted; Fish, Smoked.**

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Gary A. Wedemeyer

SEA FISH

In all the oceans of the world, fish have abounded for countless millennia, most of them doomed to spend their whole lives swimming until they are eaten by bigger fish. Shakespeare put it well when he had the Third Fisherman in *Pericles* ask how the fishes live in the sea, to which the First Fisherman replies: “Why, as men do on land; the great ones eat up the little ones.” Only a tiny minority of fish are sufficiently large or well protected to escape predators. Even they may fall prey to the latest predators to arrive on the scene—to wit, ourselves.

Until human populations began to increase at an exponential rate, and until methods of preserving and transporting foods approached their present level of sophistication, mankind’s need for food had little impact on the vast resources of the oceans and seas.

Radical change in this situation began in medieval times, when European fishing boats reached the rich cod-fishing grounds in the northwest Atlantic. Salting techniques, as well as wind-drying, meant that huge quantities of fish could be processed in, for example, Newfoundland and then brought back on the long voyage to Europe. Meanwhile the ascendancy of the Roman Catholic church, with its numerous fast days, in an increasingly populous Europe caused a sharp increase in demand. Salt cod became, and remains to this day, a staple food in the Iberian Peninsula, the south of France, and Italy.

In more recent times fishery techniques evolved swiftly, culminating in the modern fishing industry. This has such deadly accuracy in finding shoals of fish and in catching them, and such advanced means of freezing, that overfishing occurs wherever effective controls have not been instituted. These controls are hard to establish and maintain. The initial impact on fishermen is adverse. Boats have to be laid up; an appreciable number of fishermen lose their livelihood; fishing ports where many people earned a living by servicing the fleets risk falling into a slump. However, if supplies are to be maintained, fish stocks must be allowed to survive in viable number and every ancillary means, notably more and better fish “farming,” must be developed.

Considering the merits of fish as a food, nutritionists give it high marks. Sea fish, like freshwater fish, are an excellent source of protein, but have additional health benefits to offer, for example in the form of vitamins, iodine, and phosphorus. Joyce Nettleton (1987) gives a comprehensive survey of the vitamins in which seafoods are rich, including pyridoxine, niacin, and vitamin B_{12}.

So far as fat and oils are concerned, there is a major distinction between what are sometimes called “white fish” (for example, the cod family and flatfish) and what the Spaniards refer to as *pescado azul*, meaning blue fish. The latter category includes the powerful surface swimmers such as tuna and mackerel, which roam at speed over deep waters and whose coloration is usually dark blue with a pale underside, to make them inconspicuous to predators from above or below. Their lifestyle calls for very strong muscles, creating a need for more oil in their bodies. As a group they may be categorized, less romantically than in Spain, as “oily” fish.

There is, as one would expect, no sharp dividing line between oily and nonoily, but a spectrum with “white fish” clustering at one end and “blue fish” at the other. The oil content may be as high as 15 percent (sardines at certain times of year) or as low as 1 percent or even less (flatfish); in general, a content of over 5 percent would be enough to rate a fish as oily. The oily fish contribute more fat to the diet, which makes dieters wary of them, but the fish oils are in fact highly beneficial from several points of view, so much so that people who do not include oily fish in their diet may be advised to take fish oil supplements. Joyce Nettleton provides a clear and full exposition of the merits of the omega-3 fatty acids (present in seafood because it is made in the first place by the phytoplankton in the oceans) and their special virtues.

Summarizing the health benefits of eating sea fish, Nettleton points out that they are low in calories, that most of them are very low in fat, while all are low in saturated fat. The long-chain omega-3 oils have been shown to protect against heart disease and some other afflictions, and are definitely low in cholesterol and in sodium. She refers also to the vitamins and minerals mentioned above, explaining that dark-fleshed fish have especially abundant amounts of iron, and that seafood is the best source of many trace minerals such as zinc, selenium, fluoride, and copper.

Sea fish in general, and "white fish" in particular, are usually easy to digest, partly because they have very little connective tissue. Indeed certain white fish with delicate flesh (for example, whiting) are traditionally recommended as invalid food. Moreover, they can be eaten cold as well as hot.

Fish bought from a fishmonger or in a supermarket are usually from a limited number of familiar species, and bear labels saying what they are. But for some people, for example, travelers and expatriates, choosing and identifying fish can be a problem; and of course a sure means of identification is a necessity for all who are involved in the international fish trade. In these other situations there is potential for confusion, arising mainly from the sheer multiplicity of edible species. There are not many sorts of meat in common consumption, and the number of species of bird which are widely eaten is limited. But the number of edible fish is very large, and even in one market there may be scores available.

The number of species is quite enough by itself to cause perplexity, but there are aggravating circumstances of two kinds, which compound confusion. One source of confusion may be regarded as natural and viewed with tolerance. This is the confusion caused by the fact that even within one language, indeed sometimes within one dialect, the same fish will have a range of different names. These reflect local practice in small coastal communities, which were often isolated from each other in the past by poor overland communications. In Italy, for example, the common grey mullet, *Mugil cephalus*, has more than forty different names.

The other sort of confusion applies to European languages, especially English, and is a by-product of colonization. Its effect is quite the contrary—to make it seem that there are fewer families or species of fish in the world than there really are. What happened was that early English colonists, to take the main culprits as an example, applied familiar but inappropriate names to the species that they encountered in the New World, Australasia, and elsewhere. Understandably, they called the fish they found overseas by names they already knew, on the basis of a real or fancied resemblance. This could sometimes work satisfactorily. English settlers in North America, familiar with salmon at home, found salmon there too, not always of the same species, but at least of the same family (Salmonidae). But sometimes the results were less happy. The fish that settlers in Australia called salmon are not akin to the salmon of the Northern Hemisphere, while the so-called "Murray cod" of Australia is not a cod and is not even a sea fish.

In a situation affected by so many causes of confusion, it is only the scientific names of the species that can provide certainty. Fortunately, international and national authorities have been working for some time to rationalize commercial names for the species, and more and more authors are adopting the practice of identifying the species they mean, if there is any room for doubt, by its scientific name as well as by popular ones. The work of the Fisheries Division of the Food and Agriculture Organization (FAO) of the United Nations has made, since the 1950s, an outstanding contribution to clarification and precision.

In any case, and in practical terms for consumers, the sort of confusion described above is not the norm; nor does it necessarily cause bad results. A number of species occur around the world, for example, *Xiphias gladius*, the swordfish, and *Mugil cephalus*, one of the grey mullets. Nearly all the families of fish have representatives in both the great ocean areas, and these representatives differ little from the cook's point of view (although the scientists properly distinguish between them by counting their fin-rays or examining their air-bladders). Thus the famous red mullet of the Mediterranean have close relations in the Indo-Pacific; but the latter are known as goatfish, and treated by Asian cooks in a different way, and for this reason people often fail to see the connection.

There are certainly wide variations in the manner of fish consumption. In many European countries it would be normal to serve a small fish whole and a larger fish in full portions (say, 5 oz [150 g]) either separately (to be followed by a vegetable, as often in France) or with vegetables. In Britain, for example, the tradition is that fish is either what you have with chips or something to be served, like meat, with "two veg." But these traditions, although spread around the world to some extent by the influence of France and of the British Empire, are not widely shared. In most parts of the world, especially Asia and Africa, fish is more likely to be one constituent of a combination of different foods, or an element in a one-pot dish, or something that accompanies pasta, or rice, or goes into fish balls, fish puddings, or pies, or is part of a soup-plus-fish-stew dish. Many such modes of presentation produce delicious results, and make a relatively small quantity of fish "go further."

This last point has an even wider application. In most countries of Southeast Asia a product known as fish sauce

Herring barrels stacked along the docks of Aberdeen, Scotland, circa 1900. The barrels await shipment to Europe and North America. ROUGHWOOD COLLECTION.

(*nuoc mam* in Vietnam) plays an important part in the diet as a source of protein. These sauces are prepared by fermenting large quantities of small fish, usually such as would serve no other purpose, and straining the liquor which this process generates. This liquid resembles soy sauce, both in appearance and in its composition. Added to rice or other savory dishes, it enhances both flavor and nutritional qualities.

The preparation of fish sauce is one example of how fresh fish can be turned into a product that will keep for a long time. The various sorts of fish paste are others. The fish used for these purposes lose their identity, whereas those that are dried or salted or smoked (or undergo all three processes) can still usually be seen for what they are. They may also become better to eat, or anyway come to be preferred, as in the case of the kipper (salted, dried, and smoked herring) or the salt cod mentioned above, which has for centuries been a staple food in the Mediterranean region, or the smoked salmon that is now an almost inevitable feature of restaurant menus. That freshwater fish are less often subject to preservation processes may simply reflect their greater availability—trout can be found in the river (or, nowadays, fish farm) at any time and marketed on the same day, whereas many marine fish can only be harvested by distant fishing boats.

Some species of fish are purely freshwater, others are entirely marine. But the division is not clean-cut, for there are species, and important ones, of sea fish that can, and in some instances must, move from one environment to another. In many instances species that live most of their lives in the sea have to go up rivers to spawn. They are called anadromous. Some famous examples are salmon, shad, and eel. However, the eel differs from the other two in that its stay in freshwater covers the greater part of its life. It is a marine fish only in Act One of its life, when it drifts in larval form across the Atlantic from the Sargasso Sea to the river mouths of Europe, and in Act Five, when it goes back into the sea years later and sets off on its arduous journey back to the Sargasso Sea, there to spawn and die. Indeed, although the sea thus provides both its birthplace and its grave, the eel counts for many purposes as a freshwater species.

If only because of this sort of anomaly, there is little point in asking which are better, freshwater or marine species. It is true, however, that there is some division of opinion, misguided or not, about their respective merits. In inland countries and regions the former may be preferred because they have been accessible for much longer and are established as traditional dishes. Where sea fisheries are established, the reverse is usually the case. However, there are exceptions. To take two examples, people in Bangladesh and Burma prefer freshwater fish and use spices, notably ginger, to mask the marine flavor of sea fish, the very flavor that people in many other countries prize.

Even within the category of sea fish it is interesting to note that some people believe that fish from cold waters are better, the idea being that they lead a particularly active and healthy existence, whereas fish from semitropical or tropical waters laze about and have a less firm consistency. If this belief were to be investigated, it would probably turn out to have little or no foundation.

There is one respect, however, in which sea fish from colder and warmer waters do differ significantly. In cold waters it is usual to find a relatively small number of species, normally existing in huge populations. In tropical or near-tropical waters, on the other hand, there is a very great diversity of species, but few of them are anything like as numerous as those of cold waters.

However, as usual when trying to make generalizations about sea fish, one finds that this contrast is not entirely valid. Some species of tuna are among those which pass, apparently without any problem, from cold to warmer zones and back again. The whole great family of tuna is extraordinary in other ways too. One is the degree of ceremony, drama, and cultural significance with which the fishery for them in the Mediterranean is invested. The tuna traps, of which about a hundred were still operating in the 1960s, were certainly in use in classical times, and some authorities believe that they date even further back. Essentially the trap consists of a long net stretching out to sea, across the expected path of the migrating bluefin tuna. This net diverts the fish into a series of pounds, each of which leads into the next, and finally into the death chamber. There, a net stretched across the bottom can be hoisted up periodically, when there are enough tuna present, bringing them up to a position where they can be taken with gaffs. The fishermen jump in to deliver the death blows. The scene is bloody and to spectators horrifying. The Greek tragedian Aeschylus likened it to the slaughter of the Persians at the battle of Salamis. In Sicily, where the event is called the *mattanza*, and in other places around the Mediterranean the capture and slaughter of the tuna is an event that has more significance than a mere fishery episode; it has served to reaffirm, annually, the cultural identity of the whole community.

In contrast, in most communities in the Western world, the catching and killing of sea fish take place completely offstage; indeed, many of them finish up as neatly trimmed fillets whose identity would be a mystery unless revealed by the label. This distancing of the scene in a dining room from that on the deck of a trawler has left people without the feeling for fish so eloquently expressed by classical writers. This was still evident in nineteenth-century writings such as the Reverend Badham's *Prose Halieutica: Ancient and Modern Fish Tattle*. However, the Greek word in the title is a direct echo of the Greek poet Oppian's *Halieutica*; Badham wishes his readers to know that his own picture of the fishy world, in which the personalities and habits of so many of the fish are described, stems from classical times. If modern writers allude at all to these aspects of the fish, it is only in terms of the struggle fishermen are perceived as waging against the fish, so that the attributes of the fish are generally restricted to terms such as "wily," "valiant," "predatory," etc.

It was in classical Greece that the earliest known guide to finding good food was composed. The author was Archestratus. Enough of the work survives (and has recently been published in translation) to demonstrate the point that is relevant here: that more attention was paid to good sources for fish of the highest quality than to any other category of food. The recommendations were not just of the "Syracuse is the best place to buy fish" variety, but were completely specific. Thus connoisseurs were directed to the straits of Rhegium for sea-caught eels and to Ephesus for a fat gilthead bream. This argues a greater public awareness of quality in fish, and of the various species, than is common nowadays. It is of course relatively easy to have this commendable awareness in a small city-state with an economy based on slave labor and ready access to freshly caught fish. In the modern world, with much of the population inhabiting huge conurbations, far from the fishing ports, and relying in the main on what supermarkets find it economic to provide (there are far fewer fishmongers nowadays), it would be fruitless to expect to find many connoisseurs of fish. Nevertheless, there is one favorable trend, noticeable in the last decades of the twentieth century and the first of the twenty-first. This is the gradual recognition of fish that qualify for an "organic" label as desirable, leading to greater appreciation of quality in fish. This is accompanied by a growing proliferation of cookery books whose recipes frequently call for a particular species of sea fish, and not necessarily one which is in common supply. To take one example, what has happened to the anglerfish (often called monkfish and, in America, goosefish) is instructive. It used to be spurned on both sides of the North Atlantic and was appreciated only in the Mediterranean. Now it has become a valuable and relatively expensive kind of fish, and recipes for it abound. The ability to make greater use of species that had been underexploited in the past is one necessary element in maximizing the harvest of the seas, to the benefit of all.

See also **Crustaceans and Shellfish**; **FAO (Food and Agriculture Organization)**; **Fish, Salted; Fish, Smoked;**

Fish and Chips; **Fishing**; **Mammals, Sea**; **Sea Birds and Their Eggs**.

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FISH, SALTED. Sodium chloride (NaCl), also called salt, common salt, and table salt, is generally recognized as a safe (a status sometimes abbreviated by the acronym GRAS) antimicrobial and incidental food additive (Klaassen). Salt has been used for centuries as a seasoning and flavor enhancer as well as a preservative or curing agent. Salt has played a major role in many aspects of human life: nutritional, economic, political, and military. Egyptians preserved food by salting or sun-drying; Roman soldiers were paid in salt; Napoleon's campaign in Russia suffered a setback because of lack of salt; and salt was used in trade and exchanged for slaves in ancient Greece (Pszczola; Salt Institute). The Greeks also salted fish and used them as a part of their diet. Later, they passed this practice on to the Romans (Jay).

Fish Preservation

Fish are highly perishable, and they will spoil rapidly if improperly handled. Fresh iced fish generally are spoiled by bacteria, but dried fish are usually spoiled by fungi (Jay). Salting as a method of preserving fish has been used for centuries and in many places around the world such as Asia, Europe, and Latin America. The simplicity of the salting process, the low cost of production and the ease with which it combines with other preservation methods, such as drying or smoking, has led to its popularity and extensive use (Berhimpon et al.).

In the usual process of dry-salting, whole fish are eviscerated, cleaned, washed, dry-salted, stacked in containers with more NaCl in between the pieces, stored for a salting or curing period, and then dried (using sunlight or artificial indoor drying chambers). The salting period depends on several factors including the desired ripened characteristics in fish, the fish species, the amount of salt used, and the storage temperature. For example, increasing the amount of NaCl reduces the required time of storage.

Fishmonger cutting dried codfish at a fish market in Rome, Italy. The counter on which he is cutting the fish is covered with salt. © OWEN FRANKEN/CORBIS.

Use of salt in fish preservation is not limited to dry application. Salt is an important additive in the preparation of fermented, pickled, or processed fish or fish products. In the making of fermented fish, known concentrations of salt are added to promote degradation of proteins and retard the growth of undesirable, putrefactive microorganisms. Also, this allows desirable, NaCl-tolerant (halotolerant), fermentative species such as lactic acid bacteria to grow. Pickled fish are marinated in salt brine or brine containing vinegar. Curing salt (containing sodium nitrate, NO_3) can be added to the pickle to delay spoilage and control microbial activity during storage (Pederson and Meyland). Other ingredients—spices, sugar, herbs, or vinegar—are incorporated during the process to impart a particular flavor, texture, or color. Herring, haddock, and anchovies are fish species often available in the market in pickled form.

In manufacturing processed fish products, adding certain amounts of NaCl assists in the extraction of salt-soluble proteins and the formation of a sticky paste of fish meat. The development of the gelled paste might be due to the formation of a protein network structure or polymerization of myosin-heavy chains (Kumazawa, Numazawa, Seguro, and Motoki). In breaded processed fish products, NaCl is used in the predusting step to enhance adhesion of the batter to the fish (Claus, Jhung-Won, and Flick). Processing fish has created a niche market for products that otherwise would have been wasted because of overharvesting of species, low consumer appeal, high processing costs, or limited shelf life.

Salt, Spoilage, and Preservation

Over the years, a number of spoilage and pathogenic microorganisms, including lactic acid bacteria, *Pseudomonas* spp., *Staphylococcus* spp., *Salmonella* spp., *Clostridium perfringens*, *Clostridium botulinum*, *Escherichia coli* O157:H7, and *Listeria monocytogenes*, have been associated with fish and fish products. At certain concentrations, salt was found to prevent growth of many microorganisms by exerting a drying effect on microbial cells and tissue, which concentrates solutes in them, creating an environment unsuitable for microbial proliferation. Because some halotolerant or halophilic (salt-loving) microorganisms are not affected by salt, additional treatments such as drying, heating, curing, or smoking are helpful in controlling them. Dry-salted fish (that is, dried by the salting method), for example, are dried and/or smoked to extend their shelf life.

In addition to microbial spoilage, fish that contains high levels of lipids—salmon, herrings, and mackerel—are prone to oxidation and become rancid as microbial spoilage occurs (Jay). Because of their unsaturated nature, fish body oils are susceptible to oxidation and also easily develop rancid and unacceptable odors and flavors during storage (Waterman). Once fatty compounds are oxidized, the breakdown products of lipid oxidation potentially can react with proteins and vitamins, leading to a loss of nutritional value and quality of the fish (Pokorny). Salted sun-dried fish are more prone to oxidation than fish preserved by other methods because of their exposure to light and oxygen (Smith and Hole). Use of crude NaCl (which contains impurities such as chlorides, sulfates, calcium, and heavy metals) accelerates lipid oxidation during fish processing and will adversely affect the overall quality of the finished product (Yankah et al.).

In order to reduce the adverse effects of NaCl on lipid oxidation, color, and flavor of fish, fish and fish products are handled, prepared, and processed under refrigerated temperatures. Low temperatures reduce the rates of oxidative reactions and retard microbial growth. Products also can be vacuum packaged after drying and/or cold or hot smoking. Vacuum packaging creates an environment that virtually lacks oxygen, a promoter of oxidative rancidity. Chelating agents, bio-preservatives, antioxidants, and other compounds also can be added to maintain color, flavor, and integrity of the products.

Throughout history NaCl has been a popular and important food additive. The many advantageous properties that NaCl possesses led to its incorporation in several unprocessed and processed foods. Its functionality as a preservative, catalyst in extraction of NaCl-soluble proteins (binder), flavor enhancer, and color developer has played a major role in food processing and preparation. Improvements and advancements in technology worldwide have allowed even better use of NaCl by the food industry, such as production of processed fish products. Because salt does have its limitations and disadvantages, its utilization conditions must be optimized to provide safe food for consumers, at the same time addressing their needs and concerns.

See also **Fish; Fishing; Iodine; Meat, Salted; Military Rations; Preserving; Salt; Sodium**.

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FISH, SMOKED. Wind-drying is the most ancient and basic way of preserving fish. Add the discovery of fire, and early humans might have found that fish hung up over a fire dried more quickly, and that, if the fire was

Worker preparing smoked bonito at a fish smoking establishment in Miyazaki, Kyushu, Japan. © MICHAEL S. YAMASHITA/CORBIS.

smoky, fish would acquire a different flavor and keep better. Indeed Cutting (1955) suggests that people might have begun to smoke fish deliberately in the Neolithic. However, it seems to be uncertain whether such smoking of fish was carried out later on, in ancient Egypt or classical Greece and Rome.

As Sue Shephard (2000) points out, archaeologists have uncovered the remains of what was evidently a substantial fish-smoking "factory" in Poland, dating back to the seventh century. And it is clear that European use of the technique was greatly expanded, perhaps mainly in order to deal with gluts of herring, in the medieval period. Dedicated smoke houses used for this purpose were in common use in England, and no doubt elsewhere in the fourteenth century.

Smoke is highly complex, having a couple of hundred or more constituents. So what it does to fish is also complex, but can be summarized by saying that it deposits on the fish various phenols, aldehydes, tars, etc. and that the combined effect of some of these, which have bactericidal properties, is to make the fish keep noticeably better.

In modern times progress has been made in the construction of special ovens for smoking fish; in analyzing the constituents of smoke which are responsible for changes of flavor; in the choice of wood shavings or chips whose smoke produces the best results; and in elaborating the techniques of both hot and cold smoking.

Hot smoking was developed in northern Europe in medieval times. In this process the smoke temperature is very high and the fish is wholly or partly cooked by being smoked. Herring which were hot smoked on the northern coast of Germany were known as *Bücklinge*, which became "buckling" in English, but the process was also used for many other species of fish. The hot smoking of fish is also common in Africa. For example, a kind of shad is hot smoked in Ghana in primitive kilns made from oil drums. Hot smoked fish is succulent and tasty but in general does not travel or keep as well as cold smoked. Cold smoking, on the other hand, is not a cooking process; it consists simply in hanging fish in smoke (which may of course be slightly warm, but that is irrelevant), and the result keeps well.

As for the choice of combustible, the traditional preference in Britain was for oak, with ash as second choice and peat being used until recently in Scotland, especially for domestic smoking in their kitchen chimneys by fishermen's wives. In Russia, the woods used have included

HADDOCK

Since haddock does not take salt as well as cod, the traditional ways of curing haddock were by drying and smoking. In the category of smoked haddock the most famous have been what was originally a product of the fishing village of Findon, near Aberdeen in Scotland. Peat was used as the source of heat and smoke, and the haddocks, when sold, proudly bore the name Finnan haddocks or Finnan haddies. The taste spread to France where the product became so popular that in French the term "haddock" means 'smoked haddock', one significant instance of an English word invading the French language (which does of course possess its own word for fresh haddock, *églefin*). The taste also spread to the United States in the nineteenth century, witness the statement by G. Brown Goode and his associates (see bibliography) that smoked haddock were even then being manufactured in large quantities in Portland and Boston. It is interesting that Goode called them Finland haddocks, perhaps reflecting a misunderstanding of the true name by the American manufacturers.

The production of Finnan haddocks or the like no longer involves the use of peat and is carried out in many places. However, the essential process still involves the traditional stages. The fish, cleaned and split open, are left in brine for a while and then hung up to drain. As the surface dries, it develops an attractive gloss. Smoking comes next and is normally continued until the fish have taken on a straw color (which will darken further after the fish have been taken out of the smoking plant). Small haddock which have been treated in this way but withdrawn from the smoking process while their color is a very pale straw are known as Glasgow pales. This light coloration is at the opposite extreme from the lurid yellow hue often imparted artificially to the fish by large-scale commercial smokers.

Hot smoking is used for what are called Arbroath smokies. Arbroath is the Scottish town where their production became a local industry.

alder, oak, poplar, and lime. Wood from coniferous trees has also been used, but imparts a resinous flavor.

Nowadays there are numerous books on home smoking, explaining how various small contraptions can be used to produce smoked fish; and a few books which treat the subject in a general and historical manner, while not neglecting technical aspects. In this last category falls the book by Cutting and that by Burgess and others (including Cutting, 1965). Zaitsev and others (1969), in their 700-page manual *Fish Curing and Processing*, are also helpful on the technical aspects. Sea fish smoked in Russia include sturgeon, cod, herring, whitefish and grey mullet. Freshwater fish include carp, bream, and pike-perch.

In modern times, the best known smoked fish is smoked salmon, now prepared in many countries and figuring on innumerable restaurant menus around the world. Many of the salmon which are smoked are farmed salmon, but the proportion of farmed to wild varies greatly. In North America more than half of the smoked salmon are farmed, most coming from British Columbia, but even so smoked wild salmon is much easier to obtain there than in Europe. Traditions of smoking salmon in the Pacific Northwest go back a long way, and Shephard has an interesting passage about the cultural significance which American Indians attached to these fish, believing them to be "undersea people who put on salmon skins to swim ashore and offer themselves as food."

Smoked eel, of which the best comes from the Netherlands, is now being produced in the United States, in Scotland, and elsewhere; and smoked mackerel has become a success internationally. These are all fish with a relatively high oil content, a feature which works well with smoking. However, less oily fish such as cod and haddock are also smoked successfully. In Britain there is a long tradition of smoking haddock.

Despite the ubiquity of smoked salmon and the importance of smoked haddock, many people in Britain regard the kipper, a form of smoked herring, as their top favorite. It dates back only to the 1840s, the period when railways began to facilitate rapid transport of cured fish from the ports to other areas, and soon achieved prominence because it was so useful in helping to conserve the huge catches of herring which used to be made off British coasts.

In North America, smoking has been used for more and more species, both freshwater (e.g., trout, also a highly popular smoked fish in Europe) and marine. Whitefish, marlin and tuna are examples of larger fish which have to be smoked in fillets. Swordfish is another large fish of global distribution that is smoked in many of the countries where it is caught. Halibut may be smoked, indeed this treatment seems to be the best way of dealing with Greenland halibut, a delicacy in Denmark.

In Asia, much of the smoking of fish is carried out on an artisanal small-scale basis, and the number of species involved is large. Smoked snapper (for example *pla kaphong* in Thailand) is excellent. In China, especially in the south, smoked pomfret is an important delicacy.

It is not only whole fish or fillets of fish which are smoked. Smoked cod roe is a prominent example of other parts being so treated. In Greece, imported smoked cod roe has largely replaced the dried roe of grey mullet as the basis for the delicious fish roe paste known internationally as *taramosaláta*.

The indications are that the list of smoked fish and smoked fish products will be progressively extended, since most fish are susceptible to smoking and smoked fish, with smoked salmon in the vanguard, has been winning greater and greater consumer acceptance. In times gone by, smoking fish was done to preserve it. Nowadays there is a further, gastronomic, reason. The flavor of smoked fish has come to be appreciated in its own right. If the proportion of the global catch of sea fish which is smoked goes up, that should be viewed as a favorable development. It should lead to less waste, greater flexibility in the use of fish, and often more pleasure for the consumer.

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Alan Davidson

Fish and chips are a great favorite in Britain, although the health implications from eating this kind of fried food are much debated by nutritionists and physicians. This queue is eagerly awaiting lunch in Derbyshire, England. © ROBERT HOLMES/CORBIS.

FISH AND CHIPS. Fish and chips has a strong historic claim to the status of the national dish of industrial Britain. Perhaps fittingly, in postindustrial and postcolonial times it has been hit hard by competition from a proliferating variety of ethnic restaurants and takeout restaurants, especially Indian and Chinese, and by the rising cost of the traditional fish species to which its loyal adherents are firmly attached. Its origins coincided with the sustained rise in working-class purchasing power that was ushered in by falling prices in the last quarter of the nineteenth century. Although the identity of the first fish and chip shop cannot be confirmed, it was either in London's East End or in the textile factory districts of northern England, and it opened in about 1870, combining two commodities, fish fried in batter and chipped potatoes, which had previously been hawked through the streets as separate entities. It was a cheap and filling dish, enlivened with salt and vinegar, and it began as a late-night snack for revellers on the way home after the pubs had closed. By the turn of the century, however, the fish and chip shop had become a general feature of the urban industrial landscape, selling to women and families as well as to men, and to factory workers (and housewives) in the midday break as well as in the early evening and at night.

By 1910 there were about 25,000 fish and chip businesses in Britain, almost all of them single-family operations (the success of the Harry Ramsden chain in the late twentieth century was novel and anomalous). By 1927, as the industry reached its peak, there were perhaps 35,000. Fish and chips provided the dominant market for the catches of the steam trawler fleets that were rapidly expanding at the turn of the century. The business also consumed huge quantities of potatoes and generated a major specialized engineering industry to supply frying ranges and related products. It was both mocked and celebrated in music-hall song, and different British regions took pride in their own preferred species and specialities, especially "jumbo haddock" fried in beef dripping in the coal-mining and woollen-manufacturing districts of West Yorkshire.

As a labor-saving foodstuff, prepared outside the home and often defying the "civilising process" by being sold in newspaper wrapping and eaten in the street with the fingers, fish and chips attracted a lot of snobbish and pseudo-scientific criticism. Social reformers associated it with slovenly domestic habits and claimed that it was expensive, while local government medical officers alleged that it spread illnesses, and in many towns it was regulated as an "offensive trade" alongside soap boiling and rag picking. In Scotland, where many of the fish friers were Italian immigrants, authority was particularly suspicious. But the balance of the evidence suggests that it provided a valuable and palatable boost to working-class diets, while taking some of the strain off hard-working domestic labor and providing an outlet for aspiring petty capitalists in working-class communities. It was even claimed that fish and chips played an important part in winning World War I by sustaining morale and stamina on the home front, and by the 1930s it was becoming increasingly acceptable to middle-class consumers, although by that time it was beginning a long, slow decline that still continues at the turn of the millennium.

See also **England; Fast Food; Fish; Fishing; French Fries; Potato.**

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John K. Walton

FISHER, M. F. K. Mary Frances Kennedy Fisher (1908–1992) wrote twenty-three books and hundreds of articles in which cuisine was virtually always her metaphor of choice. Many of her works included recipes, and she is often characterized as a food writer; this description, however, underestimates her powers as a highly creative author and a keen observer. She wrote of human hungers in the deepest sense. Fisher recognized the rich psychological, social, and cultural meaning of cuisine, identifying food, security, and love as fundamental and intertwined needs. Memorable meals eaten, rich wines and liqueurs imbibed, and the company she kept are equally important in her often highly personalized writing.

Mary Frances Kennedy Fisher at home in Sonoma, California, 1971. © AP/WIDE WORLD PHOTOS.

Born in Albion, Michigan, but raised in Whittier, California, from the age of four, Mary Frances Kennedy was the eldest of four children. At the age of nine she began experimenting in the kitchen and preparing meals. She wrote that food preparation brought recognition from her family, as well as proof of her own ontological being. Her father, Rex Kennedy, owned and published the local newspaper. Whittier was a conservative Quaker town, and the Kennedys, Episcopalian. Their religion prevented their complete assimilation into the community; thus, Mary Frances grew up with a perspective akin to an ethnographer: never fully part of the local culture, but with a defined role to play in it. She developed a discerning eye and used it to interpret others' lives while remaining removed from them.

At age twenty-one, the author married Alfred Young Fisher, the first of her three husbands. He received a graduate fellowship to study in France, and Mary Frances accompanied him, choosing to study art at the University of Dijon. The next three years proved formative as she became fluent in French and was introduced to regional cuisines. Although she was not to consider herself a writer for some years, she was a passionate correspondent throughout her life. Her expertise as a wordsmith was already apparent in her letters home from France (Barr et al., 1997).

Fisher's permanent home was California, but she passed numerous extended periods in France. Her writing reflects these distinct parts of the world. She also owned a home and a vineyard in Switzerland with her second husband, Dillwyn Parrish. She frequently wrote of her trans-Atlantic journeys by ocean liner and train travels within Europe. These accounts included descriptions of dining rooms and dining cars, the cuisine, its preparation, and its service. The journeys became symbolic of transitions in her life, as in one of her most compelling works, *The Gastronomical Me* (1943).

Fisher wrote in a broad range of genres including fiction, nonfiction, journalism, screenplay, poetry, and children's literature. Although her writing includes two novels, she excelled at essays. While many of her writings were based on events in her own life, she fictionalized these first-person narratives, transcending the boundaries of autobiography.

Fisher had a bold character; she was strikingly independent and she spun a worldly mystique around her tales. After divorcing Donald Friede, her third husband, she raised two daughters as a single parent. Her worldly panache convinced many readers that she was wealthy. In reality, her commitment to writing meant that she often struggled to make ends meet, earning less from her books than her published essays, which included a two-year series for the *New Yorker*, compiled afterward in *With Bold Knife and Fork*.

Among Fisher's greatest contributions was the translation of Jean Anthelme Brillat-Savarin's *The Physiology of*

Taste. The early-nineteenth-century book of French manners is a masterpiece of droll commentary. Fisher's achievement lies not only in a masterful translation, but in her witty notations, equal to Brillat-Savarin's original, self-effacing, humorous style.

Fisher generously mentored young writers and had significant impact on Jeannette Ferrary and Anne Lamott. She was a close friend of both James Beard and Julia Child; the three visited, corresponded, and influenced one another. She advised and befriended restaurateurs including Alice Waters of Chez Panisse in Berkeley, California. Fisher favored fresh and local foods; she called them honest. Her approach had a significant impact on the evolution of California cuisine in the last quarter of the twentieth century. She passed her last years in the California wine country, and the region became the subject of some of her work.

W. H. Auden stated that had M. F. K. Fisher's subject been anything other than food, she would have been appreciated as the United States's finest twentieth-century author. Her books were widely translated and repeatedly republished. She made French cuisine and culture accessible, opening the doors of western European gastronomy to North Americans and other readers worldwide; her work reflects the sense of place she felt on two continents. Fisher received numerous literary prizes, including a lifetime achievement award from the James Beard Foundation. She was elected to the American Academy of Arts and Sciences in 1991.

See also **Beard, James; Brillat-Savarin, Anthelme; Gastronomy; Metaphor, Food as; United States: California and the Far West.**

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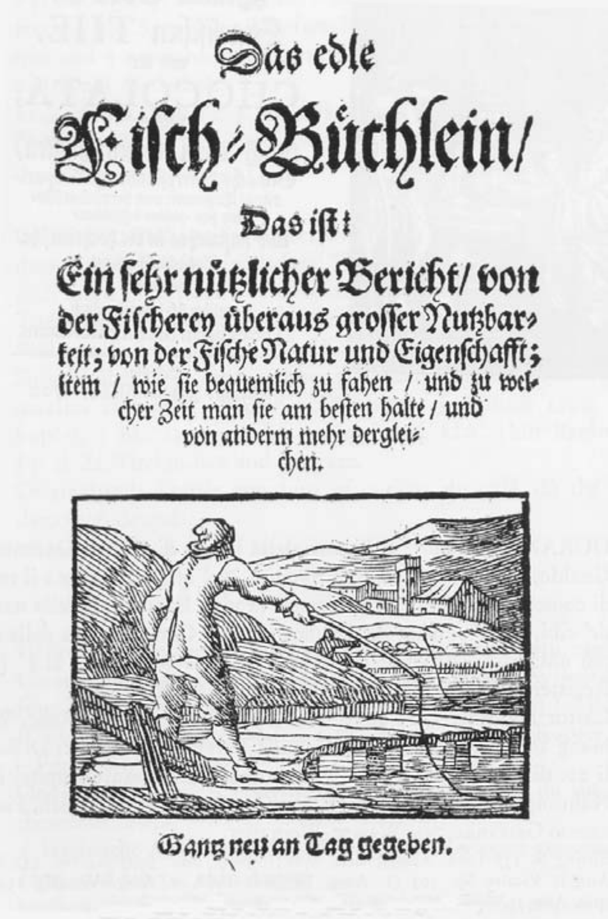
Susan L. F. Isaacs

FISHING. Fishing is the art and science of catching animals that live in water. This pursuit can be for fun or profit. Recreational angling is often practiced as an art, with little to no expectation of actually catching and keeping a fish for personal use. In commercial fishing, there is an expectation of catching and keeping fish or invertebrates and an expectation of selling those animals for profit. This article will focus on commercial fishing.



Das edle
Fiſch-Büchlein/
Das iſt:
Ein ſehr nützlicher Bericht/ von
der Fiſcherey überaus groſſer Nutzbarkeit;
von der Fiſche Natur und Eigenſchafft;
item / wie ſie bequemlich zu fahen / und zu welcher
Zeit man ſie am beſten halte / und
von anderm mehr dergleichen.

Gantz neu an Tag gegeben.

This rare manual on fishing called "The Excellent Little Fish Book" was published anonymously in Nürnberg about 1660. Parts of the text are based on Georg Mangolt's *Fischbuoch* [Fish Book] printed in Zurich in 1557, one of the first books to deal with fishing as an art and as a sport. ROUGHWOOD COLLECTION.

Hunting and gathering animals that live in water is an ancient form of food gathering. Today, aquatic animals caught from wild populations are one of, if not the last, major food category we still predominantly hunt and gather. Virtually all of the other foods we consume are grown in agricultural operations. However, we are in the early phases of a major transition from hunting and gathering fish and shellfish to agricultural production (aquaculture) of aquatic animals.

We live on a wet planet. Water comprises greater than 70 percent of Earth, and that habitat is home to far more vertebrates than the dry portion of the planet. Given the size and scope of aquatic habitats and the diversity of species present, it is not surprising that it took until 1989 to reach maximum sustainable yield from the world's oceans. Maximum sustainable yield is the tonnage of aquatic animals that can be harvested annually while maintaining healthy populations. It is important to note that there are two distinct groupings when discussing fish: individual species and the sum of all species. Further subdivisions are possible, but the important point is that individual populations or species can be in poor condition (for example, low numbers) while overall, fishes in that body of water are generally healthy.

Since 1989, global commercial harvest has been close to 90 million metric tons, and that figure is not expected to increase. The largest commercial harvest industries are for species used for making fish meal (anchovy, herring, and menhaden) and those used for food (pollack, mackerel, and capelin). The largest species-oriented industries are listed in Table 1.

There are over 22,000 species of fish, and the United Nations Food and Agriculture Organization monitors commercial harvest of slightly over 1,100 species. Further, a thorough understanding of fish taxonomy (the science of fish identification) is not commonplace among many commercial fishermen. Thus, many species simply are grouped into a nonspecific category such as marine fishes. From the data above, it seems clear that the commercial fishing fleets from the western coast of South America (Chile and Peru) and Southeast Asia (China, Thailand, Vietnam, Myanmar, and Japan) harvest more fish than other parts of the planet. Not shown in Table 1 are the most productive fishing grounds, which are the Pacific Northwest, Pacific Southeast, and the northeastern portion of the Atlantic Ocean.

TABLE 1

Commercial harvest of fish and shellfish in 1999 and the country of landing

Species	Harvest (million metric tons)
Anchovy, Peru	6,740,225
Marine fishes, China*	3,853,814
Anchovy, Chile	1,983,040
Pollack, Russian Federation	1,500,450
Marine mollusks, China*	1,445,303
Freshwater fishes, China*	1,394,610
Largehead hairtail, China	1,222,454
Jack mackerel, Chile	1,219,689
Marine crustaceans, China*	1,131,643
Anchovy, Japan	1,096,916
Pollack, United States	1,055,016
Herring, Norway	821,435
Araucanian herring, Chile	782,142
Marine fishes, Vietnam*	770,000
Marine fishes, Thailand*	750,000
Capelin, Iceland	703,694
Marine fishes, Myanmar*	695,904
Gulf menhaden, United States	694,242

*Many species are listed under a general heading.

SOURCE: United Nations Food and Agriculture Organization

There are several reasons postulated for the plateauing of commercial harvests. Pollution and other environmental stressors on fish populations are common speculations, as well as overharvest by commercial fishing fleets. From the industrial revolution to current times, pollutant levels in the oceans increased and certainly had some negative impact on populations of animals in aquatic habitats. Over the same time period, commercial harvesting equipment improved significantly and also contributed to declines in populations and leveling of harvest volumes. Regardless of the cause, wild populations of many fish and shellfish declined in the latter half of the twentieth century. However, it is important to grasp the scope of the situation before assigning blame to any particular cause.

The average depth of oceans is over 13,000 feet (4,000 meters). Over 84 percent of the oceans are deeper than 6,500 feet (2,000 meters). The Marianas Trench in the western Pacific Ocean is the deepest place at 36,000 feet (11,000 meters), deeper by a mile than the altitude of Mount Everest (29,000 feet, or 8,845 meters high). As stated earlier, the vast majority of our planet is under water. Many species of fish either travel long distances in their normal habits or the populations inhabit large areas. Given these facts, establishing accurate population estimates is virtually impossible. Fishing gears and efficiency of commercial harvest have increased significantly and also contribute to attaining maximum sustainable yield.

Fishing gears are largely unchanged from ancient times. Nets of various types are the most commonly used commercial fishing gear. The basic concept of a net, regardless of the configuration, is the same today as it was when ancient man first wove fibers together to make nets. Impaling devices such as spears and harpoons are also unchanged from ancient times. There are numerous types of traps in use, mainly for trapping crustaceans (lobsters, crabs, crayfish), and those have ancient origins. Fishing gears have become more efficient, but in subtle ways. Prior to about 1980, trawls (nets pulled behind a boat) could attain only a limited depth and were nonspecific in their catch. Significant research efforts resulted in trawls that could be fished deeper (up to 8,200 feet, or 2,500 meters) and had devices that would tend to exclude mammals or turtles. Harpoons are not routinely used in the twenty-first century, and spears have evolved to spear guns for individual fishermen. Trap materials have changed with the advent of polymers, but the basic configurations have not changed for hundreds of years. The major change that occurred is not in gears, but in the boats.

Commercial fishing boats are capable of staying at sea for months at a time, giving fishermen the ability to fish anywhere in the world. Technological advances in

Caboclo fishermen fishing in the Amazon River of Brazil. © Wolfgang Kaehler/CORBIS.

engines, fuels, and boat designs, coupled with international treaties that allow foreign fishing fleets safe harbor, increased the efficiency of commercial operations. Harvested animals can be cleaned on board and frozen at −76°F (−60°C) for extended storage. Large companies evolved to more efficiently harvest fish, and those companies developed the concept of multiple fishing boats and a mother ship for processing and storing fish. It is not uncommon to find Japanese fishermen in the North Atlantic Ocean harvesting giant bluefin tuna. Fishermen also take advantage of the other forms of commercial transport, taking some of their harvest to nearby ports and consigning them to air freight companies for transport back to home bases. Frozen giant bluefin tuna are flown from New York to Tokyo regularly.

Restrictions on commercial harvest have been common since the early 1980s. As populations declined, state or federal regulatory agencies restricted harvest by establishing quotas (limited number of fishing licenses), restricting harvest volume (limitation on volume, which can be expressed per day, week, or season), or restricting gears (numbers of traps, length of nets, number of nets). There is at least one example on every coast of the United States in which commercial harvest has been significantly curtailed, even to the point of declaring the species rare and endangered. However, as mentioned above, the size and scope of fishing demands that many countries contribute toward management of populations.

International agreements are in place that define who can fish where, seasons for fishing, and gear acceptance. Most countries claim some distance from their shores as available only to local fishermen. The Fisheries Conservation and Management Act (or the Magnuson Act) was adopted in 1976 and declared the first two hundred miles (322 kilometers) from U.S. shores as open only to U.S. fishermen. The International Whaling Commission was established in 1946 to regulate the global harvest of whales, but has only slowly gained momentum and has no real authority to enforce agreements. Native Americans retained many of their rights to traditional fisheries and harvest those populations in the twenty-first century. Many times, these harvests are contrary to recommendations from regulatory agencies and are controversial with other fishermen.

Fishing communities in New England, the Gulf Coast, and the West Coast have been seriously impacted by the decline in commercial fishing. Whole communities are in significant economic crisis. New industries are not readily apparent for a labor force trained in commercial fishing, processing, and distribution of fish and shellfish. Since the 1980s the fisheries have been in sharp decline, and with it a way of life. Some fishermen, with modified gears, are able to switch species. For example, in 1970, the harvest of the Argentine shortfin squid was 1,300 metric tons. However, harvest of anchovy became erratic and new species were sought, including the shortfin squid. Between 1970 and 1999, total harvest of the Peruvian anchovy by all countries varied from 93,000 metric tons to over 13 million metric tons. Over this same time period, harvest of the shortfin squid increased to just over 1 million metric tons. Harvest of the Atlantic cod, the species used in most fish sandwiches in the United States, has declined from over 3 million metric tons to around 1 million metric tons. A replacement has not been identified in the North Atlantic ocean. Creative marketing techniques also opened opportunities for commercial fishermen. A deep-water species around Australia, New Zealand, and Tasmania was once unmarketable. The local name for this fish was the slime head. However, under its new name, orange roughy has found a ready market in the United States.

The newest of the commercial harvest industries developed in the past forty or fifty years and focused on species inhabiting coral reefs. The pet or hobby aquarium trade increased significantly as technology made it possible to maintain saltwater fish tanks in any temperature-controlled room. Harvest was often by hand, using small dip nets, but more recently other forms of harvest have been used, including poisons (cyanide) and explosives. These collection methods are indiscriminate and have been banned in most countries. The demand for ornamental fishes coupled with the gradual bans on many harvest techniques led to development of aquaculture industries focused on tropical fishes for home aquaria. The same scenario is occurring with fishes destined for food. However, culture of fishes for making fish meal is not occurring and appears unlikely. Fish harvested for fish meal do not command high prices and need large areas. The economics of that form of aquaculture are not favorable.

See also **Crustaceans and Shellfish; Fish and Chips; Fish; Mollusks; Fish, Salted; Fish, Smoked.**

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Paul B. Brown

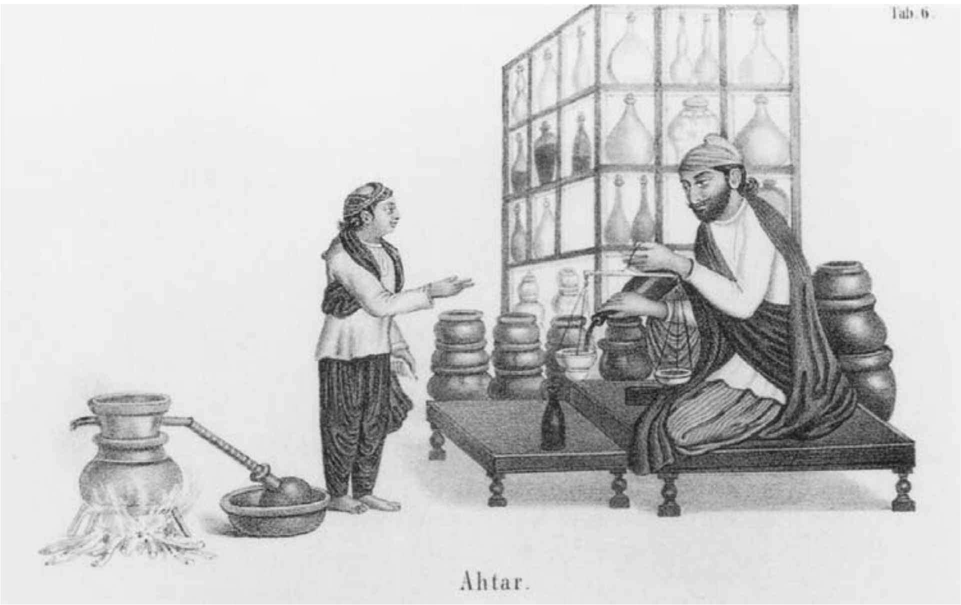
FLATWARE. *See* **Cutlery.**

FLOWERS. Throughout history, flowers, like seeds, leaves, and stems, have contributed to human cookery. But edible flowers, when added to food, provide more than sustenance and flavoring. They add form and color. They are an exception to the rule, a spark of interest, and a spectacle that cannot last. Whole fresh flowers connect people to food in a way that nothing else does. Just as beauty is associated with good in children's fairy tales, so too with food: flowers add to the pleasure of eating. Flowers have long been an essential link in the human food chain. The joining of flower pollen with flower ovules is a starting point in the cycle of life. More than we imagine, life depends on a sequence that starts with flowers and progresses to pollination, seeds, and plants. Without the rebirth of plants, without continuous replacement, life would cease to exist. To sustain life, there must be birth and growth.

Flower Biology

Flowers are the blossoms of plants and the reproductive organs of angiosperms. Edible and nonedible flowers alike have a common concentric structure of distinct parts that, beginning at the base of the flower and proceeding up to the center, include the stem, ovary, sepal, petal, stamen (filament and anther), and pistil (style and stigma).

Flowers have been used in cookery for centuries. Here, flowers offer a touch of exotic color and texture to a salad garnished with pansies and nasturtiums. PHOTO BY ANDRÉ BARANOWSKI.



Flowers also figure as a flavoring in cookery, from violet syrup to rosewater, which was popular in both Byzantine and Arabic cookery. Rosewater still plays an important role in the cookery of many Eastern Mediterranean countries. In this 1838 engraving, a vendor is shown selling rosewater in Istanbul. His still is on the left. ROUGHWOOD COLLECTION.

Flower petals are showy, fragrant, and often fully flavored. Sepals, on the other hand, are leaflike structures that enclose the flower before it blooms and, unlike petals, are not valued as a source of food, flavor, or color. Stamens are the male parts, and they produce pollen. Anther sacs hold pollen, and in the case of pine trees, so much pollen is produced in the early spring that it accumulates in masses on lake shorelines and can be scooped up, dried, and used as an ingredient in bread and soups. Pollen is a complete food, rich in proteins, carbohydrates, vitamins, minerals, and enzymes. It can tone, detoxify, and balance the human organism.

Pistils are the female flower part. When pollen grains light on pistils, they absorb moisture, grow tubes, penetrate ovaries, and, finally, connect to ovules to fertilize seeds. Flower nectaries, or nectar glands, secrete nectar, which is used by bees to form honey. Nectar glands are located at the base of the ovary and above the anther.

History

In Roman times rose petals were used to flavor cooked brains, sweet marjoram flowers were baked in hash, and safflower petals were used for a boiled sauce. Roses and violets were added to wine to enhance flavor.

Later, in the Middle Ages, rose petals were used to flavor cakes, creams, and confectionery. Both orange blossom and rose petal water are flavorings made from flowers. Since the third and fourth centuries C.E., rose water has been made by steeping petals and then distilling the water. Middle Eastern and Indian sweets such as shola, baklava, firni, and halvah are flavored with rose water. It is also used to flavor Middle Eastern beverages such as lassi and sherbet. Flower use varies from culture to culture and age to age. While in America today roses are used more as a decoration than a flavoring, dried rosebuds are used as a condiment in Asian cookery.

Symbolism and Healing

Flowers are a symbol of life and a source of birth and healing. For example, when placed on a wedding cake flowers signify new life, and at times of sickness and death they comfort the grieving. During the Easter season the passionflower is a symbol of the holy passion, the suffering of Jesus Christ. In ancient Greece the rose symbolized love, beauty, and happiness, and during the Roman era, roses were associated with Venus, the goddess of love.

Edible flowers are used with various foods to mark events such as graduation, marriage, and retirement. Christians associate flowers with Christmas, Easter, Ascension, and Epiphany. States and nations have adopted flowers as emblems. For example, the emblem of the Netherlands is the edible tulip, and Illinois, New Jersey, Rhode Island, and Wisconsin have adopted the violet as their state flower. Four states—Georgia, Iowa, New York, and North Dakota—have adopted roses. Florida adopted the orange blossom, and Hawaii the hibiscus.

But in addition to their symbolic and spiritual uses, flowers are consumed for their healing properties. Flowers from the great scarlet poppy contain alkaloids such as thebaine, which is a source of codeine. The unripe pods

Popular Garden Flowers and Their Flavors

ANISE HYSSOP: sweet, anise, or licorice; used to flavor red meats and as an herb
CARNATION: mild to sweet; use petals only in salads
CHIVE: onion smell, peppery, savory; use as garnish, flavoring for meats, salads, sauces
CHRYSANTHEMUM: savory, mild to strong, and bitter (some are poisonous)
DAISY: sweet and savory; flower buds are pickled, flowers used on salads, used to make wine
DANDELION: savory; a bitter herb mentioned in the Old Testament: used in salads and wine, the greens are eaten as a vegetable and sold canned
DAY LILY: savory (can be toxic)
FUCHSIA: mild flavor; use whole as garnish on salads and cooked fish
GRAPE HYACINTH: grape flavor, slightly sour, bitter aftertaste (can be toxic)
HOLLYHOCK: mild; use as garnish or container (can be toxic)
HIBISCUS: slightly acidic, sweet; used in tropical fruit salads
HONEYSUCKLE: sweet; use in salads and with fish
LILAC: strong smell; sweet and savory; crystallize the flowers to use on cakes or confectionary; used in tea blends
MARIGOLD: savory; small four- and five-petal varieties best; use in soups
NASTURTIUM: savory, peppery, piquant, like watercress; used in salads and used fresh as a garnish for hot vegetables
PANSY: sweet and savory; crystallized to use on cakes; used fresh on salads
POPPY, EUROPEAN AND CALIFORNIA: mild; use in salads for color
RED CLOVER: mild, like hay; used with wild herb salads; add florets to salads
ROSE: sweet to bitter; herbal teas; use old varieties; also used to decorate cold platters of meat and fish
ROSE PETALS: sweet to bitter, crystallize; add to salads; garnish plates
SCENTED GERANIUM: tastes like variety, either lemon or rose used to make tea and an herb in pastry
SQUASH: savory; batter and fry into fritters; serve as vegetable; also served stuffed
SUNFLOWER: member of daisy family; use unopened flowers like artichokes or use the bitter petals; garnish for granola made with sunflower seeds; use with pasta salads
TULIP: mild, sweet to bitter; use with asparagus or rhubarb
VIOLET: sweet; use in salad, as a garnish for poke sallet, an egg dish that includes cooked poke; use crystallized on cakes

of opium poppies are used to make many alkaloids including morphine, thebaine, narcotine, and codeine. The list of flowers used as medicine is extensive, and it includes arnica used as an anti-inflammatory analgesic and hawthorn used as an antispasmodic, cardiac, and vasodilator. The marsh mallow is a diuretic, antitussive, and demulcent. Passionflowers are a sedative. Rosemary is used as a tonic, diaphoretic, antiseptic, and astringent. And finally, due to their astringent qualities, some flowers, including nasturtiums, roses, and yarrow, are used as bath oils.

Preparation and Consumption

While flowers are often used fresh, they are also preserved for later use when they are stored dried, freeze-dried, candied, crystallized, or even frozen in ice cubes.

Flowers or flower parts are eaten as sweeteners, vegetables, flavorings, beverages, and garnishes. In terms of quantity, the most widely used flower today is the hop, a conelike flower or strobilus that is dried and used to flavor beer and ale and is also an antimicrobial agent. Squash blossoms are served stuffed, fried, or deep-fried. The great variety of flower foods is typified in honey, a sweetener made by bees from flower nectar. Cauliflower, broccoli, and pickled capers are flower buds. Pansy and lilac flowers are crystallized and then used for cake, cookie, and pastry decorations. Lavender, chamomile, lilac, and jasmine flowers are used to make herbal teas. Hibiscus flowers are boiled and sweetened to become *agua de jamaica* or jamaica water, a Mexican beverage made like tea, but served like iced tea or fruit juice. Violets, mimosa, and forget-me-nots are used to flavor confectionery.

Today, out-of-season blossoms, as well as dried flowers and flowers made of marzipan and frosting, are common on wedding and birthday cakes. Flowers are stored and shipped fresh, pressed, dried, and crystallized. Some institutions even use flowers of plastic, silk, paper, wood shavings, and wire to decorate food. This pursuit of flowers is epitomized by upscale restaurant chefs who order a box of mixed fresh flowers, and then use them indiscriminately, either whole or in parts, as the finishing touch to elegantly served dishes from medallions of venison to creamy custards with Grand Marnier.

The stigmata of the fall-blooming saffron crocus provide an essential spice for the bouillabaisse of southern France, the paella of Spain, the risotto of Italy, and the pilaf and biriani of India. Saffron, which is native to Asia Minor, adds an orange-yellow color to these dishes and gives them a spicy, pungent, and bitter flavor. Today, some of the finest saffron is produced in Spain. Saffron is costly because it must be handpicked; it takes four thousand stigmata to yield one ounce of powdered saffron.

Issues

The use of edible flowers as food also raises a number of concerns. First, culinary flowers must be free from insecticides and herbicides. In one sense, assuring toxin-free flowers is easy because fresh flower buds and flowers grow quickly. On some plants it takes only a few days for new buds and flowers to form. On the other hand, commercial flowers are often sprayed to keep them pest-free and visually attractive.

But of even greater concern than pesticides is the loss of historical species. As a result of evolution and environmental degradation, there has been a loss of species and genetic diversity. This, however, is somewhat offset by natural evolution and, in the case of flowers, the constant breeding of new and more beautiful varieties. A third problem is the use of personal or regional nomenclature that makes it difficult to trace the use of flowers in history. Cultures from Native Americans to tribal Africans have celebrated food with flowers, but these traditions are largely lost.

See also **Herbs and Spices**; **Presentation of Food**; **Weddings**.

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Mark F. Sohn

FLUORIDE. Fluoride is an important trace element in human nutrition. Daily exposure to small quantities is widely considered to be vital for maintenance of sound tooth structure. Ingested or systemic fluoride has long been known to offer significant benefit when supplied during tooth formation in childhood. More recently, topical exposure (that is, making fluoride available at the tooth surface) has been shown to provide benefits throughout life, even for older adults.

Sources of Fluoride

Water, rocks, soil, and living tissue all have naturally occurring fluoride as a constituent. Crystalline and carbonate minerals containing fluoride are common throughout the earth's near-surface crust. As water flows through the environment, fluoride and many other ions dissolve from sedimentary rock layers and soil into aquifers, streams, rivers, and oceans. Dissolved ions are essential for humans and all living things. Fluoride ions are absorbed directly from the water we drink.

Fluoride in Bone and Tooth Tissue

Fluoride ions taken systemically can become incorporated within bone and tooth tissue. Although bones and teeth have an organic matrix, it is their inorganic or crystalline hydroxyapatite composition that gives them their strength and hardness. Living human cells use available calcium and other minerals to form strong hydroxyapatite matrices. When fluoride ions are also available to the cells, an additional material called fluorapatite is formed. Integration of a small amount of fluorapatite within a hydroxyapatite matrix may produce a more durable substance than is found with hydroxyapatite alone.

Topical Mechanism

Fluoride ions can also provide a very strong surface or topical effect for teeth when available on a regular basis. One such effect is that topical fluoride inhibits the ability of some bacteria to produce dental plaque by blocking the function of important intracellular bacterial enzymes. Much more significantly, topical fluoride also leads to reduced demineralization and increased remineralization of enamel surfaces.

Bacterial Acid and Chemical Balance

Demineralization of a tooth occurs when bacteria create an acidic or low pH environment at the tooth surface. The acidity dissolves hydroxyapatite, releasing positively charged calcium ions and negatively charged carbonate and phosphate ions into saliva. When normal saliva flow dilutes the acidity, the positive and negative ions recombine and remineralize the surface.

This cycle represents a balance. Diets rich in fermentable carbohydrates such as mono- and disaccharides, which are relatively simply sugars, disrupt the balance. They stimulate some oral bacteria to produce dental plaque and acid. Dental plaque is a substance that attaches to tooth enamel and is colonized by the bacteria that form it. Once such a colony is established, each ingestion of fermentable carbohydrate causes approximately one half-hour of intense acid production by the bacteria. This burst of acid production lowers the pH near the tooth surface, demineralizing large amounts of hydroxyapatite. The balance is disrupted and, as the cycle is repeated, it damages the tooth's surface.

Topical Fluoride and Stronger Enamel

When sufficient amounts of negatively charged fluoride ions are routinely present topically at the tooth surface, a different pattern emerges for this cycle. The balance of demineralization and remineralization actually builds fluoride into the tooth's surface structure. Over long exposure to fluoride in saliva, more and more fluoride is incorporated, and the enamel surface becomes stronger. A much greater increase in acidity is then necessary before a destructive imbalance in the cycle will be initiated. This surface or topical effect is thought to be the primary means by which fluoride prevents dental caries.

Benefits of Community Water Fluoridation

In studies of many communities over several decades, it has become clear that there is great benefit to maintaining proper fluoride levels in the public water supply. A concerted public health effort throughout the decades since the 1950s has led to the maintenance of fluoride at these levels in many public water supplies.

Community water fluoridation is intended to provide fluoride at concentrations ranging from 0.7 to 1.2 ppm. Coincidentally, this is about the same concentration of fluoride that is found in ocean water. Levels are adjusted within this range regionally and throughout the year. This provides lower concentrations of fluoride when people are likely to drink more water and higher concentrations when less water consumption is expected.

Without other significant sources of fluoride during the 1950s and 1960s, community water fluoridation produced reductions of 40 to 50 percent in the number of cavities or dental caries among children. Their teeth had enamel that was more resistant to caries both when it was formed and throughout life.

Other countries have assessed a variety of alternative means for delivering protective levels of fluoride. These have included supplementation with tablets or drops, salt fluoridation, and milk fluoridation. However, in the United States, fluoridation of public water as part of purification treatment remains the most effective and economical means for providing this benefit to communities. Currently about 60 percent of the U.S. population has fluoride maintained at these levels in their drinking water.

In the 1980s, it became clear that the positive effects of water fluoridation were not limited to developing teeth. Studies of people age sixty-five and older showed that it was beneficial even when all of the fluoride exposure took place after tooth eruption. Those who lived in communities with fluoridated water as adults had significantly lower rates of dental caries on exposed tooth root surfaces than comparable older adults without fluoridated water.

Fluoride and Osteoporosis

There has been interest in potential positive effects of fluoride supplementation on increased bone density. When ingested, fluoride is absorbed primarily from the upper gastrointestinal tract and is excreted in urine. Fluoride that is not excreted is deposited in calcified tissues—bones and teeth.

Osteoporosis, loss of bone density, is an increasingly prevalent problem in the U.S. population among both men and women. Unfortunately, research to date does not suggest a useful effect of fluoride on bone strength, even when it is supplemented at concentrations twenty times greater than that found in fluoridated water.

Early Research on Fluoride

It was research on the effects of prolonged intake of excessive amounts of naturally occurring fluoride that led scientists to understand the protection afforded by healthy fluoride levels. In the 1930s, a dentist in Colorado, Dr. Frederick McKay, became curious about a brown surface stain seen on some of his patients' teeth. These teeth often had a rough and porous surface texture, yet they were also far less prone to develop dental caries.

McKay's early observations led to a long series of investigations. It became clear that this problem, a severe form of fluorosis, resulted from very high levels of naturally occurring fluoride in drinking water. McKay's water samples had fluoride concentrations as much as fourteen times greater than that recommended today for community water systems. These investigations led to the discovery that when fluoride was present at the low levels that are now widely used, it offered powerful protection from dental caries without any adverse effects.

Reevaluation of Fluoride Use

By the 1990s, the wide availability of fluoridated water led scientists to reevaluate fluoride use practices. Particular attention was paid to the potential for a diffuse exposure to fluoride throughout the population. Many packaged foods are processed in communities with fluoridated water, becoming sources of small amounts of fluoride to those who consume them. Far more important, however, is the use of toothpaste and other products containing fluoride. It was concluded that community water fluoridation levels remain appropriate, but that greater care must be taken in the use of fluoride toothpaste.

Levels of fluoride in treated drinking water are extremely low when compared to concentrations in common therapeutic products. For example, fluoride concentration in over-the-counter fluoride mouth rinses is generally about 230 parts per million (ppm); toothpastes contain about 1,000 ppm; prescription home-use mouth rinses and home-use gels range from 1,000 to 5,000 ppm; professionally applied fluoride gels contain 10,000 to 12,300 ppm; and professionally applied fluoride varnishes contain about 22,000 ppm.

The additional sources of fluoride, primarily toothpaste, have led to lower rates of dental caries in U.S. communities not provided with fluoridated water. However, even with these lower background rates of dental caries in the population, it is estimated that community water fluoridation alone still provides an additional reduction of 20 to 40 percent in dental caries when comparison is made to caries rates for Americans who do not have fluoridated water but who use fluoride toothpaste.

Fluoride Issues for the Future

During the reevaluation of fluoride in the 1990s, concerns were raised regarding the potential for fluorosis. In contemporary studies of fluorosis in the U.S. population, nearly all observed cases have been classified as "very mild" or "mild." These are categories of "white-spot" discoloration that are usually only apparent to a dentist conducting an intraoral examination. Ingestion of fluoride toothpaste is considered the primary explanation for these white-spot discolorations.

Children are likely to swallow toothpaste while brushing, ingesting an unintended and excessive amount of fluoride. The most effective strategy for avoiding mild fluorosis is to limit children to a pea-sized quantity of toothpaste at each brushing. This quantity is adequate for caries prevention and oral hygiene, but it should not lead to development of fluorosis.

Use of infant formula and some baby foods has also raised a degree of concern. Because of infants' very small body mass, the proper intake of systemic fluoride is lower than that for slightly older children. Some studies have identified varying levels of fluoride in these products, some approaching levels that are associated with increased risk for very mild or mild fluorosis in infants. Physicians and dentists are urged to use caution in prescribing fluoride supplements for infants and very young children living in communities without fluoridated water because they might be consuming these fluoride-containing products.

The U.S. Environmental Protection Agency has set a standard of 4.0 ppm as the maximum allowable fluoride level in drinking water. Within the United States, fluoride levels in drinking water are actually maintained at about one-fourth of this level. However, in some developing countries, particularly in southern Asia and northern Africa, natural fluoride is present at extremely high levels. In India, for example, a study sponsored by the World Health Organization found natural fluoride levels exceeding 1.5 ppm in about 8 percent of samples, with some concentrations as high as 22.0 ppm. In such areas, public health workers actively engage in efforts to reduce fluoride exposure and eliminate fluorosis.

Conclusion

Nearly one hundred organizations with related expertise, including the World Health Organization, the U.S. Public Health Service, the American Medical Association, the American Public Health Association, the American Society for Clinical Nutrition, the American Society for Nutritional Sciences, the International Association for Dental Research, the FDI World Dental Federation, and the American Cancer Society have recognized the importance of daily fluoride intake for dental health. Particularly when supplied through community water fluoridation, ensuring adequate dietary fluoride exposure has been an extremely safe and cost-effective public health measure. Fluoride is a trace element that has extremely important personal and public health benefits for promotion and maintenance of optimal oral health.

See also **Dentistry**; **Digestion**.

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Rob Berg

FOLIC ACID. Folic acid is a water-soluble B-vitamin first identified in 1930 by Wills and Mehta as "Wills factor." Wills factor cured the anemias of pregnant women in India, a clinical condition that commonly results from undernutrition. This vitamin was later isolated from spinach leaves and named folic acid (Latin *folium*, leaf). Unlike most bacteria and yeast, mammals cannot synthesize folate and, therefore, require folate in the diet. This vitamin is present in the body as a family of at least nine structurally related chemical compounds that are collectively referred to as folate. The term *folic acid* refers to a synthetic form of the vitamin. Folic acid, which is biologically inactive, is found in foods that have been fortified with it. Folic acid is also the form that is present in nutritional supplements. Folic acid can be converted by living cells to a biologically active form called tetrahydrofolate. This active form serves the same biological function as natural folates. The terms "folic acid" and "folate" are therefore often used interchangeably.

Chemical Forms of Folate

The different forms of folate found in the body exist primarily as modified forms of tetrahydrofolate. Each tetrahydrofolate form differs by modification of the selected positions in the molecule that involve the placement of a single carbon unit. Additionally, folate derivatives found in cells contain a glutamate polypeptide tail that consists of two to eight glutamate residues in length. This polyglutamate chain is required for folates to perform their biochemical functions and also to retain folate in the cell. The glutamate chain prevents the molecule from crossing cell membranes.

Dietary Folate

Vegetables are good dietary sources of naturally occurring folate, especially dark green leafy vegetables. Citrus fruits and fresh juices, berries, legumes, liver, and whole grains are other good sources. Most naturally occurring folates are sensitive to degradation by air and heat but are stabilized when bound to proteins present in foods. For this reason, fresh fruits and vegetables are the best sources of dietary folates since many food folates are destroyed during food preparation. Dietary folates contain a polyglutamate chain that must be removed by digestive enzymes in the intestine. These enzymes leave a single glutamate residue on the folate, and the folate is then absorbed by the intestinal cell. Most folates are taken up by the liver, which is the primary storage site for folate. Folates can then be redistributed to other tissues from the liver. Glutamate chains are re-elongated by the body after the absorption of folates with single glutamates.

Overview of Folate Metabolism

Folate serves as a cofactor that delivers single carbon units to particular enzymes that catalyze biochemical reactions. These folate-dependent biochemical reactions are referred to collectively as one-carbon metabolism. Folate functions in both the cytoplasm and mitochondria, the energy-producing units, of mammalian cells. Folate metabolism in mitochondria is responsible for the generation of formate, a source of one-carbon unit. Formate escapes the mitochondria and is a primary source of the single carbon units for one-carbon metabolism in the cytoplasm. One-carbon metabolism in the cytoplasm is required for the synthesis of DNA precursors, and the amino acid methionine from its precursor, homocysteine. Methionine, in turn, is converted to the cofactor S-adenosylmethionine or SAM. SAM serves as an additional source of single carbon units in the form of methyl groups that are required for other metabolic reactions including the methylation of DNA, RNA, and proteins. SAM also is required for the synthesis of phospholipids, neurotransmitters, and many small metabolites.

Folate as a Therapeutic Target

Folate-dependent reactions are fundamental for DNA synthesis and maintenance of DNA integrity. Therefore, folate is required for cell growth and replication. It is not surprising that folate-dependent enzymes have proven to be effective targets for antitumor and antimicrobial drug therapies. These pharmaceutical agents are structurally similar to folate and are referred to as antifolates. Agents including 5-fluorouracil and methotrexate (and related antifolates) bind to folate-dependent enzymes by mimicking the structure of folate but do not serve the same biological function. These agents enter the cell and inhibit folate-dependent reactions associated with DNA synthesis and result in cell death. Antifolates are used in the treatment of many cancers, Crohn's disease, rheumatoid arthritis, lupus, and other autoimmune disorders.

Folate Deficiency and Disease

The most common impairments of folate metabolism result from inadequate folate intake, certain drug therapies, smoking, malabsorption disorders, alcoholism, genetic mutations, and subtle individual genetic variations that occur normally in populations. Additionally, certain dietary factors can interfere with folate absorption in the gut and result in malabsorption of the vitamin. Inadequate folate status has been reported in many population groups including pregnant and lactating women, women twenty to forty-four years of age, adolescents, and the elderly. Folate requirements are greatly increased during pregnancy due to the high demand for folate by the growing fetus and placenta. Folate deficiency can present itself clinically as megaloblastic anemia, a clinical condition associated with enlarged red blood cells due to decreased DNA synthesis. Other clinical symptoms include an inflamed, red-looking tongue, nausea, vomiting, diarrhea, anorexia, hyperpigmentation, and fever. Folate deficiency during pregnancy is highly associated with several congenital defects including spina bifida. Population studies implicate impaired folate metabolism in other pathologies including cardiovascular disease, colon cancer, cervical dysplasia, and pre-eclampsia.

Folate and Homocysteine

One of the first biochemical indicators associated with impaired folate metabolism is increased serum homocysteine (resulting from decreased methionine synthesis). Both folate and vitamin B_{12} are required for converting homocysteine to methionine. Plasma homocysteine level is a sensitive marker of folate status, but homocysteine can be influenced by other vitamins, including vitamin B_6 and B_{12} status, as well as age. The relationship between folic acid and homocysteine levels in the body is important because of the association between homocysteine and vascular disease. Elevated plasma homocysteine is now considered an independent risk factor for atherosclerotic vascular disease. The risk of cardiovascular disease rises in proportion to an individual's serum homocysteine concentrations. Some studies also suggest an independent role of folate deficiency in cardiovascular disease. The relationship between homocysteine and disease is not understood, but two mechanisms are the focus of current research. Homocysteine contains a reactive thiol group that can modify proteins and affect their function. Alternatively, homocysteine can also be converted to *S*-adenosylhomocysteine, which is a potent inhibitor of many methylation reactions that modify DNA proteins and influences gene expression. Either or both of these mechanisms may account for pathologies that are associated with elevated homocysteine in humans.

Dietary Recommendations

In 1998, the National Academy of Sciences released the Dietary Reference Intake (DRI) values for folate that include a recommended dietary allowance (RDA) of 400 micrograms for males and females aged fourteen years and younger. For these individuals, the source of folate is not important. However, it is recommended that women of childbearing age consume an additional 400 micrograms of folic acid per day from fortified foods and/or supplements in addition to the intake of food folate from a varied diet. It is critical that women be folate-sufficient prior to pregnancy, since most birth defects that result from folate deficiency occur before the twenty-ninth day of pregnancy, often before the woman realizes she is pregnant. Maintaining adequate folate status is especially critical for women with a history of bearing children with neural tube defects, to prevent future incidence of birth defects. Pregnant women should consume an additional 600 micrograms of synthetic folate per day in addition to a naturally folate-rich diet. It is not normally recommended that anyone consume more than 1 milligram of folate per day.

The RDA is expressed as dietary folate equivalents (DFEs) because synthetic folic acid is more easily absorbed in the intestine than naturally occurring folate. One microgram of naturally occurring food folate is equivalent to 0.6 microgram of folic acid from fortified foods or supplements consumed with meals and to 0.5 microgram of supplements not consumed with meals. Because of recent federal regulations for food fortification, synthetic folic acid can now be found not only in dietary supplements, but also in enriched grain products (0.43 to 1.4 micrograms of folic acid per pound grain product) such as flour and pasta. Initial results from the fortification program indicate that plasma folate levels have more than doubled among adults who do not use folic acid supplements. The effect of this program on reducing spina bifida and other folate-associated birth defects and pathologies is yet to be determined.

See also **Fiber, Dietary**; **Vegetables**.

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FOLKLORE, FOOD IN. While doing folklore fieldwork with the Singing and Praying Bands of tidewater Maryland and Delaware, the present author observed a minor event that made a major impression on him. The Singing and Praying Bands are groups within some African-American Methodist churches in the Chesapeake Bay area of the East Coast of the United States that hold services in which they sing and pray with escalating fervor to invoke the Holy Spirit and to convert the unsaved. That day in particular, they were having no success: the Spirit simply was not stirring. Finally, one senior member slipped into the center of the singing group and called out the following verse to be added to the hymn:

> Old man Moses must be dead;
> Children in the wilderness crying for bread.

This couplet combines two episodes from the book of Exodus. The first line refers to the episode when Moses ascended Mount Sinai and disappeared from the camp of the Israelites, causing them to wonder about his continued survival (Exodus 32:1). The second line refers to the Israelites' muttering against Moses for leading them out of Egypt, only to face starvation in the wilderness (Exodus 16:2–3). In response to the murmuring of the Israelites, God caused bread, or manna, to rain from the heaven. This couplet, drawn from a large repertoire of folk poetry distinct to the band, summarizes the attitude of desperation of the Israelites, and applies their condition to that of the band members on that particular summer Sunday afternoon.

The moment the singing group heard this verse, they increased the energy of their singing, their clapping, and their foot stomping in a way that finally was successful in invoking the Holy Spirit. After receiving this blessing from the Spirit, people in the bands seemed to decide that the service could begin to wind down.

This use of "bread" as a metaphor for the Holy Spirit among the bands is not uncommon. On other occasions, the same groups append the line "Bread of heaven, bread of heaven, feed me till I want no more"—a line drawn form the hymn "Guide Me, O Thou Great Jehovah" by William Williams (1717–1791)—to the end of long, lined out hymns. They sing this line repeatedly as a meditation to focus the minds of the members of the group so that they can all come together in religious solidarity, as the disciples did on the day of the Pentecost (Acts 2:1-2), and the Spirit may become manifest among them.

In the liturgical language of the Judeo-Christian tradition, the word "bread" is often used as a metonym for food in general. Used as a symbol of all bodily nourishment, it may also become a symbol of the Holy Spirit, which provides band members with what they refer to as their "spiritual food." This story and the interpretation of its larger implications can be usefully employed to introduce the rich subject of food—in this case, bread—in folklore.

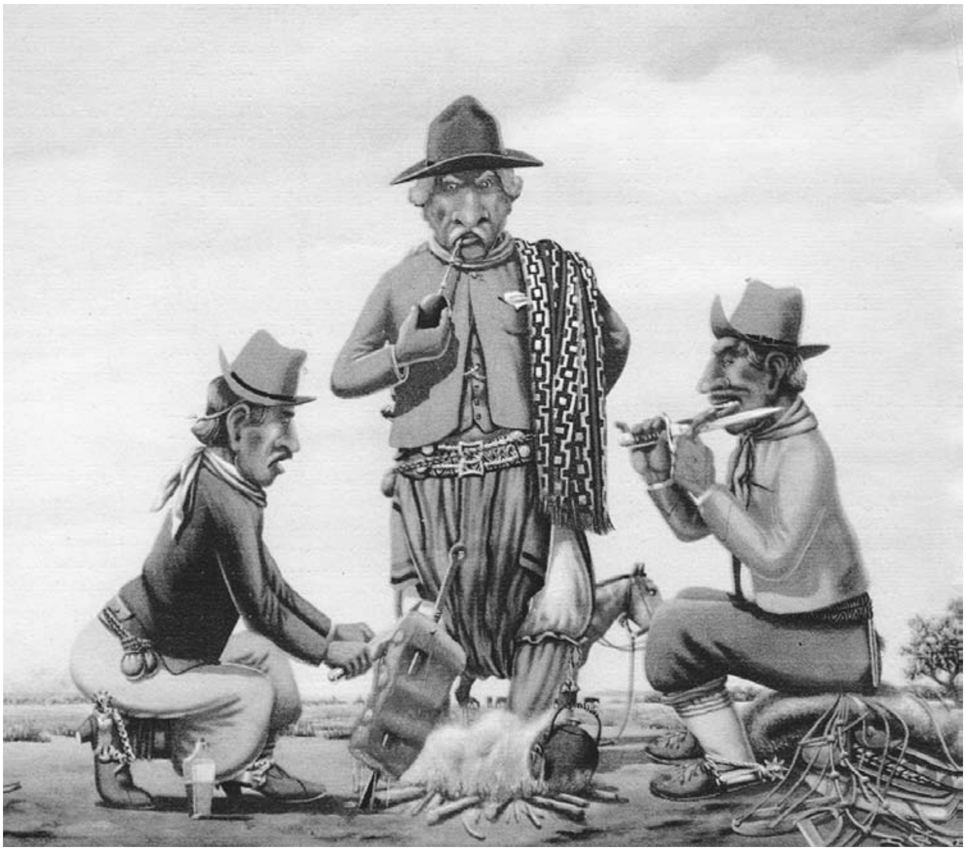
In actuality, references to food are made in all genres of folklore, and presumably in all cultures around the world. References occur in folktales (such as the story Hansel and Gretel, in which the witch's house is made of gingerbread and sugar candy, and Hansel almost becomes dinner himself), in folksongs (the hobo anthem, "The Big Rock Candy Mountain"), in folk dance (the Cake Walk, the Mashed Potato), in festival pranks (trick or treat during Halloween), in costume (a couple dressed as "a night at the movies" for Halloween, one attired as a theater ticket, the other as a bag of popcorn), and even in vernacular architecture (American roadside vernacular architecture includes buildings such as a duck-shaped drive-in restaurant selling roast duck as well as fast-food stands topped with sculptures of hot dogs amply slathered with condiments, as documented in the influential book on postmodern architecture *Learning from Las Vegas*).

While it would be impossible to develop a unifying theory or classification scheme that accounts for all such references to food in folklore, a loose framework of analysis can provide a prism through which the subject of food in folklore can be viewed. In order to establish such a framework about food in folklore, however, we should first examine the subject of folk cuisine itself, and folk eating habits. Together, these constitute the domain that scholars in the field of folklore and folklife have come to call "foodways." The food traditions of any one community include not just recipes, but the methods by which foods are gathered, stored, prepared, displayed, served, and disposed of. Such traditions include also culturally transmitted rules that govern ideas of health and cleanliness as related to food. Further, the academic analysis of foodways includes the study of foods that are especially esteemed or shunned by any particular identity group, and the study of culturally specific rules governing the contexts in which particular foods may or may not be eaten.

Great Green Globs of Greasy Grimy Gopher Guts

Great green globs of greasy grimy gopher guts
Mutilated monkey meat
Little chopped up birdies' feet
Great green globs of greasy grimy gopher guts
And I forgot my spoon.

So give me a sandwich with pus on top
Monkey vomit and camel snot
French fried eyeballs dipped in goo
Have some (Mom or Dad) it's good for you.



Like the North American cowboy, the Argentine gaucho plays a large role in South American foodlore. Here a trio of gauchos is depicted preparing *churrasco* on the pampas. Detail from a 1951 menu for La Cabaña Restaurant y Grill in Buenos Aires. Roughwood Collection.

In events that involve the serving of food—from ordinary meals to holiday feasts—ties of reciprocity between networks of preparers, as well as relationships between those preparing and those being served, become articulated. Differing customs pertaining to food also signal boundaries between differing groups of identification. Food events, therefore, tend to provide a rich subject for folk commentary about any one group's culture and social organization.

It is axiomatic in the field of folklore that folklore genres—whether food, story, art, or song—are expressive culture. Such expressive culture is not passively received and mechanically reproduced. Instead, when engaged in folk expression, individual tradition bearers in any cultural setting consciously build on the past to create the emerging culture. A corollary to this axiom is the idea that any such folk expression is rhetorical in intent: That is, it is designed to persuade its audience of the validity of its point of view about a subject. From this axiom and corollary, it follows that folklore about food in particular—that is, food in folklore, the subject of this essay—can be viewed first as expressive culture that offers a commentary on the foodways of the people from whom the commentary arises, and second as commentary designed to persuade its hearer or viewer of its point of view.

Folkloric commentary about food can be glowingly positive, even sentimental, or intensely negative. These extremes manifest themselves positively in festive, holiday cooking on the one hand, and negatively in food taboos on the other. Americans still listen longingly to songs or poems about chestnuts, wassail, and sugar plums long after these foods have disappeared as a regular feature of their diet. Americans do not just bake gingerbread men and cookies shaped like stars during this time of year. These foods are also turned into folk art when they are used as decorations on Christmas trees, thereby offering a commentary about our reverence for them as holiday foods.

Nontraditional food choices, conversely, may elicit disgust. In the United States, children's folklore, for example, abounds with songs or sayings about foods thought to be inedible. Children may enjoy the playing with the images of such foods to elicit disgust in others. In doing so, they demonstrate that they have internalized many of their culture's food taboos. In general, it is dif-

Good, Though!

Chorus: Oh, the Wild River crew is a rough old crew,
And I'll tell you the reason why:
We live on brew and cat-liver stew,
And a daily piece of moose-turd pie.

1. Old Jigger Jones kicked the knots off logs
With his bar feet, so they say,
But he hung around Wild River too long,
And it drove him nuts one day.

2. Now old Jigger Jones he got pretty tired
Of doin' all of our cookin',
So he says, "If I hear one more guy bitch,
For a new cook you'll be lookin'."

3. Jones was out in the woods next day
Chasin' a big deer herd;
Coming back to camp without any luck,
He slipped upon some fresh moose turds.

4. He scooped 'em up in his old game bag,
The grin on his face was sly;
He thought the boys would surely bitch
If they tried a piece of his moose-turd pie.

5. The boys come in for supper that night—
Their appetites were high;
They chawed their way through a ten-course meal,
Then they started in on the moose-turd pie.

6. One by one the boys turned green,
Their eyeballs rolled to and fro;
Then one guy hollered as he sank to the floor,
"My God, that's a moose-turd pie!
[Shouted] Good, though!" [cheerfully, with eyebrows and one finger raised]

In Barre Toelken, *Dynamics of Folklore,* Boston: Houghton Mifflin, 1979, pp. 179–180.

ficult to say a great deal about an item of folk expression without knowing the author, the author's motivation, the context, or the audience response. But in a society in which many children spend their formative years eating often nondescript cafeteria foods, they may also be offering a commentary on institutional food when they sing a song such as "Great green globs of greasy grimy gopher guts, mutilated monkey meat, little chopped up birdies' feet. . . ." Similarly, young people who refer to certain cafeteria offerings as "mystery meat" can be thought of as authoring a rather negative commentary on the food they are being served.

Other folk commentary about mass-produced foods is not so humorous. One urban legend tells of a couple who buy a fast-food dinner of fried chicken. When the woman bites into her meal, she finds that she has been served breaded, fried rat. The story can be viewed as a commentary on the anxiety of many Americans about potential contamination of industrially processed food. The folklorist Gary Alan Fine, who examined a large number of variations of this legend, suggests that the story also seems to chastise contemporary American women. Since the victim is always the woman of the couple, the legend seems to be contending that the whole episode might be her fault: if she had remained in the home and provided her partner with home cooking, the event would never have happened.

In African-American folklore, similar worries about the adulteration of the food supply have on occasion become transformed into rumors that blacks are vulnerable to being specifically targeted with toxic substances. In the late 1980s, folklorist Patricia Turner documented a rumor circulating among some African Americans to the effect that Church's Fried Chicken was owned by the Ku Klux Klan, and that their food contained a substance that would sterilize black men. The rumor seems to have been exacerbated by the fact that Church's located its franchises primarily in inner-city neighborhoods and did little advertising as compared with other fast-food companies. Furthermore, by offering food commonly identified with the African-American home kitchen, Church's had transgressed into somewhat sacred territory. Those who reported hearing the rumor had no problem believing that the Klan was capable of carrying out such a widespread secret plan, as the rumor claimed.

Another cycle of recent urban legends focusing on the disgust elicited by the eating of tabooed foods developed when Southeast Asian refugees began immigrating to the United States after the war in Vietnam. When several thousand refugees settled in Stockton, California, a rumor arose in adjacent communities that an expensive pet dog had disappeared; a neighbor's boy claims he saw a Vietnamese family eating the dog, and remains of the dog were later discovered by a garbage collector. While appearing to focus on racial stereotypes about the divergent eating habits of the new immigrants, according to researcher Florence Baer, this legend actually comments quite articulately on the white community's fear that new immigrants were swarming into the country and consuming so many resources and social services that none would be left for longer-term citizens.

Yet folk commentary on food taboos is not exhausted by urban legends about contamination of the food supply or diversity of eating habits. The most severely tabooed substances, according to esteemed folklore scholar Roger Abrahams, are human flesh, feces, and carrion. Nevertheless, items of folklore that speak of violating these taboos abound. In several predominantly male societies, for example, such as the logging camps of Maine, and railway construction camps in the West, a story known to folklorists as "Moose Turd Pie" has circulated as a song, a legend, and a joke. As the story is told by folksinger Utah Phillips, a new worker comes to work without knowing the workplace custom that whoever complains about the food will have to do the cooking until the next person complains. When the new man inevitably complains, he is forced to cook. To rid himself of the job, he sets about making a pie out of moose feces. On taking a bite of the pie, one of the more experienced coworkers calls out his disgust, "Moose turd! . . . Good though!"

This story comments on foodways in several ways. First, it humorously remarks on the horror of eating a grossly tabooed substance. Second, it seems to comment on gender roles in food preparation by taking for granted the idea that the men involved would rather do physically demanding manual labor than cook, which is often perceived as women's work. Third, the version told in concert by Phillips hints at traditional hazing practices to which new workers in male societies are sometimes subjected. During such hazing practices, the rookie worker is inducted into full-fledged membership in a group only after being ritually feminized—in this case by being assigned a "woman's" job. It also hints that the appropriate way for the new worker to endure such an initiation with his sense of masculinity intact is to develop a prank in retaliation that is as humiliating to the hazers as the hazing to the low man on the totem pole.

Folklore about food can reveal a great deal about gender identity. That life on the western frontier of the United States necessarily required pioneers to enlarge their repertoire of foods is incontrovertible, as folklorist Charles Camp has discussed in his review of the foodways data gathered by the Federal Writers Project during the New Deal years. Ranchers and cowboys who, like Native Americans, believed that no part of the animal on which their livelihood depended should be wasted on slaughter, developed the habit of eating bull testicles, which they often have referred to as "rocky mountain oysters." In Montana, where this specialized food may also be referred to as "Montana tendergroin" or "cowboy caviar," several festivals have come to be held every year in which all festival goers combined eat several tons of rocky mountain oysters. While there are a number of such events around the state, the first and largest, called "the Testicle Festival," takes place in Clinton, Montana, just east of Missoula.

Proverbial expressions in American English seem to imply that American males admire the virility of bulls. One speaks of being "strong as a bull." Manual labor that requires heavy lifting is called "bull work." A robust stock market is a "bull market." The eating of bull testicles can be interpreted as the human male's appropriating the bull's virility for himself. A festival that features this as its raison d'être, becomes in turn a celebration of human masculinity.

But the eating of such identifiable body parts of the bull also demands of many people who attend a suspension of some of their usual food inhibitions. Eating of such animal organs as eyeballs, brains, or sexual organs would under normal circumstances elicit displeasure from many Americans, old cowboy traditions notwithstanding. At the Testicle Festival in Clinton, Montana, this relaxation of eating habits—combined with the celebratory drinking of intoxicating beverages—seems to cause a lowering of other inhibitions as well. Human body parts that are usually covered are publicly displayed. Behaviors usually undertaken in private may be acted out or simulated in public. The result is a carnival-like folk festival the rationale of which celebrates masculinity in a way that inverts usual cultural inhibitions and exposes—as good festivals do, as good folklore does, and as some folklore about food does—human passions in their most naked form.

See also **Art, Food in: Literature; Bible, Food in the; Bread, Symbolism of; Taboos**.

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FOOD, COMPOSITION OF. Food composition activities include data generation in an analytical laboratory, data compilation in a database management system, data dissemination through print and electronic media, and data use by various professional and lay users.

Historically, food composition activities were limited to data on nutrients. Increasingly, food composition work deals with data for any component found in food: nutrients, bioactive nonnutrients, antinutrients, pesticide residues, other contaminants, additives, and more. A single food composition database, with proper documentation, can accommodate data on all these types of components.

Sectoral Elements

Food composition data are useful to many professions and sectors. Health, agriculture, environment, and trade are the sectors most fundamentally involved in food composition activities. Over time, agriculture has been the dominant sector involved in food composition research and service. This is demonstrated most clearly in international organizations such as the Food and Agriculture Organization of the United Nations (FAO), with a history of food composition work dating back to its inception in the 1940s; and in countries having the longest history of formal food composition activities such as the United Kingdom, where the Ministry of Agriculture, Fisheries and Food has had most of the responsibility, and the United States, where responsibility lies with the United States Department of Agriculture (USDA), and has since the late 1800s. Nevertheless, more than half of the participants in food composition conferences, and the researchers publishing food composition papers and books, are health sector professionals. In many countries it is the health sector that provides a high percentage of the funding for the work, and constitutes the highest percentage of the users of the information. Involvement of the environment sector is becoming increasingly important as it relates to the composition of indigenous or protected plant and animal species used as foods, and the content of environmental chemicals in the food supply. Trade has also gained more dominance in recent years. Nutrient information panels on processed foods have become regulatory requirements in many countries. And analytical data on both nutrient and contaminant content are necessary documentation for global food trade.

Organizational Elements

The international level. INFOODS, the International Network of Food Data Systems, was established in 1983 by United Nations University (UNU), with an organizational framework and international management structure that includes a global secretariat and regional data centers. Its mandate is "to improve data on the nutrient composition of foods from all parts of the world, with the goal of ensuring that eventually adequate and reliable data can be obtained and interpreted properly worldwide." In the mid-1990s, the Food and Agriculture Organization joined UNU in partnership for INFOODS. The main activities of INFOODS at the international level include development of technical food composition standards, assistance to Regional Data Centers and individual countries in developing their food composition activities, and publication of the *Journal of Food Composition and Analysis*.

The regional level. There are seventeen Regional Data Centers in operation. Some were created in the mid to late 1980s and have well-established and effective coordination (for example, LATINFOODS, ASEANFOODS, OCEANIAFOODS, and EUROFOODS); some are relatively new, yet making progress; and a few have been newly created and are trying to establish their regional or national priorities and capabilities. Regional food composition tables have been prepared, both electronically and in printed form (for example, Pacific Islands, ASEANFOODS, LATINFOODS), and many regions have regular food composition coordination activities and technical task forces involving all the individual countries in the region.

The national level. Most countries have food composition activities of one form or another. A national food composition program is usually the result of the combination and coordination of activities, within some defined administrative framework, related to food composition data generation, compilation, dissemination, and use. A steering committee is a useful structure, functioning well in many countries. This steering, or advisory, committee is ideally composed of individuals directly involved in food composition work, that is, the data generators, data compilers, and data disseminators. Crucial to the effectiveness of a steering committee is the involvement of data users. The users can be selected among dietitians, nutritionists, food industry personnel, and consumer group representatives.

Often a single organization holds the overall responsibility for managing a national food composition program, yet it is rare that a single organization accomplishes all the activities itself. Regardless of their affiliations, the laboratory-based data generators must interact closely with the data compilers, and the compilers must interact closely with the data users. In most countries there are other agencies with activities that have direct or indirect relationships with food composition data, but operate in concert with the national program. In addition to the desirability of a coordinated national approach for accomplishing essential activities, it is productive and important for a national food composition program to operate in conjunction with its Regional Data Center, and with ongoing international activities.

Technical Elements

Data generation is the process whereby foods are sampled, prepared for analysis, and analyzed in the laboratory. Data compilation is the process whereby the data from the laboratory are examined, manipulated, and incorporated into a food composition database. Data dissemination refers to the preparation and publication of books and electronic data products, which are made available to users in the various sectors. Data use also includes the application of these data to tasks, projects, and programs in the various professional sectors.

Data generation. Sampling, the process and procedures for obtaining foods that are representative of those available and consumed, is fundamental to any food composition activity. Preparation of a sampling plan often requires involvement of all the major contributors to a food composition program. Data generators must be involved in the sample collection, or at least the scheduling of sample collections, so that samples may be immediately and properly prepared for analysis. Data compilers must be involved because information on the sampling plan and details such as when and where sampling took place are important parts of a food composition database's metadata. Data users must be involved because they have the best appreciation of the foods that need to be analyzed, and often the location from which the samples should be collected. The services of a statistician are useful for developing a sampling plan, because representativeness is dictated by the number of food units collected—and analyzed—to achieve the goal. The goal might be to compare compositional differences between cultivars, or to achieve year-round, nationwide mean values for a food composition database. The overall quality of food composition data is determined largely by the sampling plan.

The collected samples must be properly handled so that they arrive at the laboratory without changes that might affect their composition. The key component, crucial to the correct determination of almost all other food components and most easily affected by improper handling and storage, is water (moisture). Once samples are delivered and documented, they are prepared for analysis. Preparation may involve separation of edible from inedible portion (for example, removal of bones from fish, or skins and seeds from pumpkins); kitchen-type preparation (for example, boiling rice); or combining of many samples into fewer samples (for example, combining five brands of similar biscuits into one representative composite sample). After this type of preparation, samples will be stored, or immediately analyzed. As with sample collection and sample handling, proper documentation of all aspects of sample preparation is essential.

Analyses. Most laboratories undertake a limited range of analyses for food composition purposes. This includes a set of core components and then additional components of interest, for example, laboratory research dealing with diet-related health problems. Core nutrients usually include the complete range of proximate components (water, nitrogen for the protein calculation, fat, glycemic carbohydrate, dietary fiber, ash, alcohol where relevant, and an energy value using factors applied to the energy-yielding proximates), some vitamins, and some nutrient elements. Additional components of interest often include cholesterol, individual fatty acids and aggregations of fatty acids (for example, total saturated fatty acids), carotenoids (both provitamin A carotenoids and antioxidant carotenoids with no provitamin A activity), other bioactive nonnutrients, heavy metals, and some so-called antinutrients (for example, phytates). Proper laboratory practices must be strictly adhered to, as well as laboratory quality assurance and quality control procedures, and details of analytical methodologies must be properly documented.

Data compilation. Data compilation requires a relational database management system, and adherence to international food composition standards where they exist. The database should accommodate numeric data, text, and graphics. Ideally, all the raw analytical data, and their attendant documentation, should be captured. The system should then be able to manipulate these data in many different ways. The same data system should provide an exhaustive reference database and any number of abridged user databases to satisfy the broad range of user requirements for food composition data. Many compilers only capture mean values, a practice that will satisfy many users. Other compilers provide more information, and therefore higher-quality databases, by including the number of samples and some expression of their variability. Other compilers are able to capture all the analytical data and prepare user databases with ranges (that is, high and low values), medians, and many different statistical expressions of the data, satisfying a broader spectrum of users and ensuring the highest quality database.

Some compilers prepare their databases with aggregations, excluding the baseline data (for example, a calculated value for vitamin A in retinol equivalents [RE] without individual values for retinol and each provitamin A carotenoid), whereas other compilers provide the analytical data for the individual components, in addition to the aggregations. This latter practice should be encouraged, since conventions for calculating aggregates based on biological activity change, and many of these individual components have other functions in addition to their roles as provitamins.

In data compilation, all food composition data can be included in the database. Complete information for all components in all foods is not necessary. Ideally, a database with one thousand foods should have complete information for core nutrients, but should also be able to accommodate sporadic data for other components in the foods included.

The early work of INFOODS included the development of standards and guidelines for compiling food composition databases for national and regional use (Rand et al., 1991), standards for unambiguously identifying food components (Klensin et al., 1989), and standards for ensuring international comparability and interchange of food composition data (Klensin, 1992). These standards are being maintained and further developed by INFOODS expert committees and consultative groups.

Data dissemination. With appropriate data compilation, food composition data can be disseminated in many different forms to satisfy all user requirements. Table 1 shows examples of some of the common forms in which food composition data are disseminated. Data disseminated as a set of relational files offers users with very specific needs, or those with customized software, the opportunity to use the data as they wish. Other common dissemination formats provide the types of information most often required by users.

Different countries have different approaches for charging, or not charging, for their data and data products. The United States Department of Agriculture prepares the largest single body of food composition data in the world and disseminates it freely via the World Wide Web, as both a downloadable set of relation files and a searchable reference volume.

Data Use

Food composition data are the basic, most fundamental information resource for most nutrition activities. Some of the specific uses of food composition data, along with examples of their uses, are listed below by sector.

Health sector. Food composition data are used in health protection activities in most countries in the world. "Food control" laboratories monitor mostly harmful components of foods. Other health protection activities include food composition activities involving total diet surveys or "market basket surveys" designed to determine the risk to populations from intakes of selected nutrients, antinutrients, and contaminants. The sampling, sample preparation, sample handling, analyses, and reporting requirements are virtually identical to the requirements of other food composition activities.

Health promotion. Health promotion activities include campaigns aimed at reducing or increasing the intake of certain nutrients in certain populations. Examples include healthy heart campaigns, typically using energy, fat, fatty acid, and cholesterol compositional data to educate the public about diet-related cardiac morbidity and mortality. In many developing countries, health promotion focuses on micronutrient data, including the necessity for including iodine in salt and provitamin A carotenoids in fruits and vegetables.

TABLE 1

Data dissemination forms

Output form	Foods	Components	Basis	Numeric data	Metadata
Set of relational files	All	All	Per 100 g e.p.; amino acids in mg/gN, fatty acids in g/100 gTFA; others as available	Mean, standard deviation, standard error, number of samples; raw analytical data as requested	Various; often as requested per sample, or per nutrient per record
Diet analysis software product	All	Subset of core nutrients with no missing values	Per 100 g or any serving size as user selection	Mean	Not provided
Tables, large reference volume, or Web format	All; portrait format; one food over 1–2 pages	All	Per 100 g e.p.; amino acids in mg/gN, fatty acids in g/100 gTFA	Mean, standard deviation, standard error, number of samples	Abridged and general; provided in introductory pages
Tables, concise	Subset of 200–800; landscape format; 15–25 foods over 1–2 pages	Subset of 12–28	Per 100 g and up to two common serves	Mean	Very general

e.p. = edible portion; N = nitrogen; TFA = total fatty acids.

Clinical research. Food composition data are central to many clinical research trials. Examples include studies focusing on amino acid digestibility in ileostomy patients, vitamin A intake in breast-fed infants, and serum cholesterol levels in vegetarians. Knowledge of the composition of the test and control food(s) and/or diet(s) is fundamental to these studies.

Clinical care. Clinical dietitians must know the composition of foods in order to provide effective and therapeutic meals in a clinical setting. Special diets for patients are often based on individual nutrients in the foods: low-sodium diets for hypertensive patients, diets low in saturated fats for heart disease patients, diets containing proper ratios of protein and fat, and those containing the proper amount of carbohydrate for diabetics, high-protein diets for burn patients, diets containing low phenylalanine for phenylketonuric patients, and so forth.

Epidemiological research and diet studies. Epidemiological and diet studies take many forms. Some studies address food intakes and relate them to nutrient content of the diet and the incidence of diseases. Interpretations of the findings of these studies often focus on individual nutrients. Recent examples include Dutch and Finnish studies of dietary antioxidants and lung cancer, and studies of vitamin E and colon cancer among Iowa women.

Public health policies. Many public health policies relating to noncommunicable disease focus on food composition. Such policies set forth nutrition goals and guidelines and include recommended dietary intakes (RDIs). An example of such goals and guidelines is "choose a diet low in fat, saturated fat, and cholesterol"; and an example of an RDI is "females between the ages of fourteen and eighteen should get 15 mg of iron daily." In order for such recommendations to be useful, both health professionals and the public must have access to data on the nutrient composition of foods.

Nutrition intervention policies. Nutrition supplementation typically takes the form of fortification of the food supply or supplementation of the population. Examples of food fortification include the addition of iodine to salt (most countries), of vitamin A to sugar (for example, in Guatemala), and of minerals and B vitamins to refined cereal products (United States, United Kingdom). Such interventions are only carried out after the nutrients in the food and water supply of a country have been studied, and a baseline position has been established and carefully monitored over a period of time.

Household food security. Although food security is an issue that spans the health, agriculture, environment, and trade sectors, household food security is usually considered to be a health sector issue. Knowledge of the nutrient content of the foods consumed by household members is a precondition for assessing household food security.

Agriculture sector. The intensive livestock industries require accurate nutrient composition data on the feeds used. These data are generally far more extensive than those required for human foods, and include many micronutrients and individual amino acids. "Performance" in these animals usually refers to weight at time of slaughter; muscle tissue to fat tissue ratios; and in the case of milk-producing animals, an accurate profile of the proximate composition (protein, fat, lactose, water, and ash).

Food security. National and global food security is generally considered an agriculture sector issue related to food production, rural development, irrigation, fertilizer and pesticide use, crop yields, and so on. A common tool used to assess national and global food security is the FAO food balance sheets that examine, at the commodity level, the amount of food available to a country. The amount of food is then converted into individual components and reported as the amount of protein, fat, and energy available per person per day from the domestic food supply. Food composition data assigned to the commodity data are the basis for many food security assessments, including FAO's yearly report on the number of undernourished people in the world.

Export food industries. The agriculture sector is responsible for ensuring that food exports meet the regulatory requirements of the intended market. Food composition data are important, as product specifications (for example, the fat content of butter) and as nutrition label panels.

Domestic food production. Agriculturalists have long professed that malnutrition is not just a health problem, but also an agriculture problem. Increased consumption of imported food commodities has brought about changes in food patterns and diets that have contributed to the increase in diet-related health problems previously unheard of in certain parts of the world. Agricultural extension workers are combating the incidences of diet-related diseases in some developing Pacific Island countries by using nutrient composition data in family food production, helping families in designing home garden projects to supply nutrients that would otherwise be consumed in insufficient quantities.

Molecular and traditional food plant and animal breeding. Breeding has been done to modify certain nutrients in foods. Familiar examples include corn bred for higher lysine and cattle bred for lower fat content of the carcass.

Environment sector. Knowledge of the nutrient composition of the native diet of endangered animal species is an important requirement for protecting them. In New Zealand, scientists have undertaken studies to determine the nutrient composition of the original diets of birds in their native habitat, to ensure that the same nutrients in the same quantities and proportions were being supplied in their human-made offshore island sanctuaries and other protected, artificial habitats.

Climate change also affects food composition. Ozone depletion affects both food production and the composition of crops and agricultural products. Like ozone depletion, global warming affects agriculture in terms of production implications. Its other major effect, now and in the future, is the creation of conditions that will permit certain food products to be cultivated where temperature conditions did not permit their cultivation previously. This will alter the food supply, and along with it the nutrient composition of certain foods, in certain countries. Food composition data have been used as markers in modeling and predicting environmental change, for example, monitoring the changes in fatty acid composition of fish to chart the climatic phenomenon of El Niño.

Trade sector. Trade has emerged in recent years as one of the more important and demanding of the sectors involved in food composition activities. Food composition in various forms features in the World Trade Organization agreements, the Codex Alimentarius Commission and several of its committees, multilateral and bilateral trade agreements, and national food regulations and standards. More than other sectors, trade has illustrated most poignantly the need for standards and harmonization in technical food composition activities. Many trade-related court cases have involved food composition data, both in the charges filed and in evidence presented, and many of the food product detentions and rejections at U.S. borders are due to the absence of the Nutrition Facts panel of nutrient content data.

See also **Agricultural Research**; **Climate and Food**; **Codex Alimentarius**; **Ecology and Food**; **FAO (Food and Agriculture Organization)**; **Food Consumption Surveys**; **Food Safety**; **Food Security**; **Food Trade Associations**; **Government Agencies**; **Green Revolution**; **International Agencies**; **Nutrition Transition: Worldwide Diet Change**; **Toxins, Unnatural, and Food Safety**; **Water: Safety of Water**.

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FOOD, FUTURE OF: A HISTORY.

Food is the first of the essentials of life, the world's largest industry, and our most frequently indulged pleasure. Food means creativity and diversity. Food is also the object of considerable concern and dread. Probably nothing is more frightening than the prospect of running out of food. Reflecting humanity's deep-rooted heritage of food insecurity, there have always been prophets warning us against complacency. And given mounting environmental concerns about population growth, global warming, soil erosion, water scarcity, agrochemical pollution, energy shortages, diminishing returns from fertilizers, and so on, it seems justified to wonder whether the banquet is over. Will our grandchildren's grandchildren enjoy the dietary abundance that most of us take for granted? And how will we feed a rapidly growing, urbanized population in the developing world?

As policy analysts debate scenarios, starkly different forecasts and proposals emerge. Some futurists predict unprecedented affluence, while others worry about global shortages and famine. Some are confident that the conventional industrial agriculture can take care of the future, while others see the status quo as a sure route to disaster. While many in government, academia, and industry look to new technologies—especially genetic engineering—to feed the world tomorrow without any modification of modern high-consumption values, others propose "low-tech" alternatives organized around smaller-scale, localized food systems dependent on a return to a more traditional appreciation of limits.

The Policy Debate

The European-American policy debate dates back at least as far as the late eighteenth century. When the economist and clergyman Thomas Malthus (1766–1834) published his *Essay on the Principle of Population* (1798) in response to "the speculations" of the French mathematician and philosopher the Marquis de Condorcet (1743–1794) and the English radical philosopher William Godwin (1756–1836), he crystallized a three-way argument about the future of the food system. As the demographer Joel Cohen writes in *How Many People Can* *the Earth Support?* (1995)—an analysis of the carrying-capacity debate—there are three enduring positions on the question of how we might feed everyone adequately in the future: 1) bake a bigger pie; 2) put fewer forks on the table; or 3) teach everyone better table manners. Condorcet offered the "bigger pie," or techno-cornucopian position: since there are no limits on human ingenuity, science and industry can always devise ways to bake bigger and better pies for everyone. Doubting the cornucopians' faith in technology, Malthus took the "fewer forks" position: humanity's capacity for reproduction outruns the farmers' capacity for production, or the scientists' capacity for miracles, so prudence dictates a more conservative, less expansive approach to the future. Profoundly pessimistic about human nature, Malthus also voiced severe doubts about Godwin's romantic-utopian "better manners" position, which held that in an egalitarian society with altruistic values, people would figure out ways to share nature's bounty and overcome scarcity. Godwin's democratic optimism was inherited and elaborated by both socialists and liberals who promoted a more equitable redistribution of resources as the solution to hunger.

In the two centuries following Malthus's *Essay*, the debates went through several cycles, becoming more pressing in particular periods such as the 1890s, the 1920s, the late 1940s, the 1970s, and the 1990s. These scares were precipitated by certain conditions and events, such as food price inflation, spikes in birthrates, exceptional environmental stresses, and acute cultural anxieties about migration and rapid demographic change. The discussion also had a self-reinforcing synergy as the three debating partners fed off each other: Doubting that science could keep performing miracles, Malthusians predicted still more hunger. Defying Malthus, cornucopians took steps to produce more food. Pointing to mounting surpluses, egalitarians critiqued an economic and political system that fattened the rich with cheap meat while depriving the poor of basic grains and depleting the soil. The debate continues today. Citing two hundred years of unexpected, indeed miraculous, productivity gains, cornucopians at the World Bank, the U.S. Department of Agriculture, and the leading agribusiness corporations hope for still more yield improvements through biotechnology. Citing two hundred years of environmental disaster and resource depletion, neo-Malthusians like Paul Ehrlich and Lester Brown worry about the limits to growth. And as over a billion people remain hungry amid mounting agricultural surpluses, neo-socialists like Frances Moore Lappé and Vandana Shiva argue that only with a more equitable economic system can the poor feed themselves.

Popular Visions of the Future

It is important to note that discussion of these issues has not been confined to the professionalized realm of academic demography, agricultural economics, and agronomy. Rather, it can be found in a diverse array of expressive, prescriptive, and material forms. Thus, speculative fiction has been a primary forum for the expression of serious doubt about the ability of modern technology to keep up with population growth. Indeed, Godwin's daughter, Mary Shelley, wrote one of the first cautionary tales about technological hubris in *Frankenstein* (1818), while her husband, the poet Percy Bysshe Shelley, promoted vegetarianism as a more just and sustainable food system in *Vindication of Natural Diet* (1813). Having been conditioned by popular novels like Aldous Huxley's *Brave New World* (1932) and films like *Soylent Green* (1973) to equate cornucopian ingenuity with distasteful synthetic foods, many modern consumers remain understandably skeptical about the latest claims of genetic engineers. Similarly, utopian novels have long offered a lively medium for the presentation of egalitarian alternatives. Thus, during the Progressive Era of the late nineteenth and early twentieth centuries, many utopian writers followed Edward Bellamy (*Looking Backward*, 1888), Mary E. Bradley Lane (*Mizora: A World of Women*, 1890), and Charlotte Perkins (*What Diantha Did*, 1910) in proposing scenarios that harnessed highly industrialized means of food production to socialistic distribution goals. In the 1970s, countercultural utopians Ernest Callenbach (*Ecotopia*, 1975) and Marge Piercy (*Woman on the Edge of Time*, 1976) inspired a generation of food radicals with their scenarios coupling localized, ecologically sensitive agriculture with communal, neotribal distribution and postmodern consumption—the outlines of what Kloppenburg, Hendrickson, and Stevenson have called sustainable "foodsheds."

Three Cornucopian Positions

Given the hegemony of techno-optimism in modern culture, however, the cornucopian position has probably had the widest dissemination, with promises of abundance available in many arenas and formats: supermarkets, restaurants, World's Fairs, Disney theme parks (especially Tomorrowland and Epcot), food advertising, mainstream editorial opinion, and the space program. Popular cornucopian thought tends to divide into three very different views of the future: classical, modernist, and postmodernist. The classical future is a smooth continuation and elaboration of past progress, a future of ever bigger and better things made available largely through the materialistic, quantitative expansion of frontiers—overseas and under the seas, in deserts and in tropical forests, under the ground and in outer space. The classical view of the future is the most traditional and often employs the most imperialistic methods of expanding the food supply (and wealth), appropriating other lands, peoples, and resources.

The modernist future represents a distinct break with the past, a radically new vision based on the very latest technologies and scientific breakthroughs, often producing a simpler, more "streamlined" and consolidated result. If the classical future eyes the visible riches of untapped frontiers, the modernist looks for wealth in the invisible—nitrogen from air, protein from microbes, energy from atoms, better yields through better genes. Suspicious of nature and tradition, the modernist vision is comfortable with the synthetic, artificial, and chemically fortified. Ultramodernistic solutions to the food-population dilemma include meal pills (a Victorian fantasy), meat analogues synthesized from soy, cellulose, and algae, and the space program's menu of tubed and "rehydratable" analogues.

While culinary modernism has been favored most by pure scientists, it may also tend to scare off consumers wary of extreme discontinuities. The postmodernist future is thus perhaps the most palatable and marketable because it blends the classical and the modern, envisioning, for example, a world of neo-traditional foods mass-produced by modernist means such as microwavable stir-fries, aseptically packaged chai, and "fifties-style hamburgers" cooked on automated grills. Recognizing the human need for "authentic" tastes, NASA's dieticians have abandoned tubed food in planning interplanetary meals that now include fajitas, pad Thai noodles, barbecued tofu, and curried lentils. Less confident in the new than modernism, more eclectic and multicultural than classicism, the postmodernist menu may reflect how most people actually approach and experience the future: one foot forward with the other planted in an imagined past.

See also **Agriculture since the Industrial Revolution; High-Technology Farming.**

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Warren Belasco

FOOD ARCHAEOLOGY.

As part of their general research, archaeologists have long been interested in food remains under the rubric of diet and subsistence. This work contributes to understanding the long-term historical development of food, and its impact on cultures. Recently, there has been increased interest in food archaeology (although it is not yet identified as a separate discipline), fueled by new technologies and curiosity about implications that go well beyond diet to the role food played in social organization, and ultimately, in the development of civilization itself.

As in all archaeology, there are essentially two broad periods that are of interest to researchers. The first is prehistory, before written records were kept. For that time, scholars are wholly dependent on the interpretation of archaeological finds. The second period is historical archaeology, during which literary and written sources, including poetry, frescoes, and government record-keeping, have been retrieved. Comparisons of excavated food remains with records is particularly valuable because the finds may either contradict or augment the historical record. For example, at the site of a former Roman villa on the Greek island of Lesbos, 7,300 animal bones from a wide variety of species, including goat, deer, hare, pheasant, capon, boar, suckling pig, sheep, lamb, starling, and woodcock, confirm contemporary reports of lavish banquets.

The Evidence

Direct evidence of diet consists of preserved food remains, both plant (paleoethnobotany) and animal (zooarchaeology); analysis of human bone and teeth; undigested stomach contents; and coprolites (fossilized feces). Collection and analysis of plant remains is often futile because most decay. If, however, they have been charred (burned), perhaps during a cooking accident, the material is preserved indefinitely. To collect and isolate tiny floral fragments, samples of excavated sediment may be placed in a flotation tank through which water is forced electronically, forcing the buoyant seeds, pollen, and grains to the surface. Once salvaged, these items can be dated by the system known as radiocarbon dating, based on carbon's known rate of very slow decay. Tiny grains of manioc, yams, and arrowroot from an ancient settlement in Panama, Central America, have been carbon-dated to five thousand to seven thousand years ago, providing the earliest evidence of cultivation of root crops in the Americas.

Microscopic examination of charred plant remains can also determine whether they were cultivated or wild, indicating whether the society was agrarian or hunter-gathering. Charring leaves silica ghosts of the epidermal cells that when examined under the electron scanning microscope reveal telltale markers that distinguish between domesticated and wild crops. Such investigation of grains, husks, and plant remains in China helped push back the date for earliest domestication of rice from 8,000 to 11,500 years ago, and pinpointed the location to the middle Yangtze River.

The more recent technique of DNA "fingerprinting" offers an alternative for establishing domestication. When applied to einkorn wheat, one of eight "founder crops" that launched agriculture in the fertile crescent of the Middle East around 9000 B.C.E., the method pinpointed earliest domestication to the Karacadaq mountains of southeast Turkey.

Skeletal Remains

Human bones provide a wealth of clues about diet. Isotopic analysis of collagen can distinguish chemical signatures of foods. It becomes possible to determine proportions of land to marine foods in the diet, for example, and even to demonstrate the relationship of nutrition to social class. Excavation of skeletons at the former Mayan city-state Caracol in Mexico established that the upper classes, living in the city center, consumed the best diets. The worst were documented in the surrounding inner-city slums while diet improved in the outlying "suburbs," proof that socioeconomic class and nutrition were related even this early.

Learning from Context

Diet may also be inferred indirectly by examining the context of food remains, the environment in which they were found: pottery with grain impressions; eating, drinking, and storage utensils with food residues; hearths where charred grain is found; and gravesites where cut or charred bone indicates funeral feasting. Chemical analysis of food residues from eating and drinking vessels, a technological advance, has provided detailed information about the ingredients used to make a dish. University of Pennsylvania archaeologists pioneered the use of infrared spectroscopy, gas liquid chromatography, and gas chromatography mass spectrometry to examine remains on cups and plates from the 2,700-year-old tomb of the legendary King Midas located in Turkey. Analysis of the protein and lipids allowed scientists to conclude that the menu for this royal funerary feast included barbecued goat or lamb; lentils in olive oil; honey and wine spiced with fennel and anise; and an alcoholic drink composed of grape wine, barley beer, and mead.

Gravesites typically yield a wealth of information. Since Neolithic times, people have been buried with food for the afterlife. Less often, people are buried in food. In a prehistoric Iron Age (500 B.C.E. to 500 C.E.) cemetery at Noen U-Loke in northeast Thailand, archaeologists found a huge sample of carbonized rice, much used in burials, "rice beds" in which some citizens were laid to rest on layers of rice, and then covered over with more. Finally, the "bed" was set on fire to purify the grave. Rice burials have been found nowhere else in the world. Since these graves also contain lavish jewelry and bronze goods, they indicate that the burial practice was reserved for those of special rank. It can be also deduced that the community produced a tremendous rice surplus under the distribution control of a chieftain, who wielded power over the rice farmers or producers.

Also of interest are containers in which food was stored and shipped. Often these were clay jars known as amphoras, ubiquitous throughout the ancient world for carrying olive oil, fish sauce, olives, fruit, and wine. Excavation at the fortress Masada in Israel has turned up Roman amphoras with wine residues bearing the inscription "For Herod of Judea" (73–4, r. 37–4, B.C.E.), indicating that this potentate favored Italian vineyards.

The recovery of food from archeological sites is one of the most challenging of all tasks due to the fragile nature of the remains. The stakes are raised when the food is buried in jars under the sea, as in the case of these Phoenician amphorae that sank with a ship during a storm about 750 B.C.E. off the coast of what is now Israel. Vestiges of the contents proved that the amphorae once held wine. They are shown here in an underwater photo released by *National Geographic* in 1999. © AFP/CORBIS

Another aspect of food archaeology is culinary archaeology, the study of food preparation and utensils. Rice steamers have been recovered from Noen-U Loke in Thailand and other locations. Sophisticated techniques even make it possible to identify the temperature at which an ancient meal was cooked. When Lindow Man, a body discovered in a British bog, was retrieved, the charred bran-and-chaff stomach contents were subjected to electron spin resonance, capable of measuring the highest temperature to which a material has been subjected and for what length of time. The conclusion: the meal was probably a griddle cake, cooked on a flat, heated surface for about half an hour at 392°F (200°C).

Preserved Meals

Occasionally, archaeologists unearth actual charred meals, most notably at Pompeii and Herculaneum, covered by ash when Mt. Vesuvius erupted in 79 C.E. There, inhabitants left complete meals on tables, food in shops, and loaves of bread in bakery ovens. The Egyptian priests at the Temple of Isis in Pompeii were eating a meal of fish and eggs when the eruption occurred. Researchers at Pompeii have taken their work a step further to investigate how the Romans, master urban planners, incorporated growing, processing, distribution, and storage of food and drink into the city layout. By measuring distances from dwellings to restaurants and bakeries, they can determine how far a citizen had to travel to quench his thirst or get something to eat.

After excavating artifacts (manmade objects) and subjecting them to laboratory analysis, the broader task is to document processes of cultural change such as the beginning of agriculture in a particular area. Food plays a critical role in the development of civilization and culture. The problem of subsistence must always be solved first before a food surplus can be generated, the population expands, and there are the beginnings of a ranked society with some elite members engaging in ruling, military activities, directing religion, and craft making. It is food that propels the development of ever more complex societies.

See also **Anthropology and Food**; **Greece, Ancient**; **Mesopotamia, Ancient**; **Mexico and Central America, Pre-Columbian**.

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Linda Murray Berzok

FOOD AS A WEAPON OF WAR. Providing or withholding food during times of conflict can be just as potent a weapon as the guns, bombs, and explosives of opposing armies. Control of food supplies during war is important because wars disrupt the seasonal pattern of growing crops, displace farming populations, and prevent the transport of food within the area of conflict. The economic costs of war may so impoverish citizens and local governments that they are unable to purchase or distribute needed food, even if it is available. A major focus of the Marshall Plan for Europe after the Second World War was to prevent the kind of starvation and social upheaval that had followed World War I. More recent relief efforts have focused on distributing food to refugees of many regional conflicts, where imposed famine was part of the combatants' military strategy in countries like Liberia, Mozambique, Somalia, and Sudan.

Withholding Food

Food can be withheld by preventing it from being grown and harvested, by destroying it after harvest, by preventing it from being shipped to where it is needed, or by contaminating it and rendering it unfit for consumption. Indigenous farming populations have been scattered or exiled from their native lands by conquering armies to make room for their own colonists who would subjugate and establish their hegemony over the local inhabitants, and provide food and warriors for future campaigns. Ancient armies have "salted the earth" and destroyed irrigation systems to make an area unsuitable for growing crops. In the culmination of the Punic Wars with Carthage in the third and second centuries B.C.E., Rome defeated the armies of Hannibal, destroyed his empire, and ploughed the land with salt to make it infertile. The Roman practice of contaminating water supplies by dumping dead animals into wells has continued into recent history as demonstrated by an instance during the American Civil War when Confederate solders fouled the water supplies of Union forces with dead animals. There are no instances of widespread contamination of food during war in the modern era, perhaps because of the universal condemnation of such practices by all civilized nations. Sieges of fortified positions have been used since time immemorial to starve, demoralize, and physically weaken the ensconced combatants. Pictorial representations in Egypt depict sieges over 4,000 years ago, while the *Iliad* of Homer describes the siege of Troy by the Greeks over 3,000 years ago. It, like many of the numerous sieges that followed, ended not through force of arms, but through deception and treachery. The Spartan siege of Athens that ended the Peloponnesian Wars (431–404 B.C.E.) was ineffective as long as Athens could obtain food by sea. Only by allying themselves with Persia and destroying the Athenian navy were the Spartans able to starve them into submission. A similar maritime strategy was employed, but in reverse, by Emperor Leo III of the Eastern Roman Empire, whose forces destroyed the Arab navy, maintained food imports, and broke their siege of Constantinople in 717. Sieges often do not work because the besieged forces have stored or can obtain enough food for the duration, or because the invading forces cannot obtain enough food or maintain their supply lines because of the surrounding hostile population.

A continuing problem with siege warfare was that the attackers could run out of food or succumb to disease in their unhealthy encampments. For this reason, the parties of siege warfare in the medieval West often agreed on a time limit, after which the besieged forces could leave without penalty. Such civility was rare even then, and certainly has not persisted to modern times of total war. Parisians were reduced to eating rats during the siege that ended the 1870 Franco-Prussian War, and over a million Russians starved to death during the 500-day siege of Leningrad in World War II; more civilians died in Leningrad than in the bombings of Hamburg, Dresden, Tokyo, Hiroshima, and Nagasaki combined.

In modern times, sieges have expanded and evolved into embargos of critical war materials (for example, food, medicine, oil, strategic metals, technology, etc.) by nation-states. England imposed an embargo by sea for that area of Europe occupied by Napoleon, and Germany tried to embargo food and war materials to England and Russia by the United States in the Second World War. While food is now usually not embargoed for humanitarian reasons by the major powers, economic sanctions remain an implement of international policy and genocidal starvation as accepted strategy in some regional conflicts.

Scorched Earth

Many countries have adopted a "scorched earth" policy (destroying anything that might be of use to an invading enemy) to prevent an invading army from living off the land. Both attackers and defenders in conventional wars and guerrilla struggles have used this strategy. During the U.S. Civil War, General William T. Sherman brought "total war" to the heart of the Confederacy by his infamous "March to the Sea" across Georgia and South Carolina, a scorched earth policy that is still debated as being barbarous or sound military strategy. The British used a scorched earth policy during their war with the Boers in South Africa, and the French conquest of Algeria (1830 to 1844) used it to starve the natives into submission. Unless ruthlessly enforced, it is often difficult to convince people to destroy all they have in advance of an invading force. The conquest of Gaul by Julius Caesar was almost prevented by this tactic, but Vercingetorix's guerrilla campaigns were ineffective because he could not persuade his countrymen to adopt this painful policy wholeheartedly.

Russia very effectively used a scorched earth policy during its invasion by Swedish armies in 1709, Napoleon's armies in 1812, and Hitler's armies in 1941. Because the Russians removed most of the food and crops in advance, Napoleon's half-a-million-man army could not live off the land as they had in previous campaigns. Despite being able to capture Moscow, they were too emaciated to hold it and had to retreat. The inability to find food locally also created severe problems for the German military in World War II, which was trying to feed three million soldiers. Forests, stores and transports were set afire; all grain and millions of cattle were shipped from the Ukraine to Russia, leaving nothing for the advancing German armies. However, nothing was left for the peasants who were equally bereft of food and shelter. As the Germans retreated towards Berlin, they too implemented a scorched earth policy to slow the pursuing Russian army.

Providing Food

Since, as Napoleon is quoted as saying, "An army marches on its stomach," procuring enough food to support an army in the field is a paramount concern for all commanders. Although weapons, clothing, and shelter are of the greatest immediate importance to soldiers, logistical support to provide food and material is often the decisive element in winning wars. Soldiers often had to truly "live off the land" even when in permanent garrisons or semipermanent encampments during lengthy sieges. Improvements in food preservation, packaging, and transportation have made modern armies immune to local vagaries in the availability of food.

The technologies of canning, freezing, dehydrating, and irradiating food were greatly advanced by the necessities of war. In 1795 Nicholas Appert, a French chef, won a prize offered by Napoleon for a way to prevent military food supplies from spoiling. By 1806, Appert's principles for canning meats and vegetables in jars had been successfully applied to the canning of meat, vegetables, fruit, and even milk for the French Navy. The English adopted the process to use with metal containers in 1810, and when Napoleon faced Wellington at Waterloo in 1815, both of their troops ate canned rations.

Frozen foods had been around since the 1920s, but did not become important until they were used to feed U.S. troops overseas during the Second World War. At home, frozen foods caught on with American consumers because canned foods required precious metal and were rationed, while frozen foods were not. Dehydration has been practiced for millennia by peoples who dried grasses, herbs, roots, berries, and meats by setting them out in the sun. Dehydrated foods are important for the military because of their light weight and minimal volume. During World War II, the U.S. Army tested irradiation on fruits, vegetables, dairy products, and meat. Irradiated food has been pioneered and extensively used since the 1960s by the military and NASA. The responsibility to feed large numbers of people on military bases and on the battlefield, and its enforced administrated structure provides an excellent opportunity for large-scale testing of new food-handling and preparation technologies by the military. Coupled with the mandated desires of the U.S. Congress for the military to eat domestically grown food, even in distant military operations, and the realities of combat, many food-handling technologies have been first implemented by the military before they gained widespread acceptance by civilians.

See also **Military Rations**; **Preserving**.

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FOOD BANKS. Warehouses that collect and store donations of surplus foods, food banks distribute the foodstuffs to authorized nonprofit organizations that provide assistance to the needy. The food comes from many sources, including individual contributions, local food drives, regional grocery stores, farmers, food service companies, and national food corporations. The surpluses arise from mislabeling, mispackaging, mishandling, and other factors that contribute to loss of commercial value—however, all the foods are safe and edible.

Food banks began in the late 1960s when the retired Arizona businessman John Van Hengel volunteered in a soup kitchen and began to solicit donations of food products that would otherwise be wasted. When the soup kitchen received more food than it could handle, Van Hengel set up a warehouse to store and distribute these food products. As other cities learned of the food bank concept, they began to duplicate it in their areas. A grant from the federal government in 1976 assisted the development of food banks throughout the nation. Although food banks developed as temporary emergency food relief organizations, they have become permanent fixtures in America because of economic recessions, job insecurity, erosion of public assistance benefits, and sharp increases in housing and other costs. Food banks multiplied from a few dozen in the 1980s to over 250 in 2002.

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A volunteer moves boxes of groceries inside a Contra Costa food bank warehouse in Concord, California. © BOB ROWAN; PROGRESSIVE IMAGE/CORBIS.

Today, approximately 80 percent of all food banks in the United States are networked through an organization called America's Second Harvest, which is the largest domestic hunger relief organization. Food banks have the capacity to receive large volumes of food and distribute it efficiently and quickly. America's Second Harvest serves as a link between food banks in its network, and can assist with moving food out of one bank and into another (thus helping to control inventory), move product quickly, and minimize waste. The banks are typically operated by a small staff of employees who direct the program, manage the warehouse operation, and oversee a large corps of volunteers. Financial records are kept and the banks are audited annually. Food banks must comply with local health codes regarding sanitation and safe food handling. Because of the Tax Reform Act of 1976, corporate donors can take advantage of tax deductions for their contributions—not only for 100 percent of production costs, but also for 50 percent of the difference between the product cost and the normal sale price. As a result of the Good Samaritan Act passed by Congress in 1981, donors are absolved from liability for the food's safety as long as they make an effort to determine that the food is edible and fit for human consumption when donated.

The funding for food banks comes from private contributions, foundations, some government sources, and fund-raising. The organizations that receive the food are also charged what is called a shared maintenance fee. This is a small amount (18 cents per pound in 2002) to help cover the cost of handling the product, and is not based on the value of the food. Grant monies are often available to those organizations that cannot afford even this small fee. Very perishable food items are sometimes given away at no cost as they cannot be stored for long periods of time.

Large food bank operations have developed innovative ways to distribute even more food. The food banks in Delaware and Washington, D.C., operate onsite community kitchens where donated foods are prepared into meals that can be distributed to programs such as the Kids Café, which is an after-school feeding program for low-income children.

Food banks collectively distribute nearly a billion pounds of food annually, feeding more than 23 million needy Americans, including 8 million children and 4 million senior citizens. As the problem of hunger in America continues to grow, low-income families will continue to rely on food banks to provide a source of low-cost food assistance and a means of decreasing their food insecurity.

Hunger and poverty go hand-in-hand, and the poor will always exist in every society. While food banks cannot eliminate poverty, their mission is to abolish hunger;

they do an admirable job of it, providing assistance to nearly a tenth of the population. They augment the many federal food assistance programs that play the larger role in the food-security safety net for limited-income families. Unfortunately, it does not look as if food banks will disappear from America as their founders had once hoped. The United States produces enough food to adequately feed all of its citizens. The problem is often getting the food to those who need it; food banks are one solution.

See also **Food Pantries**; **Government Agencies**; **Homelessness**; **Poverty**; **Soup Kitchens**; **WIC (Women, Infants, and Children's) Program**.

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FOOD CONSUMPTION SURVEYS IN THE UNITED STATES

Since the 1930s, food consumption surveys have been carried out by the U.S. Department of Agriculture (USDA). After small-scale studies, nationwide monitoring began in the 1950s. In 1955 the Household Food Consumption Survey, which was first based on a representative sample of households, was initiated. The survey investigated food use on the household level. Beginning in 1965, a component of individual dietary assessment has been included in the National Food Surveys. Since 1985, household consumption has been replaced by the Continuing Survey of Food Intakes by Individuals, which is based on dietary assessment through twenty-four-hour dietary recalls. Since the late 1980s, food surveys have been combined with the Diet and Health Knowledge Behavior Survey (DHKS). Knowledge and attitudes toward diet as well as dietary behavior are assessed to improve understanding of individual dietary patterns.

FOOD CONSUMPTION SURVEYS.

Food consumption surveys—sometimes referred to as food intake surveys or dietary surveys—monitor food use by data collection at three different levels. On the national level, food availability may be described by supply data such as food balance sheets. These results express food availability rather than food consumption in a nation and are not further discussed here. The second type of food consumption survey measures food use within a household, and the third type assesses individual intake of foods and beverages. These latter two survey types collect information on kinds, amounts, and frequencies of food consumption and occasionally on expenditure for food purchases. Furthermore, these surveys include information on factors influencing food intake patterns such as socioeconomic criteria, food perceptions, and beliefs.

At the beginning of the twentieth century, the investigation of food consumption patterns became necessary in order to identify inadequate and insufficient diets in parts of the population. This was especially important among urban industrial workers for whom mass production of food was needed because they no longer had ready access to farm produce. The first small-scale studies were carried out in different countries. As the number of participants in such surveys increased, the scope widened to include health issues related to food consumption. To gain up-to-date information, these surveys were repeated on a regular basis. Advanced sampling techniques enabled researchers to design representative surveys.

Methods and materials of data collection are selected in accordance with the objectives of the survey. If the household is the focus, food inventories and household accounts are used to collect data on present food use, while food-list recalls monitor food use in the past. Food consumed outside of the home and the food distribution among household members are not assessed. Results are expressed in quantities of food consumed, expenditures for food purchases, and energy or nutrient availability per household. Comparisons of food availability in households among different communities or socioeconomic groups can be made. Dietary changes in a total population or subgroups of a population can be investigated.

The method for assessing individuals' dietary intake is the food record. Quantities are either accurately weighed or estimated by household measures. The twenty-four-hour recall assesses food intake during the previous day while diet histories focus on usual dietary patterns in the past. Food Frequencies Questionnaires (FFQ) ask how often food items are usually consumed within a defined period. The questionnaires and the diet histories focus on long-term subjective perception while food records and twenty-four-hour recalls are suitable for investigating absolute or relative nutrient intakes of groups and individuals.

TABLE 1

Dietary assessment methods

Method	Period	Features
Food record	Present diet	Quantities and kinds of foods Time and location of consumption Presence of fellow eaters
Twenty-four-hour recall	Last 24 hours	Quantities and kinds of foods Time and location of consumption Presence of fellow eaters
Diet history	Last month(s)	Meals usually consumed Dishes and foods usually consumed
Food frequency questionnaire	Last weeks or months	Food list provided Frequency of consumption of food items Quantities, e.g., portion sizes

With assistance from food composition tables or data banks, energy and nutrient intakes are estimated. Thus quantities and qualities of diets as well as nutrient intakes of groups or individuals are monitored. Some surveys focus on specific target groups—for example, age groups (such as infants or elderly persons) or individuals with particular diets, conditions, or diseases such as pregnancy or diabetes, or on selected food groups (for example, fruits and vegetables).

Food and nutritional planning on the national or international level is based on these data sources, as are estimates of the adequacy of dietary intakes of population groups. The development and evaluation of educational programs is based on these results. The relationship of diet and health status as well as estimates of average intakes of additives and contaminants are other important issues.

The main limitation of food consumption surveys is that they depend on accurate report or recall of food quantity and type by the participants in the study. The quality of nutrient and energy values depends on the quality and accuracy of food consumption tables.

See also **Dietary Assessment**; **Intake**.

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FOOD COOPERATIVES. Food cooperatives represent a particular subset of a larger environment of cooperative businesses. Cooperative business enterprises are primarily distinguished from other forms of business organization by the fact that their members consider other goals to be more important than return on invested capital. In its Statement of Identity, the International Cooperative Alliance defines a cooperative as "an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise."

Several characteristics commonly typify a cooperative enterprise. These characteristics, based on values that are made explicit to (and by) their members, include:

Autonomy: the cooperative is as independent of government and private enterprise as possible;

Association of persons: the definition deliberately does not read an "association of individuals";

Voluntary: members are free to join and leave at will, within the purposes and resources of the cooperative;

Meet needs: the central purpose of the cooperative is to meet member needs, which can be purely economic or social and cultural;

Joint ownership and democratic control: the members own the cooperative on a mutual basis. Decisions are made democratically by the members and are not controlled by capital or by government;

Enterprise: the cooperative is an organized entity that typically functions in the marketplace and engages in the exchange of goods and services.

There are over three hundred food cooperatives in the United States today. Through food cooperatives, consumers have sought to improve the quality and nutrition of available foods, to become better educated about food and environmental issues as they pertain to food choice, and to create a marketplace for organically grown foods. Food cooperatives often have mission statements that support such goals. For example, Puget Consumers Cooperative, based in Seattle, Washington (the largest food cooperative in the United States) has as its mission statement, "to provide the highest quality natural foods and products. We create and cultivate the marketplace for locally grown and organic products and are a vital community resource on food, nutrition and environmental issues."

History

The concept of cooperation germinated in the middle 1800s during the early period of industrialization. A small group of weavers in Rochdale Village, England, is considered to be the first practical application of the concept. There, in 1844, twenty-eight weavers combined their skills and ambitions, agreeing to share the burdens and rewards of a self-supporting economic colony. Other examples of co-ops appeared in the late 1800s throughout England and Europe, particularly in Finland.

It is not clear which consumer co-op in the United States was the first. According to one source, it was a buying club for household supplies created in 1844. Another source claims that the first consumer cooperative in the United States was established in Philadelphia in 1862. Whichever was actually the "first," the popularity of consumer cooperatives has tended to increase in waves coincident with periods of economic decline (the Great Depression) and political and consumer unrest (the 1960s). What is now referred to as the "old wave" of growth in the number of cooperatives in the 1930s was inspired largely by economic depression. The cooperative was viewed by the Hoover and Roosevelt administrations as an "American concept" and as a solution to the suffering farming industry. But with the improved war-oriented economy of the 1940s, support waned for co-ops and the philosophies that went with them. The impetus for the most recent expansion (the "new wave") of American cooperatives in the relatively prosperous 1960s lay in a desire to harness and enhance social capital, build community, and achieve local autonomy from an increasingly global food system. In the 1960s and 1970s in the United States, food cooperatives were viewed as a political as well as economic alternative to conventional supermarkets.

Co-Op Values and Principles

From the earliest days of the Rochdale Pioneers, food cooperatives have emphasized the importance of honest dealings in the marketplace: accurate measurements, reliable quality, and fair prices. Members have insisted that their co-op have honest dealings with them. Ideally, this has led to honest dealings with nonmembers and a unique level of openness throughout the organization.

Since its creation in 1895, the International Cooperative Alliance (ICA) has been recognized as the authority for defining cooperatives and for determining the underlying principles that provide motivation for such enterprises. One of the major purposes of the ICA is to "promote and protect cooperative values and principles."

Three formal statements of the cooperative principles have been made by the ICA—in 1937, 1966, and 1995. Each statement was carefully crafted to adopt and explain principles that were both relevant to and of value for the contemporary world. The latest statement of principles reflects substantial changes in the global economy, in international political alignments, in the economic development of Asia, Africa and Latin America, and in the worldwide human condition. These changes brought new challenges and opportunities to cooperatives worldwide. Some traditional cooperative assumptions were challenged, giving rise to new interpretations of cooperative values and inspiring a reconsideration of the role of cooperative enterprise in the twenty-first century and in societies undergoing rapid change.

Cooperative values. Cooperative values reflect convictions that these enterprises hold about how to achieve a better society and what form that society should take. Common values among food co-ops include: *Self-help:* People have the will and the capability to improve their destiny peacefully through joint action, which can be more powerful than individual effort, particularly through collective action in the market. *Democracy:* Members have the right to participate, to be informed, to be heard and to be involved in making decisions. Members are the source of all authority in the cooperative. *Equality:* Equal rights and opportunities for people to participate democratically will improve the use of society's resources and foster mutuality, understanding, and solidarity. *Equity:* Fair distribution of income and power in society and its economic life should be based on labor, not ownership of capital. *Solidarity:* Cooperatives are based on the assumption that there is strength in mutual self-help and that the cooperative has a collective responsibility for the well-being of its members.

The 1995 cooperative principles. Principles are guidelines for putting ideals and values into practice. If successful, principles are incorporated into the organizational culture of the cooperative; they are the broad vision statement for cooperatives and cooperators individually and collectively.

Seven ICA principles (revised from the 1966 statement and adopted in 1995) in abbreviated form are:

1. Voluntary and Open Membership: Cooperatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.

   Participation as active and responsible members should be based on a clear understanding of the values for which cooperatives stand and on support for those values.
2. Democratic Member Control: Cooperatives are democratic organizations controlled by their members, who actively participate in setting policies and decision-making. Members of these societies should enjoy equal voting rights (one member, one vote) and participation in decisions affecting their societies.
3. Member Economic Participation: The economic benefits arising out of the operations of a society belong to the members of that society and should be distributed in such a manner as to avoid one member gaining at the expense of others. This may be accomplished by the following means: (a) by provision for development of the cooperative's business; (b) by provision of common services; or (c) by distribution among members in proportion to their transactions with the society.
4. Autonomy and Independence: This principle emphasizes that cooperatives must be free of intervention from governments or other sources so that ultimately the members are able to control their own destiny.
5. Education, Training, and Information: Education is a priority in cooperative enterprises. Education here is meant to be more than advertising products or distributing information. Rather, it means engaging the minds of members, elected leaders, managers, and employees of food co-ops in critical thinking regarding food, nutrition, health, and the food system.
6. Cooperation among Cooperatives: All cooperative enterprises, in order to best serve the interests of their members and their communities, should actively cooperate in every practical way with other cooperatives at local, national, and international levels.
7. Concern for Community: Grounded in the values of social responsibility and caring for others, this principle (added in the 1995 revision of ICA principles) articulates an interest in making contributions to a better society at large. By taking ownership over portions of the economy, cooperative members are saying, in effect, we can meet our needs and the needs of others better than they are currently being met. Because the effort is a mutual one, cooperative members understand that to provide for any member is to provide for all members.

The Food Co-Op Shopper

Consumer research conducted in the 1970s, 1980s, and 1990s indicated important differences between food cooperative shoppers and their supermarket counterparts. Areas of difference included food-related behaviors; attitudes toward food and food safety, health, nutrition, and the food system; and political views. Food-related behaviors studied included dietary patterns and cooking habits. Food co-op shoppers were shown to buy items such as tofu, brown rice, alfalfa sprouts, honey, dried beans, yogurt, granola, and spinach with greater frequency than supermarket shoppers. Supermarket shoppers, on the other hand, tended to consume franks, beef, poultry, pork, white bread, white rice, candy bars, and potatoes with more frequency than co-op shoppers. Food co-op shoppers tended to have a greater enjoyment of cooking and to cook "from scratch" more often than the general population. This is consistent with a strong skepticism toward heavily processed foods associated with food co-op shoppers, particularly in the 1970s and early 1980s.

Environmental concern and concern over food system issues such as globalization, genetic engineering, and corporatization are more meaningful to food co-op members than nonmembers. Co-op shoppers also tend to put relatively less importance on year-round availability of produce items.

Over the years, consumers have been motivated by several factors to join and shop at food co-ops. Research from the 1970s suggests that lower prices, availability of natural foods, and product quality were dominant motivating factors for joining a food cooperative. Support for co-op values, economic and ecological interests, freshness of the food, the availability of locally grown food, social atmosphere, variety of products, and the availability of bulk items are additional motivators for co-op shoppers.

The growth of food cooperative membership observed in the 1970s and 1980s is thought to stem in part from concerns about food safety and the impacts processed foods may have on health as well as an increasing awareness of the diet and health relationship. The use of whole and organic foods among coop shoppers may be related more to the desire to decrease control of large companies and food processors and a sense

Women making pasta at a women's cooperative in Walata, Mauritania. © JUAN ECHEVERRIA/CORBIS.

of increased personal responsibility than to the nutritional value of such products. Access to bulk items, herbs and spices, organic foods, farm-fresh eggs and preservative-free bread were incentives for shopping at the cooperative. Co-op shoppers believed that organically grown foods possess beneficial nutritional attributes, and they were willing to pay a higher price for them. This preference was largely motivated by a belief that pesticide residues in foods posed a health risk. They also felt that there are environmental factors other than food processing that are harmful to health and to the environment.

Establishing a Niche

From their beginning, consumer food co-ops have distinguished themselves from traditional food retailing by establishing active consumer education programs designed to increase awareness and understanding not only of food composition, but of the source of food and the production methods used. Co-op policies often reflect the values related to food and the marketplace that members consider to be important, such as a diverse product line that emphasizes quality, nutrition, and organic growing methods, health and nutrition awareness through education of members and staff, and shared participation by the staff in co-op decision-making.

Goals common to most food cooperatives include democracy, member education and participation, and a dedication to "pure" or "natural" foods. The latter goal in particular created the expectation that food cooperatives were places where natural foods could be found, and further defined the niche of these retail outlets. However, the demand for natural and organically grown foods is increasing dramatically, and shoppers are able to find these foods in a wide range of retail and wholesale food outlets.

Modern Trends

Food cooperatives continue to constitute a very small proportion of the food-retailing segment. As the availability of organic produce and multi-ingredient processed products has expanded throughout the food-retailing industry, and as supermarket chains have initiated active consumer education programs, the characteristics that distinguish food cooperatives as unique alternatives have become less clear. Expanded availability of "whole foods" and certified organic foods means that food cooperatives are no longer exclusive sources for these choices. However, these food-retailing enterprises may still provide important alternatives to supermarket chains. For example, food cooperatives still provide a space for debating agriculture and food system trends that is difficult to find in other institutions. Decisions about inventory are based less on market demand than on established goals, values, politics, and principles. Also, cooperatives still provide an atmosphere of community that is not found in more conventional supermarkets and megastores. In the past, food cooperatives have been innovators in the marketplace in the areas of unit pricing, consumer protection, and nutritional labeling. They may offer innovations in the future that are adopted throughout the retail industry. Finally, recent trends in food retailing in the United States and elsewhere may serve to renew interest and participation in food cooperatives. Food retailing, like agricultural production before it, is increasingly concentrated. Warehouse food stores and mass retailers with grocery sections are gaining market share in some of the most profitable categories of food products and capturing the food expenditure of families with children, who comprise the most lucrative segment of the shopping public. This threat to the traditional grocery store may provide an opportunity for food cooperatives to offer an alternative food store that, by their very nature, are resistant to such trends.

See also **Distribution of Food**; **Food Marketing: Alternative (or Direct) Strategies**; **Natural Foods**; **Retailing of Food**.

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FOOD PANTRIES. What are known as emergency feeding organizations in the United States include food banks, food pantries, soup kitchens, and shelters operated by nonprofit organizations and faith-based agencies. The emergency food assistance network provides food to people who lack the resources to obtain adequate amounts of food through conventional means. Food banks solicit donations of surplus or salvage food that they distribute to food pantries (which provide emergency grocery packages), soup kitchens and shelters (which provide on-site meals), and other feeding programs. Although religious organizations and nonprofit agencies have historically distributed food and meals to people in need, the sharp increases in such requests beginning in the 1980s associated with high unemployment, cuts in the social safety net, decline in the value of public assistance benefits, and increases in housing and other costs led to a proliferation of food pantries, soup kitchens, and government programs that defined hunger and homelessness as temporary "emergency" problems.

In 2001 the America's Second Harvest provider network included approximately 26,300 food pantries in the United States, three-quarters of which are run by faith-based agencies affiliated with churches, mosques, synagogues, and other religious organizations. These food pantries received more than half (59 percent) of the food they distributed from food banks, with religious organizations, direct purchases, and federal government commodity programs supplying the remainder. More than 90 percent of these food pantries use volunteer staff, and many rely entirely on volunteers. Only 33 percent of the pantry programs have any paid staff.

Food pantries, also known as food closets, food shelves, or grocery programs, distribute nonprepared foods and other grocery items to needy clients, who then prepare and use these items where they live. In the United States, food pantries are primarily operated through referral systems, in which trained staff at nonprofit organizations screen clients and refer them to pantries operated by volunteers. The majority of food pantries prebag the food distributed to clients, while others allow clients to select their own food "grocery-store style." To the extent possible, pantries use several different factors, including household size, household composition (number of children, adults, elderly), and health status of household members, to determine the contents of a food order. Some follow nutritional guidelines in selecting prebagged items. On average, food pantries distribute food items to provide three meals per day per household member for three to five days. A sample list of items distributed to a single adult by a Pittsburgh, Pennsylvania, food pantry includes cereal, canned vegetables, Jell-o, juice, bread, canned beef stew, ground turkey, canned fruit, pasta, spaghetti sauce, and paper products. Some food pantries provide additional services. In 2001, 18.2 percent of the food pantries in the America's Second Harvest food provider network also provided nutrition counseling, 15 percent provided eligibility counseling for food stamps, 20.3 percent provided utility bill assistance, and 42.9 percent provided clothing assistance.

Many food pantries require that recipients run out of food prior to requesting assistance and categorize this condition as a food emergency. They also focus on serving clients compatible with their service mission and have much less need for documentation and much more trust in recipients' testimonies than government agencies. Only recently have U.S. food pantries begun to enforce explicit eligibility standards, such as income or residency, or require documentation of eligibility.

In the late twentieth century, the U.S. Conference of Mayors Task Force on Hunger and Homelessness surveyed the twenty largest American cities, revealing steady increases in demand for emergency food assistance, a rising proportion of those requesting food assistance who are families with children, more requests from working families and individuals, unmet demand for emergency food assistance, and numerous cities where food assistance facilities must turn people away. In 2001 more than half (59.8 percent) of the food pantries in America's Second Harvest food provider network served more clients than they had in 1998. More than two-thirds (67.9 percent) of these pantries experienced problems related to funding, and about two-fifths (39 percent) had problems related to food supplies.

Government data indicate that at least 9.2 million households in the United States were food insecure in 1999 and that approximately 3 million households had experienced hunger at some point in that year. The food insecure households contained an estimated 27 million people, of whom 11 million were children (Andrews et al., 2000). The existence of large numbers of people without secure access to adequate nutritious food represents a serious national concern. An important response to this problem has been the growth of private sector institutions created to provide food for the needy.

Throughout the United States, food pantries, soup kitchens, and homeless shelters play a critical role in meeting the nutritional needs of America's low-income population. These organizations help meet the needs of people and households that otherwise would lack sufficient food. However, emergency feeding organizations are ultimately limited by the depth of the hunger problem, their reliance on volunteers, the availability of government and food industry surpluses, lack of legally enforceable rights for food recipients, and the discrepancies between where food providers are located and where those who need food live. Seeing these organizations as the primary solution to the problem of hunger diverts attention from the societal relationships that produce hunger, including economic restructuring, erosion of public assistance benefits, major cuts in social welfare programs, and high housing, medical, and other costs.

See also **Class, Social; Food Banks; Meals on Wheels; Poverty; School Meals; Soup Kitchens; WIC (Women, Infants, and Children's) Program.**

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FOOD POLITICS: UNITED STATES. Food, the fuel of life and a source of lifelong pleasure, might seem to be the antithesis of politics, a term redolent of power, manipulation, and commerce, but the two are tightly linked. Commercial interests affect nearly every aspect of the systems of food production, distribution, and consumption, from farm to fork. The extraordinary size of the food enterprise and the vast sums at stake readily explain the ferocity of debates about dietary advice to the public, health claims on food package labels, regulations for meat safety, nutritional requirements for school meals, and labeling of genetically modified foods, to cite just a few examples. Debates over such issues derive from the disparate interests of the principal stakeholders in the food system, including the food industry and the consuming public of course but also government regulators, public health officials, and nutrition researchers and educators. Because all stakeholders should benefit from a food supply that is adequate, healthful, safe, environmentally sound, culturally appropriate, affordable, and delicious, the interests of these groups might appear to be congruent. The food industry, however, has an additional and compelling interest—to sell products. The conflict between the commercial interests of food companies and the widely varying concerns of other stakeholders is a principal reason why food issues are so controversial.

In this context the term "food industry" encompasses the full range of companies in the United States that produce, process, manufacture, sell, and serve foods, beverages, and dietary supplements (see the sidebar "The U.S. Food Industry"). Taken together the various sectors of this industry provide a food supply so plentiful, varied, relatively inexpensive, and devoid of dependence on geography or season that all but the poorest of Americans can obtain enough energy and nutrients to meet their biological needs. Indeed the U.S. food system as a whole—food produced in this country, plus imports, less exports—provides enough energy to meet the needs of every man, woman, and child in the country nearly twice over: 3,800 calories per capita per day. This amount is one-third higher than the caloric needs of most men, is twice the level needed by most women, and exceeds the requirements of babies, young children, and the sedentary elderly by even greater amounts. Even if, as the U.S. Department of Agriculture (USDA) estimates, 1,100 of those calories might be wasted (for example, in spoiled fruit or discarded oil for frying potatoes), the overabundance of food poses a major problem for the industry. It forces competition.

Because people, even those who overindulge, are limited in the number of calories they can consume, a choice of any one food means rejection of others. Thus food companies must convince people either to select their products over competitors' products or to consume more food overall, no matter how consumption or overconsumption might affect nutritional status or body weight. Food, beverage, supplement, and food service companies spend more

The U.S. Food Industry

The huge U.S. food industry is best understood in sectors. The agribusiness sector raises food crops and animals and makes and sells fertilizer, pesticides, seeds, and feed. Other sectors sell machinery, labor, real estate, and financial services to farmers or transport, store, distribute, export, process, and market foods after they leave the farm. The food service sector includes restaurants, fast food outlets, and bars but also service by institutions, such as schools, hospitals, prisons, and workplaces, and by food carts and courts. The retail sector includes supermarkets, convenience stores, and vending machines. This vast food system generates nearly $1 trillion in annual sales, accounts for nearly 15 percent of the U.S. gross national product, and employs 17 percent of the country's labor force. Of the more than $800 billion or so that the public spent directly on food and drink in 2000, alcoholic beverages accounted for about $100 billion. The rest was distributed among retail food enterprises (54 percent) and food service (46 percent).

Within this industry huge national and multinational corporations vie for control of production or sales of specific food commodities. In 1997, for example, just three companies, Philip Morris (Kraft General Foods and Miller Brewing), ConAgra, and RJR–Nabisco, accounted for nearly 20 percent of all food expenditures in the United States. In 2000 seven U.S. companies (Philip Morris, ConAgra, Mars, IBP, Sara Lee, Heinz, and Tyson Foods) ranked among the ten largest food companies in the world and generated up to $50 billion in sales annually. Others, such as Coca-Cola, McDonald's, PepsiCo, Procter and Gamble, and Roche (vitamins), ranked among the top one hundred worldwide. The nearly thirteen thousand outlets of McDonald's, the leading U.S. food service company, brought in about $20 billion in sales in 2000, more than twice as much as its nearest competitor.

These companies and others introduce 10,000 to 15,000 new food and beverage products annually into a marketplace that already contains about 320,000 such items. These items must compete for supermarket shelf space; even the largest supermarkets have room for just 50,000 products. Of the 11,000 new products introduced in 1998, for example, more than two-thirds were condiments, candies and snacks, baked goods, soft drinks, and dairy products (cheese products and ice cream novelties), foods largely allocated to the top ("eat occasionally") section of the U.S. Department of Agriculture's 1992 Food Guide Pyramid. Slightly more than one-fourth of the products were "nutritionally enhanced" so they could be marketed as low in fat, cholesterol, salt, or sugar or as higher in fiber, calcium, or vitamins. Some enhanced products, among them no-fat cookies, vitamin-enriched cereals, and calcium-fortified juice drinks, contain so much sugar that they belong at the top of the pyramid even though they are marketed as "healthy."

than $30 billion annually to promote their products to the public, and nearly 70 percent of this amount is applied to convenience foods, candy and snacks, alcoholic beverages, soft drinks, and desserts. In contrast, just over 2 percent is used to advertise foods considered more healthful, such as fruits, vegetables, grains, or beans. Furthermore the annual advertising expenditures for any single, nationally distributed food product are tenfold to fiftyfold higher than the total expenditures by government agencies to educate the public about food and nutrition.

The inequality of funding for dietary advice is only one aspect of U.S. food politics. Food companies also use the political system to convince Congress, government agency officials, food and nutrition experts, the media, and the public that their products promote health (or at least do no harm) and should not be subject to restrictive regulations. To protect their marketing environment, they contribute to congressional campaigns, lobby members of Congress and federal agencies, and when all else fails, engage in lawsuits. Nearly every food company is represented by a trade association or public relations firm whose job is to promote a positive image of the company's product among consumers, professionals, and the media. The companies form partnerships and alliances with professional nutrition organizations, fund research on food and nutrition, sponsor professional journals and conferences, and make sure that influential groups, including federal officials, researchers, doctors, nurses, schoolteachers, and the media, will favor and not criticize their products. To distract attention from health, safety, or environmental concerns, they may argue that restrictive regulations overly involve the government in personal dietary choices and threaten constitutional guarantees of free speech.

Such actions are routine, legal, and thoroughly analogous to the political activities of any other major industry—tobacco, for example—in influencing health experts, federal agencies, and Congress. Promoting sales of food raises more complicated issues than promoting use of tobacco, however, in that food is required for life and causes health problems only when consumed inappropriately. Nevertheless the primary mission of food

FOOD POLITICS IN ACTION

Two examples, dietary recommendations and trade disputes, illustrate the breadth of ways politics connect to food. Food guides and dietary guidelines sometimes advise restriction in one or another food or component. When they do, industries affected by the advice raise objections. In 1991, for example, the U.S. Department of Agriculture (USDA) cancelled publication of its Food Guide Pyramid. Producers of meat and dairy foods protested that the placement of their products in the triangular design of the pyramid conveyed an "eat less" message. In turn nutrition and health experts protested the cancellation, arguing that the pyramid design was fully supported by research. The USDA released the guide one year later, after investing nearly a million dollars in face-saving research and agreeing to several design changes favored by meat and dairy producers. In another incident in 2000 the committee developing national dietary guidelines suggested Americans "limit" sugar consumption, but federal agencies changed that word to "moderate" in response to pressures from sugar trade associations. Although sugar contributes calories but no nutrients to diets, the trade groups maintained that existing science did not justify recommendations to restrict sugar intake. Sugar producers famously contribute large sums of money to both political parties, and the agencies did not want to do battle over so seemingly trivial a change in wording.

Trade disputes constitute an example of food politics on a global scale. The United States participates in a treaty with the World Trade Organization (WTO), an international body that sets standards for food safety and domestic farm subsidies. WTO rules are designed to prevent nations from instituting farm policies that might unfairly favor their ability to compete in world markets. In 2001 U.S. participation in the WTO came into conflict with long-standing policies that subsidize agricultural producers to protect them against price fluctuations. The most visible subsidies are price supports for sugar and milk, but taxpayers also support production and market quotas, import restrictions, and marketing and promotion programs for major food commodities. The total cost of such subsidies, most of which go to large agricultural corporations, exceeded $32 billion in 2000. In 2001 at least eight members of Congress, five of whom held positions on committees that consider agricultural policies, personally received farm subsidies ranging from nearly $40,000 to $650,000 annually. In this situation the interests of agricultural producers and their congressional supporters directly conflict with U.S. foreign policy and raise political dilemmas that cannot easily be resolved.

companies, like that of tobacco companies, is to sell products. For this reason alone basic dietary advice to prevent disease by restricting consumption of saturated fat, sugar, salt, or alcohol or to prevent obesity by eating less food in general directly conflicts with the commercial interests of food companies. Similarly, concerns about pollution of air, water, and soil conflict with the economic interests of agricultural producers and giant chicken and hog operations.

Food and politics are connected in ways both great and small, as illustrated in the sidebar "Food Politics in Action." As those examples demonstrate, food is a political issue. Overabundant food and its consequences occur in the context of increasing centralization and globalization of the food industry. Because food affects lives as well as livelihoods, almost any aspect of its production or consumption stimulates attention from interest groups and the public at large. Food issues inevitably involve struggles over the way the government balances corporate against public interests. Although all stakeholders have the same right to use the political system as do food companies, most others are motivated by health, safety, or environmental concerns rather than by profit, and they rarely have equivalent resources. Nevertheless they sometimes achieve political objectives. In this manner struggles over food issues reflect and contribute to essential functions of the American political system.

See also **Advertising of Food**; **Marketing of Food**.

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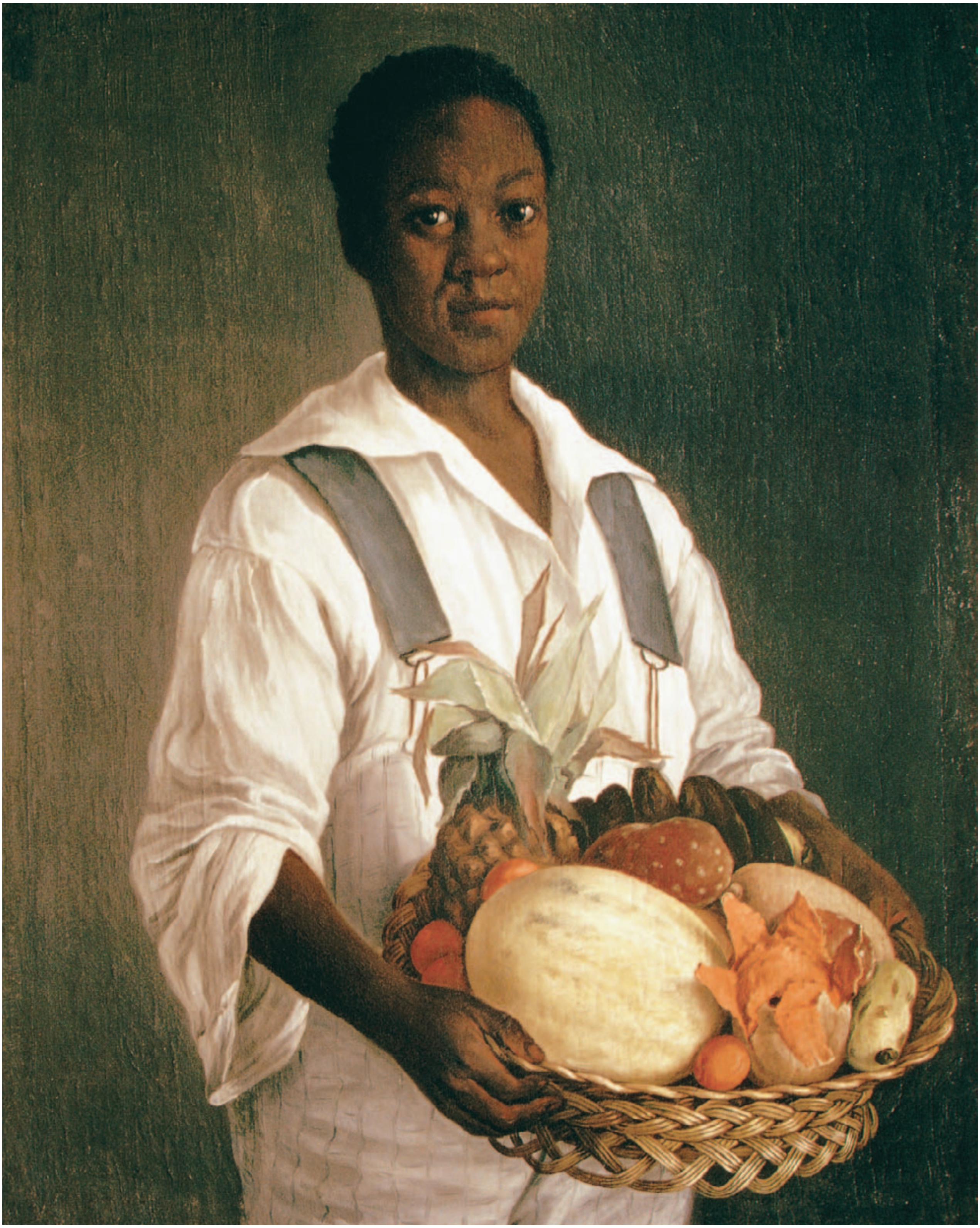
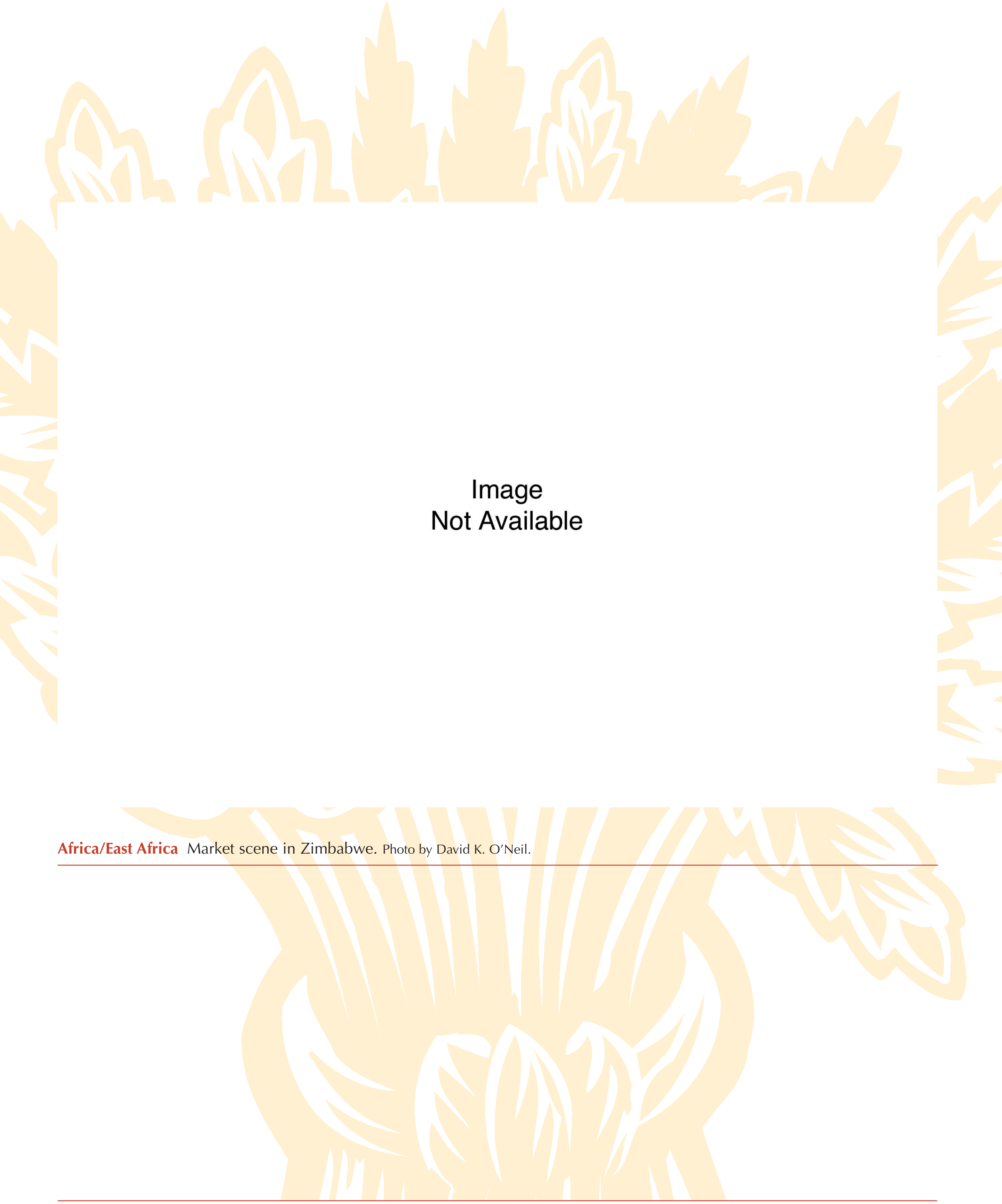
Marion Nestle



Caribbean Called *The Coastal Dweller,* this nineteenth-century portrait by José Agustin Arrieta depicts a Latin American fruit vendor of African descent. Many blacks from the Caribbean settled along the east coast of Mexico and Central America, where they have left a lasting imprint on the food culture of the region. Private Collection, Mexico. © Archivo Iconografico, S. A./CORBIS.



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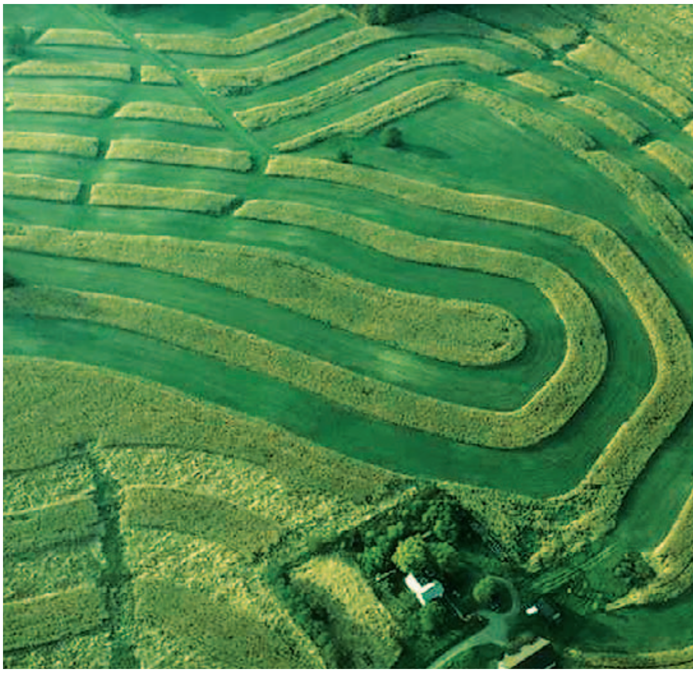
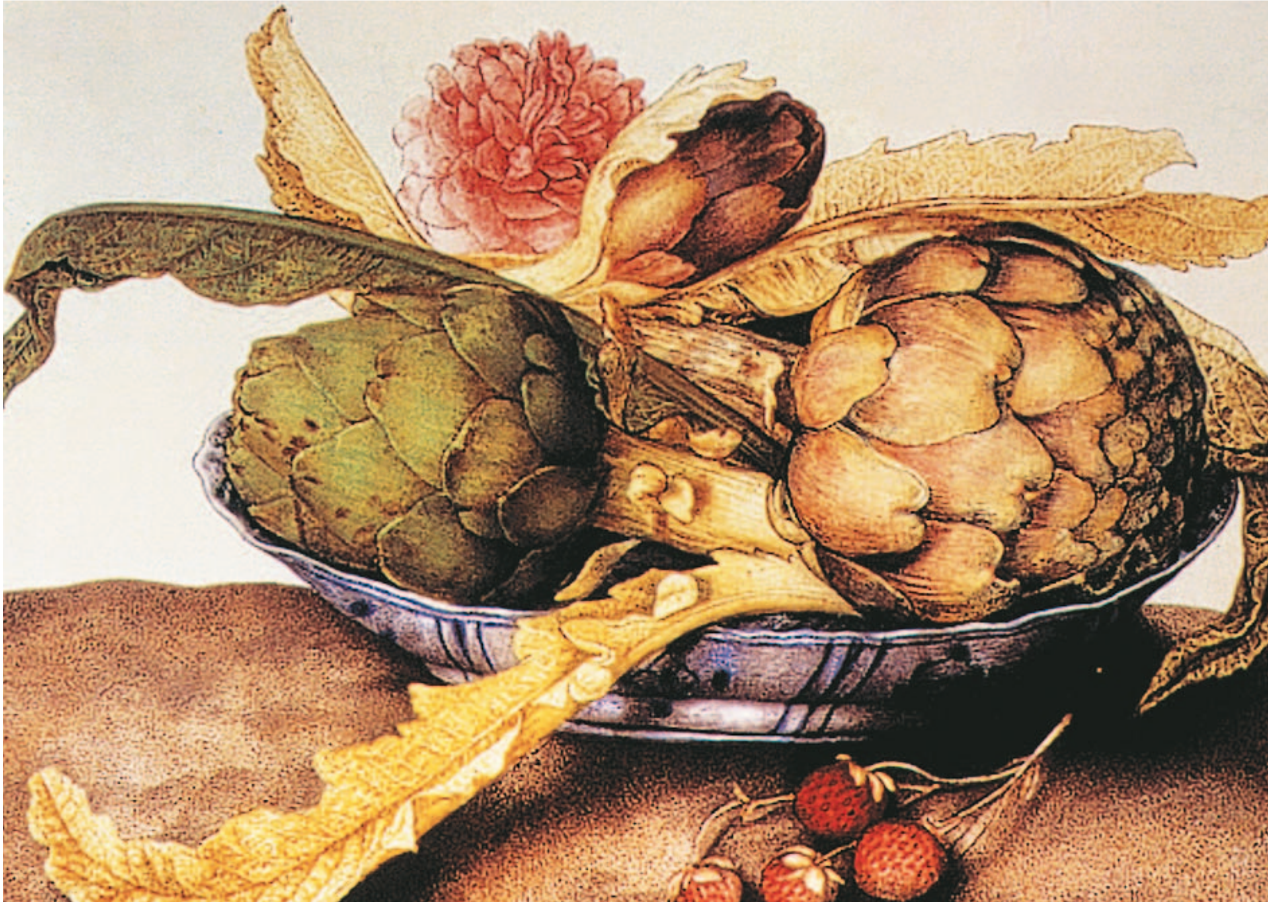
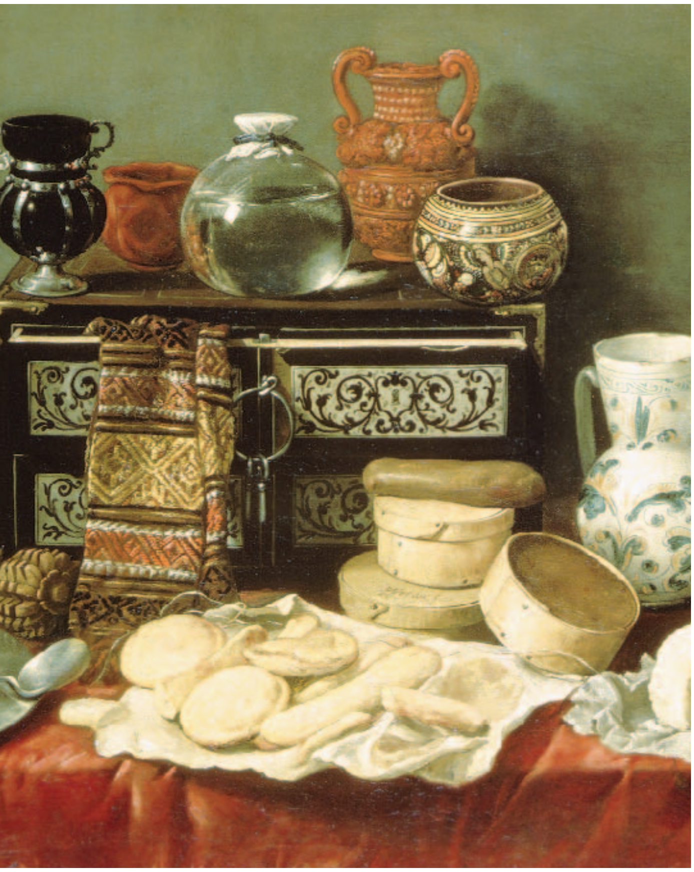
Africa/East Africa Market scene in Zimbabwe. Photo by David K. O'Neil.

***Top:* Agronomy** Methods of growing crops should match the environment where they are planted. By sowing crops in strips following the contours of the land, both soil and water are conserved, thus maintaining soil productivity for future generations. Courtesy of The John Deere Library.

***Bottom:* Food in Art** Still life with artichokes in a Chinese dish by Giovanna Garzoni (1600–1670). Collection of the Pitti Palace, Florence. Photo courtesy of Dr. Phoebe Lloyd.



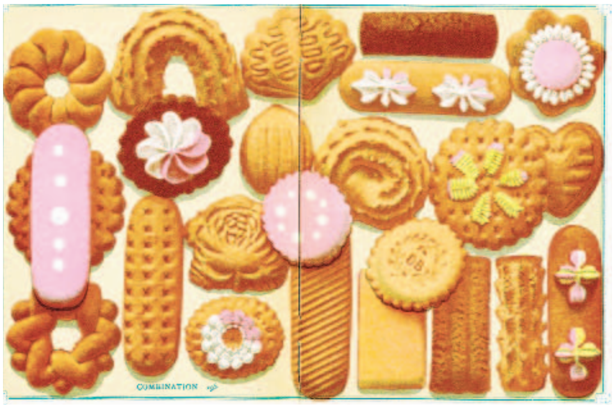




***Left top:* Biscuits** Detail of still life with biscuits painted in 1652 by Spanish painter Antonio Pereda y Salgado. Collection of the State Hermitage Museum, St. Petersburg. © Alexander Burkatowski/CORBIS.

***Right top:* Biscuits** Folding plate showing fancy biscuits from the biscuit catalog of E. De Beukelaer & Company of Anvers, Belgium, circa 1896. Roughwood Collection.

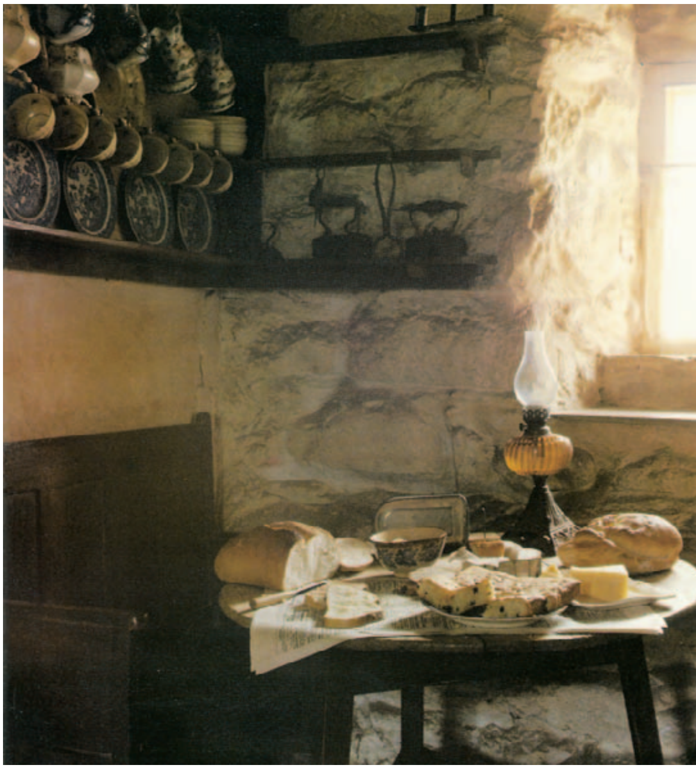
***Below:* Bread** Bread vendor in Central Asia. Ring-shaped breads are common in many cultures due to portability (they can be carried or stored on poles) and shorter baking time. Shorter baking time translates into lower fuel consumption, an important consideration in regions with a shortage of wood. Photo courtesy of Glenn R. Mack.



***Below:* British Isles/Ireland** *The Discovery of the Potato Blight,* painted in 1847 by Irish artist Daniel McDonald (1821–1853). The painting portrays the despair of "Black '47," the year when the Great Famine reached its height. Paintings of the famine are very rare in Irish art. Courtesy of the Department of Irish Folklore, University College, Dublin.

***Top left:* British Isles/Ireland** The Lumper potato is an heirloom variety dating from before 1800. It was once one of the most popular potatoes grown in Ireland and was one of the first to fail during the Great Famine. Roughwood Seed Collection. Photo by Rob Cardillo.

***Top right:* British Isles/Wales** Preparing a miner's tuck-box. Various foods for the tuck-box are spread on the table. *Teisen lap* (currant cake) was a particular favorite baked in the coal miners' villages of south Wales. It provided a "sweet" for the miners' midday meal underground. The moisture of the cake prevented it from crumbling in the tuck-box. Courtesy of the National Museum of Wales.



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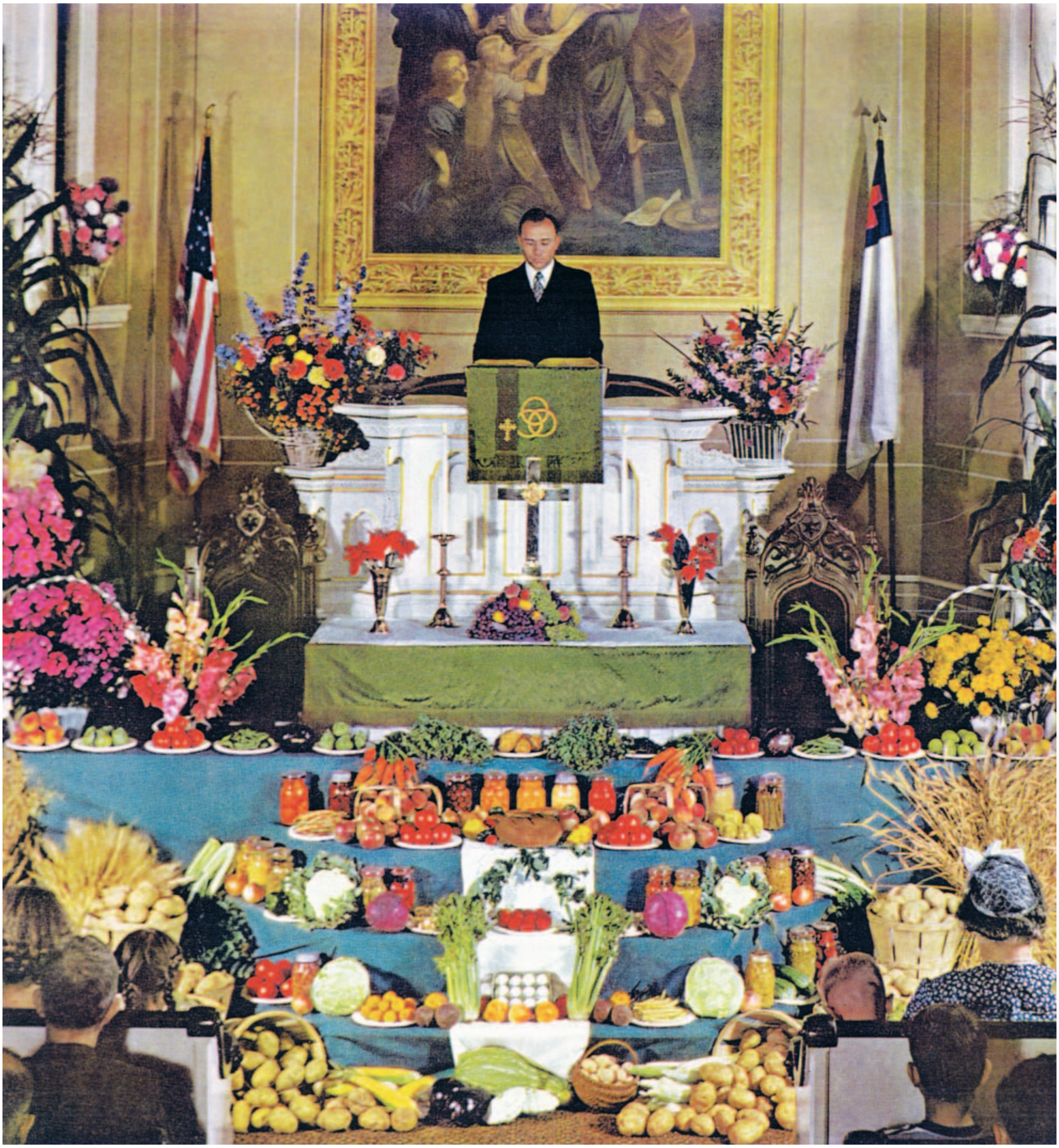
Cabbage and Crucifer Plants Cabbage figures far more prominently than lettuce in the diet of Caribbean and Central American countries. These cabbage fields are in the mountainous region of Valle Nueva near Constanza, Dominican Republic. © Richard Bickel/CORBIS.

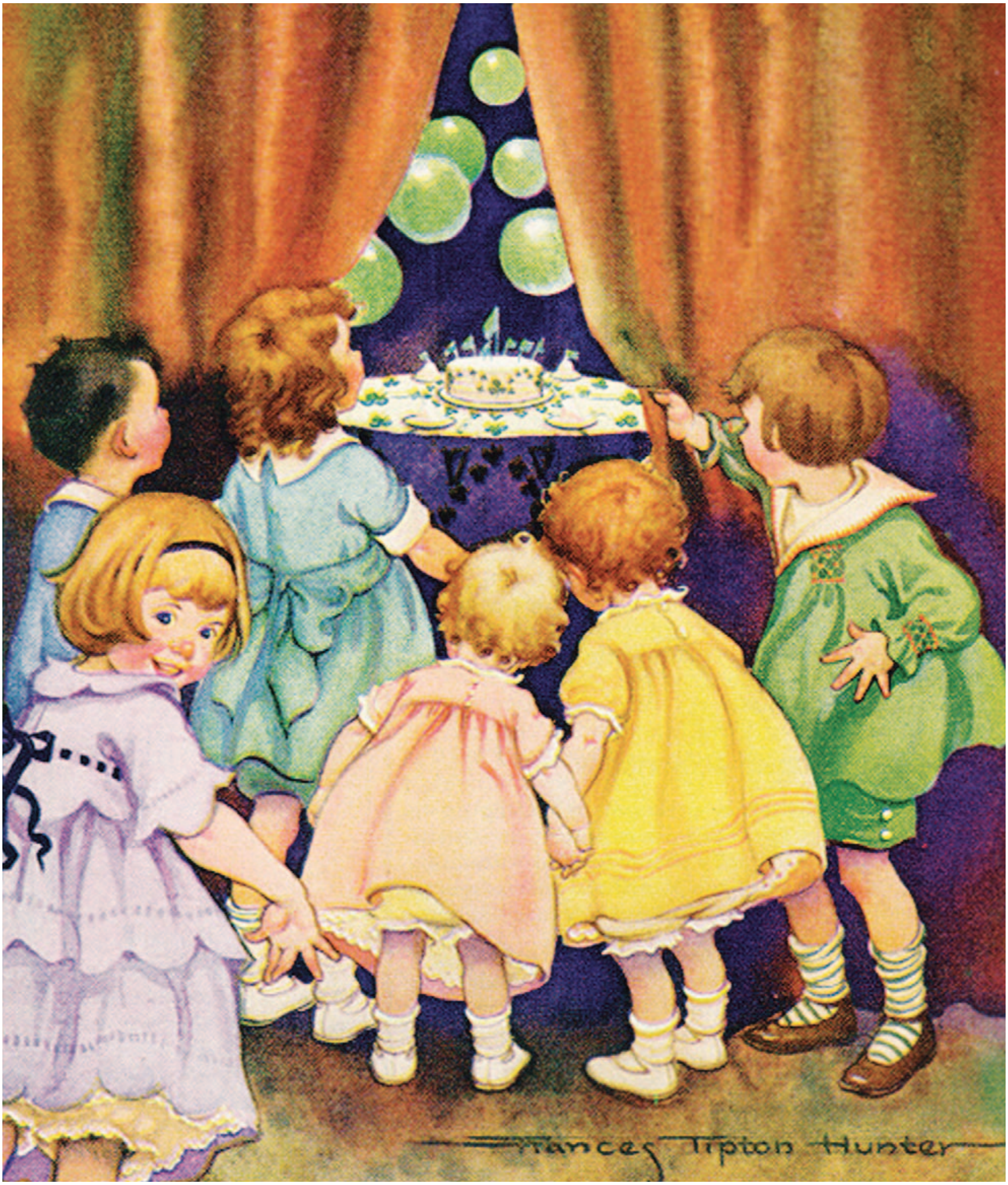
Left: Cuisine Black truffles from southern France prepared in the style of nouvelle cuisine. This style of food preparation has become so abstract and internationalized that the food has lost a sense of place and cultural identity. Photo by André Baranowski.

Below: Cooking Smoke rising from the hearth of a Guyami hut in the jungle near Chiriqui Grande, Panama. In medieval Europe, the presence of a hearth (and by implication the smoke it produced) provided a legal definition of the household regardless of the number of people it served. In contrast to the image of black truffles prepared according to the tenets of nouvelle cuisine, this hut and its abundant smoke provides an image of cooking at its most down-to-earth simplicity. © Danny Lehman/CORBIS.

Feasts and Festivals Pastor Robert J. Urffer officiates during the observance of Harvest Home at Union Church, Neffs (Lehigh County), Pennsylvania, in 1945. Harvest Home was at one time a far more common observance than Thanksgiving in the United States. The ending of World War II added poignancy to this particular occasion. Roughwood Collection.



Feasts and Festivals St. Patrick's Day party for children from Marion Jane Parker's *The Children's Party Book* (Chicago, 1923). Irish culture is celebrated with a game called "Kissing the Blarney Stone," a soap bubble contest (the green bubbles seen over the table), and St. Patrick's Ice Cream—colored green, of course. Roughwood Collection.



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ENCYCLOPEDIA OF FOOD AND CULTURE

VOLUME 2:
Food Production to Nuts

Solomon H. Katz, Editor in Chief

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FOOD PRODUCTION, HISTORY OF. Ensuring sufficient food supplies is one of the most basic challenges facing any human society. Organized and efficient food production supports population growth and the development of cities and towns, trade, and other essential elements of human progress.

For many thousands of years, people collected their food from the wild or hunted animals large and small. The teamwork required to bring down a mastodon may have been the first type of collective enterprise in which humans engaged. The "hunter-gatherer" mode was sufficient for small groups in favorable environments, but as population grew and people pushed into areas less endowed with easily obtainable food, they sought more reliable sources of nutrition.

Scientists believe that agriculture was established first in the Fertile Crescent of the Middle East about ten or eleven thousand years B.C.E. The region was home to a variety of edible and easily cultivated crops: wheat and barley among the cereal crops, and lentils, peas, and chickpeas among the vegetables. Also, the region was endowed with wild goats, sheep, pigs, and cattle, all of which were domesticated and became important sources of food. Cattle are also useful work animals, and all these animals produce manure for fertilizer. Thus, a complete agricultural package was available, and it helped give rise to the civilizations in the Middle East. The need for common facilities to thresh and store grain was a major impetus for settlements; the wall of Jericho dates from around 8000 B.C.E. and was presumably built to protect its food supply.

Agriculture developed independently in the part of Mexico and Central America known as Mesoamerica; in the Andean highlands of Peru; in the American Midwest; in north and south China; and in Africa. But the Fertile Crescent had a long head start and the most favorable combination of plants and animals, and this eventually translated into a significant cultural advantage for Europe.

In the ancient world, the Mediterranean Sea was crisscrossed with ships carrying spices from the Middle East and ultimately India, wine and olive oil from Greece, and grain from Egypt. The city of Rome came to depend on wheat from Egypt and North Africa to supply the grain (and, later, bread) that was distributed free of charge to its plebeians. The *annona* (the distribution of free or reduced-price grain or bread) reached impressive dimensions: by 350 B.C.E., an estimated 120,000 people received six half-pound loaves per day provided by 274 public bakeries. It was one of the world's first examples of mass production of a specific food product.

Roman agriculture was otherwise centered on the *villa rustica*, a type of large estate with diversified production of grain, vegetables, fruits, nuts, and livestock. After the Roman Empire collapsed, these estates became the model of the medieval fief, the property held by a lord and worked by serfs who were legally bound to the land. The serfs had to work the lord's land but also had the right to work strips of their own, plus small kitchen gardens. In the early feudal period, peasant families could gather game in the forests, but eventually these were reserved to the aristocracy and the peasants got by on little more than bread and gruel.

Technology, as simple as it was in the Middle Ages, played a role in increasing food production. The development of a heavy plow capable of breaking the dense,

The Progressive Grocer
March 1928
The National ... Grocery Trade
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Model Stores That Handle Meat
— Page 10

Professional trade journals from the past provide rich source material for the history of food production. ROUGHWOOD COLLECTION.

This Australian photograph from the early 1890s records an old method of hand grading and packing apples. © BETTMANN/CORBIS.

wet soils of northern Europe reached Germany by the eighth century, and opened up a major new grain source for the rest of the continent. Grist mills powered by wind or water popped up all over Europe beginning in the eleventh century, providing large-scale processing of grain into flour.

Medieval European crop farmers had few options for increasing production. The usual practice was to rotate fields between grain and pasture so that they would be refreshed by animal manure between crops, a practice called "fallows." In the later Middle Ages, the revitalizing power of legumes, which supply nitrogen to the soil, a technique lost since Roman times, was rediscovered. Rotating fields through grain, legumes, and fallows boosted productivity by at least a third and added peas, beans, chickpeas, lentils, and other vegetables to the European diet.

China, often thought of as a land of rice, also depended heavily on millet, wheat, and soybeans. Rice production increased significantly in the eleventh century when new strains were imported from Southeast Asia. Chinese fishermen also gathered fish from the ocean, lakes, and rivers, and sold them in vast central markets, which supplied networks of cookshops, restaurants, banqueting halls, and other eating places.

The Arab world also had a varied and sophisticated system of food production, with water-powered mills grinding grain full-time in North Africa and fishermen packing Mediterranean tuna in salt. The Arabs introduced citrus, rice, and sugarcane to Europe and controlled the lucrative spice trade with India. European interest in breaking the Arab hold on the spice trade led to the voyages of discovery of Vasco da Gama and Columbus.

Discovery of the New World touched off the greatest and most rapid spread of new crops the world had seen. The Americas contributed maize (corn), potatoes, tomatoes, and peppers to Europe, while the Europeans brought wheat and other staple crops, and sugarcane, which was very successful in Brazil and later the Caribbean region. Sugarcane cultivation created a demand for labor that was met by the African slave trade. The "Columbian Exchange" thus laid the basis for much of the subsequent economic and political history of the New World.

In the Old World, the decline of feudalism and the rise of cities and towns helped move agriculture from subsistence to a market orientation. Land that had been held in common and used mainly for grazing was consolidated under the control of individual landowners, which greatly increased production of both crops and animals. The draining of marshy land, especially in England and the Low Countries, was accelerated. All these trends supported the more intensive cultivation of the available land and the production of more and cheaper food for growing and more urban populations. By 1700, European agriculture could provide approximately two-and-a-half times the yield per input of seed that had been normal in the Middle Ages (Roberts, 1997).

Science and technology played an increasingly important role in food production in the eighteenth and nineteenth centuries. The development of mineral and then chemical fertilizers freed farmers from reliance on manure and fallows as ways of renewing the soil. New equipment, such the mechanical seed drill, made for more efficient planting. The mechanization of agriculture advanced rapidly in the nineteenth century with mechanical reapers, the tractor, and electric milking machines, among other innovations. Scientists also developed a better understanding of the nutritional components of food, which led to an emphasis on a balanced diet and, by the twentieth century, resulted in the improvement of food with the addition of vitamins and minerals to products such as bread and breakfast food.

Preserving food for later consumption has always been a challenge, especially in countries with long winters when little fresh food was available. Grain kept well if kept dry, but meat and fish had to be salted, and a monotonous diet of bread, dried peas, and salted fish sustained many Europeans through the winter until the early modern period. The preservation of food by heating it and sealing it in jars or cans began in the early nineteenth century, followed by pasteurization of wine and later milk to kill spoilage organisms. (The great chemist Louis Pasteur developed the process that bears his name to save the French wine industry, not its dairy farmers.) Canning and pasteurization made a wider variety of foods available to urban populations

With the development of steamships and refrigeration in the nineteenth century, the international food trade was transformed. Beef could be shipped from Argentina to England and bananas from Central America to New York. Worldwide food exports went from 4 million tons in the 1850s to 18 million tons thirty years later and 40 million tons by 1914 (Ponting, 1992). Chicago became the center of the U.S. meatpacking industry when refrigerated rail cars allowed packers to ship butchered meat virtually nationwide.

Agriculture, fisheries, and livestock and poultry production are now so efficient in Europe, North America, Australia, Argentina, Brazil, Japan, and other advanced countries that production can easily overwhelm demand, resulting in low prices and financial losses for producers. Governments all over the world subsidize their farmers and attempt to protect them from foreign competition, which keeps farmers in business but raises the cost of food to consumers. In the United States, for example, sugar costs twice what it does on the world market because of the protection of domestic producers.

Some of the benefits of Western agriculture and food production have been modified and transferred to the developing world. The use of high-yield wheat and rice, along with large doses of fertilizer—the so-called "Green Revolution"—has transformed the food picture in many countries. Wheat production in India nearly tripled from 1965 to 1980 while rice production increased 60 percent with the new strains and new methods. During the 1970s alone, rice production rose 37 percent in Indonesia and 40 percent in the Philippines.

Food today is often highly processed before being sold to consumers. Conversely, "pure," "organic," "all-natural" foods are becoming more popular. While dwarfed by the mainstream food industry, organic production can be profitable and viable. Governments seek to encourage this type of production, with strict regulations (effective 2003) on what can be labeled "organic" in the United States and programs such as "Label Rouge" ("red label"), which recognizes organic-style production, in France.

With rapid advances in biotechnology, genetic manipulation of crops accelerated in the 1990s and is expected to have a significant impact on food production. Maize, for example, is bioengineered to resist insect pests, and soybeans are modified to shrug off a common herbicide that keeps the fields free of weeds. These traits are advantageous to producers but not directly beneficial to consumers. The next level of genetic modification will be to insert traits actually beneficial to humans into food plants, such as rice fortified with extra vitamins that ward off blindness. Genetic modification of food plants is controversial and closely regulated by government but is felt by many to be the next frontier in food production.

See also **Agriculture, Origins of**; **Agriculture since the Industrial Revolution**; **Agronomy**; **Food Supply and the Global Food Market**; **Food Supply, Food Shortages**; **Green Revolution**; **High-Technology Farming**; **Horticulture**; **Packaging and Canning**; **Pasteur, Louis**.

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Richard L. Lobb

FOOD RIOTS. A food riot can be defined as any gathering, whether planned or spontaneous, that may begin peacefully (a "food protest") but evolves into disorder, leading to loss of control, violence, bodily harm, or damage to property. "Food riot" and "food protest" can be understood and discussed together as "food disturbances" (Gilje, p. 4). Food disturbances occur and have occurred for obvious reasons: When people feel their sense of entitlement to an adequate supply of food is being breached by those controlling the food supply, they will go to extreme measures to get the kind, quantity, and quality of food they feel they need for themselves and their families.

Historical and archaeological evidence documents the existence of food riots for several thousands of years and in all parts of the world, with periods of greater and lesser activity (Newman). Food riots occurred most frequently in the modern era (sixteenth through eighteenth centuries), declined through the nineteenth and twentieth centuries, and increased again toward the end of the twentieth century, primarily in developing countries.

Types of Food Riots

Since it is such a strong component and shaper of identity, food is deeply enmeshed in a collective as well as an individual sense of identity. How and why foods accrue special meaning—what makes them unique to particular groups of people—can vary widely: method of preparation, long-held tradition, particular "flavor principles,"

PROVISION ALIMENTAIRES
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A political power struggle in Haiti resulted in massive food riots and looting in Port-au-Prince in 1994. © PETER TURNLEY/CORBIS.

perception of purity, religious, cultural, or political significance, signification of wealth or status, or any combination of factors. The restriction in availability of foods imbued with distinctive meaning, then, whether through government manipulation or the vicissitudes of a "free market" economy, can function as a catalyst for collective protest. This is true not only in relatively isolated communities in the past, but in the ever-changing global villages of the twenty-first century.

A major subfield in social history, a rich body of scholarly work both documents and theorizes about food disturbances. European social historians especially have set the standard for scholarship in the field. While no two riots are ever exactly the same, and each contains a multiplicity of circumstances, historians have generalized that in the past food riots have fallen into three main categories: First, a blockage or entrave, where protesters blocked shipments of grain or other foodstuffs shipped from one region to another; second, the price riot or *taxation populaire*, where peasants seized the goods from a retail shop whose prices were deemed too high, which would then be sold for a "just price," and often the money paid to the merchant. The final form of food riots, the market riot, was simply looting stores and supply depots to protest high prices or the lack of goods (Thompson; Gilje; Walton and Seddon).

Modern-day riots tend to conform to the latter category of market riots, as looting and destroying property are common factors. In addition are the more calculated, less volatile, demonstrations where the food at issue is ceremoniously dumped on the grounds of, for example, the local government headquarters. The boycotting of food, also a common means of protest in the twentieth century, can be effective, especially when centered on one item such as milk, beer, bread, or grapes, or on a single manufacturer (Linden). Boycotts, however, can evolve into full-fledged food riots if participants harass or violently attack those choosing to purchase a targeted item or frequent a targeted store.

Theories of Food Rioting

Why do people riot over food? The obvious answer, that they riot because they are hungry, does not begin to answer the question since most who are poor and hungry do not riot. What intervening variables determine who eventually riots over which foods? Historians have analyzed and explained food riots in a variety of ways, including as collective action representing the "moral economy" of an era, as part of a so-called "female consciousness," and as an exhibition of nationalism/patriotism. In his 1971 article, "The Moral Economy of the English Crowd in the Eighteenth Century," eminent British historian E. P. Thompson sets about to provide a "thick description" of food rioters' motives in preindustrial England, an era when subsistence riots happened with great frequency. Thompson argues that English peasant bread riots were symptomatic of a society caught between changing economic and political forces, of an England in the midst of moving from a looser collection of landed gentry to a stronger state, and from a mercantilist, feudal economic system to one of laissez-faire market capitalism. Peasants under the feudal system were used to bread sold at "just prices"—an amount reduced for the poor as part of the communal moral ethos. In the shift to an emerging market economy that abandoned the notion of the just price, peasants understandably clung to the older "moral economy." Viewing inexpensive bread prices as an entitlement, when peasants felt the long-held social pact was not being honored under the new system, they rioted in response. People, argues Thompson, were thus not just rioting because they were hungry, but also out of a sense of injustice. As the peasantry evolved into the industrialized working class, conflicts over food were absorbed into and displaced by organized labor strikes. This explains why the number of food riots diminished considerably in the nineteenth century and beyond. Scholars have taken issue with Thompson's moral economy theory, but few if any reject his theory outright.

Since women as well as men participated in food riots, often in unique ways, in recent years historians have employed gender as a category of analysis. While not disagreeing with the moral economists, historians such as Temma Kaplan point out that, although the number of food riots decreased in the nineteenth century, food disturbances nevertheless continued. Moreover, they argue, food rioting took on a noticeably female persona, in part because labor unions, the new locus of collective action, largely excluded women. Studying early-twentieth-century food riots in Barcelona, Kaplan argues that women participated in food riots as an extension of their role in the sexual division of labor: caring for home and family, which included food procurement and preparation. Women who accepted the traditional division of labor, argues Kaplan, could be radicalized to action in the public sphere if they were prevented from fulfilling their obligation, especially the feeding and care of their families.

Food riots can also be examined in light of cultural meanings of consumption and their connection to nationalism. Historian Timothy Breen explores the relation between the growth of national consciousness and the American colonial rejection of British manufactured goods, including foodstuffs. Manufactured goods imported from Britain, readily available to so many people, Breen argues, resulted in a standardization of taste that transcended (to some extent) class boundaries. Consumer goods became politicized in the decades leading up to the American Revolution, providing a "shared language of consumption" that colonists of all regions and classes could understand and identify with, hence providing a common experience and knowledge base that united them enough to wage war against the mother country. While Breen does not limit his analysis to food but explores the meaning of consumer goods of all kinds, he focuses on the struggle over tea and its culminating food protest, the Boston Tea Party.

Modern-Day Food Rioting

While food riots and protests have occurred in the nineteenth and twentieth centuries, the recent wave of food riots and protests are directly tied to strict economic austerity plans forced on developing countries by the International Monetary Fund (IMF) and other international banks. Governments attempting to repay bank loans must enact draconian measures, including abandoning the long tradition of subsidizing staple foods such as bread, rice, and cooking oil. The resulting high prices, deflated wages, scarce resources, shrinking food supplies, and empty bellies has led to a series of food riots, including the looting and pillaging of stores, fast-food restaurants, and supply depots, the blockading of farm and supply trucks, and protests in town squares that have erupted into mayhem and violence. Often the protests and riots have centered on one food item, usually a staple or key ingredient (often with a tradition of subsidization by the government) integral to the culture's cuisine and consumed by rich and poor alike: rice, tortillas, onions, bread. The item, so central to their food habits, has functioned as a symbol of people's intense frustration and anger at being trapped in a global economic web in which they seem to have no agency. Social scientists John Walton and David Seddon note similarities between these recent austerity riots and those of the preindustrial European peasantry. Each era of food rioting, they argue, includes a context of burgeoning urban metropolises, severe economic hardship, and populations with a strong sense of moral economy that regards subsidized food prices as a government obligation.

See also **Consumer Protests; Food as a Weapon of War; Food Supply, Food Shortages; Hunger, Physiology of; Hunger Strikes; Malnutrition; Political Economy.**

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Amy Bentley

FOOD SAFETY. Food safety is a matter that affects anyone who eats food. Whether or not a person consciously thinks about food safety before eating a meal, a host of other people have thought about the safety of that food, from farmers to scientists to company presidents to federal government officials and public health officials. Ensuring the safety of food is a shared responsibility among producers, industry, government, and consumers. Safe food is food that is free not only from toxins, pesticides, and chemical and physical contaminants, but also from microbiological pathogens such as bacteria, parasites, and viruses that can cause illness.

Those working in the field of food safety are most concerned about microbial foodborne illness, a widespread but often unrecognized sickness that affects most people at one time or another. At least four factors are necessary for foodborne illness to occur: (1) a pathogen; (2) a food vehicle; (3) conditions that allow the pathogen to survive, reproduce, or produce a toxin; and (4) a susceptible person who ingests enough of the pathogen or its toxin to cause illness. The symptoms often are similar to those associated with the flu—nausea, vomiting, diarrhea, abdominal pain, fever, headache. Most people have experienced foodborne illness, even though they might not recognize it as such, instead blaming it on the stomach flu or a twenty-four-hour bug. Usually symptoms disappear within a few days, but in some cases there can be more long-lasting effects such as joint inflammation or kidney failure. In the most severe cases people die from foodborne illness.

Current estimates of foodborne illness in the United States are 76 million cases, 325,000 hospitalizations, and 5,194 deaths from foodborne pathogens per year. In cases when the pathogen is identified, bacteria cause 30 percent of foodborne illnesses, parasites 3 percent, and viruses 67 percent. But as far as deaths are concerned, bacterial pathogens are the leading cause of death, with 72 percent of total foodborne illness deaths attributable to bacteria. Fatality rates for two bacteria are particularly high; for *Listeria* 20 percent of the people may die, and for *Vibrio vulnificus* 39 percent. Just six pathogens account for over 90 percent of the deaths associated with foodborne illness: *Salmonella* (31 percent), *Listeria* (28 percent), Toxoplasma (21 percent), Norwalk-like viruses (7 percent), *Campylobacter* (5 percent), and *Escherichia coli* (3 percent). According to FoodNet data from 1996–1997, each person in the United States suffers 1.4 episodes of diarrhea per year. With a U.S. population of 267.7 million persons, that works out to 375 million episodes per year, many of them related to eating unsafe food. Factors that contributed the most to foodborne illness are improper holding temperatures, inadequate cooking, contaminated equipment, food from unsafe sources, and poor personal hygiene.

Factors Influencing the Safety of Food

Stories of foodborne illness have become much more prevalent throughout the world. Is food less safe than it used to be, and if so, what factors account for this? News travels fast these days, both electronically and through the news media. What were once isolated events and stories, now reach millions within hours. Diagnostic techniques are constantly improving, allowing for identification of diseases, foodborne and otherwise, that would have been of unknown origin in the past. But even considering these facts, public-health officials believe that the risk of foodborne illness has increased over the past twenty years (GAO, 1996). Some threats to food safety have been around since ancient times, while others are newer, the result of changing demographics and lifestyles, production practices, and even evolution of microorganisms themselves.

Demographics

The proportion of the population at serious risk of foodborne illness is increasing as the population ages and the number of people with weakened immune systems grows. People who are at higher risk of becoming seriously ill include infants, young children, the elderly, pregnant women, those taking certain medications, and those with diseases such as acquired immunodeficiency syndrome (AIDS), cancer, and diabetes that weaken their immune systems. Demographers predict that the proportion of people over sixty years old in industrialized countries such as the United States will rise from the current 17 percent of the population to 25 percent by 2025 (Kaferstein, 1999). In one survey, 89 percent of deaths with diarrhea as an underlying cause were adults fifty-five and over or children under the age of five (Morris, 1997).

While anybody can get sick from eating contaminated food, the severity of the illness depends on a number of factors. Most important among these are age, amount of contamination consumed, and health status of the individual. The body has a number of defenses to protect itself against harmful bacteria. The acidic gastric juices of the stomach are one of the first defenses against foodborne pathogens, as many bacteria cannot survive in an acidic environment. Very young infants and aging adults produce fewer, or less acidic, gastric juices than younger, healthy adults. The normal bacteria present in the gastrointestinal system form another protective barrier against foodborne illness by preventing harmful bacteria from colonizing the gut. Use of antibiotics, which destroy the protective bacteria normally present in the gastrointestinal tract as well as their target bacteria, make it easier for pathogenic bacteria to invade and cause illness. Finally, the human immune system, not fully developed at birth, gradually reaches maturity in puberty and then slowly begins to decline after about fifty years of age.

Consumer Lifestyles and Demand

As the pace of life quickens, we often eat meals on the run, and spend less time on food preparation, preferring instead restaurants, convenience foods, or already prepared meals. This means that by the time you eat your food, it may have been transported, cooked, cooled, stored, transported again, reheated, and touched by numerous individuals. Each processing step introduces new hazards that could allow for the survival and growth of pathogens. In the United States, two out of three people ate their main meal away from home at least once a week in 1998. The typical consumer over eight years of age ate food away from home at least four times per week (Collins, 1997). Americans spend fifty cents of every food dollar on food prepared outside the home—from supermarkets, restaurants, or institutions.

Add to this the mishandling of food that occurs after a consumer purchases food and takes it home, and the likelihood of illness increases. Approximately 20 percent of reported foodborne illness cases occur from food cooked at home. Experts believe that this number is actually much higher, but that most people do not report cases of illness caused by foods cooked at home (Knabel, 1995; Doyle, 2000). As people cook less, they pass on less knowledge of cooking to their children, who are nevertheless increasingly responsible for preparing meals. This has grave implications for the future of food safety. In a survey of consumer food safety knowledge and practices, 86 percent of respondents knew that they should wash their hands before preparing food, but only 66 percent reported actually doing so. Only 67 percent of respondents reported washing or changing cutting boards after cutting raw meat or poultry. Older adults practiced safe behaviors more often than did younger adults (Altekruse, 1995). In an Australian study in which researchers asked people about their food safety and kitchen habits, and then filmed them preparing food, there were large differences in what people said they did and what they actually did. Almost half the people who said they washed their hands after handling raw meat did not, and when they did it was often without soap. Nineteen percent of the households that claimed to have soap in the kitchen did not (Jay, 1999).

Consumers are increasingly demanding fresh and natural products, prepared with fewer preservatives. Without the traditional preservatives and processing methods that prevent microbial growth, modern all-natural and fresh products are more perishable. Food processing, mainly canning, freezing, and pasteurizing, not only extends the shelf-life of foods, but also inhibits bacterial growth, making food safer. As an example, fresh apple cider has been associated with several foodborne disease outbreaks. An outbreak of *Escherichia coli* O157:H7 in which a child died was associated with raw unpasteurized apple juice from a company that built its reputation on the naturalness of its products.

As the role of fresh fruits and vegetables in a nutritious diet has become evident, people are including them in their diet more. In 1993 Americans ate 27 percent more fresh produce than they did in 1973. An increase in the number of foodborne illness outbreaks associated with fresh produce has accompanied this increase in consumption. In the last twenty years of the twentieth century, the number of identifiable outbreaks in which produce was the food vehicle doubled (Tauxe et al., 1997). Most produce only grows in the United States in certain seasons, yet this seasonal availability has almost disappeared from our supermarkets as consumers demand year-round availability of produce. From 1996 to 1998 *Cyclospora cayetanensis* sickened more than 2,400 people throughout twenty states and Canada. The only common food vehicle among these individuals was raspberries imported from Guatemala. Smaller outbreaks of *Cyclospora* have been traced to basil and mesclun lettuce grown in the United States.

Food Production and Economics

In the past, outbreaks of foodborne illness were relatively small and local. Illness could be traced back to local events such as weddings, church dinners, and other gatherings where a large number of people ate the same food. Today's food is produced in vastly different ways from those of even several decades ago. Food used to be grown, produced, and distributed on a local basis. Food production is now centralized and on a larger scale than in the past. Products made in a single processing plant in mass quantities are shipped all over the country, sometimes throughout the world. A mistake made in the processing will be felt nationwide instead of just locally. In 1994 an estimated 224,000 people throughout the nation became ill from *Salmonella enteritidis* after eating ice cream produced at one ice cream processing facility in Minnesota, but shipped around the country (Hennessy, 1996). Recalls from processing plants are on a larger and larger scale. In 1998 Sara Lee recalled 35 million pounds of hot dogs and lunch meat due to the presence of *Listeria*. This is food contamination on a scale unprecedented a generation ago.

Even the manner in which farmers raise animals can contribute to an increase in food safety problems. A large number of animals are often crowded together, increasing their stress levels and weakening their immune systems. This crowding also facilitates the spread of disease from one animal to another. In the old days a sick animal would be fairly isolated and if it became sick it would not pass on illness to the rest of the flock or herd. But with closer animal-to-animal contact, disease can quickly spread throughout the whole group.

New and Evolving Pathogens

As recently as fifty years ago scientists had identified four foodborne pathogens. Today five times that number are on the list. Twenty years ago scientists did not even recognize three of the four pathogens that the Centers for Disease Control considers the most important in causing foodborne illness—*Campylobacter jejuni*, *Listeria monocytogenes*, and *E. coli* O157:H7. *C. cayetanensis* first appeared in 1979 and is still not well understood. It is likely that scientists will discover new foodborne pathogens as laboratory techniques improve.

As living organisms, pathogens are constantly evolving. With better ability to trace outbreaks, scientists are discovering that some bacteria survive in environments previously thought safe. For example, *E. coli* O157:H7, originally called "hamburger disease" because of its presence in undercooked ground beef, has shown up in foods as diverse as salami, apple cider, raw milk, and lettuce. It also survives in lower pH conditions than originally thought, leading to the outbreaks in acidic foods such as salami and apple cider. It is now known that *Yersinia enterocolitica* and *L. monocytogenes* can survive and multiply at refrigeration temperatures.

Some foods long considered safe have recently been implicated in foodborne outbreaks. For years scientists believed the inside of an egg was sterile and that *Salmonella enteritidis* was not of concern. Now however, they know that chickens infected with *Salmonella* pass this infection along in their eggs, so that the bacteria can be found inside the raw egg, making it unsafe to eat raw or undercooked eggs. This was not known until 1989. Knowledge of this fact caused food safety experts to advise people to cook eggs thoroughly or to use liquid pasteurized eggs.

Bacteria have long been capable of evolving to thwart attempts to eliminate them. Some pathogens are now becoming resistant to common antimicrobial agents. It is thought that the resistance may be related to the subtherapeutic use of these antibiotics in animals. We are seeing this same adaptability in foodborne bacteria. *Salmonella typhimurium* DT104 is widely distributed in wild and farm animals, especially in Europe, and is resistant to several common antibiotics. There has been a parallel increase with people getting sick from this type of drug-resistant *Salmonella*.

History of Food Safety

Very little about foodborne illness or food safety is found in historical records. Scientists did not begin to understand bacteria, and their relationship to disease, until the late nineteenth century. People did recognize that food spoils, but the reasons for that and the potential for becoming ill from food were not known. The history of food safety is really the history of the numerous discoveries, inventions, and regulations that all led to the present knowledge.

Food preservation methods such as drying, smoking, freezing, marinating, salting, and pickling have their beginnings thousands of years ago. Whether these methods were employed solely to keep food for later use, to improve flavor, or for other reasons is not known; but for whatever reason they were developed, they also had the effect of keeping food safer. Even cooking can be viewed as an ancient method of making food safer. The Chinese Confucian Analects of 500 B.C.E. warned against consumption of sour rice, spoiled fish or flesh, food kept too long, or insufficiently cooked food. The Chinese disliked eating uncooked food, believing that anything boiled or cooked cannot be poisonous. It is possible that the practice of drinking tea originated because tea required using hot water, which would make it safer than using unheated contaminated water (Trager, 1995). Doubtless other cultures in antiquity, while oblivious to the causes or prevention of foodborne disease, experienced it and prescribed methods to avoid it.

Much of the present knowledge about pathogens and foodborne illness is built on a foundation of scientific discoveries spanning back over three centuries. Italians Francisco Redi and Lazzaro Spallanzani performed experiments that dispelled the theory of spontaneous generation of organisms. The discovery of bacteria in the late nineteenth century, the increased understanding of bacteria's role in disease, and the realization that there is a connection between human diseases and animal diseases led to the ideas that cleanliness is important and that unsanitary conditions can contribute to disease. A leader in this effort was Hungarian physician Ignaz Semmelweiss, who in 1847 required hospital doctors to wash their hands before delivering babies. As a result, maternal death rates plummeted from 10 to 1.5 percent. His colleagues greeted his theory that doctors were carrying disease from person to person with ridicule. Instead they attributed maternal deaths to a phenomenon arising from the combustible nature of pregnant women. Lack of personal hygiene remains one of the main causes of foodborne illness 150 years later.

Louis Pasteur further elucidated the link between spoilage, disease, and microorganisms with his work on fermentation and pasteurization in the 1860s and 1870s. In 1872 German scientist Ferdinand Julius Cohn published a three-volume treatise on bacteria, essentially founding the science of bacteriology. But this new field of bacteriology needed bacteria on which to conduct experiments and study. It took Robert Koch in the 1880s to perfect the process of growing pure strains of bacteria in the laboratory. At first he used flat glass slides to grow the bacteria. His assistant, Julius Richard Petri, suggested using shallow glass dishes with covers, now commonly called Petri dishes. Koch also established strict criteria for showing that a specific microbe causes a specific disease. These are now known as Koch's Postulates. Using these criteria scientists can identify bacteria that cause a number of diseases, including foodborne diseases. In 1947 Joshua Lederberg and Edward Lawrie Tatum discovered that bacteria reproduce sexually, opening up a whole new field of bacterial genetics (Asimov, 1972).

Even though Antonie van Leeuwenhoek, a Dutch biologist and microscopist, had improved the microscope to the degree that small microscopic organisms could be seen as far back as 1673, the discovery of foodborne disease causing microorganisms developed slowly. Although James Paget and Richard Owen described the parasite *Trichinella spiralis* for the first time in 1835, and German pathologists Friedrich Albert von Zenker and Rudolph Virchow noted the clinical symptoms of trichinosis in 1860, the association between trichinosis and the parasite *Trichinella spiralis* was not realized until much later. The English scientist William Taylor showed in 1857 that milk can transmit typhoid fever. In 1885, United States Department of Agriculture (USDA) veterinarian Daniel Salmon described a microorganism that caused gastroenteritis with fever when ingested in contaminated food. The bacteria was eventually named Salmonella (Asimov, 1972). August Gärtner, a German scientist, was the first to isolate *Bacillus enteritidis* from a patient with food poisoning, in 1888. The case was the result of a cow with diarrhea slaughtered for meat; fifty-seven people who ate the meat become ill (Satin, 1999). Emilie Pierre-Mare van Ermengem, a Belgian bacteriologist, was the first to isolate the bacteria that causes botulism, *Clostridium botulinum*, in 1895. The case concerned an uncooked, salted ham served at a wake in Belgium. Twenty-three people became ill, and three died. In a perhaps overzealous use of the scientific method, M. A. Barber demonstrated that *Staphylococcus aureus* causes food poisoning. After each of three visits to a particular farm in the Philippines in 1914, he became ill. Suspecting cream from a cow with an udder infection, Barber took home two bottles of cream, let them sit out for five hours, drank some of the cream, and became ill two hours later with the same symptoms as on the farm. He isolated a bacterium from the milk, placed it in a germ-free container of milk, waited awhile, and then convinced two hapless volunteers to drink the milk with him. Sure enough, they all became ill with the same symptoms (Asimov, 1972). In 1945 *Clostridium perfringens* was first recognized as a cause of foodborne illness. It was not until the years 1975 to 1985 that scientists first recognized some of today's major foodborne pathogens—*C. jejuni*, *Y. enterocolitica*, *E. coli* O157:H7, and *Vibrio cholerae*.

Food Safety Regulations

The earliest food safety regulations in the United States were motivated not by a desire to provide safe food to consumers, but rather out of foreign trade concerns. In 1641 Massachusetts passed the Meat and Fish Inspection Law to assure foreign trading partners that the colony produced high-quality food products. Until the late nineteenth and early twentieth century state and local governments regulated food. Most food was grown and produced locally, so local laws were adequate to deal with problems. As the population changed from rural to urban, and people no longer had a personal connection with food producers, the food supply became more national in scope and distribution. This national scope necessitated national regulation.

The year 1906 was an important one for federal food safety regulation with the passage of both the Pure Food and Drug Act and the Federal Meat Inspection Act. The public was fed up with shocking disclosures of unsanitary conditions in meatpacking plants and the use of poisonous preservatives and dyes in foods. In *A Popular Treatise on the Extent and Character of Food Adulterations* consumers read that almost every food they purchased was adulterated or mislabeled. The Poison Squad, a group of USDA chemists formed in 1902 to study preservatives used in food products by eating the foods themselves, revealed that many of the chemicals used in food production were harmful to human health. Upton Sinclair's 1906 novel, *The Jungle*, highlighted the horrible working conditions of the nation's working class by describing in lurid detail the filthy conditions and adulteration of meat that was common in the Chicago meat industry. The public was more horrified at the thought of rats and other undesirables mixed in with their sausage than of the poor treatment of workers. Sinclair later wrote, "I aimed at the public's heart and by accident hit it in the stomach." Meat sales dropped by half within weeks after the book's publication.

The Federal Meat Inspection Act protected consumers by "assuring that meat and meat food products are wholesome, not adulterated, and properly marked, labeled, and packaged." The act established sanitary standards and mandated continuous inspection of cattle, sheep, goats, and equines before, during, and after slaughter. The 1906 Pure Food and Drug Act forbade the adulteration of foods, drinks, and drugs in interstate commerce. Foods were considered misbranded if they were labeled so as to deceive the public, if the contents in terms of weights and measures were either incorrect or not present on the package, or if the label contained any false or misleading statement concerning the ingredients of a food.

Although it was a good start, the Pure Food and Drug Act had some very large flaws. Since it did not set standards as to what exactly should be in a particular food, it was almost impossible to prove adulteration of a food. For example, without knowing how much strawberry was supposed to be in strawberry jam, federal lawyers could not prove that a product with almost no strawberry in it was not strawberry jam. The act required the government to prove that offenders intended to deceive or poison consumers with their product. When brought to court defendants pleaded ignorance of the results of their actions. These deficiencies led to a renewed push for regulatory reform in the 1930s.

In 1933 Arthur Kallet and F. J. Schlink published the immensely popular book *100,000,000 Guinea Pigs: Dangers in Everyday Foods, Drugs and Cosmetics*. Written in true muckraking style, it stirred the public's ire at the condition of the food they were eating. The basic premise of the book was that the federal government was unable to protect consumers from bad food and drugs, both due to incompetence and to the lack of adequate laws.

As with passage of the 1906 act, public opinion played a strong role in sending the message to Congress that reform was needed. Since much of the media sided with the food manufacturing industry against reform, the Food and Drug Administration (FDA) took its message directly to the people, speaking at women's clubs, to civic organizations, and on the radio. The FDA collected hundreds of products (both food and drug) that had injured or cheated consumers, emphasizing that the 1906 act did not regulate these products enough to prevent such occurrences. The exhibits were photographed and converted into posters to illustrate the need for new laws. They were displayed at FDA talks and at a museum in FDA headquarters. The exhibit was christened the "Chamber of Horrors," leading to the publication of *The American Chamber of Horrors* by the FDA's Chief Educational Officer, Ruth deForest Lamb, in 1936. Ms. Lamb recounted some of the little-known, and sickeningly lurid, behind-the-scenes details of the food industry. In arguing the need for a new food and drug law, she noted that the 1906 laws were outdated due to new modes of living, new kinds of products, new methods of manufacturing and selling, new tricks of sophistication, and new scientific discoveries, all demanding a more modern method of control.

Finally, in 1938, Congress passed the Federal Food, Drug, and Cosmetic Act (FDCA). This act, with a number of adjustments and amendments, is still the major force regulating foods. It continued with many of the intentions of the 1906 act, but broadened the scope of federal regulation and plugged many of the loopholes. For the first time the law defined adulteration to include bacteria or chemicals that are potentially harmful; allowed the FDA to inspect food manufacturing and processing facilities; required ingredients of nonstandard foods to be listed on labels; prohibited the sale of food prepared under unsanitary conditions; gave the FDA the authority to monitor animal drugs, feeds, and veterinary devices; and authorized mandatory standards for foods. Few laws have as great an impact on the life and health of Americans as does the Food, Drug, and Cosmetic Act. The overall function of the law was to prevent the distribution of harmful or deceptive food and drug products.

Seafood regulation came about on a voluntary basis with the Seafood Inspection Act of 1934. In the early 1930s, canned shrimp processors found that the FDA was seizing increasingly large amounts of their product because of decomposition. Poor fishing practices and poorly supervised packing operations contributed greatly to the spoilage of shrimp products. As the canners could not themselves influence fishermen and packers to improve their handling of the product, they requested that Congress enact an inspection law. Packers of any seafood product could request an inspector to examine the premises, equipment, methods, containers, and materials used. If the inspection was favorable, they could use that information on their label. The new seafood inspection program had an almost immediate favorable effect on the canned seafood industry. Product quality improved and the industry was able to regain consumer confidence in its product.

In August 1996, Congress signed into law the Food Quality Protection Act (FQPA), fundamentally changing the way the Environmental Protection Agency (EPA) regulates pesticides used in the production of food. The FQPA sets special provisions concerning pesticide ingestion for infants and children. Because little data exist on pesticide intake for children, an additional safety factor of up to tenfold, if necessary, is to be used. All existing tolerances are to be reviewed within ten years, and consideration of children's special sensitivity and exposure to pesticide chemicals must be taken into account when setting tolerance levels. The EPA is now required to periodically review pesticide registrations, with a goal of establishing a fifteen-year cycle, to ensure that all pesticides meet updated safety standards. Most importantly, the new law establishes a health-based safety standard for pesticide residues in all foods. It uses "a reasonable certainty that no harm" will result from all combined sources of exposure, including drinking water, as the general safety standard. This last facet of the FQPA is perhaps the most important because it eliminates the Delaney Clause of the Food, Drug, and Cosmetic Act, which prohibited the addition of any cancer-causing substance, no matter how small the amount, from being added to foods.

Hazard Analysis and Critical Control Points (HACCP)

In 1996 USDA issued its Pathogen Reduction: Hazard Analysis and Critical Control Points (HACCP) System rule. This rule requires that all 6,500 meat and poultry processing plants in the United States operate under a HACCP system. The FDA began its own HACCP regulations with a 1995 rule that mandated seafood processing facilities must have in place a HACCP plan by 1997. The 1999 FDA Food Code incorporates HACCP principles and in 2001 the FDA mandated that all producers of fruit and vegetable juices use HACCP principles by 2004.

Since the passage of the Meat Inspection Act in 1906, inspectors had visually examined and smelled meat to determine if it was safe or not. Such methods are not effective against the main threat to the safety of food today—bacteria so small that they cannot be seen or smelled. The failure of inspection methods in the United States came to the fore in 1993 when an outbreak of *E. coli* O157:H7 in hamburgers in the northwestern United States sickened over five hundred people and killed four. This provided the final push needed for the U.S. Department of Agriculture (USDA) to issue the Pathogen Reduction: Hazard Analysis and Critical Control Points (HACCP) System rule in 1996. Under HACCP regulations, the food processing industry assumes primary responsibility for the safety of the food it produces. The government's role is to verify that the industry is carrying out its responsibility, and to initiate appropriate regulatory action if necessary.

HACCP started from a National Aeronautics and Space Administration (NASA) food safety program in the 1960s. NASA needed to come as close as possible to 100 percent assurance that the foods astronauts consumed while on space missions would be free of bacterial or viral pathogens. NASA, the U.S. Army Natick Laboratories, and the Pillsbury Company began to develop these first space foods. While Pillsbury researchers struggled with problems such as how to keep food from crumbling in zero gravity, they also realized that traditional food quality control programs would not provide the degree of safety desired. To produce the safest food possible, they needed to have control over their production process, the raw materials, the environment, and their employees. To provide this level of control, in 1971 they introduced the HACCP system.

A typical HACCP system identifies critical points during food processing where contamination is likely to occur.Then, controls can be put in place to focus on these critical areas. Traditionally, industry and regulators depended on spot-checks of manufacturing conditions and random sampling of final products to ensure safe food. This approach, however, tends to be reactive, rather than preventive. HACCP is a preventive, systematic approach to food safety, rather than a reactive method. One key advantage of HAACP is that it focuses on identifying and preventing hazards that may contaminate food, thereby allowing control to be exerted in the manufacturing phase, rather than after food is produced. HAACP permits more efficient and effective government regulation, primarily because record keeping allows investigators to see how well a firm is complying with food safety laws over a given extended period rather than only on a given day. HACCP has achieved international recognition as the most effective means of controlling foodborne disease. The National Academy of Sciences, the joint Food and Agriculture Organization/World Health Organization Codex Alimentarius Commission, and the U.S. National Advisory Committee on Microbiological Criteria for Foods (NACMCF) all endorse the use of HACCP.

HACCP involves seven principles:

1. Analyze potential hazards (biological, such as a microbe; chemical, such as a toxin; or physical, such as ground glass or metal fragments) associated with a food and determine measures to control those hazards.
2. Identify critical control points in the production of a food—from its raw state through processing and shipping to consumption—at which it is possible to control or eliminate the potential hazard. Examples are cooking, cooling, packaging, and metal detection.
3. Establish preventive measures with critical limits for each control point. For a cooked food, this might include setting the minimum cooking temperature and time required to ensure elimination of harmful microbes.
4. Establish procedures—such as how cooking time and temperature should be checked, and by whom—to monitor critical control points.
5. Establish corrective actions to be taken when monitoring shows that a critical limit has not been met—for example, reprocessing or disposing of food if the minimum cooking temperature is has not been attained.
6. Establish procedures to verify that the system is working properly—for example, testing time and temperature recording devices to make sure that a cooking device is working properly.
7. Establish effective record keeping to document that the HAACP system is working properly, by maintaining records of hazards, methods to control them, monitoring to ensure safety requirements are met, and actions taken to control potential problems.

To protect the public from foodborne illness, more and more of the U.S. food industry is operating under voluntary or mandatory HACCP controls. The Food and Drug Administration issued HACCP regulations requiring seafood processing facilities to have a HACCP plan in place by 1997. The 1999 FDA Food Code incorporated HACCP principles, and much of the retail food industry is moving toward implementation of HACCP requirements. In 2001, the FDA implemented HACCP regulations for fruit and vegetable juices after several high-profile foodborne illness outbreaks from the consumption of contaminated juice. The dairy industry is also moving toward adopting a HACCP systems, as are other sectors of the food industry

Food Safety at the International Level

Several international organizations interact to improve the safety of the world's food supply. The Food and Agricultural Organization (FAO) was founded as part of the United Nations in 1945 to raise levels of nutrition and standards of living, to improve agricultural productivity, and to better the condition of people in rural areas. Food safety is an important part of FAO's mission since foodborne disease is one of the most widespread threats to human health, as well as an important cause of reduced economic productivity. The World Health Organization (WHO), founded in 1948, has as its mission to set global standards of health and to aid governments in strengthening national health programs. WHO recognizes that protecting consumers from contaminants and preventing foodborne diseases are two of the most important strategies for overcoming malnutrition in the world. WHO's activity in food safety issues centers around development of national food safety policies and infrastructures, food legislation and enforcement, food safety education, promotion of food technologies, food safety in urban settings and in tourism, surveillance of foodborne diseases, and monitoring of chemical contaminants in food. FAO and WHO collaborate on many food safety issues as joint FAO/WHO committees and conferences.

One of the most important joint FAO/WHO commissions is the Codex Alimentarius Commission. This body has as its task the development of uniform food standards that can be used by governments throughout the world. This food code is known as the Codex Alimentarius. The Codex Alimentarius consists of food standards for commodities, codes of practice for hygiene and technology, pesticide evaluations and limits for pesticide residues, evaluations of food additives, guidelines for contaminants, and evaluations of veterinary drugs. Although the main goal of the Codex is to set uniform regulatory standards in the interests of international trade, it has also served to raise food safety standards in many countries. One hundred forty member nations accept its standards and follow its codes of practice.

See also **Codex Alimentarius**; **FAO (Food and Agriculture Organization)**; **Government Agencies, U.S.**; **International Agencies**; **Labeling, Food**; **Pesticides**.

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FOOD SECURITY. Most people are familiar with the terms "national security" or "home security," but relatively few are familiar with the term "food security." These terms convey a sense of an absence of or lowered risk; a home is less likely to be burglarized, a nation's state secrets are less likely to fall into the hands of unfriendly nations. Food security has similar connotations in relation to food. According to the 1996 World Food Summit, food security exists "when every person has physical and economic access at all times to healthy and nutritious food in sufficient quantity to cover the needs of their daily ration and food preferences, in order to live a healthy and active life."

In its simplest form, food security means that all people have enough to eat at all times to be healthy and active, and do not have to fear that the situation will change in the future. As a concept it can be applied at many levels—global, national, household, and individual.

There are three fundamental pillars in achieving food security. The first is food availability. At the global level this is the key factor—sufficient food must be grown to ensure that everyone can be adequately fed. In the early 1970s several political missteps, combined with droughts, raised concerns about whether this could be attained. Indeed the crises of the early 1970s which resulted in high world grain prices led to an international conference in 1974 and the founding of the International Fund for Agricultural Development (IFAD), the World Food Council, and the FAO Committee on World Food Security. Today the world is food secure from the perspective of food availability, and global grain prices are less costly in real terms than at any time in recent decades.

The next pillar of food security is access to food—economic and physical. This pillar is critical at the national and household levels. At the national level, if a country does not produce all the food it consumes then it must import food. A number of countries are too poor to purchase food on the international market and thus have a structural food deficit. International food aid must make up the shortfall. At local and household levels the market distribution system needs to be adequate to ensure that food is available at all marketplaces.

At the household level, sufficient levels of food must be grown, or purchased at the marketplace, or some combination of the two. Thus poverty plays the major role in food insecurity. Generally, if there is too little food it is the result of inadequate food demand driven by poverty rather than of market failure.

The third pillar of food security is food utilization, important at the household level and critical at the individual level, which brings together both the quality of the food and other complementary factors such as safe water that underpin good nutritional outcomes. This is the pillar that ensures the nutritional outcomes of every individual in the household are adequate. This is a very complex pillar. First, the household must be able to obtain, through production or purchase, the right types of food for all household members. Inadequate dietary diversity, which results in mineral and micronutrient deficiencies, increases the incidence of sickness, which sets up a vicious cycle of malnutrition. Second, unsafe water and poor sanitation increase the likelihood of frequent illness, which affects nutritional outcomes. Third, mothers need to have sufficient time to care for small children who require frequent feeding. In the developing world many poor mothers face excessive time burdens given the absence of electricity, or running water, or labor-saving food preparation devices. Many hours can be spent fetching firewood and water, growing food, processing it, and finally cooking it. Fourth, food must be available to all household members according to their needs. In some areas of the world, notably south Asia, girls and women in poor households often receive less food than they need even though the household has sufficient amounts. They are also less likely to receive health care when they become sick. In 1995 more than 6 million children died of causes associated with being underweight. Today the growth of one in three children five years old and younger is stunted, that is, they are too short for their age, a stark testimony to a life of too little food and too much sickness.

International concerns with regard to food security have shifted in the last three decades. In the 1960s and early 1970s, with rising world grain prices, fears arose that the world would run out of food in the future as its population grew ever larger. Major improvements in agricultural productivity, particularly the impact of the "Green Revolution" on wheat and rice, have removed that fear despite a population that increased from 1.6 billion in 1900 to 6.1 billion by 2000. Today the expectation is that new advances in agriculture, particularly in biotechnology, will increase agricultural productivity sufficiently to feed a world population expected to stabilize at about 9.3 billion. This expectation, together with abundant global grain supplies at record low prices, has removed the specter of food insecurity from the agenda of most policymakers.

Famines

Famines, the worst manifestations of food insecurity, occur in specific areas when widespread and extreme hunger result in drastic weight loss and a rising death rate. They generally occur in rural areas and are the result of a complex interaction of factors such as drought, civil unrest, floods, and economic disruptions. Today, famines are rare and should be confined to the past. There is more than enough food in the world to feed everyone. Global information systems enable policymakers to predict when famine is likely, either as a result of crop failure due to drought or pest or because of civil unrest and war. Famine in today's world is testimony to policy failure, not the absence of food. Food insecurity, on the other hand, is a fact of life today for many people. Today, 815 million people go to bed at night not knowing whether they will have enough to eat tomorrow. Each year, more than 6 million children do not live to see their fifth birthday. They die silently of causes associated with hunger and malnutrition, absent the widespread media attention that famine attracts.

Today, the focus of the international development community and many policymakers is on the AIDS crisis in Africa, which is finally attracting enormous attention and with it the promise of more economic assistance. AIDS kills about 6 million people a minute, a tragedy by any definition. Yet this tragedy pales in significance when compared to the 12 million people a day who die of causes related to malnutrition, the ultimate outcome of food insecurity. The 1996 World Food Summit called for the number of undernourished people in the world to be cut in half by 2015—a not insurmountable goal given current world food supplies and their predicted trend. Reducing hunger and food insecurity today is a matter of political will. However, past performance indicates the goal is unlikely to be met. Despite falling food prices during the 1990s, the number of undernourished fell by only 40 million, with the average rate of decline slowing to just 6 million per year by the end of the decade. Achievement of the WFS target requires that at least 22 million people a year are removed from the ranks of the food insecure.

Recognition that food supplies are adequate but political will lacking has led to a new emphasis on food as a human right. The plan of action emanating from the 1996 WFS highlighted the need to implement Article 11 of the International Covenant on Economic, Social and Cultural Rights and called on countries, United Nations agencies, and intergovernmental agencies to better implement and realize the fundamental right of everyone to be free from hunger. In 2001 the international food security community has a double focus with a delicate balance—how to engage sufficient political will to secure food as a human right today, while maintaining a commitment to increasing agricultural productivity that will be required if we are to feed a more than 50 percent larger population by midcentury without further damaging the environment in the future.

See also **Food Supply and the Global Food Market**; **Food Supply, Food Shortages**.

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FOOD STAMPS. The Food Stamp Program (FSP) is intended to help low-income individuals and families meet their basic nutritional needs. Although the first food stamps were issued to needy families in 1939, the FSP was not authorized as an official food-assistance program until 1964. In 1974, all states were required to offer food stamps, and in 1977 participation increased when eligible persons no longer had to buy food stamps with cash. Participation in the FSP continued to increase through the mid-1990s, until the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA, also known as "welfare reform") of 1996 reduced the number of people who were eligible.

In the early twenty-first century, the FSP remained the largest of the fifteen federal food-assistance programs, providing aid to an estimated 17.3 million individuals in 2001. An analysis of participants in 2000 showed that 51 percent were children (eighteen years or younger), 39 percent were nonelderly adults, and 10 percent were elderly adults. About 70 percent of participating adults were women. The majority (89 percent) of FSP households included a child, or elderly or disabled person. Of the households with children, 68 percent were headed by a single adult. Average gross monthly income per household was $620, with 89 percent of households having gross monthly incomes below 100 percent, and 58 percent having gross monthly incomes below 75 percent, of the federal poverty guideline. In 2000, 40 percent of participants were white, 36 percent were non-Hispanic African Americans, 18 percent were Hispanic, and 6 percent were of another race or ethnicity.

The total cost of the FSP in 2001 was approximately $17.8 billion, of which $15.5 billion was distributed in the form of food stamps. These numbers are noticeably lower than in 1994, when expenditures peaked at $24.5 billion and the number of participants also peaked, at 27.5 million (see Table 1). Trends in FSP participation and expenditures parallel trends in poverty and reduced unemployment. They also reflect changes in FSP policy and lack of information about such changes—the most likely reason why the participation rate among persons who remained eligible decreased from 74 percent in 1994 to 57 percent in 1999.

The FSP is administered at the federal level by the Food and Nutrition Service of the U.S. Department of Agriculture, but eligibility and distribution of benefits are administered by state and local agencies. In 2002, a household qualified for Food Stamps if its gross income was less than 130 percent of the federal poverty guideline (for example, $1,585 per month for a three-person household as of 1 October 2001), if net income after certain deductions (such as for child care) was less than 100 percent of the poverty guideline (for example, $1,220 per month for a three-person household as of the same date), and if countable assets (such as a bank account, but not a home or lot) were less than $2,000 (or less than $3,000 if the household had an elderly member). After the PRWORA took effect in 1997, legal permanent-resident aliens not employed in the United States for the past ten years could no longer receive FSP assistance, and most adults who were able-bodied, nonworking, and childless could receive only three months of aid in any thirty-six months. In addition, the maximum FSP benefit amounted to 100 percent of the

TABLE 1

Food Stamp Program Participation and Costs

Fiscal Year	Average Participation Thousands	Average Benefit Per Person Dollars	Total Benefits	All Other Costs Millions of Dollars	Total Costs
1969	2,87	86.63	228.8	21.7	250.5
1970	4,340	10.55	549.7	27.2	576.9
1975	17,064	21.40	4,385.5	233.2	4,618.7
1980	21,082	34.47	8,720.9	485.6	9,206.5
1985	19,899	44.99	10,743.6	959.6	11,703.2
1990	20,067	58.92	14,186.7	1,304.4	15,491.1
1995	26,619	71.26	22,764.1	1,855.5	24,619.6
2000	17,158	72.78	14,984.8	2,073.3	17,058.1
2001 (P)	17,316	74.77	15,536.1	2,253.9	17,790.0

Data as of 25 April 2002. Fiscal Year (FY) 2001 data are preliminary; all data are subject to revision. "Average Benefit per Person" represents average monthly benefit. "All Other Costs" includes the Federal share of state administrative expenses and employment and training programs. It also includes other Federal costs (such as printing and processing of stamps, antifraud funding, and program valuation). Puerto Rico initiated Food Stamp operations during FY 1975 and participated through June of FY 1982. A separate Nutrition Assistance Grant was begun in July 1982.

Thrifty Food Plan (TFP) allowance (reduced from the 103 percent issued in 1988). The TFP identifies types and quantities of foods for twelve age-gender groups that would meet the respective 1989 Recommended Dietary Allowances (RDAs), the 1995 Dietary Guidelines for Americans, and the U.S. Department of Agriculture's Food Guide Pyramid serving recommendations, according to data from the 1989–1991 Continuing Survey of Food Intake by Individuals (CSFII) and according to national average food prices. Eligibility for the FSP has changed constantly, however, as demonstrated by the decision in 1998 to restore Food Stamp benefits to children, elderly, and disabled individuals who were legal permanent residents in the United States. The U.S. Department of Agriculture maintains a toll-free telephone number to answer questions about current policies of the FSP.

In 2001, FSP participants received an average of $75 per person monthly in the form of paper coupons in denominations of $1, $5, and $10, or as electronic benefit transfers (EBTs). The computer-based EBT system employs a plastic card that functions like a bank debit card, allowing items to be purchased without the exchange of cash or coupons. The implementation of the EBT system was intended to make Food Stamp fraud (such as the exchange of cash for coupons at a lower value) more difficult. As of October 2001, thirty-seven states and Washington, D.C. issued all Food Stamp benefits in the form of EBTs. The PRWORA of 1996 mandates that all states use EBTs by October 2002.

Food Stamp coupons or EBTs can be used to buy foods such as breads and cereals, fruits and vegetables, meats, fish and poultry, and dairy products, and to buy seeds and plants that produce food, from an estimated 155,000 authorized stores in the United States. But coupons or EBTs cannot be used to buy beer, wine, liquor, cigarettes or other forms of tobacco; nonfood items like pet foods, household supplies, or toiletries; foods that can be eaten in the store; or hot foods. Food Stamps also cannot be used to buy dietary supplements, including vitamins and minerals, a controversial policy that has undergone much scrutiny.

Evaluation of the impact of the FSP on the diets of participants is mixed. Using data from the 1996–1997 National Food Stamp Program Survey (NFSPS), average nutrient intakes of FSP participants exceeded the RDA, but a substantial number of households had folic acid and iron intakes below the respective RDAs. Data from the 1994 to 1996 CSFII and the Third National Health and Nutrition Examination Survey (NHANES III) show that FSP participants had higher intakes of most nutrients than other adults, but that median intakes of vitamin E, calcium, and zinc still fell below the respective RDAs. Within population subgroups, Food Stamps have been associated with improved nutrient intakes in children but not among the elderly. Interestingly, Food Stamp participants are more likely to be food-insecure, meaning their household does not have enough food to eat at all times. However, this counterintuitive finding is credible because people who are food-insecure are more likely than others to apply for and receive Food Stamps. The dietary quality and food security of Food Stamp participants after the implementation of the PRWORA of 1996 and subsequent changes in FSP policy are of keen interest.

See also **Class, Social**; **Government Agencies, U.S.**; **Poverty**; **School Meals**; **Soup Kitchens**; **WIC (Women, Infants, and Childrens) Program**.

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FOOD STUDIES. Although accounts of food and eating habits date to the earliest written records, the designation of more scholarly investigations of food as food studies is a modern development. In the 1990s researchers began applying this term to descriptions and analyses relying upon every conceivable method for studying the historical, cultural, behavioral, biological, and socioeconomic determinants and consequences of food production and consumption. The idea that such investigations might collectively constitute a legitimate field of study in its own right derived from earlier explorations of food practices within traditional academic disciplines. In the 1960s, for example, the folklorist Don Yoder popularized the term "foodways" to describe the entire range of food habits, behaviors, customs, and cultural practices associated with food consumption.

In the 1990s Boston University established a master's program in gastronomy focused on the cultural and culinary aspects of food consumption. In 1996 the Department of Nutrition and Food Studies at New York University began admitting students to undergraduate, master's, and doctoral programs in food studies, thereby formalizing this emerging field as a state-accredited academic entity. The NYU programs emphasize the ways individuals, communities, and societies relate to food within a cultural and historical context. In this view, food studies is an umbrella term that includes foodways, gastronomy, and culinary history as well as historical, cultural, political, economic, and geographic examinations of food production and consumption. Any field defined so broadly immediately raises questions, in this case related to the scope, methods, and acceptance of food studies as a distinct academic entity.

An Inclusive, Interdisciplinary Field

Because the concept of food studies is new, scholars investigating food topics have not yet reached complete agreement on what it should and should not include. Anthropologists, folklorists, and sociologists always have examined the relationships of individuals and populations to their food. In the era of economic globalization, with its food inequities and scarcities, precarious and often tainted food supply, concerns about diet and health, and fears of genetically modified foods and food bioterrorism, food is recognized as a "lens" through which to view, explore, analyze, and interpret society in the present as well as in the past. The breadth of this approach means that food studies can also include applied disciplines that deal with the fundamental properties of food—culinary arts, food science, and nutrition, for example—as well as food history and culinary history, agriculture and food production, and descriptive and economic analyses of food systems and the food industry.

By its very nature, food studies is interdisciplinary and must rely on methods, approaches, and themes derived from other disciplines. In this sense it is developing in much the same manner as other interdisciplinary fields, such as American studies, women's studies, and performance studies, that emerged a generation ago. Food studies may be unusual, however, in the breadth of the disciplines on which it draws. Economists, historians, psychologists, nutritionists, agronomists, geologists, geographers, archaeologists, environmental scientists, legal scholars, political scientists, and historians—culinary and otherwise—all bring distinct methods of research and analysis to bear on food themes.

Multiple Methods and Approaches

Traditional academic disciplines are often defined by the distinct methods used by scholars in conducting research. Certain areas of inquiry, for example, use surveys, participant observations, or analyses of texts, historical documents, social interactions, and self-reports. Because food studies emerged from the humanities and social sciences, researchers typically rely on ethnography, case studies, and historical investigations. Throughout the twentieth century, for example, anthropologists debated whether culture is rooted in tangible and concrete artifacts—the implements and debris of hunting, gathering, and cooking—or in ideas and belief systems. They asked why people chose certain foods and used them in certain ways. They examined how religious beliefs, practices, and rituals influenced dietary practices, and they compared those influences to the effects of the environment or evolutionary biology. Claude Lévi-Strauss, for example, used a classic anthropological approach in his study of the symbolic use of food in culture, *The Raw and the Cooked* (1979). In contrast, the anthropologist Sidney Mintz produced a quintessential example of food studies research in his book *Sweetness and Power* (1985), in which he traced the ways a single food substance, in this case sugar, transformed modern history and culture. Anthropologists have further expanded the scope of their investigations to include the nutritional implications of dietary practices.

Scholars in other fields also examine food themes from the perspectives of their traditional disciplines. Food historians investigate the ways in which foods have influenced world events in the past and present. Culinary historians focus on recipes and cooking techniques, exploring when, where, and how specific foods or ingredients might have been grown, produced, prepared, and consumed in different periods. Food sociologists focus on issues of hunger, malnutrition, and inequities of the global food supply as well as on societal determinants of diet-related conditions, such as obesity or heart disease. Psychologists often investigate how and why people make food choices or such matters as eating disorders, food phobias, and the psychological connections between eating and taste, pleasure, and disgust. Scholars trained in literature or languages examine how novels, poems, and essays are enriched with food imagery or the ways in which travel writing and memoirs use food themes to express ideas or points of view. Because food studies draws on many such disciplines, encyclopedias of food history or culture necessarily include examples of many different scholarly approaches to the study of food.

The Food Studies "Movement"

As participants in an emerging field, food studies researchers are not constrained by the methods and approaches of any one discipline, and they enjoy the freedom to study what they like in whatever way seems most appropriate. Because food studies is inherently interdisciplinary, its scholars must define their own research agendas based on elements incorporated from traditional disciplines. Because this flexibility may be perceived as unfamiliar or lacking in rigor no matter how excellent the quality of the work, the academic study of food itself, as opposed to studying food within a traditional discipline, is established in only a few universities. The field appears to be expanding, however. In the United States, culinary schools are broadening their offerings to include courses in food history and culture, and universities in France, Mexico, and Australia have established degree programs that emphasize food. To scholars writing about food, such developments constitute the food studies "movement." As further evidence for this movement, they cite the series of books on food and culture established by university presses, such as those of Columbia University, Northwestern University, and the University of California; the breadth and depth of the culinary history and food studies collections of the Schlesinger Library at Radcliffe College and the Fales Library at NYU; and the proliferation of encyclopedias on food history and culture, such as those cited in the bibliography.

In part, the growing acceptance and legitimacy of food studies as a discrete field reflects increasing recognition that innovative scholarship often crosses disciplinary boundaries. In the academic environment, the identification of food studies as a separate field may not matter much. The very existence of the food studies movement encourages students and faculty in traditional academic disciplines to conduct research on food themes and facilitates the publication of scholarly work related to the role of food in society, culture, and commerce.

See also **Anthropology and Food**; **Chef, The**; **Cuisine, Evolution of**; **Education about Food**; **Foodways**; **Gastronomy**.

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FOOD SUPPLY AND THE GLOBAL FOOD MARKET.

Worldwide, the food supply available to people depends on a variety of environmental, technical, and sociopolitical factors, the relative importance of which have varied considerably in time as well as geographically. Environmental factors have governed food production and availability throughout history, and this remains so for many societies. However, in a world where food is abundant as never before, food supply is extremely vulnerable to economic and political interests, as well as technical factors, such as transportation and communications.

Food Supply through the Ages

Before the advent of agriculture and the domestication of animals (c. 10,000 B.C.E.), hunting, fishing, and gathering provided enough food for small groups of people such as bands of wanderers. Along with agriculture came a sedentary way of life, and self-sufficient agricultural settlements appeared in every region of the world. In this type of environment, food supply was direct and immediate. Careful management of produce ensured the survival of every household member until the next harvest. Except for times of warfare or environmental calamities, the balance between food demand and food supply remained fairly stable. Though hunting and gathering societies are almost extinct today, agricultural villages still endure in many parts of the world.

As some of these villages grew into towns, however, things began to change. Societies became more complex as certain groups of people ceased to be directly involved in the production of food. Food supply and distribution became dependent on an increasingly complex set of relations among groups of different professions and ranks. Surplus food (mainly grains) was traded with neighboring settlements. Concentrated in a few hands, food became a means to political power.

The growth of empires is associated with the emergence of a professional specialist, the merchant, who ventured into new territories exchanging food and other goods across borders, often between far-off places. Food began to be regarded as a commodity subject to the rationale of profit, and it eventually became the responsibility of the state to ensure an adequate food supply for its citizens.

The Industrial Revolution of the late eighteenth century was also an agricultural revolution that dramatically changed the way food was to be produced, distributed, and used in most of the world. Farming, fishing, and other food-production activities became large-scale enterprises, organized according to the principles of maximum productivity and maximum profit. Capital-intensive agriculture produced surpluses of a magnitude never before possible. The modernization of transport and communications, and the emergence of food-processing and food-packaging industries, made it possible to extend food trade on a global scale. In urban centers, supermarkets can offer not only frozen and packaged food, but also fresh produce year-round from all over the world. For some this increased food supply has created a sense of plenty, albeit a localized and exclusive one.

Food Supply as a Political Weapon

In the twentieth century, food supply came under the rules of a new political and economic order. Large food stocks have proved to be one of the main geopolitical assets of rich nations. Most affluent countries are or have been large exporters of food, and they control the global food market to their advantage. Food prices are set at the major stock exchange institutions in North America, Europe, and Japan. In competing for the hegemony of the global food market, the United States, the world's main food exporter, has been engaged in "food wars" with Japan and the European Union. International organizations, such as the recently formed WTO (World Trade Organization), have been created to defuse these conflicts, as well as to balance the "market distortions" that affect less powerful nations.

The global food market is dominated by the most affluent countries, which, on average, have controlled almost 70 percent of the total value of imports and over 62 percent of the total value of exports of all agricultural products in the world since 1961 (see Table 1). During the last quarter of the twentieth century, these countries have been reducing the value of their imports while expanding the value of their exports. Food imports by these countries typically concentrate on specialized agricultural items, such as tropical fruits and selected vegetables, as well as coffee, tobacco, sugar, and tea, none of which is a staple in its place of origin. In order to meet the domestic demand for staples, many of the exporting countries of such products have to import large quantities of basic staples in exchange. From 1961 to 2000, the countries of Africa and Latin America increased more than eight times their imports of cereals, those of Asia more than four times, and those of Oceania more than five times.

TABLE 1

Main importers and exporters of total agricultural products, 1961–2000

(Value of imports/exports in US$1,000)

Imports

Countries	**1961**	**1970**	**1980**	**1990**	**2000**	**Decadal average**
Germany	4,191,324	7,214,668	27,890,046	38,652,300	34,488,729	22,487,413
United States of America	3,836,796	6,301,029	18,410,350	27,088,094	44,949,426	20,117,139
Japan	2,022,576	4,140,227	17,747,335	28,659,121	36,153,814	17,744,615
United Kingdom	5,362,951	5,776,370	16,309,835	22,952,289	25,877,168	15,255,723
France	2,125,596	3,262,917	14,867,182	22,613,082	23,224,627	13,218,681
Italy	1,450,729	3,386,200	14,856,545	23,651,782	21,608,095	12,990,670
Netherlands	949,437	2,121,927	11,637,467	17,962,752	16,218,531	9,778,023
USSR	1,380,364	2,478,054	17,643,338	19,714,301	0	8,243,211
Belgium-Luxembourg	823,180	1,657,552	8,247,905	12,547,486	15,484,230*	7,752,071
China	759,895	890,765	7,984,003	9,791,156	15,349,290	6,955,022
Canada	806,618	1,261,845	4,602,644	7,100,642	11,441,510	5,042,652
Spain	350,254	852,784	4,391,220	8,039,331	10,541,845	4,835,087
United Arab Emirates	3,752	31,980	1,077,403	1,692,884	18,705,047	4,302,213
China, Hong Kong SAR	349,333	671,188	3,161,775	6,821,872	8,485,711	3,897,976
Korea, Republic of	87,280	438,935	3,303,414	6,459,074	8,297,395	3,717,220
Total	**24,500,085**	**40,486,441**	**172,130,462**	**253,746,166**	**290,825,418**	**156,337,714**
World total	**34,748,770**	**56,630,704**	**255,355,968**	**353,147,624**	**447,497,428**	**229,476,099**
% of world total	**71**	**71**	**67**	**72**	**65**	**68**

Exports

Countries	**1961**	**1970**	**1980**	**1990**	**2000**	**Decadal average**
United States of America	5,187,350	7,507,566	42,921,186	45,210,987	56,479,900	31,461,398
France	1,246,491	2,962,836	18,519,111	33,432,321	33,390,182	17,910,188
Netherlands	1,267,473	3,149,676	16,091,315	30,927,503	27,884,332	15,864,060
Germany	388,354	1,362,708	11,021,979	20,374,986	24,147,297	11,459,065
United Kingdom	983,067	1,420,838	8,242,790	12,766,968	16,684,026	8,019,538
Australia	1,558,811	2,333,963	9,216,112	11,749,559	14,698,447	7,911,378
Canada	1,260,268	1,815,641	7,071,758	9,181,264	15,684,949	7,002,776
Italy	701,212	1,219,583	5,677,448	11,134,930	15,603,562	6,867,347
Brazil	1,169,525	1,946,375	9,320,492	8,763,781	12,761,338	6,792,302
China	380,869	1,147,785	4,554,142	10,207,810	13,076,473	5,873,416
Spain	375,823	767,164	3,566,320	7,825,934	13,999,088	5,306,866
Argentina	906,064	1,498,609	5,518,628	6,976,824	10,776,094	5,135,244
Denmark	826,872	1,191,745	5,222,539	8,290,189	8,788,582	4,863,985
Belgium-Luxembourg	341,240	1,095,694	6,369,385	11,787,599	17,619,979	3,918,784
Thailand	392,234	493,986	3,344,140	5,387,818	7,273,564	3,378,348
Total	**16,985,653**	**29,914,169**	**156,657,345**	**234,018,473**	**288,867,813**	**145,288,691**
World Total	**32,217,186**	**52,075,640**	**234,255,267**	**326,243,879**	**410,548,587**	**211,068,112**
% of world total	**53**	**57**	**67**	**72**	**70**	**69**

*Addition of data for Belgium and Luxembourg

SOURCE: Food and Agriculture Organization of the United Nations (FAOSTAT, on-line http://www.fao.org) May 2002.

Since the end of World War II, the global supply of cereals, the basic staples for most of humanity, has largely depended on the production and export capacity of some fifteen countries. In 1999, major cereal exporters held close to one-half of global cereal stocks (Food and Agriculture Organization of the United Nations, 2002; hereafter FAO). In the year 2000, the four largest cereal exporters, the United States, France, Canada, and Australia, produced over 495 million metric tons of cereals (wheat, maize, rice, sorghum, oats, and others), which amounted to 24 percent of the total world production, and exported 164.8 million metric tons of cereals, 61 percent of the total world exports of cereals for that year. However, in past decades this proportion had been much larger, reaching as much as 78 percent in 1980 (see Table 2).

In addition to trade, food transfers between main producers and main consumers include "food aid." Between 1970 and 2000, more than 336 million metric tons of cereals were shipped as food aid to countries in need.

TABLE 2

Main cereal exporters, 1961–2000 (Qty., Mt)

	Years				
Countries	**1961**	**1970**	**1980**	**1990**	**2000**
World Total	**79,466,691**	**114,423,775**	**223,191,018**	**226,234,678**	**272,236,822**
United States of America	31,796,032	40,406,383	112,905,797	92,615,939	87,358,248
France	4,180,590	10,283,517	19,637,116	30,897,774	32,746,384
Canada	12,112,152	14,896,455	21,866,888	23,092,252	22,885,090
Australia	6,205,202	8,357,127	19,466,766	15,013,192	21,819,313
Total 4	**54,293,976**	**73,943,482**	**173,876,567**	**161,619,157**	**164,809,035**
% of world total	**68**	**65**	**78**	**71**	**61**
Argentina	3,643,362	10,217,977	9,909,358	10,442,436	23,728,443
Germany	1,256,903	2,893,628	2,414,667	4,732,186	14,391,914
China	222,434	1,720,698	1,514,152	4,202,888	13,952,775
USSR	7,844,833	6,913,415	2,286,962	1,539,083	0
Thailand	2,140,932	2,517,588	5,158,421	5,280,948	6,206,293
United Kingdom	180,439	269,335	2,796,403	6,610,689	5,429,248
South Africa	1,181,180	1,299,770	3,780,404	2,229,861	632,776
Netherlands	304,489	1,479,634	1,659,856	4,225,808	1,214,274
Italy	284,749	1,385,875	1,845,074	2,435,261	2,179,490
Denmark	141,553	351,483	1,139,087	3,250,496	1,974,970
Belgium-Luxembourg	78,846	887,484	3,366,919	2,199,432	2,827,038*
Total 15	**71,573,696**	**103,880,369**	**209,747,870**	**208,768,245**	**257,346,256**
% of world total	**90**	**91**	**94**	**92**	**87**

*Addition of data for Belgium and Luxembourg

SOURCE: Food and Agriculture Organization of the United Nations (FAOSTAT, online http://www.fao.org), May 2002.

Over half of these shipments came from the United States alone. In 1990, the United States donated 7.2 million metric tons of cereals, 43.3 percent of which went to African countries, 21 percent to Latin American countries, and another 21 percent to countries in Asia. Despite its humanitarian character, food aid can also be used to the advantage of food donors through the conditions that may be attached to shipments and the adverse effects that these shipments may have on the domestic markets of the recipient countries (Mittal, 2002).

Food power has been used directly to pressure nations for a desired change of policy. In the second half of the twentieth century, food sanctions were applied against a handful of countries for a variety of purposes. For example, the United States embargoed a number of nations including Cuba, Iraq, Iran, Libya, and Sudan, impeding or severely restricting food trade between the United States and those countries.

Food Supply in the Twenty-First Century

In the twenty-first century, the food supply is conditioned by the rules of the global food market and global geopolitics, which affect decisions concerning the production and distribution of food at the national and local levels. The effective demand (purchasing power) of high-income buyers has precedence over the real demand of the nutritional needs of populations. For most people on earth, access to food depends on access to money and, for some, on access to charity, and the expansion of agribusiness to the countries of the so-called Third World has seriously affected these countries' self-sufficiency in food. Food trade and food markets have become subject to rules over which the majority of farmers have no control, and this has serious implications for the livelihoods of entire populations.

In the large urban centers of the world, the regular supply of fresh produce concentrates in the expensive supermarkets of wealthy neighborhoods, while a large proportion of the population can go without enough to eat. Lack of access to food leads to undernourishment, a problem that affects more than 800 million people in the world, including many living in the rich, food-exporting countries.

Food supply has become subject to a complex set of interests that governments are finding increasingly more difficult to mediate. Cereal stocks at the global level seem to have begun a diminishing trend due to an overall decline in production and an overall increase in utilization. Estimates for the year 2000 indicated an expected 4 million tons, down from the opening levels (FAO, 2000).

Though the per capita supply of cereals has been growing steadily since 1961 in most regions of the world, food shortages afflict a large number of countries. In 2002, the FAO reported that a state of emergency existed in the food-supply systems of as many as thirty-four countries on four continents, including Europe (FAO/GIEWS, 2000). One of the factors that adversely affects real food supply per capita in many countries is the utilization of cereals as animal feed, which in 1999 amounted to 35.1 percent of total world cereal stocks (Faostat, World Food Balance Sheet, May 2002). Unless local small-scale production for self-consumption is protected and encouraged, continuous and adequate access to food cannot be guaranteed for the rural populations of the world. With rural-urban migration on the rise almost everywhere, the majority of populations in the world will soon be concentrated in cities, contributing to the expansion of already impoverished slums.

A series of fundamental changes in global trade and the international financial system is in order if food security for all is ever to be attained. In this regard, the efforts of civil organizations fighting for fair trade and a more egalitarian world society are crucial.

See also **Food Supply, Food Shortages; Political Economy.**

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Luis L. Esparza Serra

FOOD SUPPLY, FOOD SHORTAGES. A nation's food supply is determined by composition and selection. The components of a food supply are limited by a number of factors, primarily climate and geography. The U.S. food supply is noticeably different from that of other nations as the twenty-first century begins. Americans are more likely to recognize food products than the specific ingredients in the seemingly endless array of products on supermarket shelves (some supermarkets stock over forty thousand different items). Fast-food outlets—a McDonald's, Taco Bell, or a Subway sandwich shop—are more recognizable than a steer, hog, chicken, or a bushel of wheat. Most such foods are slaughtered, processed, manufactured, and packaged; few are sold in bulk, as was common before World War II. Nearly all foods are shipped from distant places on pallets or in large containers, transported to huge warehouse storage facilities or to freezers close to cities, and trucked from there to be unpacked and displayed on supermarket shelves or served in fast-food outlets.

The United States enjoys a temperate climate especially hospitable to agriculture that supports the production of a wide variety of grains, fruits, and vegetables as well as milk, meat, poultry, and fish. Within the U.S. landmass, soil conditions and characteristics ensure an abundance of available farm acreage, which, in turn, assures a profuse supply of food—so much so, in fact, that the U.S. Congress authorizes programs that pay landowners to keep portions of their farmland lying fallow. Purchasing, storing, and maintaining food surpluses cost taxpayers more than paying farmers not to produce, making payments to idle farm acreage the cheaper alternative. Income also is a significant element in the composition of the food supply.

Composition of the U.S. Food Supply

Americans are among the wealthiest populations of the world, and their wealth enables most U.S. citizens to purchase from abroad any food not available from U.S. agriculture or fisheries. The United States is a magnet for the world's food supply, drawing an endless trade caravan of meats, pastas, spices and herbs, sauces, cheeses and other dairy products, wines and spirits, cakes and crackers, and fish as well as exotic and conventional fruits and vegetables, mostly fresh. While income is a means of expanding the selection of foods available in an indigenous food supply, income more often is a limiting factor in the availability of food in a population or in subgroups within a population.

Low-income families and individuals in the United States, for example, have a more limited food supply than do those with middle or higher incomes, although public policies today ease income barriers to a more adequate food supply by supplementing the purchasing power of low-income families and individuals. Still, even with the assistance provided by food stamps and other government programs, including school meals for children, low-income households can afford less for food than higher-income families, some $1,000 less annually per person, and, as a result, consume food measurably lower in nutritional value.

Populations in poor countries (euphemistically called "less developed countries" [LDCs]), in contrast, are limited by income to the food supply readily available where they live. Trade in either conventional or exotic foods is not an option, since many of the world's poor live outside a conventional marketing system. As a result, most citizens of LDCs grow or raise most of their food themselves, although imports are becoming increasingly important. In central Africa, for example, the food supply consists of locally produced staple foods such as maize, cassava, sweet potatoes, banana, millet, sorghum, and yams. Traditional vegetables, including the leaves of cassava and sweet potatoes, provide the vitamins and minerals otherwise largely lacking in these staple foods.

Food Supply: Sources

Cereals provide 69 percent of dry matter and 55 percent of the protein in the world's food supply by weight. Legumes—for example, beans—provide another 6 percent of dry matter and 13 percent of protein (Allard, 1999). Vegetables, fruit, meat and poultry, eggs, fish, nuts, sugar, and other sweeteners, in that descending order, provide the rest. People living in the United States and the countries in the European Union, as well as Canada, Japan, Australia, and New Zealand, consume a food supply with larger proportions of meat and poultry, dairy products, fruits and vegetables, fish, nuts, sugar, and oils and fat, a diet that delivers a substantially larger caloric load than that typically available in poor countries.

As personal incomes rise, the diet of individuals and nations shifts from basic food sources to those that provide a higher level of energy, or calories—animal products, more highly processed prepared foods, and oils and fat. Grains drop out of the human diet to become animal fodder as incomes rise, especially maize, oats, millet, and sorghum, which are then categorized as feed grains. Replacing grass and hay (traditional animal fodder), feed grains are fed to cattle, hogs, and chickens instead, reentering the food supply as beef, pork, poultry, milk, and other dairy products. Fish farming, or aquaculture, has emerged as a commercial source of freshwater fish and seafood in the last decade, and as a user of feed grain in rations fed to fish raised in underwater pens. Wheat is the major food grain in the United States, although rice consumption is increasing with the rising proportion of Americans of Asian and Latin American descent, for whom rice is the major food grain.

The food supply varies by nation and by geographic region, reflecting religious beliefs as well as cultural practices. Devout Muslims and Jews do not eat pork. Koreans, Chinese, Vietnamese, and other citizens of Southeast Asian nations consider both dogs and cats enjoyable sources of animal protein, and horsemeat, a staple in pet food in the United States, is a delicacy eagerly consumed by the French and other Europeans.

During the 1990s, the American people increased spending on food consumed outside the home by nearly 25 percent, a whopping increase compared to the 4 percent growth in consumption of food prepared and eaten at home during the same period.

By the end of the twentieth century, the U.S. was unable to visualize the source of its food supply from an agricultural perspective, that is, in terms of basic food groups, because a majority no longer live on farms. Instead, food had become an endless array of food products typically found on supermarket shelves, especially those that stock over forty thousand individual items. Most such foods are processed and packaged, and few are sold in bulk as was common sixty years ago. Nearly all were shipped from distant places, packaged in large containers, transported to huge warehouse storage facilities close to cities and metropolises, and trucked from there to be unpacked and displayed on supermarket shelves.

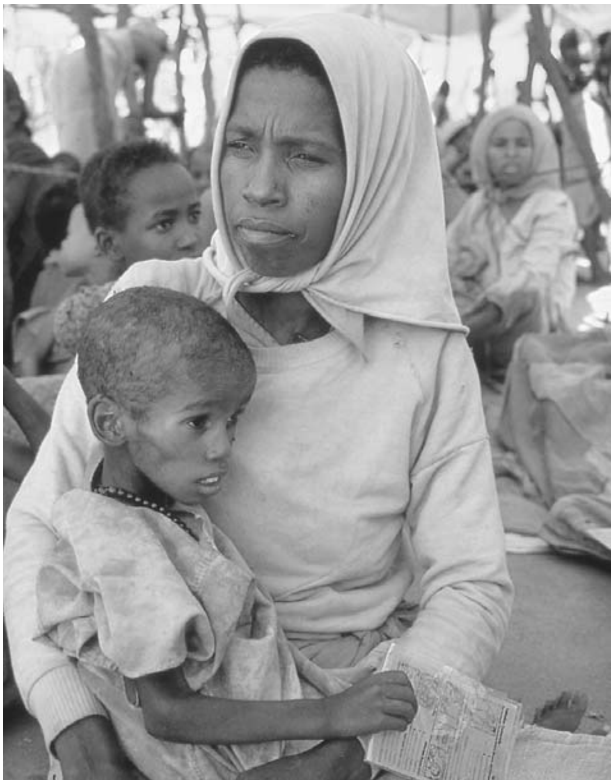
Transporting the food supply long distances requires that foods arrive in a "safe" condition, meaning that they will cause no harm when eaten. Processing and packaging are traditional methods essential to safely preserving food ingredients, either by drying fresh fruits and vegetables, fish, meat, and poultry, by freezing them, or by cooking and canning them before they are transported and distributed. Food processors and manufacturers strive to convince the public of the differences between brands through advertising and promotion, but the only differences are frequently superficial marketing "hooks" introduced to change consumers' perceptions of products in order to capture a larger share of their food dollars. Price competition keeps profit margins low. Basic ingredients do not change, but that fact can be hidden. For example, any breakfast cereal can be made to appear different and more appealing by producing it in different shapes or adding sugar, dried fruit, essential vitamins and minerals, or new flavoring or colors. Newly designed packaging, announced by a new advertising campaign, will successfully persuade consumers that the product itself is new and different.

A successful promotion is intended to achieve better differentiation of individual products, a product virtue that is more important than nutritional value. Processors do not ignore nutrition, however, especially if it has the virtue of enhancing product differentiation. Differentiation of a product is an essential marketing function that enables a food company to charge U.S. consumers more for, or to sell more of, a basic food grain than might otherwise be possible. The availability of forty different packages of a breakfast food containing corn cereal in the breakfast food section of the supermarket is not intended to provide variety for consumers. The goal is to divide the market into increasingly smaller segments within which more can be charged per ounce than can be extracted from consumers for simple cornflakes. The same segmentation game can be played in every category of processed food. Differentiation ensures that food companies do not compete on the basis of price, traditionally the distinguishing feature of an openly competitive, free market in capitalist systems. New food products quickly come and go, but the basic ingredients—flour, fat, sugar, flavoring, coloring, and preservatives—remain unchanged. An estimated twelve thousand new food products are introduced annually, and fewer than a hundred will remain on supermarket shelves after five years.

Food processors and supermarkets, squeezed by restaurants and fast-food companies into a smaller portion of the commercial food market, have defended their share of the food supply by developing products that contain the main entree of a meal or a full meal packaged in dried or frozen form. Breakfast cereals come in small packages containing a single portion. Different recipes are devised for wheat flour, fat, sugar, jams and jellies, and artificial flavoring in partially baked pastries that can be heated in the kitchen toaster as a breakfast food or as a snack, for example. Full meals are packaged frozen, to be heated in a microwave and served as a quick lunch or dinner.

As a food category, the entree items and full meal products can be differentiated from other food products, enabling food processors to charge a higher price for a product than its often meager ingredients would bring if sold individually. Within the packaged meal category, product differentiation tactics often promote convenience as well as health benefits, both strong personal objectives, especially among individuals in the upper-middle and higher income brackets, the primary targets of advertising and promotion campaigns. Supermarkets over the past decade have given more floor space to and hired more employees for deli counters that offer convenience foods as well as whole meals, or home-meal replacements.

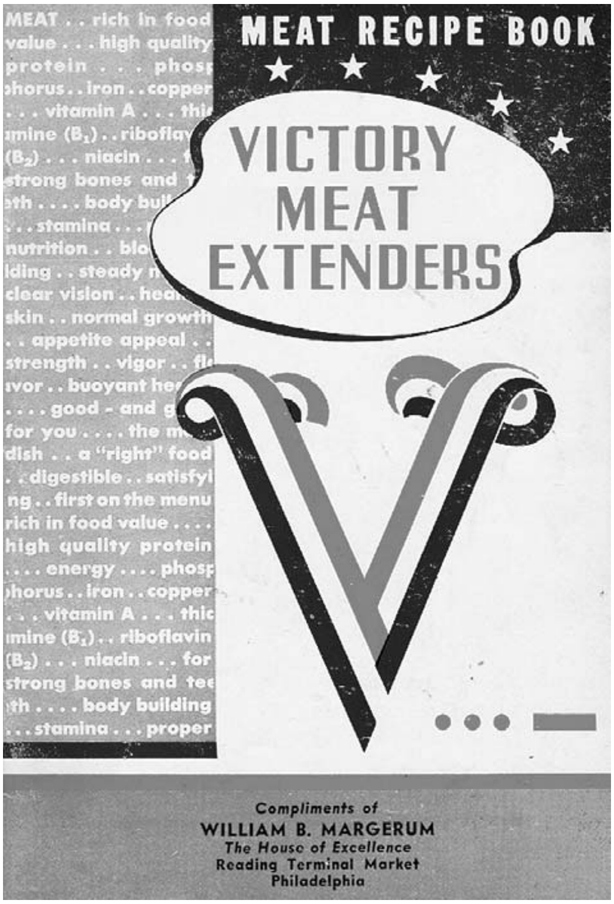
Needless to say, advertising, promotion, product development, and packaging design are not free services. They are the cost of marketing the food supply in a postindustrial society and a service economy. While the proportion of the food dollar spent to eat out grew from 44 percent in 1990 to 47.5 percent by the end of the twentieth century, consumer spending for food increased by 37 percent, with marketing costs responsible for almost all of the increase. Marketing costs in the decade rose 45 percent, compared to a rise of 13 percent in the farm value of food purchases. Marketing consumed 80 percent of the trillion-dollar cost of the food supply system in the United States, leaving the actual value of the food supply at $200 billion, or 20 percent of the operational cost of the food system as the twenty-first century began. As some corn growers mournfully point out, the cost of the package containing cornflakes is more than the farmer is paid for the ingredients.



Mother with malnourished child in famine-stricken Somalia. COURTESY PHOTO RESEARCHERS, INC.

These shifts in how money is spent for food reflect seismic changes in the social tectonics of the U.S. economy at the end of the twentieth century. Among citizens of developed countries globally, Americans alone were working more hours each week as the century ended than when it began. Employment during the 1990s rose faster than in any decade since the end of World War II. The structure of the nation's workforce changed as well. The number of two-income households rose as more women entered the workforce, and wages grew faster, even as inflation declined.

The consequences of more real income and less leisure time drove changes in the food supply system. Consumers purchased more food overall, but more higher-cost processed and packaged in-home foods. The practice of spending to eat out at restaurants grew rapidly, especially at fast-food outlets. As the twenty-first century began, the money spent on fast food consumed nearly



Due to wartime shortages, the National Live Stock and Meat Board in Chicago issued this 1944 booklet on tips for making the most of meat purchases during the national emergency. This included a pledge of the American homemaker: "I want to do my bit and more, to help America win the war." ROUGHWOOD COLLECTION.

one of every four dollars spent to eat out. Only a decade earlier, in comparison, one dollar in ten was spent on restaurant meals. Wages and employment in the food supply system rose, all in response to the search for convenience.

Consumers were working more, earning more, and willing to pay more for convenience and for appliances like the microwave, which made convenience foods more convenient. By the end of the twentieth century, only one in three U.S. consumers said their food budget was a primary consideration in food purchases, while the other two said service and convenience topped their list. Oddly, as convenience became the hallmark of the U.S. food system in the twenty-first century, more space and attention was being given to kitchens in new home designs, especially as the size and amenities in homes increased. In addition, kitchen utensils with as much decorative appeal as utility were being featured in upscale department stores and shops catering to consumers aspiring to culinary sophistication.

The prosperity at the end of the twentieth century, combined with the largely benign condition of inflation, led to an effective overall reduction in the portion of disposable income spent on food in the United States. At the close of the 1990s, U.S. households were spending 10.4 percent of disposable personal income on food, down from 11.4 percent in 1990. Household spending in 1999 was greater in four expenditure categories—medical care, housing and home expenses, transportation, and services—than it was in the category of food, for one simple reason: with each additional dollar of income, the share of family income that must be spent on food is less than the share from the previous dollar. As real income rises, more family income is available for other needs. Wealthier families allocated far less by half than 10 percent of disposable income to food, while families at the lower end of the low-income category were spending up to 40 percent of their disposable income on food.

The Immutable Economics of Food

Regardless of the marketing ingenuity of food processors and supermarkets, or the culinary talent of restaurant chefs, the food system cannot escape the reality of the inflexible economics of food. The typical stomach can hold only a finite amount of food. After a certain point, the stomach becomes inelastic; the same is true of the economics of food. To put a finer point on the observation, an individual who has not eaten for twenty-four hours may be willing to pay twice the asking price for a tempting meal, but, once the meal has been eaten, few individuals will pay a dime more to consume the same meal immediately.

Food also obeys the law of inelasticity. The need for food is constant, and people who are starving will pay almost anything, do anything, to get enough to eat. Survival depends on a minimum intake of food, averaging between 1,800 to 2,400 calories per person daily, that will also ensure adequate levels, or stores, of essential oils, fats, vitamins, and minerals. Humans can, and do, survive on less, but at a physical and physiological price measured in stunted growth and susceptibility to chronic and infectious diseases. When food is scarce, food prices will increase; the more scarce food becomes, the more rapid the escalation in food prices.

When food is plentiful, in contrast, people will not pay more to obtain greater amounts of food than they need. Farmers who harvest more food than can be easily sold will be paid a substantially lower price for all the wheat, maize, rice, or hogs and cattle they sell in the market than they would receive without the excess production. When each farmer produces only slightly more one year than the last, the combined surplus can be so large as to devastate the income of all farmers, a condition that plagued U.S. agriculture for much of the twentieth century and now looms as a global condition. Farmers cannot withhold their individual surpluses since the amount is too small to make a difference, but each farmer suffers measurably when the overall surplus is so large that commodity prices fall and profits are destroyed. No individual, cooperative, or company has the resources to acquire and store the excess food.

Farmers, food processors, and consumers each cope differently with the inflexible fact of inelastic stomachs, all with varying degrees of government intervention. With a food supply in which the value of food accounts for only 20 percent of the cost of the system, food processors have the comparative advantage of size and few competitors. Consolidation among competitors occurred rapidly at all levels in the U.S. food supply system in the 1990s, thanks to the benign attitude of the federal government toward anticompetitive behavior, creating a marketplace with enormous advantages for the survivors. The massive size of food processors—four companies essentially control processing of beef and pork, three companies dominate the poultry industry, and even these seven firms are exploring further consolidation—allows processors to largely control what they will pay to producers.

Although commodity prices in the United States are low by all historic standards, the cost of food is not as significant a factor for company management as stability of supply and the ability to either stabilize (fix) the cost or negotiate the price of ingredients. Processors with few competitors need to fix the cost of ingredients over the life of the marketing plan for a food product. Those costs will be only one factor to consider in setting the level of product prices in the development of marketing strategies that will produce a profit. With price competition virtually eliminated for grocery food items, the price obtained through product differentiation is the dominant management concern.

From the consumer's perspective, food costs are actually declining as a portion of rising household income, and food price inflation is largely absent. Both conditions are substantially influenced by government fiscal and monetary policy. As long as these conditions prevail, consumers are less likely to be upset about the growing market power of food processors than they would be if food price inflation were escalating as much as it did in the 1970s. As odd as it sounds, inflation is not a food supply issue today because of the convenience factor. Food processors and supermarkets would inflate food prices if they could, but restaurant and fast-food outlets would take a bigger share of food spending if they did. As long as consumers choose to eat out more, the food industry is stymied by the competition over market share from restaurants and fast-food outlets. Processors and supermarkets have yet to develop an effective counterstrategy to the competition of convenience and are unable to raise prices as much as they would like. With the consumer food dollar almost evenly split between eating out and eating at home, the food processor is being forced to get by with a smaller piece of the pie, so to speak. Consolidation in the processing industry is an inevitable response, dividing the consumer dollar among fewer participants.

An additional factor limiting the ability of the supermarket industry to raise food prices is a recent invasion of competitors, especially from "big box" discount retailers. Both Wal-Mart and Target are rapidly adding grocery merchandising sections to their existing stores and building new stores that emphasize groceries and food. As a result, supermarkets are being pressured not only by restaurants and fast-food outlets, but also by competition from discount stores. Supermarkets are taking the pragmatic approach, "if you can't beat them, join them," by marketing whole meals prepared in the store. While seven of every ten take-out meals sold in 2001 came from fast-food outlets, supermarkets accounted for almost two of ten, leaving the remaining one percent of the take-out market to restaurants. As long as consumers have the disposition and the disposable income to eat at restaurants or fast-food outlets, they also have the most effective strategy for playing suppliers in the food system against another.

Farmers cope with the changing trends in the food supply system with the one tool still available to them, aid from the federal government. In 1995, Congress enacted legislation to end government intervention in agriculture by phasing out income-support programs. However, when farm incomes fell in 1998 and in the following years, Congress quickly authorized emergency income payments and added another $30 billion over the next three years to already generous subsidies and government payments. In 2002, the first new farm legislation of the twenty-first century was adopted. The most generous in the sixty-year history of farm programs, the new legislation provided income support payments to farmers of over $19 billion a year for the following ten years. The scale of the subsidies allocated by Congress is unparalleled. Legislators in Washington have guaranteed that American farmers will receive nearly $200 billion in income payments over ten years, the equivalent of the farm share of annual consumer spending for food. Over 90 percent of farm output in the United States was harvested by some 200,000 farm operators who would receive most of the $19 billion in annual farm income payments. Globally, agriculture production is rising, a condition that experts predicted would drive down farm commodity prices further. If this pattern develops during the twenty-first century, even greater expenditures for farm support could be made by the federal government than had been projected under the existing farm legislation.

Immutable Law of Nutrition

If the food supply is governed by the economics of inelastic stomachs, it is also bound to the immutable law of nutritional consequences. People consume food because of an instinct for survival, but life can be put in harm's way either by too little food or by eating too much food. People die of both starvation and gluttony. Nations are similarly at risk. If citizens, threatened by food shortages or famine, confront a food supply insufficient to fill shrunken stomachs, anarchy may ensue. A nation faces a no less compelling array of social, economic, and political problems when it confronts a food supply that is grossly greater than is needed. Surpluses can destroy the farming economy. If the nation dumps its surpluses on its neighbors, professing humanitarian impulses, the policy will destroy its neighbors' farming systems. If national leaders exhort people to eat their way out of the problem, or even if the surpluses are transformed into meat, poultry, and other forms of animal protein, then people will become overweight. In addition to surpluses, health costs will increase as well, and the national budget for health services will rise because obesity is a precursor to chronic diseases and overweight individuals are at risk of early death.

MALNUTRITION

Malnutrition affects about 600 to 800 million people in the world, most of whom live in Africa and Asia, where food shortages occur more frequently and the food supply is tenuous and unpredictable. In Africa, the major cause is unstable governments combined with uncertain weather, a lethal social combination that undermines efforts to develop a more reliably productive agriculture capable of increasing domestic food production. Food assistance, mainly through the World Food Program, which distributes surplus food from developed countries, has been established worldwide to fill the calorie gap. However, food assistance treats the symptom, not the problem, and aggravates the search for long-term solutions by disrupting the agricultural economy when it is most vulnerable by displacing domestic markets.

The U.S. public has come to accept that malnutrition is the consequence of too little food for too long a time. But malnutrition has two faces. It is a Janus-like condition of nutritional extremes, of either undernourishment or overnourishment, both of which may occur at the same time in a single population. In the United States and other developed countries, classic malnutrition, or undernourishment, most often occurs in predictable groups: women, children, the elderly, and the poor. The cause may vary, but malnutrition almost always accompanies poverty, which occurs more frequently among these groups. Women are paid less than men for equal work, while four of every ten children live in poverty in the United States, where fewer than two of every ten families are poor. The proportion of the elderly who are poor continues to be greater than should be the case.

Malnutrition of the poor is not evident since undernourishment has few immediate, unique characteristics, although the condition will be visible eventually in the rising levels of infectious diseases, diarrhea, and tuberculosis. The overt signs of starvation, such as stunting, failure to thrive, kwashiorkor (extreme protein malnutrition, especially in children), or marasmus (chronic malnutrition, especially in children), are generally indicative of severe, widespread hunger throughout a population in which malnutrition already is extensive. Undernourishment in the United States, or in other highly developed nations, is not caused by food shortages but, instead, by barriers, almost always poverty, that block access to the food supply. There was no shortage of food in the world at the beginning of the twenty-first century, nor is there in the foreseeable future. Since the 1960s, the United States has established a series of federal nutrition programs to increase access to the food supply for groups of citizens at risk of hunger, including low-income families, children away from home, mothers and their infant children, and the elderly. The Food Stamp Program is intended to assist families and individuals, especially during rising unemployment and in seasonal periods when work is not available. The program also reaches families troubled by chronic unemployment and families in which the parents hold down two or more jobs but still earn only a poverty-level income. At peak unemployment in the early 1990s, nearly 25 million Americans were participating in the Food Stamp Program.

School meals, which include breakfast and lunch, are subsidized and served each day to more than 50 million schoolchildren, and schools receive additional subsidies to provide meals at nominal or no cost to over half of these children. Some 7 million mothers receive monthly certificates through the WIC (Women, Infants, and Children's) program to purchase infant formula and additional foods that provide nutrients needed especially by pregnant women and lactating mothers. The WIC Program also offers nutritional counseling and health information on pregnancy to expectant mothers. Over 2 million older Americans daily receive hot meals at nominal prices delivered to their homes or served in community centers through subsidies provided by the Older American Nutrition Program to community organizations. During the economic slowdown in 1991 and 1992, the federal government was spending over $40 billion a year on nutrition programs, including $27 billion on food stamps alone.

The unique characteristics of the U.S. food supply compared to other nations occur most notably in public policies. While the United States and the European

Union both subsidize their farm economies generously, other countries possess neither the wealth nor the political commitment to match this. At the beginning of the twenty-first century, the United States was projected to spend $200 billion over the next decade in farm income payments, and an estimated $350 to $400 billion for food assistance. No other nation allocates as much overall or as a percentage of its gross national product to ensure access to food for the poor as does the United States. The U.S. government has taken a benign view of economic concentration in the food system, permitting the accumulation of economic power among a few corporations in every sector of the industry, ranging from livestock slaughter to poultry processing, farm equipment and chemicals, as well as food manufacturing and retailing. The European Union, in comparison, is more vigilant regarding competition as an economic force in a free enterprise system.

See also **Agriculture since the Industrial Revolution**; **FAO (Food and Agriculture Organization)**; **Fast Food**; **Food Banks**; **Food Pantries**; **Food Politics: United States**; **Food Security**; **Food Stamps**; **Food Supply and the Global Market**; **Food Trade Associations**; **Government Agencies**; **High-Technology Farming**; **Homelessness**; **Hunger Strikes**; **International Agencies**; **Political Economy**; **Poverty**; **School Meals**; **Take-out Food**; **WIC (Women, Infants, and Children's) Program**.

Rodney E. Leonard

FOOD TRADE ASSOCIATIONS.

Since the time of the first Crusade (1095–1099), early food trade companies shipped raw specialty commodities (primarily spices) from exotic lands, first from Egypt and Syria, and later from China, India, and Indonesia, to market ports in the colonial world. The Italian trade families of Venice and Genoa were particularly active, most notably the Polo family, which brought goods from China between 1260 and 1294. Perhaps the most important of these shipments were seed stuffs, which were conveyed great distances, then planted on domestic soils and genetically groomed to flourish in their new habitats, to eventually become some of the staple commodity crops—such as maize and wheat—of human history. Bartering goods in both directions, the early trading companies contributed to the wealth of their risk-taking owners and sponsors who paid for their explorations.

The successful trade of even nonessentials developed dependencies on imported goods; tea and coffee, for instance, became so prized that their trade was eventually manipulated for political purposes. Frequently subsidized by royalty, food trade companies easily became players in the political arena. The East India Tea Company, which still exists today, was the beneficiary of tea taxes that Great Britain placed on its colonies in the early 1770s. When the practical Americans started drinking Dutch teas instead, the British placed tariffs on the Dutch teas, favoring their own trade association products at lower prices. That move was the impetus for the famed Boston Tea Party of 1773. After that, coffee rose quickly into American favor, having been introduced in 1600 to the West by Italian traders. So popular was the brew in the early 1960s that the coffee-producing and -consuming nations agreed to use export quotas to provide reasonable market prices and stabilize supplies. When that agreement was not renewed in 1989, the producers formed the Association of Coffee Producing Nations and developed the Coffee Retention Plan to balance supply and demand. Food trade associations had come of age and became a driving force in the global political arena.

Contemporary food trade associations may represent a commodity grower group, such as the National Cattlemen's Beef Association and National Corn Growers' Association in the United States; the Asociacion de Exportadores de Chile (Association of Chilean Exporters, or ASOEX, fruit exporters); or the Association of British Salted Fish Curers and Exporters, and the Pea Pickers and Pea Packers, in the United Kingdom. Or they can represent a group of commodities and products that share a trading platform or set of technologies, such as the Grocery Manufacturers Association (GMA), American Frozen Food Institute, Biotechnology Industry Organization, and the National Food Processors Association (NFPA) in the United States; or the Camara Nacional de Agricultura y Industria (National Chamber of Commerce for Agriculture and Industry) in Costa Rica.

These associations no longer physically trade food goods, but deal with a variety of issues that cannot be handled at the level of the food producers or processors individually, including coordination and collaboration in the marketplace on food safety, workers' rights, and agricultural health; public communication and education; distribution, pricing and marketing strategies; technical services; crisis management; and legal representation and lobbying in the international trade policy arena. Members (producers or processors), not owners or sponsors, reap the benefits of their efforts. Nowhere is this more apparent than in high-visibility marketing campaigns that have emerged for small-commodity products like raisins ("I heard it on the grapevine") and milk ("Got milk?").

Trade associations can be vitally important in legally defending an industry when it is involved in a trade dispute, for instance when it is charged with "dumping," as in the case of Chilean salmon defended in *Asociacion de Productores de Salmon y Trucha AG (Association of Salmon and Trout Producers)* v. *the United States International Trade Commission* (2 July 1999), where tariff penalties were greatly minimized. Mexico's Asociacion Agricola Local de Productores de Uva de Mesa (AALPUM) and Chile's ASOEX successfully cleared their table grape growers of dumping complaints by the Desert Grape Growers

League of California in the spring of 2001. Court and lobbying fees in international trade disputes can mount into the millions, far beyond the capacity of individual producers in developing countries where government support for the industry is nonexistent.

Trade associations can wield enough power to countermand multilateral international treaties. The World Trade Organization was established 1 January 1995 out of the General Agreement on Tariffs and Trade (GATT) of the Uruguay Round to adjudicate trade disputes according to a scientific risk-based assessment. Now, many food trade associations, like the science-based NFPA and the GMA, participate actively in that process, supplying regulatory and scientific experts to the WTO Codex Alimentarius Committees to prevent the formation of future technical barriers to trade.

See also **Civilization and Food**; **Codex Alimentarius**; **Commodity Price Supports**; **FAO (Food and Agriculture Organization)**; **Government Agencies**; **Government Agencies, U.S.**; **International Agencies**; **Maize**.

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Robin Yeaton Woo

FOOD WASTE.

Food waste is the discarding of potentially usable food. Both edible and inedible foods may be considered garbage and therefore wasted. Edible foods are considered inedible when their quality deteriorates until they become unhealthy or noxious. Food deterioration occurs from microbial contamination or from rotting as a consequence of overproduction, storage problems, or improper preparation. Food waste also occurs through food use that returns little nutritional value, like overprocessing and overconsumption.

Edible foods are also wasted when cultural or individual preferences deem food undesirable. For example, some people dislike bread crusts, so they remove them and discard them. Societies with abundant food supplies often consider reusing leftover foods as inconvenient, while less food-rich societies regard food reuse as imperative. Specific parts of animals and plants considered edible in some cultures are considered inedible in others. Animal parts viewed as waste may include bones or shells, skins or scales, fat, blood, intestines, brains, eyes, and stomachs. Plant parts viewed as waste may include cores, seeds, stems, outer leaves, shells, rinds, husks, or peels.

Cultural Variations in Food Waste

Food systems in different cultures vary in the proportion of food waste that is discarded. Cultural variations exist in what is considered garbage, and understanding cultural food rules is crucial in examining food waste. For example, intestines and other internal organs are considered delicacies in China but are discarded as offal in many Western countries. Animal fats are consumed or used as fuel in societies like the Inuit, but in postindustrial nations fats are often trimmed and discarded to reduce caloric intake. Blood is an ingredient in dishes like black pudding in Britain but is discarded in many other societies.

Cultural differences in beliefs about what is edible versus inedible exist more often for animal foods than for plant foods. This may be because animals are similar to humans, so that edibility involves more symbolic meanings. Also, plant food wastes often constitute parts indigestible by humans that therefore have no nutritional value, such as vegetable rinds.

Moral values in most cultures admonish food waste. However, food protests and food riots may intentionally waste food to make ideological and ethical points. Many groups are proud of their efficient use of all parts of a slaughtered animal, such as Cajun claims to use "everything except the squeal" of hogs. Agricultural societies often feed plant food wastes to animals, while many industrial societies process by-products of animal slaughter into livestock feed. Such practices recycle undesired by-products into edible foods and minimize actual food waste. Some societies accept the waste of less-desirable portions of animals and plants as a sign that they have attained a state of affluence and can afford to consume only high-quality items.

Food Systems and Food Waste

Postindustrial societies waste food across all stages of the food system. Food production wastes preharvest food through natural disasters, diseases, or pests; harvested food by inefficient collection of edible crops or livestock; and postharvest food in storage or contamination losses. Food processing wastes food in spillage, spoilage, discarding substandard edible materials, or removing edible food parts in inefficient processing. Food distribution wastes food by offering more food than consumers will purchase and then discarding unsold products. Food acquisition wastes food when consumers purchase more food than they use. Food preparation wastes food by removing edible parts of foodstuffs, spilling or contaminating foods, and rendering foods inedible through improper handling and overcooking. Food consumption wastes food by taking larger portions than can be eaten or by spilling food. Digestion, transport, and metabolism of foods in the body waste nutrients through inefficient absorption, storage, or utilization, thereby failing to use all nutrients that were ingested.

Waste streams in the food system are the by-products of human production and consumption. Garbology, the study of human waste behaviors, identifies food waste as a significant portion of the total human waste stream. Food waste comprises about 10 percent of the total municipal solid waste streams in postindustrial nations and higher percentages in societies lacking mechanized refrigeration and durable packaging.

The four principal methods of disposing of food waste are dumping, burning, minimizing, and recycling. Dumping is the most common method of food waste disposal, but it may create sanitation and landfill problems. Burning food waste is convenient and minimizes the amount of solids needing to be disposed, but burning reduces air quality and is banned in many places. Minimizing food waste occurs through food trades, gifts, donations, and conservation during preparation and after consumption, such as reusing leftovers. Recycling often involves feeding food waste to livestock or composting food refuse. Compost can be used as fertilizer to grow more food, reducing the absolute food waste.

The Cost of Food Waste

Food waste significantly impacts environmental, economic, and community health. The accumulation of discarded food in landfills contributes to air and water pollution, and the burning of food refuse also affects air quality. Economic and nutritional losses are incurred from the calories lost in discarded food as well as from the energy and materials used to transport food waste to landfills. Wasted food means fewer nutrients are available for human consumption, which jeopardizes community food security.

There are also costs associated with the use of salvaged foodstuffs. For example, feeding animal slaughter by-products to livestock has caused outbreaks of bovine spongiform encephalopathy (BSE) and hoof and mouth disease in several European nations. Consumption of leftover foods that were not prepared or stored properly is implicated in many cases of foodborne illness.

Historical Changes in Food Waste

Historical transformations have changed the type and amount of food waste generated. Hunter-gatherer cultures often discarded bones as their primary food waste. The development of agriculture added more plant materials to the food waste stream. Industrialized agriculture increased organic waste by-products from large-scale food processing. Increased population growth and urbanization multiplied and concentrated the amount of food waste, which was increasingly dumped as the cities that generated waste became located farther from agricultural areas.

Historical shifts occurred in the conception of food waste. The term "garbage" originated in the French word for entrails and once referred exclusively to food waste. Later the word signified all refuse, since food waste embodies the most unacceptable characteristics of solid waste, putrefaction and attraction of vermin.

Material prosperity reduces the economic necessity for food conservation and reuse, and conspicuous consumption and disposal are demonstrations of social status. Food in postindustrial societies is inexpensive relative to total income, and wasting food is increasingly accepted. Technology that improves the durability of foods, such as plastic packaging, has reduced food waste from spoilage but has created a new waste problem as food packaging contributes more to the waste stream than food itself. Regardless of consumption and disposal practices, the growing world population has increased food waste.

See also **Consumption of Food; Meat.**

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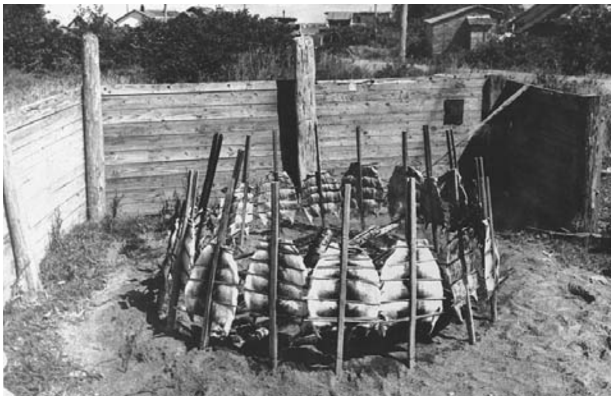
Jeffery Sobal
Mary Kay Nelson

FOODWAYS. The term "foodways" refers to the connection between food-related behavior and patterns of membership in cultural community, group, and society. In its most general usage, "foodways" refers to the systems of knowledge and expression related to food that vary with culture. For example, in modern America, foodways continue to represent cultural diversity within an increasingly interwoven society. In specific usage, "foodways" refers to those food-related behaviors that are believed to identify the primary cultural attributes of an individual or group of individuals; for example, it is in their foodways that Northern Italians are most easily distinguished from Southern Italians and Sicilians.

The first American usage of "foodways," without attribution of coinage, occurs in writings of the folklore initiative within the cultural New Deal—the program of civic reinvestment created by the administration of President Franklin D. Roosevelt in the early 1930s to combat the effects of the Great Depression. In a host of anthology publications, the publicly supported folklore work of the Federal Writers' Project celebrated American "stuff": traditional culture more easily identified by



The Makah Tribe prepares salmon for Makah Day Dinner, Neah Bay, Washington. COURTESY OF THE NATIONAL ARCHIVES AND RECORDS ADMINISTRATION.

its prevalence than its longevity. The director of the project's folklore activities, Benjamin Botkin, instructed fieldworkers to gather the evidence of tradition and creativity among America's living regional, ethnic, occupational, and spiritual communities—work songs, the calls of street vendors, festivals, tall tales, superstitions, and foodways.

In this context, foodways is a silent member within a category of expressive genres; like a festival, it is a "performed" tradition whose "texts" are activities that can be observed, and perhaps sampled, but are as emblematic of the people who produce those texts as the more conventionally recognized folk expressions that comprise collections and anthologies of published folklore. Botkin and his contemporaries also used the term "foodlore" on occasion to refer to foodways since, like folklore, it is a canon of shared beliefs or "lore" that is widely held but limited to a certain culture or situation.

Like its kindred terms "folkways" and "lifeways," "foodways" often echoes the popular anthropology of the 1950s—language carefully, if transparently, tailored to avoid infection by ethnocentrism and tuned to the broadest level of cultural comparison. Foodways is seen as a component of every culture, large or small, but one among several components artificially constructed at a level of analysis and comparison, just above the degree of particularity that might enable it to be easily understood. In its specification of the edible universe, foodways implies other categories containing elements equally innocuous yet laden with meaning: "shelterways," "clothesways," and perhaps "homeways," "workways," "schoolways," "healthways," "leisureways," or even "deathways." Each of these terms is logically sensible, but only "foodways" found its way, if by a slim thread, into contemporary usage.

The term "foodways" survived a period in folklore studies, roughly from the mid-1950s into the early 1970s, when what is now generally referred to as "material culture" in the United States did not rank as highly as the spoken word and the performed arts within the canon of folk expression. It is largely through the efforts of Don Yoder and Warren Roberts that the term was carried from one generation to another, from a period of relative low American academic interest into the current state of broad, heightened engagement.

In "material folk culture," the summary phrase of Henry Glassie's broad and renewing scholarship, foodways found revived utility in folklore studies. At the University of Pennsylvania and Indiana University, respectively, Yoder and Roberts prepared two generations of students to uphold broad applications of the term "tradition" (that is, inclusive of material folk culture) in their research. Since the late 1960s Yoder has documented the bearers of Pennsylvania's traditions, including those engaged in foodways, for the annual Pennsylvania Folklife Festival—an early example of collaboration between scholars and the general public that would arise later at the national level.

Since the 1970s, the percentage of American folklorists entering academe has been small in comparison to the number working in government-supported positions, located in arts-granting agencies, archives, and libraries as well as in foundations that are actively supporting the application of research to social issues. In both research and public programs, the early twenty-first-century generation of folklorists, more than half of whom were students of Yoder and Roberts, have found material expressions of tradition particularly useful in demonstrating the resilience of folk culture, the fundamental—and key—assertion of folklorists involved in public education.

In the 1980s, as the growing number of government-based programs continued to exercise their commitment to inclusion, many sought to engage recently emigrated peoples from Southeast Asia and Central America as nascent communities. With often limited resources, and language and translation challenges to contend with, a number of folklorists found in foodways a common ground for the presentation and comparison of contemporary tradition in action. In 1969, the Smithsonian Institution's annual Festival of American Folklife—whose advisory board over the years has included Yoder, Roberts, and Glassie—first presented foodways among festival programs that focused upon featured states or regions, ethnic communities, and occupational groups. Since its inception, the festival has included foodways as a way of focusing upon traditionally acquired skills and shared community values.

At the Smithsonian, the presentation of foodways in a festival setting became a model—a work-in-progress—that was emulated by state folklife program coordinators and festival directors. Built upon a foundation of field research that placed culinary traditions within the context of folklife genre, festival foodways presentations co-opted the "cooking show"—a presentation model made familiar by county fairs, food stores, and television. Here folklorists interviewed traditional cooks in the midst of preparing food and defined, in a way that few other public programs could, the concepts of observation and imitation, informal apprenticeship, and shared standards of appropriateness and taste.

In the early twenty-first century, foodways has generated little scholarship; however, many scholars have focused upon the cultural exchange within so-called food events, often attending to customs found in large-scale and socially significant occasions. Others, particularly those who work in both academic and public sectors of the discipline, have successfully identified matters of cultural consequences found in foodstuffs that are rapidly being depleted in their natural supply by commercial expansion into formerly wild areas. Folklorists Suzi Jones and Lynn Martin Graton, working in Alaska and Hawaii, respectively, have used the concept of foodways to describe and explain native and immigrant communities, natural resource management, and the viability of folk cultural processes.

There is both opportunity and need for more comprehensive foodways scholarship, the reappraisal of food-related traditions as a medium for creating cultural identity, and attention to the responsibilities of active tradition-bearers as teachers, conservators, and innovators. With improved standing in the American academy and the well-earned support of government agencies, foodways is poised to accommodate and frame the rapidly converging interests of scholarship and civic engagement.

See also **Folklore, Food in**; **Icon Foods**; **Religion and Food; United States: African American Foodways**.

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Charles Camp

FRANCE.

This entry includes six subentries:
Food and Cuisine in France
Northern French Cuisines
Southern French Cuisines
Tradition and Change in French Cuisine
Wine and the French Meal
French and British Cooking

FOOD AND CUISINE IN FRANCE

In 1826 a famous French gastronome, Brillat-Savarin, wrote among other things: "Animals feed, humans eat, but only those with refined taste dine," and "The creation of a new dish brings more happiness to humanity than the discovery of a new star." These two aphorisms are fundamental to an understanding of French attitudes toward food. On the one hand, food is not simply a source of nourishment, nor is it something everyone "naturally" appreciates. Only by cultivating discrimination (being attentive to tastes, colors, and textures) will food leave the realm of biological necessity and attain sensual heights. Secondly, creation is both essential and beneficial to society. It is the chef's duty to create, to advance the art of cookery and in so doing, provide pleasures that surpass those associated with more abstract achievements.

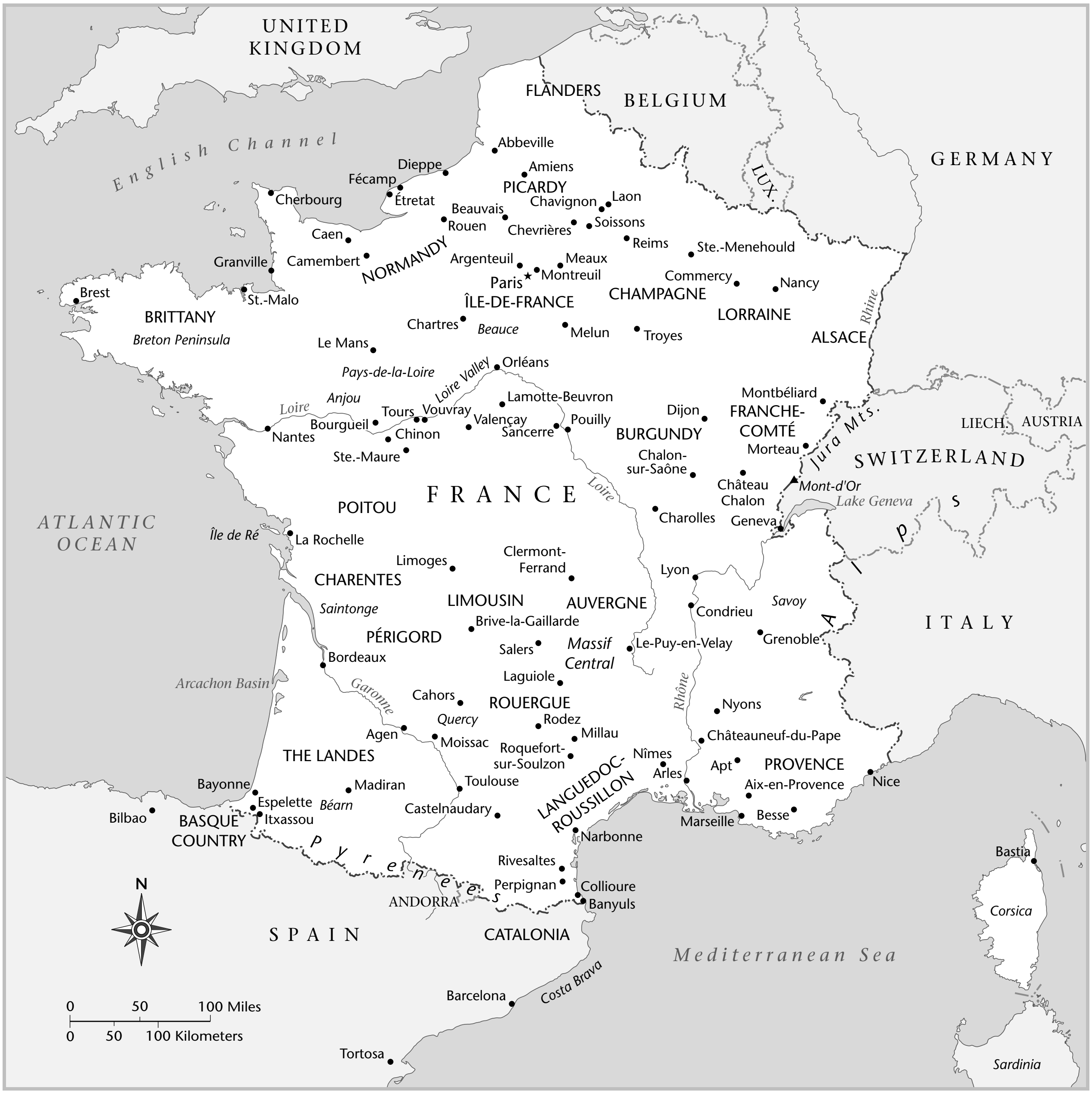
We will return to the importance of these two concepts later, since they are directly related to the prominent place French cuisine occupies in the world today. Before doing so, however, a look backward will help place French cuisine in a greater context and allow us to address several sensitive issues concerning its "birth" and evolution.

The Italian Controversy

An oft-repeated story maintains that French cuisine emerged from the "dark ages" of primitive eating only when Catherine de' Medici brought her Italian cooks to France in the mid-sixteenth century, for her marriage to Henry II in 1533. The French being more than apt students, the story goes, not only learned their lessons, but quickly surpassed their Italian masters in the art of fine cookery and . . . *Voilà*! French cuisine was born.

This legend has been repeated in popular histories of cooking for centuries, even in France. It was first evoked in 1739 in the preface to an innovative cookbook attributed to François Marin, *Les dons de comus*, where it is stated: "The Italians civilized all of Europe and it is they, without a doubt, who taught us how to eat. . . . For more than two centuries the French have enjoyed good cooking, but rest assured, dishes have never been as delicate, as expertly prepared, or better tasting, than they are today." A similar point of view is expressed by Le Chevalier de Jaucourt who authored the article on cuisine in Denis Diderot's famous *Encyclopédie* published in the 1750s:

> The Italians inherited the art of cookery from the Romans; it was they who introduced fine food to the French. . . . During the reign of Henry II, cooks from beyond the Alps came and settled in France, and we are eternally indebted to this motley band that served at Catherine de Medici's court. . . . The French, finely attuned to the flavors that should dominate in each dish, quickly surpassed their masters who were soon forgotten. From that moment on, as if they had successfully met the challenge of stressing what was important, they could pride themselves in the knowledge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Sardinia

> that the taste of their cuisine had surpassed that of all others and reigned supreme in opulent kingdoms from North to South.

Thus, the simple cooking of ages past, having become more complex and refined from century to century, has today become a subject of study, a complex science about which numerous treatises constantly appear under titles such as *Le Cuisinier françois*, *Le Cuisinier royal*, *Le Cuisinier moderne*, *Les Dons de comus*, *L'école des officiers de bouche*, and many others, each one teaching a different method, which proves how futile it is to attempt to reduce to an established order what human beings, with their whims and changes of taste, search, invent, and imagine in the preparation of their food.

We will treat these points separately, starting with the reference to Catherine de' Medici and the Italian influence on French cuisine. Both of these eighteenth-century authors agree that the French have enjoyed good cooking "for more than two centuries," that is, since the sixteenth century. In fact, long before the young queen arrived in 1533, numerous sources bear witness to the sophistication of French cuisine.

Starting in the early fourteenth century, manuscript cookbooks were being written in France, one of which became extremely popular. This book, simply known as the *Viandier* (the term *viande* [meat] at that time referred to all eatables, hence a *viandier* was simply a cookbook) was said to be the work of one Taillevent, a chef in the royal kitchens of Charles V. The recipes we find in the *Viandier* are as rich and varied as those in contemporary Italian, English, Germany, or Spanish cookery manuscripts. This said, French cooks do not appear to have had a greater reputation than those in other European countries. They served dishes common to an "international repertoire" as well as some specific to France.

The situation seems to change in the sixteenth century but not it the way our two eighteenth-century authors suggest. Although a new generation of French cooks did rejuvenate cooking in France, the dishes they propose owe little or nothing to the Italian cuisine of the time, the style of which was radically different. Indeed, the earliest published cookbooks are German and French, not Italian, and barring an Italian dietetic work by Platina published in the 1470s that included some recipes from some fifty years earlier, not one Italian culinary treatise is translated into French. At a time when Catherine de' Medici was still a baby, travelers, including Italians visiting France, claim that French cooks are the best in Europe, and Rabelais, the most gourmand of writers, clearly prefers French dishes to those of any other nation since he frequently mentions those specific to the national repertoire in his gargantuan menus. In fact, there is no proof that Catherine de' Medici even brought her cooks with her to France!

No author living in the sixteenth century mentions the supposed superiority of Italian cookery, although Montaigne does marvel at the eloquence and precision of an Italian *maitre d'hôtel* describing the art of banqueting, and the expertise of Italian gardeners, confectioners, and carvers is not only recognized, but admired and copied. Nevertheless, notwithstanding the esteem in which Italians are held in the accessory arts of serving and confectionery, it is not until two centuries later that any hint of the so-called Italian influence on French cuisine per se appears in print. Be that as it may, French cooks do not achieve a clear dominance in the kitchens of Europe until the mid-seventeenth century.

The Beginnings of French Hegemony

Neither Marin nor Le Chevalier de Jaucourt gives a specific date for the rise of French cuisine. The latter does indicate that the French had "surpassed their masters" in the seventeenth century by including three seventeenth-century cookbooks (*Le Cuisinier françois*, *Le Cuisinier royal* and *L'école des officiers de bouche*) in his list of treatises devoted to the culinary arts. One of these books, *Le Cuisinier françois* of La Varenne, is the first to document the radical changes French cooking had undergone since the end of the Renaissance. Published for the first time in 1651, La Varenne's book would be translated into several languages and remain in print for over one hundred years. In the preface to the English translation of 1653 we read, "Of all the cooks in the world, the French are esteemed the best," and from that time forward French predominance in the kitchen will continue its almost uninterrupted ascendancy.

A partial explanation for the influence of French cuisine lies in its vitality. The best professional chefs feel a duty to improve on the work of their predecessors in order to "advance" the art of cookery. Not only do they create new dishes, their cooking embodies new attitudes toward food, which often spread with the dissemination of the dishes they have invented. Over and over again, a new philosophy of cookery emerges, often in conflict with that of previous generations, always claiming to mark significant "progress" in the culinary art. In the eighteenth century, for instance, devotees compared the cooking of their *nouvelle cuisine* to alchemy, claiming to distill the essence of taste from the ingredients employed. A century later, a new generation of chefs led by Antonin Carême saw the cook more as an architect than a chemist. They encouraged the creation of monumental assemblages and developed a family of basic sauces, some of which are still in use today.

In turn, Auguste Escoffier in his *Guide culinaire* of 1903 rejected the elaborate cuisine developed by Carême, claiming that the "fast pace of modern life" no longer allowed chefs the leisure to prepare elaborated displays, and argued for a simplification of cuisine. It should be noted, in this context, that Escoffier was the first chef to obtain international recognition and to father a new school of cookery who did not work in a private home. Whereas previously the greatest French chefs all worked in aristocratic households or in royal kitchens, Escoffier built his reputation as a hotel chef at the Savoy Hotel in London and later at the newly created Ritz Hotel in Paris, before returning to London to the kitchens of the Carlton Hotel as an internationally acclaimed celebrity whose writings would form the basis of French cooking throughout the greater part of the twentieth century.

Gastronomy and Gastronomes

Food and cooking alone do not explain France's reputation in culinary matters. To recall Brillat-Savarin's words, "only people with refined taste know how to dine," and the French have not only cultivated the art of cookery but have long considered it an integral part of their culture: how one eats is as important as what one eats. Indeed, the French claim that they invented gastronomy and linguistically, this is certainly true. The term first appears in the title of an epic poem, *La Gastronomie* by Joseph Berchoux, published in 1803, its four cantos treating respectively the history of cuisine in antiquity, the first service, the second service, and the dessert of a banquet. The word rapidly came to designate the study of food and cookery as an art; those who excelled in this study, and for whom gastronomy was a central feature of their existence, were "gastronomes."

The gastronome was defined as a critical observer of the chef's work—not a chef. As professionals, gastronomes became food critics, the earliest of whom in the western world appear to be French. Among them, Grimod de la Reynière leads the list as the inventor of a new branch of literature with the publication of his *L'almanach des gourmands* from 1803 to 1812. In this yearly journal, he reviewed restaurants and published the results of tastings aimed at selecting the best artisans and products of his day, beginning a tradition of searching out quality that remains very much alive in the French mentality today.

L'exception française

One has only to contemplate the ferocious aversion of French consumers to hormone-fed beef and veal, to genetically modified food plants and the standardization of food in general, to understand that their relationship to food goes far beyond just eating—much to the bemusement and exasperation of France's trading partners. And where else but in France would the Education and Culture Ministries sponsor a national inventory of traditional food products, or classes teaching children how various foods are made and how to appreciate different tastes, smells, and textures?

The French approach to cookery, the institutions developed by its proponents and the gastronomic culture it glorifies have all contributed to the preeminence of French cuisine. Indeed, the very use of the term "cuisine," when applied to the food of another nation, implies that it has gone from simply being cooking to something more refined and complex—something closer to the French model. Naturally, the culinary superiority of France has been challenged in the past and continues to be challenged today, but no other cuisine has had such a sustained influence on the cooking practices of its neighbors, nor can any other claim to have exerted as universal an impact on professional cooks around the world, as that which developed and continues to evolve in France.

See also **Carême, Marie Antoine; Chef, The; Cookbooks; Cuisine, Evolution of; Escoffier, Georges-Auguste; La Varenne, Pierre François de; Medici, Catherine de'; Middle Ages, European; Nouvelle Cuisine; Rabelais, François**.

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NORTHERN FRENCH CUISINES

The Loire River has long served as a divide between northern and southern France. It runs from Nantes on the Atlantic coast to the south of Burgundy, where it veers south at Pouilly, though the French mentally continue the division line eastward to Geneva. Roughly half of France is north of the Nantes-Geneva line, including Brittany, the château country (Orléans to Tours), Normandy, Paris and the surrounding area known as Île-de-France, French Flanders, Alsace, Lorraine, Burgundy, and the Franche-Comté.

Farmers here are basically well-off. The wheat fields of the Beauce, just south of Paris, produce the finest wheat in France, Normandy is famous for its beef and cheese, and the lambs that graze near the sea in Brittany and in Picardy are among the most esteemed in France. Paris itself was once surrounded by vast gardens that supplied the capital's needs.

Beer, Gin, and Sugar Beets

Running along its most northerly perimeter and extending out to the tip of Brittany is France's longest coastline. From the English Channel to the Atlantic seaboard, fishing has always been a major industry. Herring was the dominant fish along the northeastern part of the Channel, and today salted and smoked herring are still a specialty there. French Flanders, however—like neighboring Belgium, with which it has strong cultural ties—does not spontaneously come to mind as a gastronomic haven. Coal mining was a major industry here, and those who survived the backbreaking work often sought relief in taverns and bars. Beer and hard liquor were consumed in great quantities, and a French version of gin (*genièvre*) wreaked havoc on the health of those who overindulged. It is therefore no surprise that this province holds the sad record of having the highest rate of cirrhosis of the liver in France.

One can nevertheless find something positive here: nowhere else in France is there as great a variety of traditional beers, of every conceivable taste and ranging in color from rich brown to amber, blond, and white. Not surprisingly, beer is the perfect accompaniment to the hearty local cuisine, whether one of the many forms of herring, a Flemish hotpot (*hochepot flamand)*, or a pungent Maroilles, "the most delicate of strong cheeses." A by-product of beer production, brewer's yeast, also contributes to the character of the pastries, many of which use raised doughs, such as the light and airy Flemish-style waffles (*gaufres flamandes)* or briochelike cakes with names like *craquelin*, *cramique*, or *couquebottrom.*

Traditional ceramic terrine for *Alsatian Hasepfeffer* (*civet de lièvre*). Poterie artisanale Gérard Wehrling, Soufflenheim, Alsace (France), 1998. Rack of hare is baked in wine and gingerbread crumbs in this elaborate earthenware vessel, which also doubles as a serving dish. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

The North is also the largest sugar-producing region of France. It has been ever since the British navy imposed the Continental blockade at the beginning of the nineteenth century, depriving France of cane sugar from its overseas colonies and prompting Napoleon to reward anyone who could apply a newly-discovered technique for producing sugar from beets on a commercial scale. The North quickly became a center of production of the precious commodity, and it is surely no coincidence that this is the only region where people use brown sugar (called *vergeoise* here), not only in desserts like the sumptuous sugar tart (*tarte au sucre)* with its light or dark brown-sugar filling, but in savory dishes prepared *à la flamande*, including the local blood sausage (*boudin)*, sweet-sour red cabbage *(chou rouge)*, and beef stewed in beer *(carbonade)*.

Foie Gras and Sauerkraut

Like the ties between French Flanders and Belgium, Alsace, in the northeasternmost corner of France, shares many traits with Germany, its neighbor across the Rhine. Up until the treaty of Westphalia in the mid-seventeenth century, both Alsace and adjoining Lorraine were part of Germany. In the course of ensuing wars, they went back and forth between France and Germany until the end of World War II. As a result, trade with Germany has long been an important source of income for this region, as has tourism, which has increased in the course of time.

In this land of lager beers, *bretzels* (pretzels), and sausages—where white wines have names like Edelzwicker, Sylvaner, Riesling, and Gewürztraminer—Alsatian culture at first seems purely Germanic. Fat white Alsatian asparagus, which originated in Germany, is a springtime favorite served with slices of smoked ham and Alsatian Riesling. Even mustard is different here. Unlike the sharp Dijon-style mustard preferred elsewhere in France, the white mustard seeds used in Alsace result in a truly sweet mustard that reigns on virtually every table, as in Germany. The celebration of Saint Nicholas Day (6 December) is as important as Christmas in both places. In Alsace, it provides the occasion for making gingerbread effigies of the good bishop and *Mannala* (little man), a doll-shaped cookie associated exclusively with this day.

Not everything in Alsace has a German origin, however, and Alsatians proudly assert their differences with their imposing neighbor to the east. Not only are their wines and beers lighter, but a specific repertoire of dishes and a French penchant for fine gastronomy all distinguish them from their German cousins. A favorite Alsatian specialty that does not seem to have a German equivalent is *Bäckeoffe*, made by marinating beef, pork, and lamb in white wine and baking them slowly for several hours with sliced potatoes and onions in a special earthenware terrine. Even sauerkraut is prepared so differently here—braised in Alsatian white wine with smoked, salted, and fresh cuts of pork and served with additional Strasbourg sausages and liver dumplings—that Germans cross the river in droves to enjoy *choucroute à l'alsacienne* as a special treat.

The great cheese of Alsace is Muenster, a French-style soft, creamy cheese, albeit served with a decidedly un-French accompaniment of caraway seeds (called *cumin* here). Alsace is also the home of *foie gras*, a quintessentially French specialty that, curiously enough, appears to have been introduced by the large Jewish population that settled here. Over the centuries, the Jews perfected the art of force-feeding geese to increase the quantity of fat, to be used for cooking since pork fat was prohibited by their religion. The enlarged, buttery livers or *foie gras*, a by-product of this operation, had become a highly sought-after specialty by the eighteenth century. Unlike southwestern France (the site of Jewish immigration from Spain), where *foie gras* is most often baked simply in a terrine, the livers are traditionally baked in a pastry shell in Alsace.

Baba and Quiche

The Germanic influence is much less evident in neighboring Lorraine, where specialties more closely resemble those encountered elsewhere in France. One could name the *potée lorraine*, a poached salt pork and vegetable dinner very similar to the ubiquitous beef-based *pot-au-feu*, the *macarons* from Nancy, or the *madeleines* from Commercy. Another product specific to Lorraine, and the emblem of the region, is the *mirabelle*, a small yellow plum that is enjoyed eaten on its own, distilled to produce an aromatic brandy, made into preserves, or baked into a tart.

Lorraine is also the home of one the best known specialties in all of France—*quiche*. Mentioned as early as the sixteenth century and initially made with a simple filling of eggs and cream, it was prepared only in the region until the nineteenth century, then started to spread to the rest of country. Today the word, and the pastry, can be found around the world with a bacon-studded filling, an early-twentieth-century variant on the original, meatless filling rarely encountered today.

Like French Flanders and Alsace, Lorraine is beer-drinking country, where many pastries are made with egg- and yeast-rich doughs. The most famous of these is the *baba*, a light, raised cake with raisins. It is derived from a cake of the same name that was introduced in the eighteenth century by the exiled Polish king, Stanislas Leszczynsky, whose daughter, Marie, married King Louis XV of France. As Duke of Lorraine, Stanislas held court in Nancy, where local bakers adopted and perfected the baba. By the beginning of the nineteenth century, its fame had spread to Paris, where a pastry chef named Stohrer (whom many believe was from Lorraine) added the final touch of making individual babas and dousing them with rum.

Smoked Meats and Hefty Cheeses

Directly south of Lorraine is the mountainous region of Franche-Comté, sandwiched between Switzerland and Burgundy. It is a land of hilly, green pastures that produce some of the finest cheeses and meat products in all of France as well as some of the country's most unusual wines. The mountain cheeses, made from the milk of the local Montbéliard cow, range from the creamy *vacherin* of the Mont-d'or, encircled with a strip of spruce wood, to large, hard-pressed wheels of *comté*, the French version of gruyere. Every bit as fruity as its more familiar Swiss cousin, *comté* improves with age. Another cheese peculiar to the region is *cancoillotte*, made in the valleys. After skimming off all the cream to make butter, the milk is allowed to curdle naturally, the curds are dried, and the resulting *metton*, as it is called, is broken up and aged until it has become yellow and waxy. To make *cancoillotte*, a piece of *metton* is melted with butter and water and seasoned with garlic or caraway. Definitely an acquired taste, the creamy, pungent *cancoillotte* is a favorite local topping for baked or steamed potatoes, or scrambled eggs.

Unlike their treatment in most of France, meat products are traditionally smoked here, rather than simply salted and dried. This preference is related to the structure of the typical farmhouse of the area, built around a large central chimney called a *tuyé*. The ham from the Haut-Doubs, the sausages from the towns of Morteau and Montbéliard, and an unusual smoked beef tenderloin known as *bresi*—to name only these few—are among the finest *charcuterie* in France.

As for the wines, the most striking are the whites, made with a local grape variety, the *savagnin*. Their almost sherrylike taste is surprising at first but perfect with the *charcuterie*, cheeses, and cream-based dishes from the region, especially those garnished with morel and chanterelle mushrooms from the Jura mountains. The most astonishing is the "yellow wine" (*vin jaune*) produced near the village of Château Chalon. Always served at room temperature, it can be aged for up to a hundred years, and its particular fruit and walnut flavors are unique.

Snails, Wine, and Aperitifs

To the west of Franche-Comté lies Burgundy. The most famous dish associated with the region, *boeuf bourguignon*, combines wine and beef, two of Burgundy's most valued resources. Though wine comes immediately to mind when Burgundy is mentioned, there are few vineyards in the southern part of the region where equally famous white cattle are raised on small farms near the town of Charolles. A very large breed with tender, lean meat especially well suited to grilling and roasting, Charolais beef has few rivals in France, and the breed is now raised in some seventy countries worldwide.

Driving north on the road back toward Paris, one sees multicolored tiles covering rooftops in the valley that runs through some of France's most prestigious vineyards. There are virtually no imposing estates here, and the wines take their names from the towns, the most famous of which lie along the stretch of the N7 highway between Chalon-sur-Saône and Dijon: Chassagne-Montrachet, Meursault, Pommard, Aloxe-Corton, Vosne-Romanée, Vougeot. . . . Producers live in simple farmhouses and tend small plots of land, so one must know the names of the specific growers whose style one prefers. Production is small compared to Bordeaux and prices are, on the whole, higher.

For many, the food most associated with Burgundy is snails, once plentiful in the vineyards. Naturally, if they were not gathered, they feasted upon the precious grapes—a sort of eat-or-be-eaten situation. Burgundians long ago chose the first option, consuming them with such gusto that the local snail is now an endangered species that can be gathered for personal use, but not marketed. The large Burgundian snail (*Helix pomatia*) is harder to raise than its southern cousin the *petit gris* (*Helix aspersa*), so the majority of the *escargots de Bourgogne* sold in France are shipped alive to Burgundy from such faraway places as Turkey, where they are still plentiful in the wild and do not fit into the national diet.

In the upper end of the region, Dijon is famous for several specialties. *Moutarde de Dijon* has been renowned throughout France since the thirteenth century and is an indispensable item in French kitchens. The hot, tangy mustard enters into the *vinaigrette* salad dressing familiar to all, or into sauces of all kinds (particularly those for rabbit and pork), or is served alone to accompany a wide variety of dishes: grilled meats, the homey boiled-beef dinner or *pot-au-feu*, and even French fries, dipped into the mustard pot for an extra "zing."

Pain d'épice, a honey-rich gingerbread loaf, can be bought in shops throughout the city. Often eaten casually in the course of the day, Dijon's *pain d'épice* differs from others in that it is always made with wheat flour rather than rye, more popular in the rest of the country.

Crème de cassis, a lightly alcoholic, sweet black-currant liqueur produced in Dijon since at least the eighteenth century, can be sipped on its own, or added to a glass of dry white wine (traditionally from the aligoté grape). It was in this latter form that it became enormously popular starting in the 1950s, when the mayor of Dijon routinely served the mixture at public events. As a result, it is now known by his name—Kir—and served as an *aperitif* throughout France.

Pigs' trotters and . . . Champagne!

Given the celebrity of its wine, whose bubbles are synonymous with elegance, one might believe that Champagne, directly north of Burgundy, is a region with a highly sophisticated cuisine. Nothing could be much further from the truth. Although the *pain d'épice* of Reims, the wine capital, has been famous for centuries and the pink ladyfingers made there (*biscuit de Reims)* are the ultimate in refinement, for the most part the cuisine of Champagne is hearty country fare. Particularly well-known is the *charcuterie* of Troyes, most notably the *andouillette*, a tripe sausage served either grilled with mustard or baked with a cream-shallot-mustard sauce. Other regional favorites include the boiled-vegetable and salt-pork *potée champeoise*, and *salade au lard*, a deceptively simple dandelion salad that has become the subject of such hot debate that a local historian wrote a 150-page book comparing the merits of different versions: Should the dandelion greens be cut or left whole? Should the bacon be fatty or lean, smoked or just salted? Should the potatoes be cooked in their skins or peeled? And so forth.

Another humble but delicious specialty from Champagne is grilled pigs' trotters *à la Sainte-Menehould*, delightfully creamy inside and crisp on the outside. Named for the town in which they have been served for over three hundred years, the trotters are simmered for up to fifty hours in an aromatic stock, then breaded, broiled, and eaten—bones and all.

Champagne also shares one very prestigious product with the Île-de-France, the region surrounding Paris immediately to the west. For hundreds of years, the northern half of Brie country belonged to the province of Champagne, with its capital at Meaux. The cheeses from the area have been famous since the fifteenth century, and when made with unpasteurized whole milk, *brie de Meaux* is still among the finest cheeses in France. After the French Revolution, however, Meaux was incorporated into the newly created *département* of the Seine-et-Marne, with its capital at Melun, which was (and still is) part of the Île-de-France. This, of course, did not stop farmers in the Marne *département*, to the east of the new administrative line, from continuing to make "Brie de Meaux" as they had for centuries. In 1980, when the coveted *appellation contrôlée* (Denomination of Protected Origin) status was awarded to the cheese, this fact was taken into account. To this day, a small proportion of the mammoth wheels of Brie that can be seen in Parisian cheese shops come from Champagne.

Feeding Paris

Along with cheeses from Brie, until very recently the Île-de-France could count on the farmland encircling Paris to come close to meeting the needs of the capital in fruits and vegetables. With the spread of suburbs since the 1960s, virtually all of the orchards and vegetable gardens have disappeared. The peaches from Montreuil and the succulent grapes from Thomery (trained against a labyrinth of sun-heated walls near Paris in order to ripen on all sides) are now a thing of the past, as are the mountains of fat white asparagus from Argenteuil that were once served at the finest tables. Nevertheless, although the great majority of the once-famous fruits and vegetables developed in the Île-de-France are now produced outside of the region, their names remain, reminding us of the past glory of the cherries from Montmorency, the *champignons de Paris* (button mushrooms first cultivated in the limestone quarries that tunnel under Paris), or the delicate, pale-green dried beans *(flagéolets)* from Chevrier.

All of this legendary produce, as well as the finest fish and meat from all around France, was sold for centuries at the equally legendary central wholesale market, les Halles, until 1969, when the demands of a constantly growing population and the paralyzing traffic jams it caused forced it outside of Paris, to Rungis. Nevertheless, the bistros that grew up around les Halles still thrive and continue to serve quintessentially Parisian dishes like steaming onion soup *(gratinée)*, calf's head *(tête de veau)* with a tangy vinaigrette or highly seasoned mayonnaise *(sauce gribiche)*, or the exquisitely simple but refined *boeuf à la ficelle*, beef tenderloin tied to a string, dipped for only minutes in an aromatic vegetable bouillon, served rare with the vegetables, and accompanied by coarse salt, mustard, and pickles or, for an even more refined presentation, by béarnaise sauce.

In the past, much of the produce that arrived in les Halles came from Picardy, directly north of the Île-de-France and sandwiched between Champagne on the east, Flanders on the north, and the English Channel and Normandy on the west. A rich agricultural province, Picardy's main city, Amiens, is only 137 kilometers (85 miles) from Nôtre-Dame. Parisian connoisseurs could order excellent lamb from Beauvais, duck pâtés *(pâté de canard)* from Amiens, eels baked in pastry *(pâté d'anguille)* from Abbeville in the north, and a wide variety of vegetables long before the existence of modern transportation. Artichokes from Laon, beans from Soissons, peas, and even potatoes were once important "exports," although today they can hardly compete with the same products shipped by train or truck from all over France. The small, moist macaroons from Amiens have been famous for well over a century, and few cakes can match the lightness of the Picard *gâteau battu*, a tall, fluted *brioche* shaped like a chef's hat.

Camembert and Calvados

To the west of Picardy, green pastures and half-timbered houses welcome you to Normandy. A land long famous for the quality of its butter and cream, Normandy is also a land of great cheeses, and the little town of Camembert can lay claim to producing what is arguably the most famous cheese in the entire country. Curiously, most people don't know that Camembert is a relatively recent invention, as cheeses go. Dating back to the eighteenth century, it is said to be a variant of Brie, and its popularity dates only from the nineteenth century, when railways made it possible to ship the cheese to distant markets. An authentic Camembert is made from unpasteurized whole milk and aged until its white crust is streaked with rust-colored stripes.

Those who associate Norman cooking with butter and cream are often surprised when they encounter another specialty—*tripes à la mode de Caen*. One of the gastronomic glories of the region, the tripe is simmered for hours with carrots, onions, and condiments before a dash of calvados is added as a finishing touch. Made by distilling apple cider (apples are another product indissociable from Normandy), calvados is a popular digestive brandy (*digestif*) both in and outside the region. It is as common as (and generally cheaper than) cognac, although the finest old calvados can equal its more famous rival in both taste and price.

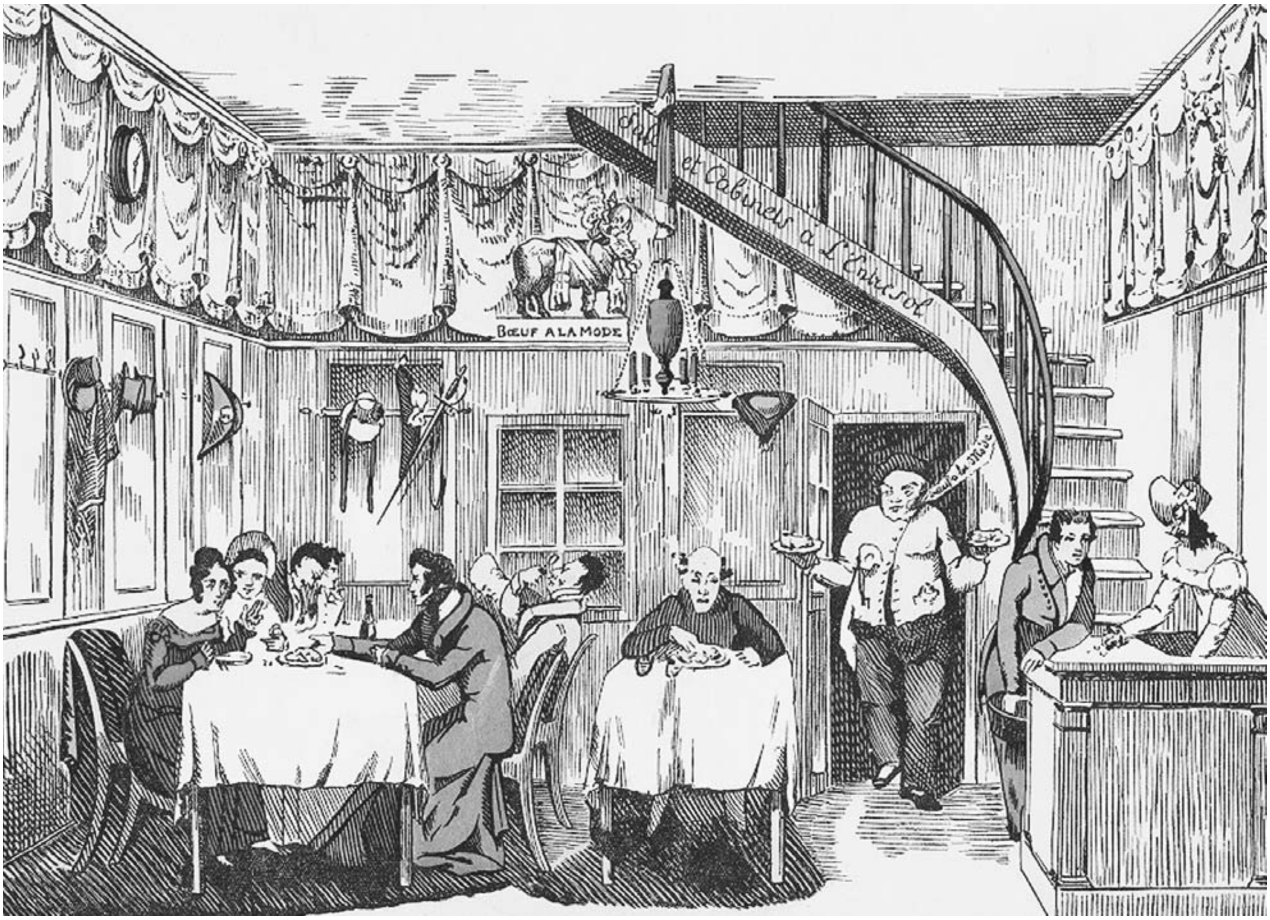
Another unusual Norman specialty is duck—not just any duck, but a special breed developed in Rouen and slaughtered by suffocation so that blood remains inside. Only this duck should be used when preparing *canard à la Rouennaise*. Young and tender, it is cooked and served in a complex manner—which involves crushing the carcass in a specially designed silver press to recover the blood and juices for the making of a sumptuous sauce.

In addition, the Normandy seacoast is historically the site of intense fishing, and many ports are associated with specific fish. Fécamp, for example, was once an important center for the fish-curing industry. Inexpensive and nonperishable, salt cod and herring were in centuries past a staple throughout Europe, particularly sought-after during Lent when meat and poultry were banned. The curing industry has now vanished, but the fresh fish remain. Other ports are known for other specialties: particularly prized are the sole from Dieppe, the shrimp and lobsters from Cherbourg, and the oysters from Etretat and Granville.

Castles in France

As one travels south toward Orléans and the Loire valley, the culinary landscape changes. After the flat, wheat-growing plains of the Beauce around Chartres, game becomes plentiful, eel stewed in red wine is a popular dish, and white asparagus is abundant every spring. In Orléans, one can sample a delicious quince paste called *cotignac*, already famous in the sixteenth century, and the vinegar made in the city is considered the best in France. Some 37 kilometers (23 miles) south of Orléans lies Lamotte-Beuvron, the birthplace of one France's favorite desserts. It was here, in the modest Tatin hotel run by two sisters, that the famous *tarte tatin*, a rich and buttery caramelized apple tart baked upside down, is said to have been invented.

Nestled in the gentle hills along the Loire River from Orléans to Tours are the extraordinary châteaus built by the kings and high nobles of France. Rabelais was a native son of Chinon, and his love of good food is no wonder in this idyllic region of excellent lamb and poultry, fruity and delicate goat cheeses from Chavignol, Sainte-Maure, and Valençay, and wonderful pork products, among which the *rillettes de Tours*, a creamy, spreadable pâté, has no equal. Not to mention the local wines—light,



One of the oldest restaurants in Paris was the Boeuf à la Mode, which opened in 1792. Shown here is a detail from one of the restaurant's menus in 1919. The scene is intended to evoke an image of the restaurant in its heyday. ROUGHWOOD COLLECTION.

elegant reds from Chinon, Anjou, and Bourgueil, and lively whites from Vouvray, Pouilly, Quincy, and Sancerre—which are the perfect companion to these and other delicacies of the region.

A bit farther back from the river, caves hollowed out of the chalky hillsides are used for growing button mushrooms, and as one wends one's way westward, the lambs are joined by cattle; the Pays-de-la-Loire is the largest beef-producing region of France, providing 20 percent of the total production. Poultry is first-rate, especially in the *département* of the Sarthe, where the capon *(chapon)* from Le Mans has been famous since the sixteenth century.

Bagpipes and Butter Cakes

Proceeding west, one enters the Breton peninsula, which extends far out into the Atlantic, measuring about 150 kilometers (about 95 miles) from north to south at its widest point, but only half that at its tip. It is a province inhabited by one of France's most independent-minded peoples, who have long fought to preserve their traditional language and culture, descended as they are from the Celts who fled here from Great Britain during the invasion of the Angles and Saxons starting in the fifth century. Not only are the Bretons trying to preserve their Celtic language, but they celebrate holidays and festive occasions to the sound of bagpipes, as do their Celtic cousins in the British Isles. A separatist movement would like to see this province secede from France, but most Bretons consider themselves thoroughly French and are proud to be so.

Contrary to most of France, virtually no cheese is produced here. The Bretons churn virtually all of their cream into butter which, unlike that made elsewhere in France, is preferred salted. The importance of butter is nowhere better appreciated than in the local pastries, whether in the form of cookies like the paper-thin *galettes* or the crumbly, shortbread-like *palets*, the *gâteau breton* (a sort of cake-sized *palet)*, or the inimitable *kouign-amann* (literally, "butter cake"), in which butter and sugar are rolled and folded together in a bread dough that is baked until caramelized. Although cider is the main beverage, this is also the only French province where buttermilk *(lait ribot)* is drunk, more often than not with savory buckwheat pancakes (*galettes de blé noir*) or sweet wheaten *crêpes*, both spread out to an almost transparent thinness.

Given Brittany's extensive coastline, it is no surprise that the Bretons are a legendary seafaring people. From the sixteenth century onward, countless ships have set out from Nantes, Brest, and Saint-Malo, sailing thousands of miles to fish the great cod banks of Newfoundland. Sardines and mackerel are also plentiful, and, as in Normandy, the salt-cod trade once made towns like Saint-Malo the center of constant activity. Brittany is also a favorite vacation spot for those who wish to escape the crowded beaches in the south of France. Vacationers feast on seafood, particularly shellfish; most notable are lobsters, virtually absent from every other French coast and considered superior to the American variety that lives on the other side of the Atlantic.

Benefiting more than any other part of France from the Gulf Stream, the province has for centuries been renowned for the quality of its fruits and vegetables. In recent years, it has literally been transformed by industrious farmers growing cauliflower, strawberries, and even tomatoes. One vegetable that is especially associated with the region's agriculture is the globe artichoke. Despite competition in recent years from the purple artichoke grown in Spain and southern France, Breton artichokes are still highly sought-after, and plentiful, in markets throughout the country from June to October.

Northern Riches

Living in the most populated and by far the most industrial part of the country, few inhabitants of the northern half of France have suffered the hardships of those living in the most desolate parts of the south. Farmers in the north have benefited most from the presence of Paris in its center, since the French capital has always been a vast market for goods produced here. The extensive seacoast has been the source of a thriving fishing industry from the Middle Ages until today. Northern France is a patchwork of cultures where beer and cider can be more important than wine, not only on the table but in the dishes as well, although butter and cream are universally employed here. From the rugged, foggy coasts of Brittany to the green, low-lying mountains of the Franche-Comté, this gentle France is a far cry from the sun-baked fields, the olive trees, and the snowy heights of the Pyrenees and Alps only a few hundred miles to the south.

See also **Cheese**; **Germany, Austria, Switzerland**; **Italy**; **Mustard**; **Wine**.

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SOUTHERN FRENCH CUISINES

Broadly speaking, southern France extends southward from the Loire River to the Mediterranean, and eastward from the Atlantic coast to the Alps along an imaginary line running from Nantes to Geneva. Numerous cultures and cuisines coexist in this vast area. Walnut oil and goose fat in the southwest give way to olive oil along the Mediterranean coast which, in turn, yields to butter in the foothills of the Alps.

Most of southern France is covered with grape vines but the wines they produce differ greatly from one another. South and east of the prestigious Bordeaux châteaus lie the vineyards that produce the earthy reds of Madiran and Cahors. Along the Mediterranean seacoast, the lighter reds and whites of Languedoc-Roussillon blend into the rosés of Provence. At their juncture, the Rhône Valley runs north, with full-bodied wines that range from the rich reds of Châteauneuf-du-Pape and Hermitage to the flowery white Condrieu, a far cry from the crisp white wines of Savoy, nestled in the Alps.

Although Bordeaux on the Atlantic seaboard, Toulouse in the southwest, Marseilles in the south, and Lyons in the northern Rhone Valley all function as regional capitals in southern France, none of them acts as a center for concentrating wealth and stimulating production as Paris does in the north. On the whole, the south is more varied from both a physical and culinary point of view.

Of Oysters and Mussels and Goat Cheese Cakes

Proceeding southward along the Atlantic coast from Nantes to Bordeaux by way of La Rochelle, one encounters two provinces rarely visited by the casual tourist: Poitou and Saintonge. Grouped together into the administrative region of Poitou-Charentes, this is a transition area that shares some aspects with the north of France and some with the south. One of the most famous butters in all of France, *beurre d'Echiré*, is produced here and butter-based dishes are common, though they in no way resemble those made in Brittany or Normandy. One of the most popular is *embeurré de choux*, literally "buttered cabbage," made by crushing boiled cabbage with a fork, then stirring in a healthy amount of fresh butter. Steamed new potatoes from the Île de Ré, served with butter and sprinkled with the sea salt (*fleur de sel*) also produced on this island off La Rochelle, are another treat far more sumptuous than the simplicity of the preparation would lead one to imagine. And the local goat cheese, called *cabichou*, although delicious on its own, is also turned into desserts, whether the tartlike *fromageau* or the astonishing *tourteau fromagé*, with its jet black, rounded top and light, moist inside.

Curiously enough, the food most frequently associated with the Charentes is the snail, so much so that people here are called *les cagouilles* (snails). They like their snails—not the large Burgundian snail but the smaller, southwestern *petit gris*—grilled over an open fire or simmered in red wine. Mussels, too, are popular, particularly when transformed into *mouclade*, that is, opened over the heat with a little white wine, then finished with cream (and occasionally a pinch of curry powder!). Oysters from the Arcachon basin (*huîtres de Marennes*), both sought after and plentiful, are preferred raw on the half-shell here with an accompaniment of grilled sausages and a glass of white wine.

From Lamprey Eels to Foie Gras

South of the Charentes is Bordeaux. The wine capital of France, this city is also a major port with numerous links to the sea. Given its location on the estuary of the Gironde River, it is perhaps not surprising that the most emblematic fish of the region are estuary fish: shad, lamprey eel, and sturgeon. The first two swim in from the sea and up the Gironde in the spring and are highly prized by local gourmets who relish grilled shad with a sorrel sauce (*alose à l'oseille*) and prefer their lampreys in a red wine sauce thickened with the fish's own blood (*lamproie à la bordelaise*). In centuries past, however, the sturgeon was the king of fish, not only around Bordeaux but on aristocratic tables throughout France, where it reigned supreme until the end of the sixteenth century. By the end of the nineteenth century, however, the French had also discovered the joys of caviar, which so decimated the wild Atlantic sturgeon population that, since 1982, its fishing has been banned. In recent years, however, a slightly smaller species has been successfully farmed, permitting the curious to once again sample sturgeon and caviar from the Gironde.

South of Bordeaux a once treeless expanse known as the Landes stretches down the coast almost to Spain. Planted with pines over a century ago, it is still sparsely populated but attracts tourists in search of a pleasant beachfront with inexpensive holiday accommodations. In the Landes, and extending inland for many miles, geese and ducks have brought fortune and fame to farmers for centuries. Force-fed until their livers swell to enormous size, they are then sacrificed, producing *foie gras*, a luxury product highly sought after both in and outside the region.

Although *foie gras* is indisputably a French specialty today, it was probably introduced into the southwest by Spanish Jews fleeing religious persecution in the seventeenth century. They had perfected the art of force-feeding geese as a means of obtaining a ready supply of cooking fat (pork fat being prohibited by their religion), much as northern European Jews introduced *foie gras* into Alsace (see Northern French Cuisines). Today, goose *foie gras* is produced on a very small scale, but fattened duck livers are a major cottage industry. Easier to handle than geese and demanding a much shorter fattening period, the plump ducks also provide locals with two other highly prized specialties: duck steaks (*magret de canard*) and preserved duck (*confit de canard*). The thick steaks, made from the meaty breasts of the fattened ducks, started becoming popular in the 1970s when local restaurateurs began putting them on their menu. Previously they were salted, then simmered in a cauldron of fat until completely tender, like the rest of the bird, to make *confit*, which could be kept for several months packed in their cooking fat in large stoneware jars. Today, this ancient technique is carried one step further, and the *confit* is subject to a second preserving process by being sterilized and canned. Jars of *confit* can be kept on a kitchen shelf for many more months than the traditional preserve and are sold at roadside stands all year round.

Legs of lamb rubbed with Provençal herbs (among them, French lavender) roast slowly beside a fire at the Bistro des Alpilles in St. Remy-de-Provence, France. © OWEN FRANKEN/CORBIS.

The area northeast of the Landes, Périgord, produces perhaps the most expensive delicacy in all of France: black truffles. Specially trained dogs and pigs smell their location in the ground since, to this day, no one has found a way to successfully cultivate the elusive subterranean mushrooms, which explains their high price and scarcity even in France. Thinly sliced and barely warmed, truffles can be used to garnish many dishes. They are frequently served with *foie gras* or poultry although many people maintain that they are best with very simple foods—steamed potatoes with butter and salt, or creamy scrambled eggs, for example—or on their own, wrapped in waxed paper and buried in the embers until the truffle has been warmed through.

Although truffles are in season from December to March, they are in such high demand during the holiday season that patient gourmets wait to purchase them until after 15 January when prices drop to more "reasonable" levels. Like *foie gras*, canned truffles also form a lucrative part of the preserving industry, but neither of these exceptional foods survives the canning process unscathed. Though they are exported in this form around the world, they are in no way comparable to their fresh counterparts, which are rarely available outside of France.

Nations within a Nation: The Basque Country and French Catalonia

Although only 500 miles (800 kilometers) separate the Atlantic Ocean from the Mediterranean Sea, the culinary traditions that straddle the Pyrenees Mountains along these two seaboards are as different from each other as the people who created them. On the Atlantic coast is the Basque country that extends roughly from Bayonne to Bilbao. Much like the Bretons in the North, the fiercely nationalistic Basques have long demanded independence from both France and Spain and struggle to keep their native customs and unique language alive on both sides of the mountains. They are proud of their "differentness," which is reflected in their cuisine. Unlike almost any other in France, Basque cookery is marked by a preference for spicy tastes. A special variety of chili pepper grown near the town of Espelette is particularly sought after and used in preparing *piperade*, a spicy tomato stew, most often stirred into scrambled eggs and garnished with a slice of Bayonne ham, or served next to the ham with a fried egg on top. Inveterate fishermen, the Basques were among the first to exploit the great cod banks of Newfoundland in the sixteenth century, and their love of fish is expressed in dishes like *ttoro*, a fish stew, stuffed squid (*encornets farcis*), or sweet red *piquillo* peppers stuffed with a creamy codfish purée. Irouleguy wine is a perfect accompaniment to all these delicacies, unless one prefers to taste the local sparkling cider (*sagarnoa* in Basque), another specialty of this most remarkable corner of France. And to finish the meal in a typically unusual way, Basques like to serve their famous Ossau-Iraty sheep's cheese (*fromage de brebis des Pyrénées*), with orange marmalade or black cherry jam from the village of Itxassou and a glass of sweet Jurançon wine from the neighboring Béarn region just to the east.

Another product that arrived from the Americas four centuries ago and took hold in the traditional cuisines of the French southwest along with the chili pepper and its relatives is corn (maize). Originally a replacement for the once popular millet, ground cornmeal is used principally to make a bread (*pain de maïs* or *mesture*), and a thick porridge known variously as *cruchade*, *escauton*, or *millas*, eaten hot as a garnish with any number of stews or allowed to cool, cut into slices, pan fried in butter, and sprinkled with sugar for dessert. Cornmeal quickly became a staple in the peasant diet, and the grain had the added advantage of fattening both ducks and geese much more efficiently than native European cereals.

At the other end of the Pyrenees facing the Mediterranean is another community that takes great pains to preserve its proud traditions. Catalonia, a powerful nation during the Middle Ages, straddles the border between France and Spain, roughly from Perpignan to Tortosa, south of Barcelona on the Costa Brava. The Catalan language is still spoken on both sides of the Pyrenees, and Catalan nationalists have long argued that the two provinces should be united again to make an independent border state. Much of Catalonia hugs the Mediterranean and it comes as no surprise to find that the people excel in preparing seafood dishes of all kinds, among which are the *bullinada* (a fish soup similar to bouillabaisse), the *llagostada* made with spiny lobster (*langouste*), or the *pinyata* from Collioure, which includes everything from octopus, shellfish, and eels to red mullet cooked in a tomato sauce. Fresh anchovies, sardines, and tuna are also used to create many a Catalan dish but for centuries, the tiny village of Collioure, nestled near the Spanish border between the foot of the Pyrenees and the Mediterranean sea, has made a specialty of salting them. Used as condiments, or eaten alone, the salted anchovies (*anchois de Collioure*) are especially esteemed and used extensively in Catalan cooking. Unfortunately, they have become a rarity, and canned or salted anchovies from North Africa tend to take their place.

Fish are not the only strong point of Catalan cooking. It also boasts a wide range of pork products including an air-dried prosciutto-like ham called *gambajo*, and sausages (*embotits*) of all kinds that fall generally into two categories: *boutifarra*, or blood sausages, and *llonganissa*, long pork sausages that can be either fresh (*fresca*) or dried (*seca*). And no meal would be truly complete without *touron*, the multifaceted Catalan sweet that can be anything from white and creamy to crunchy and dark (with lots of almonds or pistachios), or a glass of one of the naturally sweet wines from Rivesaltes and Banyuls, either at the start of the meal or to accompany dessert.

Cassoulet, Clafoutis, and Cantal

North of the Pyrenees and east of the Landes is a vast expanse that continues the southwestern traditions of *foie gras* and *confit*, and where a third American "immigrant," the white kidney bean, has become the basis of yet another emblematic preparation, *cassoulet*, traditionally cooked and served in a large earthenware bowl known as a *cassole*—hence its name. As with most legendary dishes, the number of recipes is countless, but two towns claim to have invented it: Castelnaudary, where the beans are cooked only with pork products, and Toulouse, where lamb is added. Both include at least one kind of sausage and generally duck or goose *confit* as well. Although most people consider that the original *cassoulet* was that of Castelnaudary, each has its partisans who religiously defend their local version as the only "authentic" one.

Extending north of Toulouse, toward Limoges, are some of the finest orchards in France, producing the inimitable, plump prunes (*pruneaux*) of Agen, the sweet white grapes (*chasselas*) and greengage plums (*prunes Reine claude*) of Moissac, and the walnuts and melons of Quercy.

And although the Limousin has long been one of the most destitute regions in the entire country, it can nevertheless lay claim to producing not only some of the finest china in the world but beef, veal, lamb, and pork that are among the best in all of France. In centuries past, the impoverished peasants lived principally on a diet of chestnuts and a large variety of turnip called the *rave du Limousin*, one of the vegetables that is still a must in a true *potée limousine*, a one-pot boiled salt-pork and vegetable dinner. Another essential *potée* ingredient is the *mique* or *farcidure*, a dumpling (either plain or flavored with various leaf vegetables or herbs) originally made of millet flour, then corn flour, but more often today with wheat flour, which has become more widely available in the last half century or so. And no *potée limousine* would be complete without its accompaniment of *moutarde violette*, purple mustard from Brive-la-Gaillarde, which gets its color from the grape must with which it is still made.

By far the most famous of the specialties from this region is *clafoutis*, a Limousine cherry flan that has become a favorite all over France. But beware! In order to preserve the intense flavor of the black cherries and keep them from losing their juice, the people of the Limousin are adamant that the fruits must be baked with their pits!

To the east of the Limousin, in a vast, mountainous area called the Massif Central, lies the Auvergne, another very poor region where the peasants once survived on a diet of chestnuts, dairy products, and black rye bread baked into mammoth, round loaves. Nevertheless, it is a region that can be proud of its gastronomic heritage. Clermont-Ferrand has been famous for its fruit jellies (*pâtes de fruit*) since the sixteenth century, especially those made with apricots that were unequalled even in Paris, according to one early traveler. The sausages and hams made from chestnut-fed pigs and dried in the cool mountain air are sought after nationwide, as are the tiny green lentils from Le-Puy-en-Velay, considered to be distinctive enough to have been awarded the coveted AOC status (*Appellation d'origine contrôlée*) usually reserved for fine wines and cheeses. The *lentilles vertes du Puy* were so famous by the end of the eighteenth century that they were not only shipped all over southern France but as far as Italy, Spain, and Portugal.

Nevertheless, Auvergne's claim to fame, as well as that of the neighboring Rouergue, immediately to the south, is undoubtedly the quality of its cheeses. Most of them are made from cow's milk; among them are bleu d'Auvergne, tender Saint Nectaire, and Cantal, a large, thick cylindrical cheese whose taste ranges from buttery to pungent, depending on its age. When very young, it is used in cooking, often with potatoes in dishes like the crusty *truffade* or the creamy *aligot* that, when properly made, forms a rope when the spoon is lifted out of the pot and must be cut with scissors to be served!

Cantal is made over a large area, with famous variants from Salers in the Auvergne, made from the milk of mahogany-colored cows of the same name, and from Laguiole (pronounced lye-ole), made from the milk of the Aubrac breed of cow in the area around Rodez in the Aveyron *département.* But the most celebrated cheese of this area is made from ewe's milk in and around the little town of Roquefort-sur-Soulzon near Millau, southeast of Rodez. In the course of fermentation, the cheese is strewn with crumbs of moldy rye bread, creating the greenish-blue pockets that give Roquefort cheese its distinctive look and taste.

When asked why French cooking tastes the way it does, most chefs will reply "it's the butter." French butter is world renowned and the farmhouse butter from Brittany, shown here, is among the best. © MICHELLE GARRETT/CORBIS.

Olives, Olive Oil, and Honey

Continuing south from Roquefort toward the Mediterranean coast, one passes through almond, apricot, and peach orchards, leaving the domain of lard, goose fat, and walnut oil and entering the realm where the olive reigns supreme. All along the crescent that forms the French Mediterranean coast, olive trees abound. Introduced by the Greeks, olives and olive oil have had a checkered history in Languedoc and Provence. Although the best oil

In an effort to reaffirm regional food identities, village fairs are cropping up all over France. This Renaissance fair at Salon-de-Provence features a rich variety of local pastries as well as reconstructions of Renaissance dishes. © Gail Mooney/CORBIS.

has always been a valuable export, in the not so distant past, inferior oil was burned in oil lamps. Even to this day, a green soap known as *Savon de Marseilles* is made from low-grade oils of the region.

Gastronomically speaking, the olives and olive oils of southern France are as varied as wines, as are their uses. At the western end, the inhabitants of Languedoc-Roussillon are partial to the slender, delicate green *picholine* and the darker green, crescent-shaped *lucque* with its almost lemony flavor; in the east, although the wrinkled brown olives from Nyons, in the southern Rhône Valley, have gained national renown, the people from Nice remain faithful to the tiny black olives produced in the hills rising up behind that city's famous pebble beaches. In between, the number of varieties and the ways of preparing them are countless, as are the flavors of black or green *tapenade*, an olive paste spread on toast as an appetizer.

Among the oils of southern France, those made in the Valley of Baux-de-Provence north of Arles, in Aix-en-Provence, in Nyons, and in Nice are the most sought after today. However, because oils can vary widely in taste depending on the variety of olive used and whether the fruits are pressed green or ripe, it is best to sample as many as possible since some go best with steamed vegetables, others with fish, and yet others are better adapted to making sauces, according to personal taste. In this part of the country, not only is olive oil ubiquitous in the preparation of savory dishes, it even enters into traditional pastries such as the *fougassette*, *pompe à l'huile*, or *gibassié*, an enriched hearth bread lightly flavored with orange-flower water that is the most substantial of the thirteen desserts served at a traditional Provençal Christmas banquet, or *gros souper de Noël* (the others being walnuts, hazelnuts, almonds, white nougat, black nougat, figs, raisins, dried apricots, peaches, apples or pears, fresh mandarin oranges or clementines, a special melon called a *verdau*, and finally, either *calissons d'Aix* or fruit jellies from Apt).

Another southern product with extraordinary diversity is honey, which comes in as many flavors as there are aromatic flowers for the bees to gather pollen from: rosemary, thyme, and lavender from the plains, chestnut, heather, and any number of scrub plants from the hills. Of all these honeys, the most famous historically is that of Narbonne, a small town at the west end of the Mediterranean north of Perpignan, renowned for its incomparable rosemary honey (*miel de Narbonne*) since at least the twelfth century.

From Nîmes to Bastia

The image of Provençal cooking as based on olive oil, tomatoes, and garlic is a much abused stereotype. For centuries lard was the dominant fat in the southern French kitchen, olive oil being reserved for the many meatless days imposed by the Roman Catholic Church (which explains at least in part its lingering presence in festive pastries). Although garlic has been around since the Middle Ages, tomatoes, now the pride of the region, were not used on a wide scale until the end of the eighteenth century. Therefore, it comes as no surprise to find famous southern dishes that use no tomatoes. A particularly striking case in point is *brandade de morue*, a creamy purée of salt cod from Nîmes flavored with just a hint of garlic and into which warm olive oil and milk have been beaten. Another example is *daube de bœuf*, an aromatic beef stew from Nice in which the bouquet garni always contains a piece of orange peel. Indeed, a great many of the traditional specialties sold in the street markets of Nice and other Provençal cities have not a hint of tomato: *socca*, a large, thin pancake made of chickpea flour; *pissaladière*, an onion-anchovy pizzalike tart with black olives; sardines, either grilled or stuffed with spinach. Among the desserts, one of the most astonishing is the *tourte de blettes* from Nice, a sweet tart filled with Swiss chard greens or spinach studded with pine nuts and raisins. And although vanilla, another newcomer from the Americas, is now a ubiquitous flavoring in pastries all over France, traditional cakes and cookies throughout the south—*fougassette*, *navette*, *gimblette d'Albi*, or the spectacular *gâteau à la broche* (baked on a spit), to name only those few—have remained faithful to lemon peel and orange-flower water, firmly entrenched here for centuries.

A rapid survey of French Mediterranean cooking would not be complete without a visit to Corsica, home of one of the most colorful figures in French history, Napoleon Bonaparte. Nicknamed *l'Îde beauté* (the isle of beauty), Corsica became part of France only in 1768, after a forty-year struggle for independence from a thousand years of Italian domination. The local language and products are still heavily impregnated with their Italian heritage, yet maintain their differences. The Italian origin of pork products with names such as *coppa*, *prisuttu*, and *salamu* is clear, but the excellent quality of the semi-wild Corsican pigs, fattened on the chestnuts and acorns of the island's extensive forests (*le maquis*), sets them quite apart—to say nothing of the inimitable *ficatellu*, a pungent liver-based sausage, grilled when fresh, sliced like salami when dried. The Corsicans themselves subsisted for centuries on chestnuts, and chestnut flour is still used in many local specialties like *nicci* (thin crepes) or *castagnacciu* (chestnut cake). But perhaps the most emblematic products of the Isle of Beauty are *cabri*, baby goat, the high point of every festive occasion, and *brocciu*, the "national cheese of Corsica," made from the whey left over from the fabrication of other cheeses. Although it may be consumed as is, fresh or aged, *brocciu* often enters into desserts, whether fritters (*fritelle*), turnovers (*pastelle*), or the king of Corsican cheesecakes, *fiadone*.

The Northeast and Lyons

Just north of Nice the Alps begin, extending all the way to Geneva. The olive groves blend progressively into a land of pasture, cows, and butter. Cow's milk cheeses such as the orange-crusted Reblochon, the creamy Vacherin, or the gruyerelike Beaufort are the pride of the region. Rich potato dishes abound, the most famous being the *gratin dauphinois*, from around Grenoble, where thinly sliced potatoes are baked in cream until brown. To put cheese on top is considered heresy here (but typical of the Savoyard version of the dish made high in the Alps to the north). Another specialty associated all over France with Grenoble is walnuts. The large tender nuts, shipped in their shells throughout the country during the fall and winter seasons, are considered so specific to the area that they have been accorded their own prestigious AOC.

A small pocket of flat land lying roughly halfway between the Alps and the Rhone Valley prides itself on another unique AOC. Called Bresse, this area is familiar to all French gourmets as being the part of the country where the best chickens are raised. The white-feathered, blue-footed *poulet de Bresse* can sell for three to four times the price of other free-range birds. Served in the finest restaurants around the country, it is the only bird to have been awarded AOC status. Once a year the finest specimens are displayed to compete for blue ribbons in Bourg-en-Bresse. Capons and pullets are specially fattened, slaughtered, and wrapped tightly in linen to press the wings and legs into the fat, producing a smooth torpedo shape. The slightest flaw, a bruise or tear in the translucent skin, immediately eliminates the bird. The prize winners bring not only prestige but also considerable income to their owners since they are sold at a premium at the conclusion of the fair.

About forty miles (sixty kilometers) southwest of Bresse is Lyons, which prides itself on being "the gastronomic capital of France." Lyonnaise cuisine is very hearty, with a penchant for extremities, innards, sausages, and lots of onions. Small restaurants, called *bouchons*, perpetuate local traditions and serve such typically Lyonnaise fare as sheep's trotters salad (*salade de pieds de mouton*), crunchy, pan-fried smooth tripe (*tablier de sapeur*), honeycomb tripe sauteed with onions (*gras-double à la lyonnaise*), pork sausage with potatoes (*saucisson lyonnais, pommes à l'huile*), as well as more refined dishes like pike dumplings with crayfish sauce (*quenelles de brochet, sauce nantua*), or a creamy cheese mixture laced with herbs and a little white wine called *cervelle des canuts*.

The French Paradox

Each part of France has its own culinary traditions. France's temperate climate, varied topography, different soils, and multiple coastlines combine to make it one of the richest agricultural countries in Europe. Nonetheless, like most industrial countries today, France's culinary landscape is changing. Although some foods like the wind-dried cod (stockfish) still favored in isolated communities in south-central France and in Nice rarely travel far from home, many that were once reserved for festive occasions are now consumed on a daily basis while others, once hardly eaten outside their place of origin, like *confit de canard*, are now readily available in shops and restaurants throughout the country.

The wide variety of French regional cuisines bears witness to the longevity of local cultural traditions—as well as of the country's inhabitants: France enjoys the lowest rate of cardiovascular disease in Europe (ahead of Portugal, Spain, and Italy) and, curiously enough, it is precisely in the southwest of French, the land of *foie gras* and *confit de canard*, that people enjoy the lowest rate of cardiovascular disease in the industrialized world outside of Japan. The famous French paradox. What is the secret? Nobody knows for sure, but goose and duck fat, garlic, and tannic red wines—the staples of the local diet along with a wide variety of fruits and vegetables—are all known to produce substances that protect the heart. Beyond that, the sheer beauty of a French open-air market with its multiplicity of fresh foodstuffs of every possible color and smell, and the enjoyment of savoring them at a leisurely meal with a glass of wine and good company, may provide part of the answer.

See also **Cheese; Fish; Iberian Peninsula; Wine**.

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TRADITION AND CHANGE IN FRENCH CUISINE

France is a country with many cuisines. Some dishes are part of a national repertoire and generally referred to as "traditional family fare." Examples might be *pot-au-feu* (a boiled beef dinner), *gigot d'agneau* (roast leg of lamb), *vinaigrette* (oil and vinegar dressing), or *pâté de campagne* (country-style pâté). From North to South, these dishes can be found in most French homes. A second group of dishes is mainly, or only, encountered in specific regions. Typically based on ingredients native to the region, they include *choucroute* (sauerkraut) in Alsace, *galettes de sarrasin* (thin buckwheat pancakes) in Brittany, *soupe de poissons* (fish soup) or the more elaborate *bouillabaisse* in Provence. Lastly, certain dishes are part of the *haute cuisine* tradition, which includes dishes prepared by chefs both past and present. A vast group, this repertoire is constantly shifting as tastes evolve and culinary trends change. Such things as *Tournedos Rossini* (beef tenderloin topped with *foie gras*), *pêche Melba* (vanilla ice cream and peaches with fresh raspberry sauce), or the more recent *terrine de poissons* (fish pâté) or *salade folle* (a salad of foie gras and mixed greens) are all dishes that can be attributed to specific periods of French culinary history, the first two evoking the *cuisine classique* of the early 1900s, the latter two the *nouvelle cuisine* of the 1970s.

Changing Fortunes

These various types of cuisine are not mutually exclusive. Béchamel sauce, said to have been created by Louis de Béchamel (1635–1688), was quickly adopted as part of the fashionable repertoire of the eighteenth century and went on to become a mainstay of nineteenth- and early-twentieth-century *cuisine classique*; today it is more likely to appear in private homes than on the menu of some trendy chef. *Boeuf bourguignon* has gone from being a "local" to a "traditional family" dish. Other regional favorites, such as *magret de canard* (fattened-duck steaks), a specialty of the southwest, have been adopted by chefs committed to a more creative cuisine. This said, one is more likely to find elaborate French dishes than traditional or regional ones in restaurants around the world. Only a handful of regional specialties (*cassoulet*, *bouillabaisse*, *foie gras*) are known outside the country, and even then they are often misunderstood and misinterpreted. The vast majority of preparations identified with France and upon which the reputation of French cuisine stands are chefs' creations, some dated and old-fashioned (*sauce béarnaise*, *béchamel*, *crêpes Suzettes*), others more contemporary (salmon with sorrel sauce, tropical fruit sorbets, flourless chocolate cakes).

La Nouvelle Cuisine

The exploits of fashionable chefs keep French cuisine alive beyond national boundaries and, to a large extent, influence eating habits within France itself. The most recent trend to remodel the way the world and the French think of food is *nouvelle cuisine* (literally, "new cooking"). Revolutionary in its beginnings, this movement is now thirty years old. Many of the dishes associated with it have lost their shock value and can now be found in modest households around the country. What was this culinary upheaval all about?

In 1972 two French food critics, Henri Gault and Christian Millau, noticed that several young chefs had started serving dishes with a noticeably different style from those of the past fifty years that had been based on Auguste Escoffier's early-twentieth-century reinterpretation of classic cuisine. As spokesmen for this new generation of chefs, Gault and Millau became vocal exponents of the "new" cuisine, encouraging the rejection of what were now perceived as obsolete standards and the pursuit of innovative dishes that reflected more personal tastes. They wrote and published a sort of manifesto, not too modestly called "the ten commandments of *nouvelle cuisine*," which not only gave *nouvelle cuisine* a base to grow on, but profoundly influenced the way many people thought about food and its preparation. The principles Gault and Millau propounded were the following:

1. *Reject unnecessarily complex preparations.* This basically meant abandoning many classic dishes that involved a multitude of sauces (each specific to an element in the final presentation), complicated garnishes, and elaborate preparations that sacrificed taste to appearance. Chefs were invited to emphasize the inherent nature of the foods they were preparing, such as by serving a roast partridge as it came from the oven with a light, simple sauce made from its pan juices and a little butter.
2. *Reduce cooking times.* It was better to undercook rather than overcook: green beans would be served "al dente" and fish would be cooked "slightly pink on the bone."
3. *Use seasonal produce.* Chefs were encouraged literally to shop daily and cook only what was found at the market that day.
4. *Shorten menus.* Greater attention was to be given to a small number of dishes rather than trying to impress clients with a multitude of preparations that could not be given the attention they deserved. This said, *nouvelle cuisine* popularized "tasting menus" that allowed the curious to sample many dishes in very small quantities. These two ideas are not necessarily contradictory since tasting menus are generally served to entire tables only (not individuals), which means that there are fewer dishes to prepare than it might appear.
5. *Do not marinate meats or hang game.* This complemented the first "commandment" which called for respecting the natural tastes of foods. Gault and Millau added that "marinating meat hides its taste . . . if game is hung at all it should only be for a very short time, otherwise its flavor is altered and an undesirable fermentation begins." They did, however, ac-

cept the use of spices, particularly new and "exotic" ones, such as green peppercorns and fresh ginger, as a means of heightening flavors.

6. *Abandon heavy sauces.* This was a direct condemnation of such classics as *béchamel*, brown sauce, and other thick, flour-based sauces that produce an opaque coating. The idea was to use light sauces made by deglazing the pan juices with a liquid (wine, water, stock, etc.), and swirling in fresh butter.
7. *Promote regional cooking.* Traditional local dishes could be just as exciting as any others—if they had been "reinvented" according to *nouvelle cuisine* principles.
8. *Take an interest in new cooking methods and utensils.* Steamers, "dry-steam" ovens, and time-saving devices such as the food processor and blender should become standard equipment in the professional kitchen.
9. *Be health conscious.* Good eating is not incompatible with a healthy diet. The chef who best embodied this "commandment" was Michel Guérard, who created *cuisine minceur* (literally, slimness cooking) in the late 1970s. In keeping with this principle, chefs were encouraged to give greater importance to a wide variety of fresh vegetables than in the past.
10. *Be creative.* This speaks for itself.

Thanks to the enormous interest the media took in *nouvelle cuisine*, virtually all of the "commandments" had some effect on the way the French cooked and on their attitudes towards food. The principles would be adopted not only by chefs throughout the country but, in the course of time, by the general public, which was anxious to eat dishes more in tune with contemporary aesthetics and dietary concerns and welcomed the simplification of their preparation.

Beyond Cuisine

Movements such as *nouvelle cuisine* have not been the only force at work on the French diet. Another new term entered the French language at about the same time as *nouvelle cuisine*: *le fast-food.* Hamburgers and hot dogs were no strangers to France, but in the late 1970s American and British hamburger chains started to proliferate. Their success was at least partially due to the low prices they charged and their link with a foreign culture that was then in vogue. Immediately popular with the younger generation, their success was regarded with dismay by parents who lamented that their offspring had lost all interest in traditional cooking and that French cuisine was doomed to disappear. With the passage of time, however, these fears have proved to be unfounded. Despite the ongoing popularity of fast-food outlets among the young, as the youths of yesteryear mature and their incomes increase, they return to *cuisine* via the chefs' answer to the foreign invasion: the bistro.

les Verts
mmm.

The "McDonaldization" of French cuisine is viewed in France as one of the most threatening influences on traditional cooking and eating habits. This protest was staged in July 2000 by the Green Party to protest the opening of the forty-sixth McDonald's in the French capital. French breads, pâtés, cheeses, and wines were distributed in front of McDonald's "golden arches." © REUTERS NEWMEDIA INC./CORBIS.

Bistros, old-fashioned, homey, reasonably priced places, are a French establishment dating from the end of the nineteenth century, but as the twentieth century drew to a close, the term came to be applied to any small establishment serving moderately-priced food—not necessarily "old-fashioned" or in the least "homey." Chef's bistros were adjoined to many famous and prestigious restaurants; in these bistros, one could sample toned-down versions of "the master's" cooking at bargain prices. Specialized bistros also began to appear, with those dedicated to fish cookery becoming particularly popular. Another spin-off of the fast-food challenge to the French palate was the wine bar, where a collection of regional hams, sausages, pâtés, and cheeses, or a small simple dish, could be enjoyed with a glass of wine.

In short, tradition and change constantly find new ways to coexist as each "lost generation" of French diners rediscovers the gastronomy it had so ardently rejected. Just as with *nouvelle cuisine*, the invasion of fast food has enriched and diversified the dining experience and provided yet another opportunity for France to show the world that its cuisine is alive and well—responding to new challenges and incorporating new ideas without losing sight of the foundations upon which it continues to build its reputation.

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WINE AND THE FRENCH MEAL

For the French, wine is not an alcohol but a beverage. Like most beverages, it is generally consumed at mealtimes and like bread, it is so much a part of most meals that many French people would not enjoy eating without drinking a little wine. Given its importance and the wide variety of French wines to choose from, they have devised a few simple rules for serving wine:

- White with fish, red with meat
- White before red
- Serve wines in ascending order (the best wine last)
- Drink wines of a region with foods from that region
- Drink reds at room temperature and whites chilled

Of course, the French being typically French, there are exceptions to every rule.

White with fish, red with meat

For the most part, this rule is respected, especially concerning beef and lamb. But there are important regional differences. In Alsace, for instance, white wine is served with both fish and meat. This is no doubt because the region produces very little red wine and because Alsatian whites go so well with pork and pork sausages that the famous Alsatian *Choucroute* (sauerkraut with an assortment of salted and smoked pork products) is *never* served with red wine but with an Alsatian white wine (or beer). The full-bodied whites of Burgundy can also be served with poultry and go surprisingly well with *pâtés* of all kinds. In the Jura the distinctive sherry-flavored "yellow wine" (*vin jaune)* may be served with poultry or fish, especially when cooked with cream and morel mushrooms from the nearby mountains. In Bordeaux, oysters on the half shell are eaten with grilled link sausages, a delightful combination with which the wine of choice is a white Graves. Conversely, it is also in Bordeaux that one encounters the unusual practice of serving red wine with fish, most specifically lamprey eel, which is cooked in a red wine sauce.

The French meal invariably includes cheese. The French are among the world's highest consumers of cheese, but the cheese is generally eaten with wine. A waiter at Le Grand Vefour restaurant in Paris is shown here serving cheese from a cart. © OWEN FRANKEN/CORBIS.

White before red

This is true so long as the wine is dry, the case for most of the white wine produced in France. Sweet white wines or champagne, on the other hand, can be served at the end of the meal. Admittedly, this practice is dying out and, these days, one is more likely to be served a glass of sweet *sauternes* with a slice of *foie gras* as a starter than with dessert, and champagne is a favorite *apéritif* throughout the country.

Serve wines in ascending order (the best wine last)

Exponents of this idea argue that if the best wine is served first, all that follow will disappoint. Those who question this approach point out that cheese and dessert come in last place, hence the best wine would always be served with one of them. The problem is an obvious one: great wines are not always at their best with cheese (dessert wines are rarely served these days). Though certain wines can be exquisite with specific cheeses (Alsatian Riesling with Munster, red Burgundy with a pungent *époisses*) certain subtleties in very fine wines can be lost if the cheese they are served with is too pungent. One solution is to follow a complex, mature wine that was served with the main dish with a young, full-bodied wine carefully chosen to enhance the taste of the cheeses. The wine in question is so different from the preceding one that the two cannot really be compared, leaving the impression of progressing from a delicate, suave taste to a "stronger" one.

Drink wines of a region with foods from that region

Although this rule applies marvelously well to the foods and wines of the lesser-known regions, oddly enough the great wine-producing regions—Bordeaux, Burgundy, and Champagne—are not associated with a wide range of regional specialties. Though Burgundy is rich in natural resources, notably beef, too often *any* dish with a red wine sauce is (mistakenly) considered to be *bourguignon*. Few French people can name even one dish that is specifically associated with either Bordeaux or Champagne. This is not to say that they do not exist; they are simply unknown to the public outside the region. Bordeaux, for example, claims to produce some of the finest lamb in all of France (*agneau de Pauillac*) and every spring the *Bordelais* delight in grilling shad, fished in the Gironde estuary. Dishes one might encounter when traveling in Champagne often have no specific links to culinary traditions: add a splash of Champagne to virtually any dish and, *voilà!* you've made it *champenois*! The true specialties from that region are simple farmhouse food—poached salt pork and cabbage, tripe sausage, dandelion salad—hardly what one might accompany with a glass of vintage bubbly.

Reds at room temperature, whites chilled

This is perhaps one of the most misunderstood and frequently challenged practices in France. What exactly is "room temperature"? Essentially this means that wines should not appear to be cold when served. Too often, "room temperature" is interpreted to mean "warm," a terrible blunder. Though most of the best reds are still served "at room temperature" (60–63°F/16–17°C for Burgundies and 64–66°F/18°–19°C for Bordeaux) there is a growing tendency to serve young, fruity reds at "cellar temperature," cool but not cold (55°F/12°C). This is specifically the case of *Beaujolais* and the light reds from the Loire Valley.

Though white wines are generally brought to the table in an ice bucket, wine stewards in better restaurants often advise their clients to chill fine, full-bodied whites like those from Burgundy just long enough to bring them slightly below "cellar temperature" and feel cool to the tongue (about 48–50°F/9–10°C). Only young, very dry white wines, light rosés, or sparkling wines should be drunk truly cold.

One of the most dramatic exceptions to this rule concerns the famous "yellow wine" from the Jura. This is the only white wine made in France that is served at room temperature.

Wine and Pleasure

Ideally, a wine should enhance the food it is served with and vice versa. This is why wine is rarely served with salads unless they are made without vinegar because vinegar ruins the taste of wine. Most people are familiar with a few "perfect marriages" (oysters with *muscadet*, lamb with Bordeaux, Sauternes with *foie gras*) though several recent books have encouraged the exploration of more daring combinations like white wines with goat cheeses and pâtés, or light reds with certain fish like fresh grilled tuna or sardines. Nonetheless, the French have conservative tastes generally speaking, and are more likely to respect the rules given above then to break them (regional practices aside). Drinking wine is part of life, not an intellectual exercise, and what count most of all are the pleasures of the table—many French people could not imagine even a simple meal without a glass of wine.

Although wine, whatever its origin, is indispensable to a French meal, one should never conclude that the French are wine "experts." Most people are familiar with only a limited array of wines and do not anguish over making choices. On festive occasions, however, wine takes on central importance and much time might be spent selecting and orchestrating the serving of several wines. Foreign wines are still an oddity; indeed, those who live in wine-producing regions are often perfectly content to drink *only* wines from their area.

The French are more interested in enjoying their wines than in analyzing them. This is not to say that they do not pay attention when selecting wine, or that they are not attentive when wine is served. But they are more concerned with serving wines to enhance the pleasure of a meal than in anything else. This customarily implies personal discretion and moderation: getting drunk is considered antisocial and severely frowned upon.

See also **Dinner**; **Etiquette and Eating Habits**; **Meal**; **Table Talk**; **Wine**.

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FRENCH AND BRITISH COOKING COMPARED

England and France are two countries which, in world perspective, are actually rather similar. Their pattern of long-term development differs subtly in detail but in broad terms is equally similar, and their cultures and cuisines have been in reciprocal contact ever since the Middle Ages. Moreover, the alimentary raw materials available were broadly the same though not identical. How, then, did their strikingly different culinary cultures take shape?

Caricature is a serious danger in this field. What people eat is universally a potent ingredient of national and social stereotyping. That applies both to the formation of people's "we-images" of their own group and of their "they-images" of outsider groups. Food has long played a prominent part in the sense of national identity of both the English and the French, and it is very risky to accept their reciprocal stereotypes of each other's cuisine at face value. At the very least, one must not fall into the trap of comparing, say, the food of Paul Bocuse with that served at some British transport café, or French professional cuisine with English domestic cookery. Yet, the conclusion is that such common stereotypes as the rotund and rubicund John Bull sitting at a table of roast beef, or the lank and bony French cook smelling of garlic and spearing a frog leg with a fork really do have a kernel of truth in them, particularly in relation to underlying attitudes.

Still-life photographic study of the flavors of France. © Matthias Kulka/CORBIS.

This investigation took as its baseline the late Middle Ages, reviewing the published documents and drawing upon the work of specialists, notably Stouff's outstanding monograph (1970) on late medieval Provence. The picture that emerges from such studies can be briefly summarized. First, the national differences in cuisine that we take for granted were as yet very little developed in medieval Europe. Members of the same estate of society ate in strikingly similar fashion throughout Western Europe. Before Columbus, many of the vegetables now seen as typically Mediterranean were unknown, so that, for example, the humble cabbage was as prominent an item in Provence as in Northumberland. Second, however, the differences between the estates were quite marked, though quantitative differences in consumption were possibly more striking than differences in quality (with an exception registered for a very small elite in really major courts). Stouff depicted graphically the increase in sheer quantity of food consumed as one progressed up the social ranks. Before the Black Death, this was especially marked in the case of meat, though subsequently meat was relatively abundant for the lower ranks, too. The famous gargantuan banquets thrown by kings and nobles to mark particular occasions were notable for their vast scale rather than the subtlety of the cooking; their motivation and social function resembled that of the potlatch among the Kwakiutl Indians. Only in the greatest princely courts, and even there probably only for the more special occasions, was the famous courtly cuisine with its elaborate mixtures and proliferation of spices to be found. The recipes found in the manuscripts, whether from France, Italy, or England, are strikingly similar.

Although the evidence from the Middle Ages is too sparse to be conclusive, the best guess from the similarity between surviving manuscripts from different places and periods is that the pace of change in matters culinary was then very slow in all strata of society. From the time of the Renaissance onward, however, the pace of change perceptibly quickens in these as in so many other aspects of everyday life (cf. Elias, 2000), at first among the secular upper classes and then very gradually among lower strata, too. We must be careful: the history of eating is a prime instance of what Elias has called "the polyphony of history." Marc Bloch contended that only in the nineteenth century was it possible to see "the beginning of a trend towards greater uniformity in food—speaking in very relative terms—from the top to the bottom of the social ladder (1970, p. 232)." Until then, the food and the cookery of the peasants in the countryside seem to have changed only extremely slowly over the centuries. It was something to be studied in the perspective of the *longue durée.* From the advent of the printed book, however, it is possible to trace a gradually accelerating pattern of change in the cookery of the upper and upper middle classes. If changes in technique and fashion never quite attain the pace of *histoire événementielle*—although the gastronomic myth-makers delight in representing the invention of new dishes as unique creations of great men on unique occasions (see Mennell, 1985, Chapter 10)—it could fairly be portrayed as *histoire des conjonctures.*

The first elaborate cuisine representing a definite change from the medieval traditions is to be found in the secular and religious courts of Renaissance Italy, but the leadership of Europe in culinary as in so many other facets of culture soon passed to France. Very detailed work by Jean-Louis Flandrin and his associates in Paris may be interpreted to show that French leadership goes back further, but from the appearance of La Varenne's famous book *Le Cuisinier François* in 1651, it does not require in-depth research to see that something recognizable to later eyes as a distinctively French style of cuisine has emerged. From then on, the cookery books are more numerous, and not only can advances in cookery techniques be seen, but it is quite clear that contemporaries were conscious of the rapid pace of change and of the importance of food as an aspect of fashion in courtly circles. By the 1740s, the first gastronomic controversies were being fought out in Paris between minor courtiers (Mennell, 1981). Although by then cookery books were being directed specifically at the bourgeoisie, and some differentiation between courtly haute cuisine and domestic cookery was being codified, the models still clearly stemmed from courtly circles. One of the important consequences of this was that the spirit of thrift and economizing in the kitchen, which was very marked from an early date in England, was much less in evidence even in French cookery books, and something of the courtly functions of luxurious display heedless of the cost (cf. Elias, 1983) lived on until the present day in the French kitchen.

In England, the cookery books from the late sixteenth century onward depict a more rustic, "country housewife" style of cookery. They were still directed at readers among the nobility and gentry—this is not the food of the peasants—but they reflect their readers' greater continuing involvement in country life and pursuits than was the case among their French counterparts. There was for a time a line of English courtly cookery books too, but that tradition lost its vitality in England after the Civil Wars of the mid-seventeenth century, and from the early eighteenth century it is eclipsed by the resurgence of the "country housewife" style of book, written mainly by women, unlike those of the French and courtly traditions. The spirit of thrift and economy, often linked with an overt hostility to French extravagance, is strongly expressed.

This is a very compressed summary of only part of the evidence for differences in culinary culture between England and France. To counteract the necessary oversimplification, it must be emphasized that when speaking of "English cookery" and "French cookery," we are not dealing with two entirely separate things. French cookery had an early and continuing influence on English cookery, particularly through English cooks having worked in France and French cooks working for the very wealthiest English families. Yet there is a valid contrast. The food of the English gentry and prosperous farmers, depicted in the English cookery books, enjoyed a prestige of its own to which there was no equivalent at that date in France. From the technical point of view, there are also clear differences. The French developed a "cuisine of impregnation," replacing the antique "cuisine of mixtures." The use of cullis (the English translation of *coulis*) as a *fonds* and the proliferation of sauces—a process carried still further in France in the nineteenth century—was precisely not the foundation of English cookery. In England, continuities from the past were much more in evidence. The old pies and joints of meat remained the center of the English meal, whereas in France the focus of attention shifted to the ever-increasing variety of delicate little "made dishes."

What explanations can be offered for the rather different courses of development observed in the taste in food of the two countries?

One explanation has been so often repeated that it has the force of conventional wisdom. It is that meat (and other raw materials) were so abundant and of such superior quality in England that it was not necessary to cook them with great skill, disguise their flavor, or eke them out in made dishes. This explanation is implausible. For one thing, the superiority and abundance of English raw materials is highly questionable. For another, this popular explanation rests on the implicit proposition that all human beings prefer the "natural" taste of foods, transformed as little as possible by the culinary arts, which are thus seen as little more than a forced adaptation to circumstance. There is no serious evidence for this proposition.

On the contrary, three more explicitly social strands of explanation bear closer examination. These are, first, the possible influence of Puritanism, or other religious differences between England and France; second, the role and influence of the court society, and, more generally, differences in the distribution of power and social stratification; and, third, the differing relationship between town and country on the two sides of the Channel.

The influence of religion on eating is certainly very strong and familiar in many of the world's cultures. But the contention, advanced by such popular writers as Philippa Pullar (1970), that Puritanism blighted the English kitchen needs to be treated with some skepticism. For one thing, it is not clear that the English Puritans of the mid-seventeenth century were at all the general killjoys of later stereotype; they certainly do not have much to say against enjoying one's food. Later, perhaps, as Dissenters, their outlook narrowed, but by then they were not in the prominent positions in society from which they might once have commanded taste-setting power. Moreover, it is often overlooked that, besides the sizeable Huguenot community, seventeenth-century France also saw an influential Jansenist current within Catholicism that has long been seen to have similarities to the Calvinist predestinarian kind of Protestantism. Yet no one has ever suggested that Jansenism permanently damaged French taste buds.

As for the royal and princely courts, their direct influence on the authors of French cookery books is plain to see. In the light particularly of Norbert Elias's account of the place of luxury and display in French court society (1978), it is highly likely that competition between courtiers would be acted out through their kitchens and their tables as in many other aspects of culture. An essential link in the argument is that the French nobility, having emerged on the losing side from a series of struggles with the king, became deracinated and defunctionalized—deprived of their roots in a rural way of life, deprived in particular of their relatively independent power bases and governmental functions in the provinces. This did not happen to the same extent in England. The power shifts that were the outcome of the Civil Wars, the Glorious Revolution of 1688, and the Hanoverian succession in 1714 nipped in the bud the growth of an absolutist monarchy and court society on the French model. The royal court in eighteenth-century England was more *primus inter pares;* noble houses and the gentry retained a relatively independent power and governmental function in the provinces; and the pressures toward competition through virtuosity in consumption were relatively less intense.

That connects with a third consideration. The relationship between town and country in England was rather different from that in France. It was not that England was a more rural country than France. Quite the contrary. London in the eighteenth century was absolutely bigger than Paris, and its population relatively still larger as a proportion of the nation as a whole. It is estimated that as many as one in six people in that period spent some part of their lives in London. Nevertheless, the prestige of the country way of life remained much higher in England than it did in France, and London and country society remained more closely interlocked than in France. A larger proportion of English noblemen and gentlemen spent a larger proportion of the year living on their country estates and largely eating the seasonal products of their lands than was the case in France. Rustication from court was dread punishment for a French courtier. Besides, it should not be forgotten that in a preindustrial economy the range of available foods was generally more limited in the country than in the markets of major cities. The very diversity of the products to be found in the principal markets of great cities is a prerequisite for the creation of a great diversity of made dishes. Haute cuisine is a characteristic of urban life.

Convergences: The Nineteenth and Twentieth Centuries

After the Napoleonic Wars, the divergence between English and French cuisines appeared to widen. What was actually happening was something rather more complicated. Certainly, French professional cuisine, founded in the aristocratic kitchens of the ancien régime, was raised to new heights through competition between the restaurants of nineteenth-century Paris. And there is a good deal of evidence that, especially in the latter half of the century, the rather fine English country cooking tradition declined and became coarsened. What appears to have happened was that French culinary hegemony in the higher circles of English society became far more firmly established than in the eighteenth century, when only a few of the greatest grandees had employed French chefs. French culinary colonialism now extended further down into the highest reaches of the middle class. Besides, the sheer number of families involved in London "Society" was growing very rapidly (Davidoff, 1973), and the intense competition created by this social inflation mimicked in some degree the competitive display found among French courtiers a century earlier.

It was not, however, likely that these conditions would favor the emergence of a separate and distinctive English haute cuisine. Something like the "dependency theory" of "world-systems" theory applies to culinary colonialism as well as to colonialism proper. French cookery having already reached great heights, its techniques, recipes, rules, and vocabulary were there to be adopted by the colonized, just as about the same time the advanced state of many English sports led to the adoption of the games and their English vocabulary in many parts of the world.

The coarsening of the English "country housewife" tradition of cookery in the nineteenth century may have been due not just to the defection of the social model-setting circles to French cuisine but also, lower down the social scale, to the disruptive effects of very rapid urbanization and population growth on the transmission of traditional knowledge from mother to daughter. Urbanization took place in England far earlier and far more rapidly than in France. By the time the corresponding movement to the towns took place in France, largely during the twentieth century, the popular press and other mass media may to some extent have provided alternative channels for the maintenance of traditional knowledge.

That is to some extent speculative and requires deeper investigation. What becomes quite clear, however, is that by the 1960s, forces leading to convergence between the culinary cultures of France and England were dominant over the forces of divergence. That was to be seen quite clearly in the further diffusion of French influence down the English social scale through cookery columns in women's magazines and cookery programs on television. But far more important was the enormous growth of the food processing industry and its impact on the domestic kitchen in both countries and indeed throughout the developed world. That, and the growth of the fast-food industry, have become very powerful agents for the internationalization of food, and that has involved contrary yet interlinked trends both to standardization and to the greater diversity of styles in an increasingly cosmopolitan culinary culture. This applies not just to the actual dishes that come out of domestic and commercial kitchens, but also—in the richer countries—to social contrasts in eating. Both have been marked, in Elias's phrase, by "diminishing contrasts and increasing varieties."

In summary, France and England, two similar neighboring countries that had been in continuous contact with each other since the Middle Ages, nevertheless developed contrasting culinary cultures. The explanation for why that happened should not be sought not in any "innate" differences in the "taste" of English and French people, nor to any great extent in their natural endowments of alimentary raw materials, nor yet in religious differences. An answer lies rather in the divergence between their social structures from about the seventeenth century onward. In particular, competitive display and virtuoso consumption played a more compelling part in the absolutist monarchy that developed in France under Louis XIV and up to the Revolution than it did among the gentry and aristocracy in England after the defeat of the king in the Civil Wars in the mid-seventeenth century. Linked to these differences in stratification was a different relationship between the city and the country. French haute cuisine had its origins in courtly cookery, and courts are urban institutions. In contrast, the greater prestige of the country way of life in England is reflected in its cookery.

See also **British Isles: England.**

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Stephen Mennell

FRENCH FRIES. In the United States, potatoes cut into long strips and fried in deep fat have been known as french fried potatoes, then french fries, and now just "fries."

French fried potatoes are a favorite food in countries around the world. What makes them so popular? Perhaps it is the flavor of the fat, or the salt—or both—that leads us to purchase the potatoes often. French fries do not require eating utensils in informal situations, which makes them easy to eat and to carry away from the point of purchase. The many restaurants selling french fires frequently combine servings of fries with another food, for example, fried fish or hamburgers. Also, these restaurants advertise widely, so we are tempted to buy french fried potatoes repeatedly.

Origin

There is disagreement as to the origin of this method of cooking potatoes. Because the term "French" is used in the name, many people give cooks in France credit for having first prepared french fries. A French writer of the nineteenth century who went by the name of Curnonsky (his real name was Maurice Edmond Sailland) said that if there were regional Parisian cooking, its greatest contribution to gastronomy would be *pommes frites* (French fried potatoes). Others have suggested that "French" refers to the way in which the potatoes are cut, into lengthwise strips, as with frenched green beans.

Legend has it that President Thomas Jefferson introduced the deep-fried potatoes at a state dinner in 1802 upon his return to the United States from a trip to France. There seems to be no record of them in the United States for about sixty years. Some restaurants were selling them by the 1860s, but this form of potatoes was not popular here until the 1920s when World War I veterans returned from Europe. Drive-in restaurants, opened in the 1930s and 1940s, sold french fries. Since they did not require a utensil, they were easy to eat while driving.

A British food history book states that "chipped" potatoes were introduced into Britain from France about 1870. The term "chips" is used to designate fries in Britain, while potato crisps is the British name for what are known as chips in North America. The British "chipped" potatoes were paired with fried fish and sold in shops instead of the sliced bread or baked potatoes that had accompanied fried fish since about 1850.

Preparation

In French cookbooks, one finds recipes for potatoes cut into many shapes before frying. For example: *pommes frites allumettes* (also called *julienne de pommes de terre*), which are matchstick-shaped; *pommes frites paille*, cut into thin straws; and *pommes gaufrettes*, which are waffle-shaped potatoes. It is not usual to find a recipe for plain *pommes frites*. *Pommes frites pont-neuf*, first sold in a Parisian restaurant on the Pont Neuf, may be the closest to our traditional shape for fries.

Recipes for souffléd potatoes are found often in French cookbooks. Souffléd potatoes were first made in 1837, when a dinner being prepared for King Louis Philippe and Queen Amelie was held up by the late arrival

The curse of nutritionists, the enemy of sustainable agriculture, the standby of the teenage diet, French fries are not only loaded with fat, but are also the subject of heated debate and a symbol of food globalization. © Robert Young Pelton/CORBIS.

of the guests of honor. The chef took the potatoes off the heat before they were quite done, then put them back into hot fat just before serving. The potatoes puffed and were a great success at the dinner. French fries are said to be of best quality when they, too, are partially cooked at a lower temperature, then finished in fat that has been heated to a higher temperature; that has become the traditional way of preparing them. Some American cooks were doing this at home about 1950. American food writer Pam Anderson has developed what she calls a new way for home cooks to do fries, using less oil and raising the temperature of the oil toward the end of the cooking period, rather than removing the potatoes from the fat, then adding them back later. The method still depends on the two different temperatures for a good product.

In the United States, Russet Burbank potatoes are the variety used most for frozen fries. This variety does not grow well in other countries, so about half a million metric tons of frozen fries are exported annually. The greatest market for these is Asia, with the Japanese being the largest consumers. Other potato varieties, especially Bintje, are used fresh for fries in the Netherlands and France, and by some sellers on the East Coast of the United States.

One potato expert says that the best french fries are made in the Netherlands, where they are found on almost every street corner in Amsterdam. There, the fries are served with lots of ketchup, mayonnaise, and mustard on top. Others think the Belgians have the best fries, and there are shops in New York City selling Belgian-style fries. The Belgians are known to eat *pommes frites* more often than the Americans. The correct term for potatoes is *pommes de terre*, "earth apples," but no one seems to be confused by *pommes frites*. Belgians might eat them every day, both with meals and as snacks. Along with coffee, *pommes frites* are known as Belgian staples. The potatoes are usually served with mayonnaise, tartar sauce, Russian dressing, or béarnaise sauce, and may be accompanied by pickles or pickled onions. In Paris, the best *pommes frites* are said to be made by Algerians, Turks, and Greeks, rather than by French cooks. In each of these countries fresh potatoes are used rather than frozen ones. Americans tend to like fries with tomato ketchup accompanying them, and, in the northernmost parts of the United

A Belgian writer says that *frites* shacks, small wooden shops selling fries along the sidewalks, have all but disappeared in Belgium. In the 1940s in the United States and Canada, there were trailers selling freshly cooked fries parked along the streets of small towns or at beaches.

States and in Canada, vinegar is the choice of topping, a practice probably adopted from the British.

The fat in which the potatoes are fried can make a big difference in flavor of the finished product. McDonald's fries used to be cooked in a mixture of vegetable oil and beef tallow, which gave them a unique flavor. This practice ceased when enough consumers complained about the saturated fat, and so all vegetable fat has been used, and no beef tallow, since 1990. The flavor was different, though, so natural beef flavor was added to the frozen fries, much to the outrage of vegetarians, who expected there to be no animal product in the potatoes. A Belgian recipe for *pommes frites* calls for beef kidney suet, which gives them a unique flavor.

A Dutch-Egyptian factory near Cairo uses palm oil for its fries. A *New York Times* food writer fries the potatoes in a mixture of peanut oil and duck fat with bacon added. Another suggestion is to use horse fat, which is difficult to obtain in the United States. Burger King coats the potatoes with a mixture of potato starch and rice flour, then uses liquid smoke for flavor, but does not tell consumers what kind of fat is used.

French Fries as an American Icon Food

In America, frozen french fries were sold at R. H. Macy in New York City in 1946. Maxon Food Systems of Long Island City introduced the fries, but the company failed. Idaho potato processor J. R. Simplot had chemists develop frozen french fries for his company in 1953. These did not catch on because the potatoes tasted best when reheated in hot fat and home cooks did not want to bother doing that for a convenience food. Simplot decided to aim at restaurant owners who would be interested in saving labor in preparing potatoes for frying.

In about 1966, McDonald's restaurants began selling Simplot's frozen french fries. The potato processor had a new factory built just to prepare the fries for McDonald's. Customers did not object to the frozen product, and the reduced labor cost meant that french fries became a very profitable menu item. By 1995, Simplot had produced two billion pounds of french fries and other frozen potato products in the northwestern United States and in China.

Residents of the Southeast United States eat more french fries than those of the rest of the country. The Midwest is next, with the West and the Northeast following in that order.

Monitoring the sugar content versus starch content of potatoes is important in getting top-quality fries. If there is too much sugar, the potatoes will brown too fast. Companies may add some sugar to the fries in the fall, and leach out sugar in the spring, in order to get uniform color and taste throughout the year. Storage temperatures will affect sugar content of the potatoes.

In 1960, Americans consumed eighty-one pounds of fresh potatoes per capita and approximately four pounds of frozen french fries. By 1971, the consumption of processed potatoes was greater than that of fresh potatoes. Frozen potatoes accounted for most of the processed potatoes. In 2001 the consumption was forty-nine pounds of fresh potatoes and over thirty-one pounds of frozen french fries. The thirty pounds is equal to about four servings of fries a week. About 67 percent of the fries are bought at fast-food restaurants, with other restaurants accounting for 13 percent of the market share. Americans aged sixty and above eat fewer fries than younger persons.

There are now two other American frozen potato processors larger than Simplot: Lamb Weston, part of ConAgra, and Ore-Ida, owned by Heinz Frozen Food. Both of these companies are located in the Northwest. Lamb Weston processes fries for McDonald's and makes more that 130 different types of fries, some of which are sold in school lunch programs. In 2002, Ore-Ida stimulated sales of frozen french fries by introducing Funky Kool Blue Fries (not made from blue varieties of potatoes, but artificially colored a brilliant blue), chocolate-flavored (and colored) fries, and cinnamon sugar fries.

Frozen french fries have been a profitable item for fast-food companies. In 2001, it was possible to buy the potatoes for about 30 cents a pound and sell french fries for around $6.00 a pound. Unfortunately, farmers get very little of the profits. Increasingly, big corporations own the farms, while the farmers who have been driven from the land are hired to manage the farms for the corporations.

See also **Fast Food**; **Fish and Chips**; **Hamburger**; **Icon Foods**; **Potato**; **Take-Out Food**.

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FROZEN FOODS. In the early twenty-first century, frozen foods are an important component of meals prepared and served in both homes and restaurants. They have expanded the kind and quality of meals served and continue to influence food preparations and consumption in this country. The variety of frozen foods in the market reflects the wide use of frozen foods in households. These include ethnic, vegetarian, fast foods, imported gourmet, dietary, and many others.

Early use of freezing occurred in parts of the world, such as Canada, where temperatures in winter drop below freezing for significant periods of time. When hunters brought game animals home in winter, it was possible to freeze the catch by using the outdoor environment as the freezer. It was also convenient on farms where butchering was done. These meats were frozen and used before temperatures moderated. Experiences like this demonstrated the advantages of freezing. Because the storage time was dependent on the weather, this procedure had limitations.

The advantages of freezing as a method of preservation prompted researchers to develop freezing technology. In 1842, a patent for freezing foods by immersion in a brine of ice and salt was issued to Henry Benjamin in Britain. Fish was first frozen in the United States in 1865, and in 1917, Clarence Birdseye began word on freezing foods for retail trade. The use of different refrigerants was one of the early needs examined. The possibility of freons as refrigerants was well received for industrial and consumer applications and led to their early incorporation into household freezers. These early models offered were large in size and were designed to be used for the game and butchering needs of farm families at that time. But soon after their introduction, it was obvious that they were extensively used to store fruits and vegetables, an attractive application for farm households who were growing their own produce. These early models were great successes, and they launched the freezing preservation of fruits and vegetables in this country.

The possibility of freezing preservation of fruits and vegetables became an important interest in the United States, catching the attention of many city apartment dwellers and suburban families who lived in small houses. Unable to accommodate the large-size freezers that appliance manufactures were selling to farm families, these householders teamed up with their neighbors to develop community freezers, where families could rent freezer space in a large freezer-locker rental operation. Although this solved the problem, it was less than convenient.

Questions were raised about the effect of freezing meats, fruits, and vegetables on the quality of the thawed

Photo of one of the original TV dinners, with its compartmentalized aluminum serving dish for turkey, mashed potatoes, and peas. COURTESY ARCHIVE PHOTOS, INC.

TV Dinner

In 1954 C. A. Swanson & Sons introduced TV dinners to consumers in the United States. Gerald Thomas, an executive at Swanson, conceived the idea after the company unexpectedly found itself with 520,000 pounds of unsold Thanksgiving Day turkeys (information available at any website on popular culture of the 1950s). The turkeys were being stored in refrigerated railroad cars moving coast to coast across the country because there was not enough storage space in the company's warehouses. Thomas also conceived of the idea of using aluminum trays with three separate compartments. Based on his experiences in World War II, when soldiers ate from a tray, commonly known as "mess gear," he wanted to solve the problem of different foods running together in their serving tray. He observed the lightweight metal trays then being utilized by the airline food industry to heat meals and adopted them for use with the TV dinner.

The TV dinner concept was not met with immediate approval or enthusiasm at Swanson, though, where two more traditional-thinking brothers owned and operated the company. It was not until the older brother, who opposed the idea, went on vacation that Thomas's idea became a reality. The first dinner contained turkey, corn bread stuffing, gravy, sweet potatoes, and buttered peas. Its packaging was designed to look like a TV. Because most consumers did not own freezers in 1954, the dinners were usually consumed on the day they were purchased.

The market for TV dinners, or "frozen food dinners or entrées" (as they have come to be described almost exclusively by the frozen food industry since the 1960s), has continued to expand over the past five decades, reflecting the values and concerns of a larger American society. The initial production order by Swanson was for five thousand dinners, at a cost of 98 cents to consumers. Within a year, Swanson sold more than ten million turkey TV dinners. To ensure successful sales of the TV dinner, Swanson created an ad campaign featuring Sue Swanson, who "re-assured housewives they needn't feel guilty about not cooking homemade meals for their families." During the 1960s the sale of frozen food entrées rose dramatically after it became well publicized that the first American astronauts to land on the moon ate prepared meals while in space. In the 1950s and 1960s these entrées featured mostly comfort foods, similar to the homemade dinners that "Mom" would make, such as meatloaf or fried chicken combined with mashed potatoes.

The microwave oven was then invented in the 1960s, and it became a standard feature in most American homes by the 1980s. This development further increased the convenience and attractiveness of TV dinners to consumers. The 1980s witnessed a rise in the production of ethnic, low-calorie, and budget entrées, whereas the 1990s saw an increase in the production of gourmet entréees, "kid cuisine," and "hearty portions." The new millennium has so far indicated increasing growth in the production of frozen food entrées that are either healthy or "wholesome."

The frozen dinner is currently the largest category within the frozen food market; it currently accounts for over $5 billion worth of supermarket sales annually. One of the ten most popular dinners served in American homes is now a TV dinner, and nearly half of all Americans purchase frozen entrées. Those individuals most likely to consume TV dinners are "blue-collar families, older couples, and retired singles," whereas those least likely to consume TV dinners are either more wealthy families living in the suburbs or poorer people living in the country (see *American Demographics* for further information). In addition, frozen dinners are being delivered increasingly across the country to individuals who are homebound because of poor health or functional impairment. Survey findings reported by the Frozen Food Institute in 2002 reveal that certain frozen foods are among the top three items that Americans would not want to live without.

Julie Locher

product, including its nutrient retention. The USDA and land grant universities responded to this concern with research studies to assess the impact of freezing on nutrients in fruits, vegetables, and meat, which are summarized by Karmas and Harris. The results of this work showed the nutritional advantages of frozen foods and gave recommendations for freezing methods aimed at retaining maximum quality and nutritional value.

During World War II, homemakers began to join the U.S. workforce in large numbers and appreciated the timesaving advantages of frozen food. The appliance and food industries noted the acceptance by consumers of both freezing preservation of foods and the small freezer sections in household refrigerators. Early models of refrigerators did not offer separate compressor units for the freezer section. As a result, these appliances provided only limited freezing capacity and ability to freeze. The development of appliances with freezing sections that had separate compressors that allowed the freezing section to successfully hold frozen foods in the frozen condition had a major impact on the consumer's ability to store food. The food industry has also responded to the abilities of the new refrigerator models to hold frozen food by introducing frozen foods such as entrees, vegetable, breads, fruits, desserts, juices, snack foods, and ice cream. The refrigerator and freezer combination appliance fits into small spaces and is especially appreciated by those living in apartments and small homes. In the early twenty-first century, few refrigerators do not include a freezer on a separate compressor.

In microwave heating, foods are placed in an electromagnetic field when they are positioned in the oven cavity and the microwave energy is turned on. Heat is generated by molecular friction among the free water molecules in the food load. Since a frozen food has a very small amount of unfrozen water that attracts the microwave energy first, the heat is generated in a small part of the food load and is rapidly absorbed by the frozen part. In frozen foods, a large part of the water is in the form of ice. While water readily absorbs microwaves, ice does not. Some of the water in frozen foods does not freeze; this may be due to the salt content. The unfrozen water absorbs microwaves quickly in the microwave appliance. As a consequence, the use of microwaves to thaw and cook food may result in "runaway heating," a situation in which the unfrozen water containing salts is boiling while next to it, areas of ice exist. To prevent this, a defrost program is recommended; this feature exposes the food load to microwave energy for a short time, then turns microwaves off for a slightly longer time, allowing the heat to be conducted to the ice. This cycle is repeated until thawing is completed and does not usually produce runaway heating.

See also **Birdseye, Clarence**; **Microwave**; **Preparation of Food**; **Preserving**.

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Gertrude Ambruster

FRUIT.

This entry includes three subentries:
Citrus Fruit
Temperate Fruit
Tropical and Subtropical Fruit

CITRUS FRUIT

Citrus fruits are native to southeastern Asia and are among the oldest fruit crops to be domesticated by humans. They are widely grown in all suitable subtropical and tropical climates and are consumed worldwide. The most important of the citrus fruits commonly eaten include sweet oranges, mandarins, lemons, limes, grapefruits, and pummelos. These are eaten fresh, juiced, and in processed products. Citrus fruits have well-documented nutritional and health benefits as well as industrial uses. Their beauty and utility were well described by Georges Gallesio in 1811:

> Of all the plants spread by nature upon the surface of the globe, there are none more beautiful than those we know under the names of citron, lemon, and orange trees which botanists have included under the technical and generic name *Citrus.* These charming trees are both useful and ornamental. No others equal them in beauty of leaf, delightful odor of flowers, or splendor and taste of fruit. No other plant supplies delicious confection, agreeable seasoning, perfume, essences, syrups, and the valuable aides so useful to colorers. In a word, these trees charm the eye, satisfy the smell, gratify the taste, serving both luxury and art and presenting to astonished man a union of all delights. These brilliant qualities have made the citrus a favorite in all countries.

Botany

Citrus fruits constitute several species of the genus *Citrus* of the subfamily Aurantiodeae of the plant family Rutaceae. The Aurantiodeae has a total of thirty-three mostly subtropical and tropical genera, a few of which have economic importance. Most genera originated in Southeast Asia: the Malaysian and Indonesian Archipelagos, the Indochinese Peninsula, India, and China. A few genera originated in Australia or Africa.

The citrus fruits proper are characterized by their distinctive fruit, the hesperidium, which is a berry with the internal fleshy parts divided into segments (typically 10 to 16) and surrounded by a separable skin. The name is derived from classical mythology, referring to the "golden apples" grown in the garden of the Hesperides (the daughters of Hesperus, the evening star), located in the far west, in Paradise. When grown naturally, citrus plants are generally small to large trees, with glossy alternate leaves having oil glands. The attractive and fragrant flowers have an annular disk and generally bloom in the early spring.

The genus *Citrus* is divided into two subgenera, *Citrus* and *Papeda*. The former contains "edible" citrus fruits (including some less than palatable varieties), while the latter consists of the papedas. These are a distinctive group, the fruits of which have high concentrations of droplets of acrid oil in the pulp vesicles, rendering them inedible due to the bitter, unpleasant flavor. The leaves are also distinctive as compared to those of the subgenus *Citrus*, having large, prominent petioles. The leaves of one species, *Citrus hystrix*, are used as a condiment in Southeast Asian cooking.

The taxonomy of *Citrus*, as a genus, is unclear. So, for that matter, is the taxonomy of the other thirty-two genera in the subfamily. Different authorities have recognized anywhere from 3 to 170 species of *Citrus*. Obviously, this large a difference is due to more than mere hair-splitting. The most commonly used systems, that of W. T. Swingle (see Reuther, Webber, and Batchelor, pp. 190–430) or its modifications, recognize about sixteen species.

Most of the difficulties in *Citrus* taxonomy arise due the free hybridization that can occur between different varieties and even between different species of *Citrus*. In fact, many of the other Aurantiodeae genera are capable of free hybridization with Citrus. The result is that many types of citrus arose from these hybridization events at some time in the past. A strict interpretation of the "species" concept would result in fewer types being awarded species rank, whereas a looser interpretation would result in a higher number of species. This problem is compounded by the numerous controlled hybridizations and selections made by humans with the goal of producing a more desirable fruit.

Currently, the generally accepted concept is that there are three primordial or fundamental Citrus species: *Citrus medica* (citrons), *Citrus maxima* (pummelos), and *Citrus reticulata* (mandarins). All other types of citrus currently existing arose from single or sequential hybridization events between these species or their offspring. This concept is supported by various types of studies: classical taxonomy, chemotaxonomy, and molecular analysis.

Edible citrus is generally divided into sweet oranges, sour oranges, mandarins, grapefruit, pummelos, lemons, limes, and citrons. Within each of these types there are various subtypes, as well as types that arose from free or controlled hybridization. Depending on the taxonomic system used, these subtypes and hybrids may or may not be accorded species status. Table 1 presents some basic information on these standard types of edible citrus. Some of this information is not strictly accurate in a scientific sense: Oroblanco is actually a hybrid of a pummelo and a grapefruit, but it is generally marketed as a grapefruit; Meyer is probably a low-acid natural hybrid of a lemon and a sweet orange, but it is usually marketed as a lemon; Mediterranean Sweet is probably more accurately referred to as a "limetta" rather than a sweet lemon. However, the idea is to present the reader with some general information on fruits that might be encountered and eaten. Some types (low-acid sweet oranges, sour oranges, citrons) are not of much importance commercially, while others (sweet lemons, sweet limes) are important in some regions of the world but not in others.

There are four types of sweet oranges. The navel oranges possess a small, secondary fruit in the stylar end of the main fruit. This is the navel. Since navel oranges were introduced to California from Brazil in 1873, they have assumed a primary importance throughout the world as a sweet orange for fresh consumption. Like the navel oranges, common sweet oranges mature during the winter. Because of the popularity of the navel as a fresh fruit, common oranges are generally grown mostly for processing, although they can be important locally as fresh fruits. Blood oranges have a pigment called anthocyanin in the rind and juice, producing a reddish blush that becomes more pronounced with cooler night temperatures in the fall. The blood oranges have a distinctive taste compared to other sweet oranges. Valencia oranges mature later than the other sweet oranges and are generally harvested in the late spring or summer. Low-acid oranges have about the same levels of sugars as regular sweet oranges, but much lower levels of acid, resulting in a rather bland flavor.

Mandarins are often referred to somewhat incorrectly as tangerines. The word "tangerine" was used in the nineteenth century to designate Mediterranean types of mandarins, and referred to the city of Tangier. This term later became associated with other types of mandarins. Mandarins are of ancient cultivation in China, their probable area of origin, and other parts of Asia. The common mandarins include such important varieties as Ponkan, which is widely grown in Asia under different names. The Satsumas are a distinctive, seedless, early maturing group apparently originating in Japan relatively recently as compared to the common mandarins. The Clementines are another distinctive group that apparently originated in Algeria as recently as the 1890s. There are now many different selections of Satsumas and Clementines. The hybrids of tangelo (crossed with pummelo or grapefruit) and tangor (crossed with sweet orange) are included here as types of mandarins since they are generally thought of by the public as being more like mandarins than the other parent.

Sour oranges are not often eaten as fresh fruit or used for processing. However, the fruit is used to produce marmalade, and the flowers of certain types are used in the production of perfume. The Bergamot, a sour orange hybrid, has a distinctively scented oil that is used in

TABLE 1

Edible citrus: A summary

Fruit type	Species	Known age (yrs)	Year named	Probable origin	Probable native habitat	Subtypes	Harvest period	Representative varieties
Sweet orange	C. sinensis	500	1757	hybrid	China	common sweet orange	winter	Pera Hamlin Pineapple Shamouti Itabora Westin
						navel orange	winter	Washington Newhall Bahianinha Atwood Navelina Lane's Late
						Valencia orange	summer	Olinda Valencia Late
						blood orange	winter	Moro Tarocco Ruby Sanguinelli
						acidless	winter	Succari Lima
Mandarin	C. reticulata	2000 (?)	1837	true species	China	common	fall–spring	Dancy Pixie Fairchild Ponkan Kinnow Imperial
						Satsuma	fall	Okitsu Wase Owari Aoshima Clausellina
						Clementine	fall–spring	Fina Oroval Nules Marisol
						tangor	winter–spring	Temple Murcott Ortanique King Iyo Ellendale
						tangelo	winter–spring	Orlando Minneola Seminole Hassaku
Sour orange	C. aurantium	900	1753	hybrid	China		winter	Seville
Grapefruit	C. paradisi	200	1930	hybrid	Barbados	white-fleshed	winter–spring	Marsh Duncan Oroblanco
						pink-fleshed	winter–spring	Marsh Pink Ruby Red Rio Red Star Ruby Flame
Pummelo	C. maxima	2000 (?)	1765	true species	China		winter–spring	Kao Panne Kao Phuang Thong Dee Banpeiyu Chandler Reinking

[continued]

TABLE 1 (CONTINUED)

Edible citrus: A summary

Fruit type	Species	Known age (yrs)	Year named	Probable origin	Probable native habitat	Subtypes	Harvest period	Representative varieties
Lemon	C. limon	800	1766	hybrid	India	acid	winter–spring	Fino Genoa Interdonato Monachello Villafranca Verna
						Eureka	variable	Taylor Allen Genoa
						Lisbon	winter–spring	Limoneira 8A Monroe Walker
						sweet	winter–spring	Dorshapo Mediterranean sweet Meyer
Lime	C. aurantifolia	700	1913	hybrid	Malaya	small acid	winter–spring	Mexican Galego Kagzi
						large acid	winter–spring	Persian Tahiti Bearss
						sweet	winter–spring	Palestine
Citron	C. medica	2300	1753	true species	India		winter–spring	Etrog Diamante Buddha’s Hand

SOURCE: Compiled from various sources

teas as well as perfume. Sour oranges often make attractive ornamentals.

Pummelos are generally large fruit that originated in more tropical areas than most other types of citrus. They are commonly grown in southeastern Asia, where consumption is the highest. Pummelos are not eaten much outside of that area. The pummelos are a very diverse group, with large variations in size and shape, rind, flesh pigmentation, and acid level.

Grapefruit is another natural hybrid (probably pummelo crossed with sweet orange) arising relatively recently (in the eighteenth century). In the twentieth century, it became widely planted and was used for both fresh fruit and processing. White- and pink-fleshed varieties exist. The pink-fleshed varieties derive their color from the pigment lycopene and require high heat levels for good color development (in contrast to the blood oranges).

Lemons have not been identified as a wild species, and probably arose sometime in the remote past as a cross between a citron and a sour orange (itself probably a hybrid of pummelo and mandarin). Lemons are rather variable and it is sometimes difficult to distinguish between different varieties and types. Low-acid, sweet lemons also exist. The limettas are similar to and more common than sweet lemons and are often referred to in this manner.

Limes are somewhat similar to lemons in appearance and ancestry, and the distinction between the two groups is not always clear. Like lemons, low-acid, sweet types exist. The acid lemons are generally divided into the large, fruited types (generally seedless) and the small-fruited, “Key” types.

Citrons were probably the oldest citrus fruit to be cultivated in the West, but today they are not widely grown. Citrons are a highly variable group including acid and sweet varieties, but to the general public they often resemble large lemons. Citrons are sometimes used in the production of a candied peel and in Jewish religious ritual. The citrons are aromatic and are occasionally grown as ornamentals.

The kumquats are not, strictly speaking, citrus fruits. They are, however, in the genus *Fortunella*, which is closely related to *Citrus* in the Aurantioideae. Kumquats are distinctive in that they have small fruits with a sweet, edible peel. The trees are small and attractive and they are generally grown as backyard trees rather than commercially. The most important varieties of kumquats are Nagami, Meiwa, and Marumi.

Natural History and Spread

As well stated in Reuther, Webber, and Batchelor, "The history of the spread of citrus reads like a romance. Even in very early times the beautiful appearance of both tree and fruit attracted the attention of travelers and received mention in their written narratives" (p. 1).

Citrus is native to and has its center of diversity in northeastern India, southern China, the Indochinese peninsula, and nearby archipelagos. A theoretical dividing line (the Tanaka line) runs southeastwardly from the northwest border of India, above Burma, through the Yunnan province of China, to south of the island of Hainan. Citron, lemon, lime, sweet and sour oranges, and pummelo originated south of this line, while mandarins and kumquats originated north of the line. The mandarins apparently developed along a line northeast of the Tanaka line, along the east China coast, through Formosa, and to Japan, while kumquats are found in a line crossing south-central China in an east-west direction.

The cultivation of citrus began in ancient times in these areas. In fact, citrus was one of the earliest crops to be exploited and domesticated by man. Probably cultivation of citrus began independently in several locations within the area of origin and spread throughout the Southeast Asian region, and eventually into the Middle East, Europe, and America.

The oldest mention of citrus fruits known is from China, in the Yu Kung, a book of tributes to the Emperor Ta Yu, who lived from about 2205 to 2197 B.C.E. This book mentions the use of various types of citrus as tributes to the emperor. Later writings describe other types of mandarins, sweet oranges, pummelos, and kumquats. The monograph on citriculture written in 1178 C.E. by Han Yen Chih mentions twenty-seven varieties of citrus. The earliest mention of citrus in Indian writings is from about 800 B.C.E. in a collection of devotional texts, the Vajasaneyi samhita. This text mentions citrons and lemons. Sweet oranges are not mentioned in Indian writing until about 100 C.E.

The sweet orange probably arose in southern China where both mandarins and pummelos were planted together. From there, it spread through Burma and Assam into India. Much the same route was probably followed by the mandarins. Mandarins also spread into Japan. This probably occurred in the middle of the first millennium C.E., but the first mention of mandarins in Japanese literature dates from the thirteenth century.

Conversely, the citron probably originated in northern India and spread northward into China later. The citron also spread from India westward to Medea (Persia) by the first millennium B.C.E., and then into Palestine and the Near East. It is supposed that it was brought to this area by Alexander the Great. The citron became established in Italy during Roman times. The sweet and sour oranges, lemons, and pummelos followed this route at a later date.

The Arabs were instrumental in introducing most of the citrus types to Europe and northern Africa. The invasion of southern Europe by the Moors introduced citrons, sour oranges, lemons, and pummelos to the Iberian Peninsula, which is still an important area of citriculture. However, the sweet orange was apparently not established in Europe until the fifteenth century C.E. This was probably due to an entirely different route by Portuguese trade with southern Asia. The mandarins were apparently not introduced to Europe until early in the nineteenth century, when they arrived directly from China. Kumquats were introduced from China in the middle of that same century.

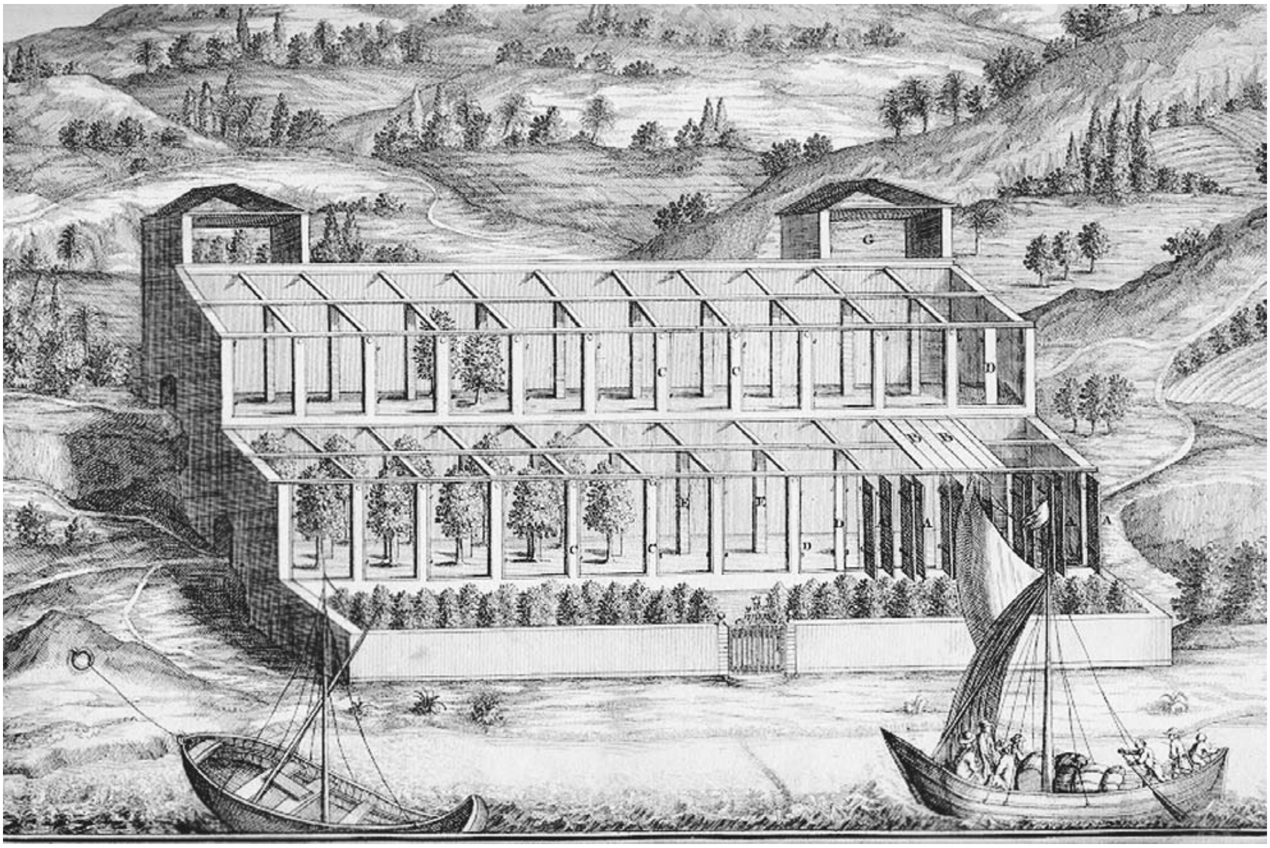
Citrus can be, and is, grown in southern Europe. That citrus represented a new and appealing type of fruit and had more exacting climatic requirements created a sort of cult of citrus in the more northern areas of Europe that persists to this day. Since citrus cannot be grown outdoors in such areas as the British Isles, northern France, and Germany, special houses (later known as orangeries) were in use by the fourteenth century for growing oranges and citrons. Some of these structures, which can be considered precursors to modern greenhouses, are still standing. In some cases, the citrus overwintered in the orangeries and were brought outdoors to enjoy the brief and mild summers and to enchant the public.

Citrus was carried to America by the Spanish and Portuguese colonizers beginning in the sixteenth century with the second voyage of Columbus in 1493. From its initial establishment in the Caribbean islands, it spread to the mainland (Mexico) and from there into the southern United States and Latin America. Citrus was introduced into Florida earlier than into California. Citrus was introduced separately into Brazil by the Portuguese, who were also responsible for the introduction of citrus into West Africa. It had apparently been introduced to the African continent earlier by Arab or Indian traders. Citrus was introduced in Australia from Brazil in 1788 by the colonists of the First Fleet.

The World Citrus Industry

In the New World, as in the Old, wherever citrus was introduced it became a popular fruit. If climatic conditions were appropriate, citrus was planted for commercial and for personal use. It remains the most widely planted fruit, except for grapes, in the world today. Most grape production is for winemaking, so citrus is undoubtedly the most widely planted fruit for direct human consumption in the world.

Citrus is grown throughout the world in the "Citrus Belt" between approximately 40°N and 40°S latitude. Within this belt there are tropical, semitropical, and subtropical climates, and it is possible to grow citrus in all three. Although there is some influence of scion and rootstock in cold susceptibility, frost is the main climatic limitation to citrus production. At the northern and southern margins



The method for protecting lemon and orange trees during the winter along the Lake of Garda in northern Italy. At the beginning of cold weather, the orangerie was shuttered along the front and roofed over with moveable boards. From Johann Christoph Volkamer's *Nürnbergische Hesperides* (Nuremberg, 1708). Roughwood Collection.

of production (Corsica, Japan, New Zealand), the mildness and shortness of the summers is a secondary constraint. In areas that have a Mediterranean climate, which has a long, dry summer, supplemental irrigation is necessary.

The majority of commercial production is in the subtropical regions between 20° and 40° northern and southern latitudes. In the tropics, flowering is often erratic, and fruit may mature throughout the year. Although fruit size is generally large in the tropics, fruit quality is usually lower. Fruit color is generally less intense and acids may be too low for good eating quality. Yellow-fleshed and high-acid types (lemons and limes) are not as affected by these factors and are widely grown in the tropics, as are pummelos. Although there is less large-scale commercial production in the tropics, citrus is important locally and when grown for personal consumption.

In the subtropical areas, the yearly cycle of flowering and fruit development, as well as vegetative growth, is more tightly regulated by climatic conditions. This results in a crop that matures at the same time and has higher fruit quality. Semitropical conditions are intermediate between tropical and subtropical conditions. These areas, which include such major production areas as Brazil and Florida, produce high yields of citrus that is of acceptable quality. Fruit quality for fresh consumption is lower than in subtropical climates such as California and Spain, but most fruit produced in Brazil and Florida is grown for processing, which has slightly lower-quality standards.

Within these climatic types, there are some variations in types of citrus successfully produced. For example, varieties that are colored by lycopene, such as the pigmented grapefruits, do well in these semitropical climates, while those colored by anthocyanins (blood oranges) do better in areas with lower winter temperatures. In marginal areas such as Japan and New Zealand, early maturing varieties such as Satsumas are grown.

Brazil has been the largest producer of citrus for some time, followed by the United States. Other important producing countries include China, India, Spain, Morocco, Argentina, Italy, South Africa, Australia, Mexico, and Egypt. The relative ranking of these countries varies from year to year. Recently, there has been much interest in large-scale production in countries such as China and India, where the climate is suitable and labor and infrastructure inexpensive. There are many niches within the world citrus production. For instance, in the United States, Florida produces a large proportion of the sweet oranges, the majority of which are used in processing. California produces a higher quality sweet orange, with emphasis on navel varieties, which is eaten fresh and largely exported. Countries such as Spain and Morocco produce large quantities of mandarins for export to the United Kingdom and northern Europe. Some of the Southern Hemisphere countries export to major Northern Hemisphere producers during the off-season.

As with any industry, there have been changes over the years. In the last decades of the twentieth century, the trend has been toward increased global trade and yearlong availability in most major markets. Processed products have grown in importance. In fresh fruit, the trend has been toward easy-peeling, seedless mandarins and sweet oranges. In grapefruit, the pigmented varieties are becoming predominant.

Production

Citrus is produced in slightly different ways in different areas. Commercial production is more uniform throughout the world than is local or personal production, but there are some differences here as well. Many of the differences are in the nature of farming inputs rather than the production of trees. For instance, fertilization and irrigation are necessary in most areas. However, a more industrialized producer in an exporting country may utilize drip irrigation with inorganic fertilizers injected through the drip system, while a producer for the local market in a poor country or area may use manure and flood irrigation.

Citrus can be grown from seed; however, there are some disadvantages. In some cases, seedlings are not true-to-type with the mother tree; due to juvenility factors, seedling trees do not usually bear fruit until they are nearly a decade old; and they are vulnerable to unfavorable soil conditions, diseases, and so forth. For these reasons, most citrus produced throughout the world utilizes budded (grafted) trees.

A budded tree consists of two parts: the scion, which is the fruit variety, and the rootstock, which supports the scion in the soil environment. Rootstocks are chosen based on a number of factors, including compatibility with the scion, resistance to diseases or pests, adaptation to soil conditions, effect on fruit quality. Citrus rootstocks can be grown from seed, since the commonly used rootstocks are apomictic (and hence true-to-type), and there are no confirmed seed-transmitted systemic diseases of citrus. Production from seed is easier than from cuttings, the common method of production for rootstocks for most other tree crops.

The rootstock is usually of an appropriate size for budding about nine months to a year after germination, when it is about the diameter of a wood pencil. The scion variety is budded onto the rootstock by making an incision into the bark of the rootstock, inserting a bud removed from the scion variety, and wrapping it with tape. A callus should form between the rootstock and scion tissues in two to four weeks. With appropriate training, the young tree is ready for planting in the field in about another year.

Once planted, it is usually about two to three years before the tree begins to produce fruit. Full production is usually achieved at about ten years of age. Under appropriate conditions, citrus trees may live a long and productive life and achieve a fairly tall height. This was common in many older citrus-producing areas. Since about the 1970s, citrus production has become more cyclical, like that of other tree crops, and the life of an orchard may be no more than twenty to thirty years.

Citrus requires relatively little cultural manipulation compared to crops such as grapes and deciduous trees, which require pruning and extensive training. In some areas, however, such as the Mediterranean basin, mandarins and sweet orange may receive somewhat more manipulation than in areas such as California. Lemons grow vigorously upright and require more frequent topping. Irrigation and fertilization are necessary. Certain production problems or challenges in citrus have been successfully managed with the application of plant growth regulators. This is more established in citrus than in most other perennial crops.

In contrast to the relatively low cultural inputs for citrus, disease and pest management in this crop is more critical and challenging than for many others. Because citrus is grown in warm areas of the world, reproduction of insect pests is rapid and insect pressure can be great. The individual insect pests vary greatly with geographic area. Compared to other crops, citrus is also subject to a larger number of systemic, graft-transmissible diseases caused by virus and viruslike pathogens that can potentially devastate industries. The most important worldwide is the tristeza virus, which destroyed many thousands of hectares in California and South America starting in the 1930s. This has been managed in some areas by certification programs requiring the use of virus-tested propagative materials and in a few cases with eradication programs. Other diseases, such as greening and citrus variegated chlorosis, are equally deadly but less widespread throughout the world.

Citrus is harvested by hand. At this point, there have not been any widely accepted methods of mechanical harvest. The time of harvest is dictated by the market or in some cases by legal maturity standards. Citrus is more forgiving than some other crops in that harvesting can be delayed somewhat and fruit quality is not decreased too much by the extra time on the tree. This varies with variety. However, if fruit are left on the tree too long, quality deteriorates as acid levels decrease and the taste becomes insipid. Other fruit quality problems can also occur. After harvest, citrus can be stored at low (refrig-

Lemon vendors in Oaxaca, Mexico. Oil painting by Mexican artist Rocio Levito, 2002. PHOTO COURTESY OF THE ARTIST.

erated) temperatures for several months. This has had important implications in the development of the industry since the beginning of the twentieth century.

After harvest, commercial citrus is transported to a packinghouse. There, the fruit is washed, sorted and graded, treated with fungicides and waxes, and packed. In some cases, ethylene gas treatment is used for degreening. Citrus packing today is highly automated in some ways, with various sensors and other devices routing and sorting the fruit through a complexly routed pathway of conveyor belts, and bins. However, there is still a substantial amount of hand labor necessary for sorting, grading, and movement. After citrus is packed, it is transported away from the packinghouse and enters wholesale and retail market channels.

In addition to commercial production, citrus is widely grown for personal use in "door yards," roadsides, small subsistence plots. Growing citrus for this use is extremely variable. Trees are grown from seed, are grafted by the grower, are purchased from commercial sources, and so forth. Varietal selection is based on personal preference rather than economic factors. Citrus is also prized for its ornamental value and often serves a decorative purpose as well. There are some cultivars that are grown strictly as ornamentals, such as some variegated types and the Buddha's Hand citron.

Use of Citrus Fruits

Citrus is consumed fresh, juiced, and processed. The most nutritious ways of serving citrus are as fresh fruit or fresh-squeezed juice. Citrus fruits are well known for their vitamin C content, but are also good sources of vitamin A, folic acid, and dietary fiber. Nutritional profiles of some citrus fruit and fresh juices are shown in Table 2.

Fresh citrus fruits can be stored for several days at room temperature or for several weeks in the refrigerator. Fresh-squeezed juice should be stored in the refrigerator and is stable at refrigerator temperatures for several weeks from a nutritional standpoint. However, there is often a loss of quality when fresh-squeezed juice is stored. This is especially true of navel orange juice.

Processing is an important part of the citrus market worldwide. Two of the major producers of citrus, Brazil and Florida, produce fruit predominantly for the processing trade. Low-grade and excess fruit from fresh market production may also be routed into processing. Where production is oriented toward producing citrus for processing, different varieties and to some extent different cultural practices are employed than when grown for fresh market. Criteria for harvest and quality standards are also different. Internal quality is paramount for processing citrus, whereas external appearance counts for more in fresh market fruit.

The most important use of citrus for processing is the production of frozen concentrated orange juice. The production of this is different from but equally as complex as packing fresh fruit. After fruit enter the plant, they are washed, juiced with a press or extractor, and strained to remove peel and rag. The juice then goes to the finisher, where excess pulp and essential oils are removed from the juice. It is then concentrated by an evaporator.

TABLE 2

Nutritive value of citrus fruits and raw juices

Fruit	Grapefruit	Grapefruit juice	Lemon	Lemon juice	Lime juice	Orange	Orange juice	Tangerine
Serving	1/2 grapefruit, raw, without peel, membrane, and seeds (3.75 in. diam., 1 lb. 1 oz., whole, with refuse)	Raw, 1 cup	1 lemon, raw, without peel and seeds (about 4 per lb. with peel and seeds)	Raw, 1 cup	Raw, 1 cup	1 orange, whole, raw, without peel and seeds (2.625 in. diam., about 2.5 per lb., with peel and seeds)	Raw, 1 cup	1 tangerine, raw, without peel and seeds (2.375 in. diam., about 4 per lb. with peel and seeds)
Grams	120	247	58	244	246	131	248	84
Water, %	91	90	89	91	90	87	88	88
Food energy, kcal	40	95	15	60	65	60	110	35
Carbohydrate, g	10	23	5	21	22	15	26	9
Protein, g	1	1	1	1	1	1	2	1
Fat, g	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr
Fatty acids, saturated, g	Tr	Tr	Tr	Tr	Tr	Tr	0.1	Tr
Fatty acids, monounsaturated, g	Tr	Tr	Tr	Tr	Tr	Tr	0.1	Tr
Fatty acids, polyunsaturated, g	Tr	0.1	0.1	Tr	0.1	Tr	0.1	Tr
Cholesterol, mg	0	0	0	0	0	0	0	0
Calcium, mg	14	22	15	17	22	52	27	12
Phosphorus, mg	10	37	9	15	17	18	42	8
Iron, mg	0.1	0.5	0.3	0.1	0.1	0.1	0.5	0.1
Potassium, mg	167	400	80	303	268	237	496	132
Sodium, mg	Tr	2	1	2	2	Tr	2	1
Vitamin A, IU	10	20	20	50	20	270	500	770
Thiamin, mg	0.04	0.10	0.02	0.07	0.05	0.11	0.22	0.09
Riboflavin, mg	0.02	0.05	0.01	0.02	0.02	0.05	0.07	0.02
Niacin, mg	0.3	0.5	0.1	0.2	0.2	0.4	1.0	0.1
Ascorbic acid, mg	41	94	31	112	72	70	124	26

SOURCE: Gebhardt and Matthews, pp. 20–26.

The bulk concentrate is stored in tank farms and transported in refrigerated trucks, train cars, or ships. The bulk concentrate is packaged into consumer- or industrial-sized containers. Frozen concentrate orange juice is sometimes reconstituted into "single strength orange juice." This is also produced directly without first being concentrated. Processing has little effect on the nutritional value of orange juice, but there is generally a loss of palatability. Grapefruit juice and to a lesser extent lemons, limes, and mandarins are processed similarly. These products are sometimes used to blend with other types of fruit juice or for the production of frozen confections. By-products of processing include essential oils and pulp. The latter is used for cattle feed. Other processed products of citrus include canned segments, segments in juice, pectin, jellies, and jams. Peel products are used for animal feed, marmalade, and shaved peel.

In addition to processing for juice and its associated by-products, there are minor industrial uses of citrus. Although essential oils are extracted as part of juice processing, in some instances trees are grown specifically for the production of these oils. The center of this industry is Calabria, Italy, and the main variety used is Bergamot, of which there are various selections. Citrus is also used to produce pesticides, cleaning products, and hair care products.

Health Benefits and Traditional Usage

In addition to the nutritional value and vitamin content of citrus, there are certain health benefits associated with some of the secondary products. For instance, various limonoid compounds, particularly D-limonene, have been shown to reduce tumorgenesis under experimental conditions. Carotenoids, such as lycopene, have been associated with decreased risks of heart attacks as well as general antioxidant activity. The high pectin content of some types of citrus contributes to soluble fiber consumption, which has been linked to increased cardiovascular health and reduced risk of certain types of cancer.

As might be expected with a crop utilized by humans for a number of millennia, these health benefits are reflected in the traditional use of citrus by indigenous people. Many of these uses are focused around the center of origin in China and India. However, health-related use of citrus has also been reported from traditional peoples in such areas as Fiji, Guatemala, and Chile. Citrus has been reported to be used for treatment of various illnesses, to reduce vomiting or diarrhea, and for regulating fertility. The sour orange has been reported to be used in voodoo ceremonies in Haiti.

Many of these uses are also associated with other plants in the subfamily Aurantiodeae. The kumquats have been mentioned already as being edible, but some other types of fruits are sometimes eaten by traditional peoples. Of particular note are the use of the leaves of *Murraya koenigii* as condiments and in the preparation of curry (the common name for this tree is curry leaf) and the use of Aegle marmelos ("Bael") for the preparation of teas. Other traditional uses reflect some of the properties suggested by the industrial use of citrus: insecticides and shampoos. As more insight into ethnopharmacology and secondary plant products is gained, it is possible that industrial use of citrus may increase, and probably some of these uses will reflect traditional uses of these plants.

See also **China**; **Dietary Guidelines**; **Ethnopharmacology**; **India**; **Scurvy**; **Southeast Asia**; **Vitamin C**.

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Robert R. Krueger

TEMPERATE FRUIT

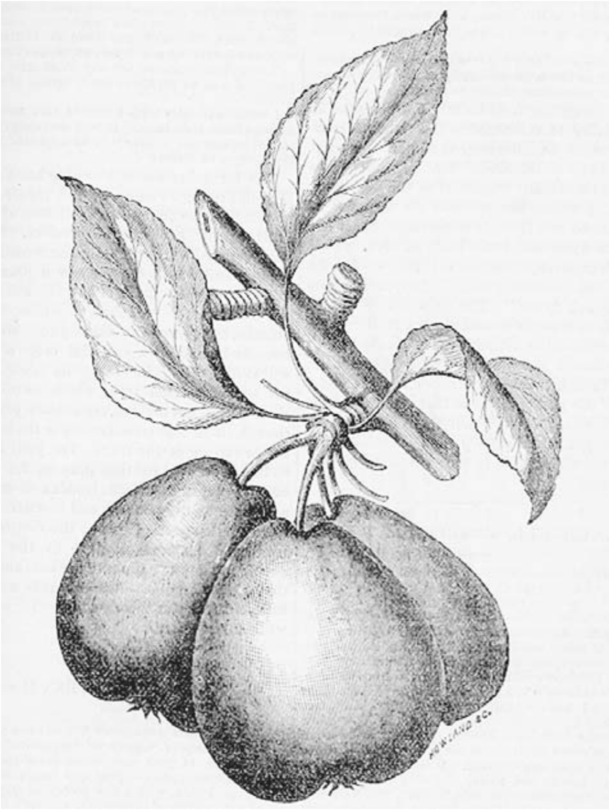
Many of the world's best-known and favorite fruits (such as apple, pear, peach, plum, grape, and strawberry) are adapted to climates in the middle latitudes and are known as temperate fruits. Temperate fruits have two climatic adaptations: they require some cold periods (dormancy) to complete their life cycle, which conditions their adaptation in tropical climates, and they have various degrees of winter hardiness, which conditions their adaptability in cold climates. Fruits that do not specifically require cold but have slight frost tolerance (citrus, fig, olive, persimmon, pomegranate) are known as subtropical fruits; they are not discussed here. In contrast, tropical fruits typically are very sensitive to cold and are often injured by low temperatures above freezing. Temperate fruits are usually classified by their growth habit as tree fruits (apple, pear, peach), vine fruits (grape, kiwifruit), or small fruits (strawberry, raspberry, currant, and blueberry). The term "small fruits" refers to the size of the plant and not necessarily the fruit. In the United Kingdom they are better known as bush fruits or soft fruits.

Tree Fruits

The best-known temperate tree fruits are members of the rose family (Rosaceae). These include the pome and stone fruits. Pome fruits (apple, pear, quince, and medlar) are fleshy fruits in which the outer portion is formed by expanded floral parts and receptacle. The stone fruits, all members of the genus *Prunus* (almond, apricot, cherry, peach, nectarine, and plum) are fleshy fruits that contain a stony pit (hence the name "stone fruits"), which encloses a solitary seed.

Apple (*Malus* × *domestica*) is the best known of the pome fruits. It has been known since antiquity and is grown in Siberia and northern China where winter temperatures can fall as low as –40°F and in high elevations in Colombia as well as Java, Indonesia, straddling the equator, where two crops can be produced in a single year provided leaves are stripped. While there are many species of *Malus*, the domesticated kinds seem to be derived from *M. siversii* indigenous to Kazakhstan and neighboring countries where forests of wild apple contain seedlings with all of the characteristics of the domesticated sorts. Apples are popular because they can be consumed in many ways: fresh, dried, or cooked and in liquid form as juice, alcoholic cider, or brandy (Calvados). Processed apples are appreciated as a filling for many bakery items and enjoyed as a sauce or concentrated as a butter. Some apples have a long storage life under refrigeration, in some cases as long as a year, especially under controlled atmospheres (low oxygen). In the United States the apple is the symbol of wholesomeness; "an apple a day keeps the doctor away" is a popular aphorism.

Pear (*Pyrus* species) can be divided into two types, the European pear (*P. communis*), which usually are consumed when they soften after harvest, and the Asian pear



Pears are a popular winter fruit because of their storing qualities. Shown here is the heirloom Seckel pear, which was discovered in the 1790s growing wild along the Delaware River by Philadelphia wine merchant Lorenz Seckel (1747–1823). The pear is believed to be a natural hybrid of older pear varieties brought to colonial America. FROM A NINETEENTH-CENTURY WOODCUT COURTESY OF THE ROUGHWOOD COLLECTION.

(*P. pyrifolia* and *P. ussuriensis*), which are consumed when crisp. The pear is as old a fruit crop as apple but is somewhat less popular in the West. This is probably because the postharvest ripening required makes it difficult to determine optimum quality, and some fruits contain grit (stone cells), which can be objectionable. Asian pears (known as *nashi* in Japan and as *li* in China) are probably more popular than apples in China, Japan, and Korea. Pears are closely related to apples and are consumed in similar ways.

The quince (*Cydonia oblonga*) is the third most important pome fruit. It is not very popular because most are too sour and astringent to be consumed raw, but it is excellent cooked, especially in preserves, jams, and jellies, to which sugar is added. Some types grown in warm climates soften and can be consumed raw. It is an important crop in Argentina. Some quinces are used as dwarfing rootstocks for pear. Quinces have a wonderful perfume and should be more widely grown but have passed into the realm of a neglected fruit. The Asian quinces (species of *Chaenomeles*) are often grown as ornamentals, but there have been attempts to domesticate these species in the Balkans for juices and preserves.

Medlar (*Mespilus germanica*) is truly an almost forgotten fruit. It is mentioned and disparaged by Shakespeare, who notes that it must be almost rotten to be enjoyed. The medlar is inedible until an internal fermentation occurs, producing an aromatic taste that appeals to some. The medlar can still be found in Italian markets.

The peach, despite its scientific name (*Prunus persica*), which suggests a Persian origin, is native to China, where it has always been highly prized for the beauty of its flowers and fruit. The peach seems to have been introduced to Europe via Persia in the first century B.C.E. but may have been known to the Greek philosopher Theophrastus (372–287 B.C.E.), who writes of Persian fruit and Persian apple. The fruit was well known to the Romans, and pictures of peaches were found in Herculaneum, destroyed in the eruption of Vesuvius in 79 C.E. Peach germplasm was introduced to the United States by the Spanish in the sixteenth century and became naturalized, but quality was low. Introductions from China in the middle of the nineteenth century, particularly one called Chinese Cling, are the progenitors of modern American cultivars. Peach is now the most popular temperate summer fruit. There are a number of distinct types. The freestone types with melting flesh and white or yellow flesh are usually consumed fresh. The clingstone, rubbery-flesh types are used in processing. The nectarine, a peach with a nonfuzzy skin, resulted from a mutation. Peentao, a saucer-shaped, flat peach is another variant type. Breeding in the United States has created many cultivars of both peach and nectarine that are widely grown in Europe, and some have been reintroduced to China for greenhouse production.

Almond (*Prunus amygdalus*) is native to the hot arid regions of western Asia but was introduced to Greece and West Africa in prehistory. The flesh is leathery and inedible, although the very immature fruits are consumed in Arab countries. Unlike most stone fruits, which have a bitter seed due to hydrocyanic (prussic) acid, the seeds of almond are nonbitter and are the edible part of this fruit. This species is therefore discussed under nuts. The almond is the most extensively planted “fruit” in California and is widely grown in countries of the Mediterranean basin.

Cherries, one of the most popular early summer fruits, are a symbol of joy as expressed in a famous song line: “life is just a bowl of cherries.” There are about thirty species of cherry. The edible types include sweet cherry (*Prunus aviuim*), a diploid with two sets of chromosomes ($2n = 16$), and tart (sour) cherry (*P. cerasus*), a tetraploid with four sets of chromosomes ($2n = 32$). Another tetraploid type called Duke cherry is derived from a hybrid between sweet and tart cherries. Cherries may be red, yellow, or bicolored and are consumed fresh, dried, or processed, including as a liquor called kirsch.

The Maraschino cherry is almost an artificial fruit in which cherries are brined, bleached, and then artificially colored and flavored with bitter almond oil. They are often used in a wonderful confection: chocolate-covered cherries. Cherries are now available over a long season in North American markets due to the efforts of American and Canadian breeders.

Apricot (*Prunus armeniaca*), an ancient fruit native to central Asia and China, was thought by the Greeks to have originated in Armenia, hence its scientific name. The beautiful, aromatic fruit with a velvety skin is consumed fresh, dried, and processed. Apricot liquor is well appreciated. The apricot blooms very early, is subject to spring frost, and is difficult to grow. This may explain why apricot has not become as important as peach, cherry, or plum. The beautifully flowered Chinese plum (*P. mume*) is more properly included with the apricots than the plums.

Plums are a diverse group of fruits, as exemplified by the many names by which they are known: bullaces, cherry plums, damsons, date plums, egg plums, greengages, mirabelles, plums, prunes, and sloes. Various species originated in Europe, Asia, and America. Two European species (*Prunus domestica* and *P. insititia*) are hexaploid, with six sets of chromosomes. The *domestica* plums include several groups of cultivars, such as greengage and prune types, while *P. insititia* includes bullaces, damsons, mirabelles, and St. Julien types. Among Asiatic species are *P. salicina* and *P. simonii*, the former of which includes both red- and green-fleshed Japanese plums. Many of these were introduced by Luther Burbank, with the red-fleshed Santa Rosa being the best known. *P. simonii* (apricot plum) is cultivated in China. There are a number of American plum species, but none are widely cultivated. At the start of the twenty-first century, the world plum industry is largely made up of *P. domestica* in Europe and *P. salicina* in Asia. Plums are consumed fresh or dried. Plums that dry without fermentation are called prune plums or simply prunes. They are dried down to very low moisture levels, in which state they can be stored for long periods of time. They are rehydrated when they are sold as packaged prunes, processed into jelly and jam (popular as a bakery filling), made into a diluted juice, or turned into brandy or cordials. The wrinkled dried fruit was widely consumed by senior citizens because of its laxative properties and thus became a source of comic derision. (It has been said that the turndown service at senior hostels includes a prune rather than a chocolate on the bed.) As a result, the industry has changed the name of prune to dried plum!

Vine Fruits

Grapes (species of *Vitis*, Vitaceae, or grape, family), one of the most important temperate fruit species, are usually grown on trellises. Total world production of this fruit is surpassed only by all citrus and species of *Musa* (banana and plantain). Grapes derived from the European species, *V. vinifera*, have been prized as the source of wine since antiquity. Although wine can be made from any sweet fruit, the grape is the preferred species because the combination of sugars, acids, and astringent substances such as tannins gives character to the product. The name of wines, such as cabernet sauvignon and pinot noir, refer to the grape cultivar. Because these wines have become a standard product there is great reluctance to change grape cultivars used for wine, but various clones have been selected throughout the many years they have been cultivated. Some grapes (known as table grapes) can also be enjoyed fresh; many of the new cultivars bred for this purpose are seedless. Nonalcoholic grape juice is enjoyed in the United States; this industry derives from Concord, a cultivar of the American species *V. labrusca*, the fox grape. American grapes are typically winter-hardy and have a slip skin and a unique flavor referred to as foxy. Concord juice in the United States is also used to make the sweet wine used traditionally in Jewish ceremonies, a product often derided by wine connoisseurs but still enjoyed by millions of ordinary folk. (When the astronaut Gene Cernan landed on the moon, he expressed his wonder at the sight with the famous expression "Man O Manischewitz," the name of a popular brand!) American grapes have long been grown in Japan, where their foxy flavor is appreciated. The large-fruited table grape Italia, widely appreciated in Europe, has a muscat flavor that is similar to the foxy flavor of *labrusca* grapes, many of which are sweet and pleasant but insipid. The strong-flavored muscadine (*V. rotundifolia*), native to the southern United States, has a small market in this area for fresh fruit, juice, and wine.

The kiwifruit (*Actinidia deliciosa*, Actinidiaceae) is an example of a fruit species that has been essentially domesticated in the twentieth century. It derives from a gathered Chinese fruit known as yangtao, which had long been appreciated in China but was collected rather than cultivated. Introduced to the United States and New Zealand early in the twentieth century by the plant explorer E. H. (Chinese) Wilson, it was referred to as Chinese gooseberries. Although it remained a curiosity in the United States, New Zealand growers and nurserymen succeeded in domesticating the crop by selecting suitable male and female clones (the plant is dioecious), as well as techniques for cultivation. One seedling selected by A. Hayward Wright and subsequently named Hayward became the mainstay of the world industry. The fruit was exported to the United States and promoted by Frieda Caplan, a marketer of new crops. In 1959 the relatively unattractive brown fruit received the new name kiwifruit after the kiwi, an endemic flightless bird often used as a nickname for New Zealanders. Kiwifruit has a pleasant but weak flavor with very high vitamin C content, but the nutritious quality of the fruit has not been promoted; rather, it was the beautiful and unique appearance of the sliced flesh, which is used as a garnish on bakery products or as a component of mixed fruit, that made this fruit popular worldwide. The long storage life of the fruit made it possible for New Zealand to export the fruit year-round. The popularity of the crop made millionaires of many New Zealand growers, but as kiwifruit began to be grown in such countries as the United States, Italy, and Chile, the boom crashed and New Zealand growers had to struggle to survive. Kiwifruit is consumed out of hand in New Zealand, usually scooped with a spoon, but this technique has not caught on, and further expansion is probably linked to development of a simple method for peeling. A yellow-fleshed kiwifruit marketed as Zespri Gold (*A. chinensis*) was introduced at the turn of the twenty-first century, and the New Zealand growers are attempting to control its distribution. It is too early to know if this will succeed. A small-fruited hardy American species (*A. arguta*), sometimes called tara fig, is now cultivated in gardens but this species has not been commercialized.

Small Fruits

Strawberry, the most widely grown small fruit, has an interesting history. Although a small-fruited species of strawberry (*Fragaria vesca*, a diploid species, $2n = 16$) is native to Europe, the modern strawberry is derived from hybrids between two octoploid ($2n = 56$) native American species, *F. virginiana*, indigenous to the East Coast of North America, and *F. chiloensis*, native to Chile. Hybrids between these two species were produced naturally in Brest, France, early in the eighteenth century when a pistillate clone of the large-fruited *F. chiloensis*, introduced by Amedée François Frezier, a French army officer, was interplanted with staminate plants of *F. virginiana.* The new hybrids (now known as *Fragaria* × *ananassa*, or pineapple-strawberry) initiated the modern strawberry industry. Breeding efforts through the years have resulted in tremendous advances as the plant was changed from a predominantly dioecious species with male and female plants to a hermaphroditic species, in which flowers contain both stamens and pistils. Fruit size has been greatly increased, and modern cultivars tend to be very firm-fleshed (too firm for some), with improved flavor and appearance. Although strawberries are grown in all temperate countries, the industry is now concentrated in some favored locations such as southern California in the United States, southern Spain, and various locations in Italy. Some strawberries now are grown in greenhouses.

The genus *Rubus* is very diverse. The cultivated *Rubus* species known as brambles includes red raspberry (*R. idaeus*), black raspberry (*R. occidentalis*), and blackberry (*Rubus species*), including various interspecific hybrids between raspberry and blackberry, such as loganberry, boysenberry, and tayberry. Brambles have delicious flavors but marketing has been a problem because of the soft texture of the fruit.

Cultivated species of *Vaccinium* and *Ericaceae* are berry crops domesticated in the twentieth century. Blueberry (various species) is native to the United States and grows in bushes of various heights. The blue fruits are easy to preserve by freezing and have become very popular in the United States because of their use as a fresh fruit and in muffins or pancakes. They are increasing in popularity in Europe and in New Zealand. The cranberry (*V. macrocarpon*) is an unusual berry crop because it is grown submerged in bogs. The fruits are too acid to be eaten raw and are consumed processed as jelly or as a sauce. In the United States cranberry is a favorite food for the feast of Thanksgiving. Sweetened dilute cranberry juice, consumed alone or mixed with other fruit juices, has become popular because of its therapeutic benefits in urinary tract problems of women. Lingonberry (*V. vitisidaea minus*) is native to northern regions of Europe, Asia, and North America. The bright red fruit has long been gathered from wild stands in Scandinavia, and a large commerce developed from this source. Attempts to domesticate the crop are based on the management of natural stands. There are a number of other native *Vacciniums*, such as bilberry (*V. myrtillus*) and bog bilberry (*V. uliginosum*), that have been considered as possible domesticates.

Cultivated *Ribes* species include a number of popular berries such as black currant (*Ribes nigrum*), red and white currant (*R. sativum* and *R. rubrum*), and gooseberries (*R. grossularia*). They are too acid to be consumed fresh and are essentially used for jams, jellies, and juice. Black currant was the source of ribena syrup, widely fed to British children during World War II as a source of vitamins. Black currant is not widely grown in North America because cultivation was discouraged and even made illegal because the plants were alternate hosts for white pine blister rust.

See also **Apple; Berries; Grapes and Grape Juice; Wine; Wine in the Modern World.**

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Jules Janick

TROPICAL AND SUBTROPICAL

Tropical and subtropical fruits, in contrast with temperate fruits, can be broadly defined as those meeting all of the following criteria: crops that have their origin and commercial growing areas (when such exist) in the tropics or subtropics, plants that are evergreen and perennial, crops with a limited degree of frost resistance, and plants whose growth is practically nonexistent below 50ºF (10ºC) (with some exceptions according to species and individual age). A distinction between tropical and subtropical is possible if one considers that tropical species are not only sensitive to temperatures below 68ºF (20ºC) but indeed require a climate with average mean temperatures higher than 50ºF (10ºC) for the coldest month (Watson and Moncur, 1985, p. 3). Additionally most tropicals require humid environmental conditions. Examples of truly tropical crops are traditional fruits native to Southeast Asia, like mangosteen, durian, and rambutan. A good example of a typical subtropical fruit crop is the cherimoya, which when cultivated in cold subtropical areas may suffer some foliage loss during the winter with regrowth in spring. However, some fruit crops can be cultivated equally well in either the tropics or the subtropics, of which the banana and the avocado are the most outstanding examples.

Strictly speaking, the tropics extend between the Tropics of Cancer and Capricorn, at 23° north and south of the equator. But, agronomically speaking, these boundaries are too rigid. Not only do they contain areas, especially at higher altitudes, that do not conform to the climatic characteristics generally assigned to the tropics, but regions outside this belt have coastal areas or insular climates that may exhibit climatic conditions fitting properly in the tropics. This is the reason why some climatologists have extended the region to the thirtieth parallels (Nakasone and Paull, 1998, p.1). In any event the main feature associated with the tropics is not so much that of heat but rather steady warm temperatures throughout the year. J. A. Samson (1986, p. 1) gave a good working definition of the tropical climate: temperature averages around 80.6ºF (27ºC), with the warmest month being only a few degrees higher than the coldest and temperature differences between night and day, at any given time, being greater than those between winter and summer, and, finally, little variation in day length, with the longest day being less than thirteen hours long. In comparison, the subtropics have hotter summers and cooler winters. Humidity is also generally lower. Day length differences become greater with increased latitude. The limit for the subtropics is the isotherm of 50ºF (10ºC) average for the coldest month (Nakasone and Paull, 1998, p. 12).

Hundreds of tropical and subtropical fruits exist, but only some fifty are well known throughout most of the world (Martin et al., 1987, p.1). These are important production crops (see Box 1), although a considerable gap exists between world per capita consumption (54.9 kilograms per year) and estimated consumption saturation (about 100 to 120 kilograms per year) (Jansen and Subramanian, 2000). Production and trade figures allow the division of tropicals and subtropicals into three main categories (Galán Saúco, 1996) with some overlapping.

1. Major fruits, such as banana and plantain, citrus, coconut, mango, and pineapple.
2. Minor fruits, such as abiu, atemoya, avocado, breadfruit, carambola, cashew nut, cherimoya, durian, guava, jaboticaba, jackfruit, langsat, litchi, longan, macadamia, mangosteen, papaya, passion fruit, pulusan, rambutan, sapodilla, soursop, and white sapote.
3. Wild fruits belonging to diverse botanical families. These are not cultivated commercially in any country and are much in need of characterization, conservation (both in situ, including on farm, and ex situ), selection, and breeding.

Major-category fruits are cultivated in most tropical (and subtropical) countries and are well known in both local and export-import markets. Minor fruits are not so extensively cultivated, and consumption and trade tend to be more limited, both geographically and quantitatively. However, many are of considerable economic importance in their respective regional markets, as is the case with carambola, durian, and mangosteen, which are major fruits throughout Southeast Asia (Anang and Chan, 1999).

TABLE 1

Production of major tropical and subtropical fruits in 2000

Fruit	World production (x 1,000 t)	Important producing countries
Orange	66,055	Brazil, United States, India, Mexico, Spain, China, Italy, Egypt, Pakistan, Greece, South Africa
Banana	58,687	Burundi, Nigeria, Costa Rica, Mexico, Colombia, Ecuador, Brazil, India, Indonesia, Philippines, Papua New Guinea, Spain
Coconut	48,375	Indonesia, Philippines, India, Sri Lanka, Brazil, Thailand, Mexico, Vietnam, Malaysia, Papua New Guinea
Plantain	30,583	Colombia, Ecuador, Peru, Venezuela, Ivory Coast, Cameroon, Sri Lanka, Myanmar
Mango	24,975	India, Indonesia, Philippines, Thailand, Mexico, Haiti, Brazil, Nigeria
Papaya	8,426	Nigeria, Mexico, Brazil, China, India, Indonesia, Thailand, Sri Lanka
Avocado	2,331	Mexico, United States, Dominican Republic, Brazil, Colombia, Chile, South Africa, Indonesia, Israel, Spain
Pineapple	13,455	Philippines, India, Indonesia, China, Brazil, United States, Mexico, Nigeria, Vietnam

SOURCE: http://www.fao.org.

Botanical Aspects

Tropical and subtropical fruits include not only woody plants, such as the mango or the orange, but also herbaceous crops like the banana and vines like the passion fruit. Most botanical families can lay claim to at least one species of tropical or subtropical fruit. Franklin Martin and colleagues (1987) list some 137 families, and the best known are in Box 2.

From the botanical point of view, a fruit is the structure developed from flowers or inflorescences. In most cases the fruit consists only of the developed ovary, but it may include other parts of the flower, such as the pedicel, sepal, or receptacle, or even a portion of the seed stalk. As with temperate crops, many different fruit types appear among the tropicals and subtropicals, from single fruits, including berries, such as the avocado or orange; drupes, such as the mango; pomes, such as the loquat; capsules, such as the durian; nutlets, such as the litchi and the longan; to compound fruits, as in the typical syncarpium of the pineapple; or even a bunch of individual berries, as in the banana. To differentiate fruit crops from perennial vegetables whose fruits are also eaten, it is necessary to keep in mind that in a horticultural sense a fruit is something that is normally eaten fresh and out of hand. A number of exceptions exist, like the breadfruit and the plantain, considered fruits by all but only palatable when cooked, as if they were vegetables. Nuts, obviously not eaten out of hand, and some tree crops whose seeds are the only part eaten, are also included among tropicals and subtropicals in most horticultural books and as such are included in this entry.

TABLE 2

Best-known tropical and subtropical fruits and their botanical families

Family	Common names of species
Anacardiaceae	Mango, Cashew
Annonaceae	Cherimoya, Guanábana, Custard apple
Bombacaceae	Durian
Bromeliaceae	Pineapple
Cactaceae	Pitaya
Caricaceae	Papaya
Ebenaceae	Caki
Guttifferae	Mangosteen
Lauraceae	Avocado
Malphigiaceae	Acerola
Meliaceae	Langsat or Lanson
Moraceae	Breadfruit, Jackfruit
Musaceae	Banana, Plantain
Myrtaceae	Guava
Oxalidaceae	Carambola
Palmaceae	Coconut, Date
Passifloraceae	Passion fruit, Granadilla
Proteaceae	Macadamia
Rosaceae	Loquat
Rutaceae	Orange, Grapefruit, Mandarin
Sapindaceae	Litchi, Longan, Rambutan
Sapotaceae	Chicosapote, Lucuma
Solanaceae	Sweet pepino, Lulo, Tamarillo

Areas of Origin and Spread

Although most of the continents, including the islands throughout the Pacific, have contributed tropical and subtropical fruits (see Box 3), most of the best-known ones came from the tropical and subtropical regions of America (for example, papaya, avocado, pineapple, guava) and Asia (for example, orange and most citrus fruits, mango, banana, litchi). Only two commercially important fruits originated in Oceania, the macadamia in Australia (specifically Queensland) and the coconut in the Pacific, the latter to the extent that its origin is considered pantropical (Martin et al., 1987, p. 47). The only important fruit native to the African continent is the date. Europe, with no tropical and limited subtropical areas, has none.

Spread to the regions surrounding their areas of origin probably began early, as soon as humans realized their value in terms of nutrition and the variety they could add to the primitive diets of the time. The potential of some species to provide not only food but also shelter or clothing (some types of banana), wood, and medicine hastened distribution.

An outstanding example is the mango. Native to the Indo-Burman region, by the end of the fourth century C.E. it had spread to all the tropical countries of Southeast Asia (Galán Saúco, 1999, p. 36). The Arabs were apparently responsible for its spread to the east coast of Africa around 700 C.E. as an adjunct to their slaving ventures. Just as Malaysians introduced the banana to Madagascar some two centuries earlier, Islamic domination brought the orange to the Mediterranean and southern Europe. Crops from the Americas are not as well documented, but archaeological findings have shown connections between the cultures of Mexico and Peru dating as far back as 1000 B.C.E. (Purseglove, 1968, p.12), giving a solid opportunity for some tropical and subtropical fruits to spread around the warmer American lands.

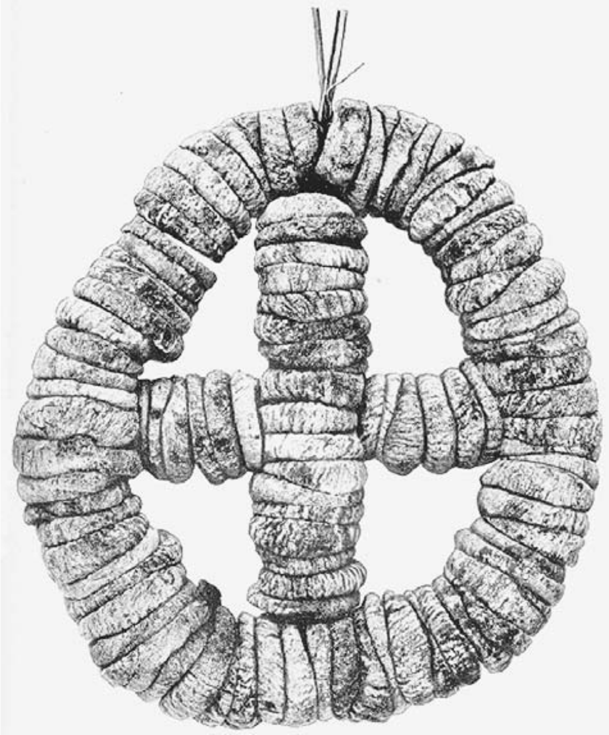
Soon after the European discovery of America, the Old and New Worlds rapidly exchanged crops. The sixteenth-century monk Bartolomé de las Casas mentioned that orange seeds were carried from the island of La Gomera (Canary Islands, Spain) to Haiti on Christopher Columbus's second voyage in 1493 (Amador de los Ríos, 1851–1855, vol. 1, p. 3). It is similarly well documented that the banana was carried to Santo Domingo from the Canary Islands in 1516 (the Canaries were a routine last port of call for European ships facing an Atlantic crossing). After Columbus's voyages, a veritable avalanche of expeditions explored all corners of the world, and where the ships went, food went also, to say nothing of tasty fruits and easily propagated species. Between 1500 and 1650 Portuguese sailors connected Brazil and the Cape of Good Hope, touching Goa, Malacca, the Moluccas, Canton, and Macao, trading from there with Japan and Formosa. The Spanish Manila galleon route dominated shipping from 1565 to 1815, plying the seas between the Philippines and Mexico. Dutch, British, and French voyagers were also important in spreading tropical fruits around the world.

No hard and fast rule explains why some fruits spread quickly throughout the world while others remain limited in scope even in the twenty-first century. Several factors may be involved, among them crop adaptability, shelf life, ease of propagation (including the capacity to survive long voyages), size of the plant, multiplicity of uses (that is, other than as fresh fruit), and taste acceptance.

The excellent taste of the pineapple, the long-lasting viability of the plant's suckers as planting material, and the rapidity with which it produces fruit all account for its prompt appearance in Europe—albeit in glasshouses—and India as early as 1548 (Nagy and Shaw, 1980, p.16; Galán Saúco, 2001). Similar considerations apply to the banana and the papaya and even to woody perennial trees like the mango or the guava, which soon spread throughout the tropics and subtropics, even though their size precluded cultivation in greenhouses outside these areas. On the other hand true tropical trees are usually demanding in climate and in some cases are difficult to propagate. The mangosteen, rambutan, and durian (this last deemed by many people to have a peculiar taste) have remained confined almost exclusively to their area of origin in Southeast Asia. The mangosteen is notable among tropical fruits in that it has proven particularly intractable to most attempts to establish it outside of its area of origin via the usual method, which is selection or breeding of cultivars capable of adapting to environments different in climate or edaphic conditions. The species consists of a single genotype, which in essence means no genetic variation exists with which to breed or improve stock, and it is entirely possible that its evolution has ceased (Yaacob and Tindall, 1995, p. 25).

Nutritional and Medicinal Value

Despite the relatively low caloric values of tropical and subtropical fruits (banana and plantain and avocado are the notable exceptions), they play an important role in human diet mainly because of their high and diverse vitamin and mineral content. This has been of capital importance in the tropics, where people have been consuming them since ancient times, either by collecting fruit from the wild or by cultivating plants in kitchen gardens. They have become an important part of the diet of people in the developed countries of the world, especially among the health and fitness conscious. In a properly balanced diet, tropical and subtropical fruits may be an excellent component for the sports-oriented person. This is not to say that one can live by tropical fruits alone or that they can be considered staple fruits within the diet (again the banana and especially its relative the plantain are the exception in some tropical areas). But nutritionists have long recommended a minimum of one hundred grams of fruit per day and that it be as varied as possible. Toward the end of the twentieth century market campaigns commonly recommended consumption of five fruits per day, which, while it may have more to do with commerce than with science, does reinforce the value of fruit as a part of the human diet.



A traditional Greek fig wheel, showing the manner in which figs were dried and shipped since ancient times. This photograph dates from 1910. ROUGHWOOD COLLECTION.

Tropical and subtropical fruits also have some medicinal properties. Many tropical fruits, notably the mango and the papaya, are a good source of carotene (provitamin A). An indication of the high content of this vitamin is the orange-yellow color of the flesh. Others, like all citrus fruits and the guava, are well known as good sources of ascorbic acid (vitamin C). In general they are not a good source of the B group of vitamins (thiamine, riboflavin, and niacin) except for nuts, which are also a good source of vitamin E, proteins, and fats (Martin et al., 1987, p. 7). Tropical and subtropical fruits are also rich in pectin, fiber, and cellulase, which promote intestinal motility. In common with other fruits, they are good sources of antioxidants, and some are also good sources of organic acids, which stimulate appetite and aid digestion.

Values for the chemical composition of tropical and subtropical fruits are widely available in many texts, some of which are included in the bibliography cited here, but the salient points related to general nutritional value follow. Banana is a good source of vitamins A, B, and C and riboflavin. Together with the tropical and subtropical nut fruits, the banana has the highest calorie content. It is low in protein and fat and rich in potassium. Easy to digest, it constitutes an excellent food for young and old alike and is recommended for athletes. Avocado has a good oil content (of the different avocado races, the West Indian types have the lowest) composed of highly digestible unsaturated fatty acids, and it is rich in folic acid. Some cultivars contain good quantities of proteins, vitamin A, riboflavin, and phosphorus.

All citrus fruits have fairly high amounts of vitamin C, as does the guava, which in turn contains fair amounts of niacin and iron. The papaya has high quantities of vitamins C and A as well as potassium and calcium, and it is low in carbohydrates. However, its outstanding feature, which distinguishes the papaya from all other fruits, is the fact that it contains papain, an enzyme that promotes digestion (although papain content does decrease as the fruit ripens). It is highly recommended for people with certain digestive disorders. The mango is rich in provitamin A and carbohydrates and is an acceptable source of vitamin C. The same is true of the passion fruit, which additionally has acceptable quantities of niacin. The pineapple is also rich in vitamin C and carbohydrates and is a good source of calcium, phosphorus, iron, potassium, and thiamine.

The litchi and the longan, most of the Annonaceae, and the durian are all good sources of carbohydrates and vitamin C. The durian also has fair amounts of iron and niacin. The mangosteen is considered by many to be one of the finest tasting fruits of all, according it the title of "queen of fruits" (Yaacob and Tindall, 1995, p. v). It is one of the lowest in nutritive value, but even so it can boast moderate quantities of calcium, phosphorus, ascorbic acid, and carbohydrates. The carambola is low in calories and rich in vitamin C, and it is an adequate source of vitamin A. It is prohibited for people with kidney problems (specifically stone formation) due to its high oxalic acid content, but new cultivars have been selected for lower oxalic content while maintaining sugar and vitamin levels (Galán Saúco et al., 1993, p. 5).

The macadamia nut is rich in protein, oil, iron, calcium, thiamine, riboflavin, and niacin. The subtropical date also has a high nutritive value. Rich in carbohydrates, it is a good source of vitamin A, potassium, and iron but is low in oils and sodium. The coconut is high in phosphorus, iron, proteins, and oils—in this case all saturated fatty acids, the consumption of which should be limited according to health recommendations. Coconut milk aids in balancing pH in the body due to its alkaline reaction.

The medicinal value of tropicals and subtropicals, both the fruits themselves and their actual plant parts (bark, roots, and even pollen), has long been acknowledged by the diverse peoples in and around their areas of origin. These regions are rich in recipes for preparing infusions, decoctions, syrups, pastes, jellies, juices, and so forth for myriad purposes. All the citrus fruits and several others rich in vitamin C are obviously useful to prevent colds and similar infections, while fruits rich in vitamin A prevent dietary deficiencies, such as those leading to blindness. An excellent compilation of popular medicinal uses is in the book *Fruits of Warm Climates* (1987), written by Julia F. Morton, but a few examples follow.

The date has a high tannin content that is reportedly useful as an astringent in intestinal complaints and is good for sore throats, colds, and bronchial catarrh. Breadfruit is reported to reduce high blood pressure. Carambola fruit and pineapple juice are reportedly useful diuretics, while the flesh of the very young fruit of the pineapple is reputedly an abortifacient. The skin of the avocado and extracts of ripe and unripe fruits and seeds of the papaya reportedly have antibiotic properties. In traditional medicine a decoction of young mango leaves is recommended as a remedy for asthma, blenorraghia, and bronchitis. The roots, bark, leaves, and immature fruits of many tropical fruit crops are widely used in the tropics as astringents to stop gastroenteritis, diarrhea, and dysentery. A decoction of the boiled fruit of the sapodilla has also been reported useful in treating diarrhea. The flesh of the longan has been recommended for its febrifuge and vermifuge properties and as an antidote against some types of poisons. The infusion of passion fruit leaves, rich in the glycosid passiflorine, is reported to have sedative properties.

Consumption and Other Uses

The main method of consumption of most tropical and subtropical fruits is as fresh fruit. The breadfruit is the most important exception, as it is only eaten cooked. Nuts can be eaten directly or processed (roasted, candied, and so forth). Salads, both savory and sweet types, are prepared with many fruits. Indeed consumption is virtually as unlimited as the chef's imagination. Jams, jellies, juices (made with fresh fruits, concentrates, or frozen pulp), sauces, ice cream and sherbets, and other desserts and diverse confectionaries are typical of the uses to which tropical and subtropical fruits are put, both industrially and domestically. Infusions as social beverages, not as medicinal remedies, are made from many different fruits.

A specific product is baby food, especially made with "healthy" fruits like the banana or the papaya, based on different kinds of puree (industrially known as aseptic, chilled aseptic, or simply chilled purees). Flour is also made from the durian and the banana. Pickles and chutneys are made from many fruits, the most famous of which is mango chutney, a staple in Indian cuisine and highly esteemed by gourmets. Dips are also popular in many countries, of which perhaps the best known is avocado-based guacamole. Guava paste or spread is consumed, usually with bread and cheese, in many countries, particularly Cuba, Brazil, and the Canary Islands.

Besides their edible and pleasant fruits, the actual plants of several tropical and subtropical fruit crops are also put to good use. Descriptions of the many properties of parts other than fruits—wood, leaves, flowers, roots, seeds—are frequently dealt with in older texts (including, among others not yet mentioned, Popenoe, 1974 [1920]; Chandler, 1958; Singh, 1960; Purseglove, 1968; Ochse et al., 1972; Coronel, 1983), but a clear dearth of in-depth studies on many of these aspects is apparent. The potential of leaves or flower extracts as biological products for use against pests and diseases is in much the same situation and is an issue relevant to organic produce, of increasing importance to concerned consumers. Some outstanding examples of alternative uses follow.

Religious uses. Some orchards of date palms in the Mediterranean are maintained solely to supply young leaves used on Palm Sunday during the Christian Easter week.

Oils, perfumes, and the like. An essential oil is extracted from some citrus species, particularly from certain oranges and their flowers. Avocado oil, occasionally used for cooking, is a commercial product in some countries. Soaps, bath gels, and shampoos include extracts from different tropical and subtropical fruits. Loquat seed oil is used in soaps and paints.

Animal feed. Banana leaves, pseudostems, and fruits are fed to goats in several countries, particularly in the Canary Islands (Galán Saúco, 2001). Dried dates and their pits, breadfruit leaves, and mango seed kernels are used as feed in several countries. In India, Gandhi recommended using peanuts and mango seed kernels rather than expensive cereals and imported fodders (Galán Saúco, 1999, p. 44).

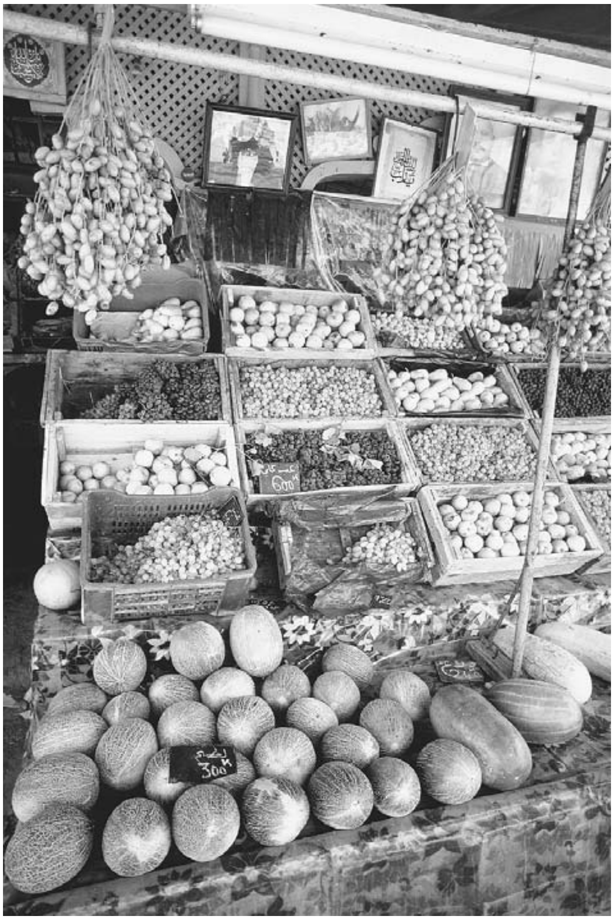
Textiles and paper. Fibers from pineapple and banana leaves are used in several places for papermaking and cloth, notably in the Philippines to make the typical loose-fitting shirts called guayaberas.

Handicrafts. Mature date palm leaves and avocado wood are excellent for decorative carvings.

Construction and furniture. The wood of breadfruit, citrus in general, guava, longan, mango, and mangosteen are regularly used for interior paneling or for furniture. The wood of the caki is highly prized. Banana and date palm leaves are a traditional roofing material in many regions.

Firewood. Orange wood is long lasting, while avocado wood is highly combustible. Mango wood is held in high esteem in Bangladesh, to the extent that the locals consider the best trees those that faithfully provide both wood and fruit (Galán Saúco, 1999, p. 44).

Other uses. For many years chewing gum (chicle) was made from sapodilla latex. Although the industry subsequently began to use artificial substances, the trend in favor of organic products may signify a return to traditional chicle. Garden brooms are made out of the stripped fruit clusters of the date palm. Fishermen in the Pacific have used the coconut as a fishing aid, chewing the coconut meat and spitting the resulting mass onto the water to produce a glossy calm spot, smooth enough to allow a brief glimpse of the fish below the surface (Hawaii).



Dates, figs, jujubes, citrons, oranges, pomegranates, and a rich array of other fruits crowd this enticing stand in the market at Kairouan, Tunisia. © DAVE BARTRUFF/CORBIS.

The potential for development of tropical fruits does not rely only on consumption. Planting tropical fruits for agroforestry and for urban horticulture are important endeavors. In fact tropical countries like Malaysia encourage and promote intercropping of suitable perennial fruits with compatible forest species (Anang and Chan, 1999). Many tropical fruit trees make beautiful ornamental plants not only capable of improving air quality but also capable of contributing to ecological stability. They are easy to handle in gardens or in industrial or community buildings and are adequate for planting along country roads. These considerations may involve new lines of research, particularly searching for cultivars that can be oriented toward wood (or flower) production. As indicated at the World Conference on Horticultural Research (WCHR) held in Rome in June 1998, international agencies and local authorities should work together with university and government scientists to promote the

Dates

The date palm (*Phoenix dactylifera*) has been cultivated in the Middle East since ancient times, where it has assumed a role as more than simply a source of food and become culturally associated with Islamic culture. In the words of the Prophet Muhammad, “There is among trees one tree which is blessed . . . it is the palm.”

The date palm is adapted to areas with long, very hot summers with little rain, low humidity, and abundant underground water. This is expressed by the saying that the date palm “must have its feet in running water and its head in the fire of the sky.” These conditions are found in oases and river valleys in the arid subtropical deserts of the Middle East, the area of origin of the date palm. This is the “Fertile Crescent,” where agriculture in the Old World is thought to have arisen. The date palm has been cultivated in this area since about 7000 B.C.E., and was possibly one of the first crops domesticated. By 2000 B.C.E., date palm culture had spread to Palestine, Arabia, Egypt, North Africa, and western India.

Date palms or their wild progenitors were undoubtedly used by man even before actual cultivation began. A date palm oasis must have been a welcome sight to those crossing the desert. Here were water, shade, and fresh and dried fruits high in carbohydrates. The dried fruits were easily stored and transported after leaving the oasis. The date palm also supplied building material, fiber, fuel, animal feed, honey (syrup), and wine.

The date palm had great spiritual and cultural significance to peoples of the region. It is depicted on many ancient tablets, bas-reliefs, and so forth. The date palm is mentioned a number of times in Jewish and Christian writings, but achieved its greatest esteem in Islamic culture. The date palm was consecrated by Muhammad in both his public and private life, and is prominently mentioned in the Koran and in other Islamic writings. Date consumption spread from Arabia along with Islam, and dates are now eaten by Muslims in areas unsuitable for their production, such as Indonesia and Thailand. Date culture eventually spread to non-Islamic countries with suitable growing conditions, but its culture and consumption in these areas is minor compared to that in the Islamic world.

In the early twenty-first century, the Middle East is still the center of date production and consumption. The largest producers of dates are Egypt, Iran, Iraq, and Saudi Arabia. Most dates are consumed locally, but there is some export, mostly to other Islamic countries that do not have suitable growing conditions. Production of dates is highly specialized and labor-intensive. There are great variations in date growing practices: from traditional oasis culture to modern industrial plantings. The United States has led the way in mechanization of date production, but this practice is spreading to other countries as they modernize.

There are thousands of local varieties of dates grown in the Middle East. Other countries have a more limited number of varieties derived from a few importations. Recently, *barhee* and *medjool* have become increasingly prominent due to their use as foundation materials for tissue-cultured plants. The use of tissue-cultured plants has become common in some countries as the increase in land area devoted to date culture has expanded beyond that which can be planted with offshoots, the traditional method of propagation.

Dates are consumed fresh or in processed form. Fresh market dates are divided into dry, semidry, and soft varieties. In Middle Eastern countries, they are also eaten in the early *khalal* stage. Dates are nutritious, being high in carbohydrate and fiber. In most varieties, the sugar content is mostly invert sugar (glucose and fructose), with only low levels of sucrose. Processed products are more common in the Middle East, where large amounts of dates are produced, than they are elsewhere. Processed products include sugars, pastes, flours, preserves, syrups, and fermentation products.

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utilization of horticultural plants in large metropolitan areas (Gosselin et al., 1999).

Commercialization and Trade

In addition to citrus and the banana, four other tropical and subtropical fruits, pineapple, mango, avocado, and papaya, dominate the fresh fruit export trade (see Box 4). Pineapple clearly leads the ranking in processed fruits with a wide range of products, although juice and rings in syrup are the best known.

Many other tropical and subtropical fruits are no longer exotic products in world markets, having become firmly established with guaranteed supply and reasonable prices. Carambola, guava, litchi, mangosteen, passion fruit, and rambutan have experienced notable development. The main importers of most of these tropical and subtropical fruits are the European Union, the United States, Japan, Canada, and China.

Exports of fresh fruits are mainly by ship or surface transport. Postharvest techniques for extending the shelf life of most tropical and subtropical fruits have been mastered, and refrigerated boats (some even providing controlled atmosphere installations) move these commodities from production countries to their ultimate markets with ease. A small proportion of the major fruits, particularly pineapple, mango, and papaya, are transported by air, either destined specially for gourmet or niche markets or for celebrations at certain times of the year, such as Christmas and New Year's, when they command higher prices. Some of the minor crops, still considered exotics, like the mangosteen and the rambutan, have a more difficult postharvest life and therefore are exported by air.

Many countries from virtually all the continents have designated specific areas for production of fruits destined purely for export. Those countries include India, Malaysia, Thailand, and China in Asia; the Philippines and Australia in Oceania; South Africa and Ivory Coast in Africa; Mexico, Brazil, the United States, Peru, Costa Rica, and Chile in North and South America; Spain in Europe; and Israel.

While banana, pineapple, and citrus have a long history of international trade, the avocado trade burst upon the scene in the 1970s. The mango did not become a well-known fruit (from a consumption point of view) until the 1990s, with Mexico as the leading exporter. The papaya and the litchi may still revolutionize trade.

Of particular relevance for the development of tropical and subtropical fruit trade is the World Trade Organization (WTO) agreement in Marrakech on 15 April 1994 following the conclusion of the Uruguayan round of General Agreement on Tariffs and Trade (GATT) talks. Basically these agreements established the principle of free trade not exposed to arbitrary market entrance taxes, and obligate signatory countries (in practice most of the world) to use only sanitary and phytosanitary quarantine measures based on solid scientific information, thus effectively halting the use of these measures as a loophole to arbitrarily restrict imports.

As in other commodities, an interesting market is developing for organically produced tropical and subtropical fruits, and organic pineapples and bananas are available in Western markets.

International Forum on Tropical and Subtropical Fruits

Many organizations and horticultural societies at national and international levels are dedicated to particular tropical or subtropical fruits (or a closely related group). Their members include amateurs, growers, researchers and academics, handlers, traders, and consumers. By reason of both magnitude and global concern, some of these merit special mention.

The International Society of Horticultural Science (ISHS), headquartered in Louvain, Belgium, has established a Commission of Tropical and Subtropical Horticulture with working groups in specific tropical and subtropical fruits. The ISHS meets regularly in different countries to discuss aspects of production, research, and trade of these fruits, and it holds an international congress every four years, which congregates a minimum of four thousand people.

The Interamerican Society of Tropical Horticulture was formerly known as the Tropical Region of the American Society of Horticultural Science. It holds annual meetings in different American countries with tropical crops to discuss the same issues mentioned above but including vegetables and ornamental plants.

The Intergovernmental Group on Bananas and on Tropical Fruits, under the auspices of the Food and Agriculture Organization of the United Nations (FAO), meets every two years to discuss issues related to marketing and trade.

See also **Banana and Plantain**; **Durian**; **Nuts**; **Vegetables**.

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Víctor Galán Saúco

FRYING. Fried foods, though widely considered indelicate, are also among the most ephemeral. Regarding fried foods, a Chinese proverb states: It is better that your guests wait for their meal, than that the meal wait for the guests. Fried dishes cannot wait, and if allowed to stand, rising interior steam causes them to lose their crisp exterior and, thereby, their character.

Frying is a means of heat transfer that works by both conduction (direct contact) and convection (the natural movement of molecules in a fluid). Like broiling, boiling, and baking, frying is a method of cooking, but unlike water-based cooking (boiling, braising, or steaming), frying uses dry heat. Oil wicks moisture away from food surfaces. Because oil heats to a higher temperature than water, frying is faster than boiling, and fried surfaces, rather than becoming soft as they do when boiled, broiled, or steamed, coagulate. The resulting fried food is incomparably tasty, crisp, and beautiful. Frying comprises not only deep-frying and pan-frying, but also the cooking method used to prepare common foods such as pancakes and fried eggs as well as less-known foods such as the Indian dish *dalia uppma*, an herbed bulgur with fried vegetables. Most, but not all, of the world's cultures have practiced frying.

Some fried foods are so popular that they can be identified as cultural stereotypes. American french fries and Middle Eastern falafel (chickpea or fava bean fritters) are examples. Native Americans of the Southwest are known for fry bread, and corn dogs are associated with New York's Coney Island. The American South has southern fried chicken, while in Asia, sweet potatoes are fried and served from vendors' carts. In Mexico, on the *zócalo* (the central square), vendors working from carts sell *churros*, a deep-fried pastry.

Advantages and Disadvantages

Through the ages, frying has remained popular because it adds an outside layer of flavor and crunch to soft foods, such as eggplant and okra. In addition, frying cooks and browns beautifully. It adds texture and yields the smooth and taste-imparting feel that comes only from various oils and fats.

On the negative side, the process of deep-fat frying is dangerous and requires special equipment and controlled environments. To avoid the overflow of hot oil from the pan, large temperature-controlled deep fryers are used, and these pans are filled only about one-third of their depth with oil. In addition, to maintain the desired high temperature, deep fryers are not filled with food, but rather, food is fried in small batches. Moist foods are not placed in hot oil because they cause boiling and popping, which can be dangerous. To avoid burns and fires protective gloves and clothing, long-handled utensils, as well as fire extinguishers and baking soda, are used. Unlike water, oil can catch on fire, and oil fires spread quickly. If a pan of oil catches fire, the pan is covered with a lid, doused with salt, or sprayed with a fire extinguisher. A stream of water is not effective in dousing an oil fire.

The use of oils and fats has also become a health concern. Those who support frying claim that with fast, clean frying, only a small amount of oil remains on the food, and certain oils and fats are healthier than others. Olive oil and canola oil, monounsaturated vegetable oils, are recommended for human consumption, while saturated oils, such as palm and coconut oil, or saturated fats, such as butter or lard, are not recommended. Canola oil is considered good for one's health because of its ratio of linoleic acid (an omega-6 fatty acid) to linolenic acid (an omega-3). A balance of omega-6s and omega-3s is an asset to health, with other oils often lacking the omega-3s. Canola oil offers the best balance for omega-3 and omega-6 fatty acids.

Methods of Frying and Equipment

Frying methods include sautéing, stir-frying, pan-frying, and deep-fat frying. These styles of frying form a continuum based on the amount of oil used, with sautéing using the least oil and deep-fat frying using the most.

Each of the principal frying methods is associated with a particular pan. Pan-frying is practiced in stainless steel, aluminum, and heavy cast-iron skillets, all with sloping sides. To sauté, there exists a French sauterne or sauté pan, which is wide like a skillet, but has low and straight sides. Deep-frying occurs in the deep fryer or wok, with either a fry basket insert, the long-handled slotted skimmer, or, as in China, the spider (small basket) attached to a long bamboo handle. Deep-frying thermometers are used to help the cook maintain a constant temperature. Finally, when fried foods, such as bacon or potato chips, are removed from the oil, they are placed on drip racks or paper towels. Deep-fat fryers are available in many sizes, from large multigallon commercial vats to small personal fryers that hold two or three cups of oil.

Other frying pans, too, are associated with specific foods. In crêpe pans, thin pancakes are cooked in a style associated with classical French cooking. Round or oval omelet pans are used to fry omelets. Heavy cast-iron chicken fryers are deep pans that include nippled lids that allow moisture to drip back onto the frying chicken. Restaurant kitchens often fry eggs, pancakes, sausages, and sandwiches on large steel frying surfaces called griddles, but home cooks can purchase small, hand-held griddle pans for the same purpose.

With a wok, many foods are stir-fried in the style of several Asian traditions. Woks are available as self-contained electric units or as wide, deeply sloped circular pans that fit over a gas flame. They are often sold with lids so that foods can be steamed for part of the cooking time. Before vegetables, seafood, poultry, or meats are added to the stir-fry pan, a small amount of oil is heated to a high temperature. In China, where stir-frying is an ancient tradition as well as a modern art form, small pieces of food are placed in a large pan over intense heat, and they are stirred quickly as they cook.

Oils and Fats

Frying fats may be solid or liquid. In selecting an oil or fat, the oil should be fresh and clean. Its flavor should not overpower the food being cooked, and monounsaturated vegetable oils have been recommended for presumed health reasons. Solid vegetable shortenings contain emulsifiers, which make them good for use in cakes, but poor for frying. The emulsifiers lower smoke points to about 370°F. Margarine and butter spreads are also not recommended for frying as they contain a variety of fats and even water.

Butter is a special case, as it adds much-valued flavor to many foods. Butter, however, until it is clarified, contains milk solids and burns at about 250°F. When the solids are removed by clarification, butter is an improved medium for frying, and its smoke point rises to 375°F. In India, both solids and water are removed from butter, and the resulting ghee or *usli* ghee is used for pan- and deep-frying. Lard as well as chicken, duck, and goose fats are also used successfully for frying. They impart excellent flavor but prompt health concerns among some researchers.

The purest flavor and safest frying are achieved when oil and fats are used one time. If frying is continuous for long periods, the oil requires changing, as it begins to darken or deteriorate. If frying oil is too hot, it will burn or break down, and if too cold, or less than about 300°F, the food being fried will absorb too much oil and become greasy.

Smoke Points

Frying is faster than boiling or steaming because oils get hotter than do water or steam. Smoke points, however, limit maximum possible frying temperatures. Oil is too hot when it reaches the smoke point, the temperature at which the oil starts to smoke, deteriorate, and burn. Too much heat causes gaseous fumes and chemically active, free fatty acids to negatively impact flavor. Maintaining the optimum temperature can be challenging, as each time oil is used, it picks up food particles, breaks down, and loses its ability to absorb heat. In addition, over-used or rancid oil smells and tastes bad.

Oils deteriorate by oxidation or contact with the air, and heat speeds this process. Thus, in storage and cooking, contact with air should be minimized. For deep-frying, a deep and narrow pan is better than a shallow, wide one because it allows for less air contact.

Suitable frying oils have high smoke points; the higher the smoke point, the faster the cooking. Depending on the oil, smoke points range from a low 250°F to a high 520°F. For example, while water boils at 212°F, the favored frying oils such as olive, peanut, and canola have smoke points ranging from 410°F to 437°F and are best heated to 365°F. This temperature cooks food quickly yet does not burn these oils.

Cultural Differences

During the British colonial period, frying spread from Europe to the Americas and Africa. American colonists adapted frying with great frenzy, and in a *Harper's* magazine story of 1866, Americans were said to be eating, "Fried ham, fried eggs, fried liver, fried steak, fried fish, fried oysters, fried potatoes, and last, but not least, fried hash." These preparations, as well as doughnuts, pancakes, and fritters, were served "morning, noon, and night," according to the magazine contributor, who thought that Americans consumed too much fried food.

Due to a lack of either resources or technology, frying was absent from some ancient cultures. Early European scholars writing about the food among the original inhabitants of the New World could not believe that these cultures did not have oil and did not fry. Because these cultures did not have use of rotary motion, they could not reduce their quantities of peanuts or other seeds to oil. While European cultures used round wheels, Native Americans ground maize and other grains with a to-and-fro motion. After Europeans arrived, some Native Americans found the unfamiliar cooking oils and fats repulsive. In modern Latin America, with some exceptions, such as street fair food, fried tortillas, and *pescado frito* (fried fish), frying is not among the significant methods of cooking.

Foods, especially meats, were fried during the first century C.E. in many cultures around the Mediterranean. In Rome the term "frying," or *frigere*, had two meanings, first, the toasting of grains in a dry skillet, and second, cooking in oil. From the eighth to the fifteenth century, fats and frying played an essential role in Arab cooking. Sheep tail fat was a frying delicacy; books from this region and period tell how to extract, clarify, perfume, color, and store this fat, which was used to finish-fry boiled meats. During the same period, Andalusia, Maghreb, and Syria were known for their olive oil, which was exported to Iraq and Egypt. The modern practice of browning, or lightly searing, meats through frying before stewing is described in Arab literature, also from this period. The result of this practice is that outer surfaces are slightly burned, and this enhances the flavor of stews.

Sautéing and Pan-frying

The first step in preparing an Indian curry is to heat a small amount of oil and then quickly sauté a variety of herbs and spices. Similarly, Chinese cooks pre-heat oil, often with garlic, before stir-frying. High heat releases flavor and aroma. Stew meats, for example, are often pan-fried to seal juices and develop surface flavor. In French and American kitchens, sautéing is used to quickly fry vegetables and other foods with little oil.

Pan-frying is the use of a shallow, slope-sided frying pan or skillet to cook in oil. Like deep-frying, it depends on conduction and convection. In pan-frying, a layer of oil has four functions: it lubricates the surface; increases contact between the food and the pan; reduces cooking time; and increases flavor and color.

When frying battered fish or chicken, the oil covers the pan but not the food, but when frying pancakes, the oil is but a thin film to keep the batter from sticking. Asian cooks fry rice with all kinds of meats, seafood, vegetables, and nuts. Chinese fried rice is pan-fried in a skillet with very little oil, perhaps one tablespoon per cup of rice. The challenge of pan-frying thick items such as chicken parts is to cook to the center without burning the surface. The Chinese have effectively solved this problem by slicing foods thin enough so the surface and interior cook in the same time.

Deep-Fat Frying

With deep-fat frying, foods are submerged in hot oil. Because of the expense of the oil or because of the difficulty of this method, deep-frying is associated with celebrations, festivals, and street carnivals. American street fair vendors commonly serve deep-fried corn dogs, elephant ears, and funnel cakes. Deep-fat frying, also called deep-frying, is popular for breads, like southern cornmeal hush puppies, as well as for battered food, such as seafood or vegetables. Some food categories such as tempura, croquettes, and fritters are always deep-fried.

In India, *poori* breads are deep-fried, while *paratha* breads of whole wheat, potato, pea, chickpea, and corn are both griddle- and shallow-fried. *Poori* bread is a puffed up whole-wheat bread, much like *chapati*, another Indian bread that rather than being deep-fried is fried or "baked" on a griddle.

While European and Western cooks deep-fry with a single frying, the Chinese deep-fry in stages. After being marinated, foods are then deep-fried at a low temperature, maybe 290°F, and later finish-fried at a high temperature, 365°F to 385°F. This staged cooking increases crispness and color.

Batters reduce surface moisture, and a dryer surface reduces initial boiling. In addition, batters add color, flavor, and texture to many deep-fat fried foods, with green tomatoes, eggplant, okra, and even ice cream being examples of foods that are battered before they are fried. A meunière is a thin, light breading, or flour dusting, often used on fish and popular in traditional French kitchens. But batters can also be thick, as in the case of double, triple, or breaded coatings used for fried fish and chicken.

In summary, frying is quite expensive, somewhat controversial, almost universal, and very pleasing. The quick removal of moisture from food surfaces through the wicking effect of hot oil is a cooking method that will remain popular in homes and restaurants and at public events.

See also **Baking; Boiling; Broiling; Butter; Fats; Oil; Roasting; Stew; United States: The South; Utensils, Cooking.**

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FUNCTIONAL FOODS. The term "functional foods" refers to foods and their components that may provide a health benefit beyond basic nutrition. Functional foods do more than meet minimum daily nutrient requirements—they also can play a role in reducing the risk of disease and promoting good health. Biologically active components in functional foods impart health benefits or desirable physiological effects.

All foods have a function when consumed in proper balance as part of an overall healthy diet. Functional foods may include whole foods, such as fruits and vegetables, which represent the simplest example. Those foods that have been fortified, enriched, or enhanced with nutrients, phytochemicals, or botanicals, as well as dietary supplements, also fall within the realm of functional foods.

The functional attributes of many traditional foods are only now being discovered. Examples include phytoestrogens in soy foods and a variety of antioxidants in fruits and vegetables, such as lycopene in tomatoes. Still, new food products are being developed with beneficial components, with a focus on wellness and the reduced risk of chronic disease (i.e., foods and beverages containing pre- and probiotics to maintain gastrointestinal health, calcium-fortified beverages to maintain bone health, and dressings and spreads containing plant stanol and sterol esters, which may decrease the risk of heart disease).

History

Over two thousand years ago Hippocrates said, "Let food be thy medicine." Although the concept of functional foods is not entirely new, it has evolved considerably over the years. In the early 1900s food manufacturers in the United States began adding iodine to salt in an effort to prevent goiter, representing one of the first attempts at creating a functional food through fortification.

Other twentieth-century examples include vitamin A and D fortification of milk and niacin and folic acid fortification of grains. These early fortification examples, however, focused on reducing the risk of diseases of deficiency. In the latter part of the twentieth century, consumers began to focus on wellness and the reduction of chronic disease. Research now focuses frequently on the promotion of health through many lifestyle factors, including the consumption of an optimal diet. As of 2002, researchers have identified hundreds of food components with functional qualities, and they continue to make new discoveries surrounding the complex benefits of phytochemicals in foods.

Demand

Consumer interest in the relationship between diet and health has increased the demand for information on functional foods. Rapid advances in science and technology, increasing health-care costs, changes in food laws affecting label and product claims, an aging population, and a rising interest in attaining wellness through diet are among the factors fueling U.S. interest in functional foods. Credible scientific research indicates many potential health benefits from food components. These benefits could expand the health claims now permitted by the U.S. Food and Drug Administration (FDA).

WHAT IS THE RELATIONSHIP BETWEEN FOOD BIOTECHNOLOGY AND FUNCTIONAL FOODS?

Although many of the nutritional compounds in functional foods are either naturally present or added during processing, some may be the result of agricultural breeding techniques, including conventional crossbreeding and, in the future, food biotechnology.

Crossbreeding to produce a plant for a specific genetic trait, such as higher sulforaphane-containing broccoli, can take as long as a decade or more. Modern biotechnology, however, makes it possible to select a specific genetic trait from any plant and move it into the genetic code of another plant in a much shorter time span, and with more precision than crossbreeding allows.

Researchers are working with farmers around the world to develop dozens of functional foods through the use of this promising technology. For example, a high-oleic acid soybean oil has been developed through biotechnology to have the health benefits of soybeans (possible protection against heart disease) without the saturated fat content of other cooking oils. Other research holds promise for boosting levels of beneficial components such as carotenoids in fruits and vegetables.

Consumer Attitudes

The International Food Information Council (IFIC) has been researching awareness of, and attitudes about, functional foods, through both qualitative and quantitative research. In 2002 telephone surveys with U.S. consumers were conducted, building on quantitative data collected in 1998 and 2000.

As in 1998 and 2000, the vast majority of consumers believe that they have a "great amount" of control over their own health. Also, in comparing the effects of nutrition, exercise, and family health history on health, consumers believe that nutrition plays the greatest role (71 percent versus 63 percent and 41 percent, respectively). Therefore, it is no surprise that 93 percent of Americans believe that some foods have health benefits that go beyond basic nutrition and that 85 percent are interested

TABLE 1

Examples of functional components*

Class/Components	Source*	Potential benefit
Carotenoids		
Alpha-carotene	carrots	Neutralizes free radicals that may cause damage to cells
Beta-carotene	various fruits, vegetables	Neutralizes free radicals
Lutein	green vegetables	Contributes to maintenance of vision
Lycopene	tomatoes and tomato products (ketchup, sauces, etc.)	May reduce risk of prostate cancer
Zeaxanthin	eggs, citrus, corn	Contributes to maintenance of vision
Collagen Hydrolysate		
Collagen Hydrolysate	gelatin	May help alleviate some symptoms associated with osteoarthritis
Dietary Fiber		
Insoluble fiber	wheat bran	May reduce risk of breast and/or colon cancer
Beta glucan**	oats	Reduces risk of cardiovascular disease (CVD)
Soluble fiber**	psyllium	Reduces risk of CVD
Whole grains**	cereal grains	Reduce risk of CVD
Fatty Acids		
Omega-3 fatty acids, DHA/EPA	tuna; fish and marine oils	May reduce risk of CVD and improve mental, visual functions
Conjugated linoleic acid (CLA)	cheese, meat products	May improve body composition, may decrease risk of certain cancers
Flavonoids		
Anthocyanidins	fruits	Neutralize free radicals, may reduce risk of cancer
Catechins	tea	Neutralize free radicals, may reduce risk of cancer
Flavanones	citrus	Neutralize free radicals, may reduce risk of cancer
Flavones	fruits/vegetables	Neutralize free radicals, may reduce risk of cancer
Glucosinolates, Indoles, Isothiocyanates		
Sulphoraphane	cruciferous vegetables (broccoli, kale), horseradish	Neutralizes free radicals, may reduce risk of cancer
Phenols		
Caffeic acid		
ferulic acid	fruits, vegetables, citrus	Antioxidantlike activities, may reduce risk of degenerative diseases like heart disease and eye disease
Plant Stanols/Sterols		
Stanol/stanol ester**	corn, soy, wheat, wood oils	May reduce the risk of coronary hear disease (CHD) by lowering blood cholesterol levels
Prebiotic/Probiotics		
Fructo-oligosaccharides (FOS)	Jerusalem artichokes, shallots, onion powder	May improve gastrointestinal health
Lactobacillus	yogurt, other dairy	May improve gastrointestinal health
Saponins		
Saponins	soybeans, soy foods, soy protein-containing foods	May lower LDL cholesterol, contains anticancer enzymes
Soy Protein		
Soy Protein**	soybeans and soy-based foods	1 ounce per day may reduce risk of heat disease
Phytoestrogens		
Isoflavones, daidzein, genistein	soybeans and soy-based foods	May reduce symptoms of menopause, such as hot flashes
Lignans	flax, rye, vegetables	May protect against heart disease and some cancers; lowers LDL cholesterol, total cholesterol, and triglycerides
Sulfides/Thiols		
Diallyl sulfide	onions, garlic, olives, leeks, scallions	Lowers LDL cholesterol, maintains healthy immune system
Allyl methyl trisulfide, dithiolthiones	cruciferous vegetables	Lowers LDL cholesterol, maintains healthy immune system
Tannins		
Proanthocyanidins	cranberries, cranberry products, cocoa, chocolate	May improve urinary tract health and reduce risk of CVD

*Examples are not an all-inclusive list.
** FDA-approved health claim established for component.

in learning more about such foods. These levels of interest have been consistently strong since 1998.

The top ten foods that consumers identify as having a health benefit beyond basic nutrition include broccoli (9 percent), fish or fish oil (9 percent), green, leafy vegetables (9 percent), oranges or orange juice (9 percent), carrots (8 percent), garlic (7 percent), fiber (6 percent), milk (6 percent), calcium (5 percent), oats/oat bran/oatmeal (6 percent), and tomatoes (6 percent). The top five foods have remained consistent for the past three surveys; they are associated with America's top health concerns. Cardiovascular disease factors, including heart disease/attack, high blood pressure, stroke, and high cholesterol, remain the primary collective concern of American consumers. Cancer continues to concern almost a third (30 percent) of all consumers. Other areas of worry include weight (17 percent), diabetes (17 percent), and nutrition/diet (12 percent).

Almost two-thirds (63 percent) of Americans say they are eating at least one food in order to receive a functional health benefit. Although not significantly different from the 2000 results (59 percent), this does represent a significant increase since 1998 (53 percent).

Finally, the terms "functional foods" and "nutraceuticals" are often used to describe foods that may have health benefits beyond basic nutrition. "Functional foods" is preferred over "nutraceuticals" two to one (62 percent versus 31 percent). In reality, all foods have some function even if it is mostly taste and enjoyment. In addition, health benefits can be reaped from an apple, yogurt, or a filet of salmon as much as from calcium-fortified fruit juice or a supplement.

Scientific Criteria

Many academic, scientific, and regulatory organizations are considering ways to establish the scientific basis to support claims for functional components or the foods containing them. FDA regulates food products according to their intended use and the nature of claims made on the package. Three types of claims are allowed on food and dietary supplement labels: (1) structure and function claims describing effects on the normal function of the body; (2) disease risk-reduction (health) claims implying relationships between components in the diet and diseases or health conditions, as approved by FDA and supported by significant scientific agreement; and (3) content claims.

Whereas science can confirm broad connections between some foods or eating patterns and health benefits, it is still not known how all individual food components work and whether there are synergistic effects among compounds. For example, numerous studies suggest that the consumption of a diet rich in whole grains, fruits, and vegetables is associated with a decreased risk of prostate, bladder, esophageal, stomach, and other cancers. However, the interactions among various components in these foods continue to be elucidated. The roles of vitamins, minerals, fiber, antioxidants, and other phytonutrients do not stand alone.

How Can More Functional Foods Be Added to the Diet?

The most effective way to reap the health benefits from foods is to eat a balanced and varied diet, including whole grains, lean meats, low-fat dairy products, legumes, fruits and vegetables, as well as foods with added beneficial components. Watch labels and read articles for information about foods and health. Before deciding to make any major dietary changes, however, take the time to evaluate your personal health and speak to your health-care provider on ways to help reduce the risk of certain diseases. It is also important to remember that there is no magic bullet that can cure or prevent health concerns, even when eaten in abundance. The best advice is to choose foods wisely from each level of the food guide pyramid in order to incorporate many potentially beneficial components into the diet.

A large body of credible scientific research is needed to confirm the benefits of any particular food or component. Although scientific studies point to many functional components in foods that provide added health benefits, more research is needed to determine which components are responsible for the beneficial effects as well as how individual components interact. The scientific community is still in the early stages of understanding the potential for functional foods. For functional foods to deliver their potential public-health benefits, consumers must have a clear understanding of and a strong confidence level in the scientific criteria that are used to document health effects and claims.

Functional foods are an important part of wellness, which includes a balanced diet and physical activity. The good news with functional foods is that what one does eat may be more important for health than what one does not eat. Individuals should consume a wide variety of foods, including the examples listed in Table 1. These examples are not "magic bullets." The best advice is to include a variety of foods from each of the food groups, which would incorporate many potentially beneficial components.

See also **Biotechnology; Food Safety; Fruit; Health and Disease; Hippocrates; Nutraceuticals; Vegetables**.

Wendy Reinhardt

Where Can Additional Information about Functional Foods Be Found?

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FUNGI. Fungi—sing. fungus; from the Greek *sphongis* (sponge)—are nonphotosynthetic and thus must absorb nutrients from organic matter formed by other organisms. The great majority of fungi obtain their food from dead organic matter and hence are known as saprophytes; a relatively small percentage derive their food from other living organisms and are known as parasites. Fungi may be unicellular (yeasts) or multicellular (mushrooms) and their cell walls usually contain chitin or cellulose and b-glucan. They may produce sexually or asexually by means of spores that are roughly comparable with the seeds of higher plants.

The fungal kingdom offers enormous biodiversity with over seventy thousand known species and an estimated 1.5 million species. According to molecular evidence (16S-like ribosome RNA sequences), the fungi may have originated from protozoan ancestors before the kingdoms Animalia and Plantae split; there is strong evidence that Fungi are closer to Animalia than Plantae (Hawksworth et al.). Fungi are associated with some of the earliest remains of land plants. Some scientists believe that lichens (a stable self-supporting association of a fungus and an alga) might be transmigrants, the earliest colonizers of land.

Fungi have contributed to the shaping of humankind's welfare since the beginning of civilization. Fungi are recognized as both beneficial and harmful in their relationship to humans although this role is predominantly beneficial. They are responsible for a major portion of food deterioration in developing countries; however, the preservative effects of fermentation of foods and beverages with fungi are well-known benefits, including organic acids, alcohol, antibiotics, pigments, vitamins, growth regulators, immunomodulating agents, and enzymes. Finally, various types of edible mushrooms are consumed as an important part of human diets in many countries.

Fungi and Food Processing

Fungi used in food processing have been an integral part of the human diet since the beginning of civilization. In such foods, fungi are the agents responsible for imparting special flavors, textures, odors, or consistencies to food products. Fungi such as *Aspergillus* spp., *Rhizopus* spp., *Penicillium* spp., *Neurospora* spp., *Cladosporium* spp., and *Mucor* spp., as well as yeasts and many others have long been used to process a number of food products from soybeans to peanuts, rice, gram, maize, cassava, taro, and cacao beans.

Fungal enzymes. Food formulation using enzymes derived from fungi has undergone a rebirth in recent years. Enzyme suppliers have improved their ability to supply single-activity enzymes that do not have undesirable side activities (see Table 1 for a list of commercial fungal enzymes and their uses). Enzyme products have found increasing application for improving product clarity and yield and in replacing costly physical processes such as heating.

Cheese manufacture. Two general types of cheese are made with fungi as the ripening agents. Roquefort cheese is an example of cheese that is ripened primarily by growth of fungi (*Penicillium roquefortii*) throughout the cheese mass. Brie cheese is an example of one type of soft cheese that is ripened by the growth of fungi (*Penicillium camemberti*) on the outside of the cheese mass. In both types of cheeses, the fungi grow and release protein and fat-degrading enzymes that soften and ripen the cheese. Roquefort cheese requires about two months to ripen while Brie cheese requires only about one month to ripen.

Baker's yeast. Leavening, a process whereby batter or dough is caused to rise via the production of gas, especially carbon dioxide, was first discovered in Egypt. Today, most of the bread, cakes, cookies, and the like consumed by the public are prepared from leavened bat-

TABLE 1

List, source, and uses of enzymes derived from fungi for food manufacture

Enzyme	Source	Use
α-Amylase, amyloglucosidase	*Aspergillus niger* *A. oryzae* *Rhizopus* spp.	Hydrolysis of starch in production of beer, bread; manufacture of high-fructose syrups
α-Galactosidase	*Mortierella vinacea*	Hydrolysis of raffinose to sucrose and galactose during sugar refining
Catalase	*Aspergillus niger* *Penicillium vitale*	Remove excess hydrogen peroxide formed during cake baking or that may be added during pasteurization of milk and cheese
Cellulase	*Aspergillus niger* *Trichoderma viride*	Improve palatability of low-quality vegetables, accelerate drying of vegetables, alter texture of foods, increase flavor of commercial mushrooms
Hemicellulase	*Aspergillus niger* *Trichoderma viride*	Manufacture of instant coffee
Invertase	Yeasts *Aspergillus* spp.	Increases sweetness in confections; yields soft center in chocolate-covered candies
Lactase	*Aspergillus niger* *A. oryzae*	Hydrolysis of lactose in milk products, enabling their use by lactose-intolerant individuals; production of syrups for use as sweetening agents
Lipase	*Candida spp.* Aspergillus spp. *Mucor* spp. *Rhizopus spp.*	Used for flavor development in cheese, chocolate crumb, apple wine, and cooking fats; improved whipping properties of egg whites; fish processing
Naringinase	*Aspergillus niger*	Reduce bitter flavonone glycoside derivative found in some citrus products
Nuclease	*Penicillium spp.*	Flavor enhancers
Pectic Enzymes	*Aspergillus niger* *Penicillium notatum* *Botrytis cinerea*	Remove turbidity from fresh fruit juices; removal of pectins before concentrating juice; clarifying agent in wine
Protease	*Aspergillus* spp. *Mucor pusillus*	Meat tenderizer; remove bitter flavors, replace rennin in cheese manufacture, chill-proofing of beer; reduce elasticity of glutin proteins in bread
Rennet	*Mucor* spp.	Milk coagulation in cheese manufacture
Tannase	*Aspergillus niger*	Treat insoluable material that forms during manufacture of instant tea

SOURCE: Adapted from: Beuchat (1987) and Moore-Landecker (1995)

ter or dough. Most cakes and cookies are leavened chemically (by using baking powder) while most bread is leavened by yeasts (such as *Saccharomyces cerevisiae*). Yeasts develop and reproduce by producing buds on mother cells that subsequently enlarge and produce more buds. During growth, carbohydrates in the dough are metabolized to carbon dioxide that is trapped in the dough in the form of bubbles. During the leavening process, alcohol may accumulate in the dough to as high as 0.5 percent. The alcohol is driven off during baking and helps give the bread a pleasant aroma.

Edible Mushrooms

Mushrooms have a long history of human consumption. Traces of puffball fungi have been found in Stone Age settlements. Over 4,500 years ago in ancient Egypt only pharaohs were permitted to eat mushrooms, which they believed were "sons of the gods" sent down to earth on lightning bolts announced by claps of thunder. The legend that mushrooms may have originated from thunder and lightning also existed among people of other ethnic groups. In Roman folklore, some fungi were believed to spring from the ground in places struck by a thunderbolt. In the Hindu tradition, there was a god named Soma that manifested himself to the priests in the form of hallucinogenic fluids. Some scientists believe that Soma was the fly mushroom, *Amanita muscaria*. A similar legend may have existed among the inhabitants of the highlands of Guatemala and Mexico, where even today the people refer to *A. muscaria* by a common name meaning thunderbolt (Lowy).

Cultivated species. The cultivation of edible mushrooms worldwide reached 6.16 million metric tons in 1997, up from 1.26 million tons in 1981 (Table 2; Chang). This represents a 12 percent annual increase. Six mushroom genera accounted for 87 percent of the total mushroom supply (Table 2). These were *Agaricus* (31.8%), *Lentinula* (25.4%), *Pleurotus* (14.2%), *Auricularia* (7.9%), *Flammulina* (4.6%), and *Volvariella* (3%). China produced 3.92 million tons of mushrooms in 1997, or 63.6 percent of the total world output. The major mushroom of commerce in China is *L. edodes*, which accounts for 35 percent of the total output for that country. China currently produces 88 percent of the total world production of *L. edodes*.

Agaricus bisporus (button mushroom). The cultivation of the button mushroom originated in the Paris region in France. Melon growers in this region discovered how mushrooms could be grown and started cultivating them in 1650. By the mid 1700s it was discovered that *A. bisporus* could grow without light, and that very favorable conditions for growing mushrooms prevailed in subterranean tunnels and caves. As a result of this discovery,

TABLE 2

World production of cultivated edible mushrooms in 1981, 1990, and 1997

	1981		1990		1997	
Species	**Fresh Wt (x 1,000 t)**	**%**	**Fresh Wt (x 1,000 t)**	**%**	**Fresh Wt (x 1,000 t)**	**%**
Agaricus bisporus	900.0	71.6	1,424.0	37.8	1,955.9	31.8
Lentinula edodes	180.0	14.3	393.0	10.4	1,564.4	25.4
Pleurotus spp.	35.0	2.8	900.0	23.9	875.6	14.2
Auricularia spp.	10.0	0.8	400.0	10.6	485.3	7.9
Volvariella volvacea	54.0	4.3	207.0	5.5	180.8	3.0
Flammulina velutipes	60.0	4.8	143.0	3.8	284.7	3.0
Tremella spp.	-	-	105.0	2.8	130.5	2.1
Hypsizygus spp.	-	-	22.6	0.6	74.2	1.2
Pholiota spp.	17.0	1.3	22.0	0.6	55.5	0.9
Grifola frondosa	-	-	7.0	0.2	33.1	0.5
Others	1.2	0.1	139.4	3.7	518.4	8.4
Total	**1,257.2**	**100.0**	**3,763.0**	**100.0**	**6,158.4**	**100.0**

SOURCE: Chang, 1999

successful culture was undertaken inside the numerous caves that were excavated for building stones and for gypsum. The caves presented, from a climatic point of view, several advantages over the previous growing conditions in open air. Factors such as temperature and relative humidity were much more constant in caves compared with aboveground conditions.

From France, mushroom cultivation spread to other parts of the world. The business grew and soon spread to England and other countries. By 1825, the first mushroom crops were being produced in caves in Holland. In 1865, mushroom culture entered the United States via England and the first mushrooms were grown on a small scale on Long Island, New York; by 1870 the industry had begun to develop.

Detail view of cepes (*Boletus edulis*), one of the most highly prized of all culinary mushrooms. PHOTO ANDRÉ BARANOWSKI.

The button mushroom is produced commercially on a selective substrate prepared by composting mixtures of wheat straw, hay, corncobs, horse manure, or combinations thereof. The finished compost should have a nitrogen (N) content of 2–2.5 percent, and to reach such a level, nitrogen-rich supplements must be added. Inorganic nitrogen supplements can be added but only to provide part of the necessary amount. Organic sources of nitrogren include oilseed meal, brewers' grain, malt sprouts, and poultry manure.

Once the compost has been prepared, it is seeded with mushroom spawn that is prepared from a mother culture maintained by a spawn laboratory. Spawn is prepared by inoculating a pure culture of the mushroom onto steam-sterilized grain, usually rye or millet. Approximately one liter (500 g) of spawn is used to seed 0.5 m^2 of production surface that is contained in trays or beds inside environment-controlled production houses. Spawn run (vegetative growth of the mycelium) lasts ten to fourteen days, then a layer of neutralized peat moss (casing) is placed on top of the colonized compost to stimulate production of mushrooms. Approximately ten to fourteen days after casing, mushrooms are ready for harvest.

***Lentinula edodes* (shiitake).** Production of shiitake worldwide increased more than sevenfold in the fourteen-year period from 1983 (207,000 t) to 1997 (1,573,000 t; Chang). Most of this increase occurred in China, where more than ten million part- and full-time farmers cultivate shiitake. Shiitake is widely consumed in China, yet one-third of production is exported. In 1997, China produced approximately 88 percent of the total world output (Chang). In the United States, production of shiitake is a relatively new enterprise, having begun only in the late 1970s. In 1990, the United States produced 1,123 tons of shiitake and by 1999 production reached 3,941 tons, a 3.5-fold increase (USDA). This increase in production was due, in part, to increased production efficiency and to increasing consumer demand. Farmers have learned to provide the specialized management this crop requires, thereby reducing production costs. The amount of controlled-environment production surface devoted to growing shiitake on synthetic logs has increased 2.9 fold from 1990 to 1999 (74,200 m^2 to 212,400 m^2, respectively).

Sawdust is the most popular basal ingredient used in synthetic formulations of substrate for producing shiitake in the United States, but other basal ingredients may include straw, corncobs, or both. Starch-based supplements (20–60 percent dry weight) such as wheat bran, rice bran, millet, rye, and maize may be added to the mix. These supplements serve as nutrients to provide a more optimal growth medium (Royse).

Pleurotus* spp. *(oyster mushroom). Oyster mushroom production increased at a rapid rate worldwide during the 1980s and then decreased slightly during the 1990s (Table 2). From 1986 to 1997, oyster mushroom production increased from 169,000 tons to 917,000 tons (a 5.4-fold increase). China was responsible for most of the production increase. In the United States, production of oyster mushrooms was 1,647 tons in 2001, up 2 percent from the previous year (USDA).

In the United States, the primary ingredients used for *Pleurotus* spp. production are chopped wheat straw or cottonseed hulls or mixtures thereof. After completion of pasteurization (140ºF [60°C] for one to two hours) the substrate is cooled and spawned with the desired strain. There are several species of oyster mushrooms cultivated, with various colors of fruiting body. In Japan, bottle production of oyster mushrooms is most common. Substrate is filled into bottles, sterilized, and inoculated with *Pleurotus* spawn. Upon completion of the spawn run, bottle lids are removed and mushrooms emerge from the surface of the substrate. After the mushrooms are harvested they are weighed and packaged for shipment to market.

Auricularia* spp. *(wood ear mushroom). Total production of *Auricularia* spp. in 1997 exceeded 485,000 metric tons (fresh weight; Table 2). This value is an increase of 366,000 tons or fourfold over 1986 levels (Chang). *Auricularia* spp. production now represents about 8 percent of the total cultivated mushroom supply worldwide.

Auricularia auricula and *A. polytricha* commonly are produced on a synthetic medium consisting of sawdust, cottonseed hulls, bran, and other cereal grains or on natural logs of broadleaf trees. For synthetic medium production of Auricularias, the substrate may be composted for up to five days or used directly after mixing. The medium is filled into heat-resistant polypropylene bags and sterilized (substrate temperature 240ºF [121ºC]) for sixty minutes. After the substrate has cooled, it is inoculated with either grain or sawdust spawn. Light intensity of more than 500 lux during the spawn run may result in premature formation of primordia. Temperature, light intensity, and relative humidity all interact to influence the nature and quality of the mushrooms.

While the white truffles of Italy are best eaten raw, France's black truffles (*Tuber melanosporum*) are most flavorful when cooked. This French society of truffle devotees meets annually to herald the beginning of the truffle season. PHOTO ANDRÉ BARANOWSKI.

Flammulina velutipes (enokitake). Worldwide production of *F. velutipes* has increased from about 100,000 metric tons in 1986 to about 285,000 tons in 1997. Japan is the main producer of enokitake. In the United States, enokitake production has increased at an estimated rate of 25 percent or more per year for the last four years. However, only about 60 tons of enokitake were produced in the United States in 2001.

Production of most enokitake in Japan is based on synthetic substrate contained in polypropylene bottles. Substrates (primarily sawdust and rice bran; 4:1 ratio) are mechanically mixed and filled into heat-resistant bottles with a capacity of 800 to 1,000 ml. Sawdust primarily from *Cryptomeria japonica*, *Chamaecyparis obtusa*, or aged (nine to twelve months) *Pinus* spp. appears to offer the best yields. In the United States, a sterilized, bran-supplemented medium, consisting primarily of corncobs, serves as the primary medium. When the substrate is fully colonized, the original inoculum is removed mechanically from the surface of the substrate and the bottles may be placed upside down for a few days.

To further improve quality during fruiting, temperatures are lowered to 37° to 46°F (3 to 8°C) until harvest. As the mushrooms begin to elongate above the lip of the bottle, a plastic collar is placed around the neck and secured with a Velcro® strip. This collar serves to hold the mushrooms in place so that they are long and straight. When the mushrooms are thirteen to fourteen cm long, the collars are removed and the mushrooms are pulled as a bunch from the substrate. The mushrooms then are vacuum packed and placed into boxes for shipment to market.

Grifola frondosa (maitake). Japan is the major producer and consumer of maitake. Commercial production of maitake in Japan began in 1981 (325 t) and by 1997 reached 32,000 tons (a 98-fold increase). Maitake is produced primarily in the Japanese provinces of Niigata, Nagano, Gunnma, and Shizuoka. Other countries, such as the United States, began maitake production in the early 1990s. Maitake production in the United States in 2001 was estimated at about 84 tons.

Most maitake is marketed as food. However, maitake has been shown to have both antitumor and antiviral properties. Powdered fruit bodies are used in the production of many health foods such as maitake tea, whole powder, granules, drinks, and tablets. Maitake also is believed to lower blood pressure, reduce cholesterol, and reduce the symptoms of chronic fatigue syndrome.

Commercial production of most *G. frondosa* is on synthetic substrate contained in polypropylene bottles or bags. A common substrate used for production is hardwood sawdust supplemented with rice bran or wheat bran in a 5:1 ratio, respectively. Other formulas include hardwood sawdust (70 percent based on oven dry weight basis) supplemented with white millet (20 percent) and wheat bran (10 percent). Some growers may add soil to the mix to stimulate fruit body formation. For production in bags, the moistened substrate is filled into microfiltered polypropylene bags and sterilized to kill unwanted competitive microorganisms. After cooling (sixteen to twenty hours), the substrate is inoculated and the bags are heat-sealed and shaken to uniformly distribute the spawn throughout the substrate. Spawn run lasts about thirty to fifty days depending on strain and substrate formulation.

Volvariella volvacea (straw mushroom). Cultivation of *V. volvaceae* is believed to have begun in China as early as 1822. In the 1930s, straw mushroom cultivation began in the Philippines, Malaysia, and other Southeast Asian countries. Production of the straw mushroom increased from 54,000 tons in 1981 to about 181,000 tons in 1997 (about 3 percent of the total mushroom supply).

Many agricultural by-products and waste materials have been used to produce the straw mushroom. These include paddy straw, water hyacinth, oil palm bunch, oil palm pericarp waste, banana leaves and sawdust, cotton waste, and sugarcane waste. *Volvariella* is well suited for cultivation in the tropics because of its requirement for higher production temperatures. In addition, the mushroom can be grown on nonpasteurized substrate, which is more desirable for low-input agricultural practices.

In recent years, cotton wastes (discarded after sorting in textile mills) have become popular as substrates for straw mushroom production. Cotton waste gives higher and more stable biological efficiencies (30 to 45 percent), earlier fructification (four days after spawning) and harvesting (first nine days after spawning) than that obtained using straw as a substratum. Semi-industrialization of paddy straw cultivation on cotton wastes has occurred in Hong Kong, Taiwan, and Indonesia as a result of the introduction of this method.

Wild mushrooms. In many developing countries, the collection and sale of wild edible mushrooms has become an important source of income for many people in remote forested regions. Despite a relatively short growing season, wild mushrooms provide many families with 50 to 100 percent of their income. World trade in wild, edible mushrooms is estimated at more than $7 billion annually (Arora). The global trade in matsutake (*Tricholoma matsutake*), the most expensive wild mushrooms after truffles, is estimated at $3 to $5 billion. Matsutake may sell for as much as $200 apiece in Tokyo markets. The King Bolete (*Boletus edulis*; also known as porcini, cepe, borovik, etc.) is the most popular wild mushroom of Europe. These may be served fresh in some upscale restaurants. Dried boletes are famous for their concentrated flavor and choice aroma and are available year round from almost anywhere in the world. Other wild mushrooms available on world markets include chanterelles (*Cantharellus cibarius*), morels (*Morchella* spp.), hedgehog mushrooms (*Hydnum repandum*), lobster mushrooms (*Hypomyces lactifluorum*), candy caps (*Lactarius fragilis*), and cauliflower mushrooms (*Sparassis crispa*).

WARNING: Collecting and ingesting wild mushrooms without the presence of an expert to correctly identify specimens can be very dangerous and should be discouraged since there are several deadly mushrooms that look like edible wild ones.

Mycotoxins

Mycotoxins are chemical compounds produced by fungi growing on organic substances such as corn, cottonseed, or peanuts that, when ingested, have some undesirable effect on humans or on an animal consuming them. Adverse effects can range from vomiting to weight loss, various types of tumors, and in some cases, death. Over one hundred toxic compounds produced by fungi have been identified, and about forty-five of these occur in grain crops. Some mycotoxins are rare in occurrence while others such as aflatoxin are common in some years. The seriousness of the mycotoxin problem varies with the year, the crop being grown, and the intended use of the crop product. Most mycotoxins affect the blood, kidneys, skin, or central nervous system, and some may cause cancer.

MUSHROOM COLLECTORS

The consumption of wild mushrooms has a lengthy history, dating back well over two millennia and extending throughout the world. For over two hundred years, mushrooms have been a cultivated crop as well. Despite somewhat negative images of mushrooms in the popular imagination and despite the possibility of real danger in their consumption, they have long been valued for their culinary and psychedelic properties. In 300 B.C. Theophrastus recorded that mushrooms were valued as food and for trade. Pliny, Juvenal, Martial, and Cicero all considered mushrooms to be great delicacies, and the Roman emperor Claudius was allegedly poisoned by a plate of mushrooms. Mushrooms are also mentioned in the Hindu Rig Veda and were eaten on the Indian subcontinent. Mushrooms were probably consumed for food and for their psychedelic properties in Mesoamerica, Siberia, and Scandinavia. Some suggest that the biblical "manna from heaven" was a fungus. By the eighteenth-century reign of Louis XIV, mushrooms were cultivated in caves near Paris. During the nineteenth century mushrooming became a popular leisure pursuit in Europe and America, and by the end of the century mushroom societies were formed.

One estimate placed the number of mushroomers in the United States at thirty million in the early 1980s. A survey conducted at the same time found that 22 percent of Americans collect wild mushrooms, and 15 percent consume mushrooms they find. In the nations of eastern, central, and southern Europe with stronger mushroom cultures, these figures would likely be higher. Mushroom societies are found in every region of the United States, as well as Canada and Europe. In the United States, mushroom societies were founded in Boston and Minneapolis in the late nineteenth century. The North American Mycological Association, covering the United States and Canada, has approximately 2,000 members. These clubs organize talks, dinners, sharing of advice, and forays to mushroom collecting sites.

Novices worry about the toxic qualities of wild mushrooms. Despite this, the number of mushroom fatalities, at least in the United States, is very low. In some years, there are no fatalities although illnesses or hospitalizations might occur as a result of the misidentification of mushrooms, the contamination of otherwise edible specimens, or allergic reactions. Among the edible wild mushrooms that are most widely collected in the United States and Europe are morels, chanterelles, puffballs, boletes, and coral mushrooms. While the collection of wild mushrooms has increased in the past decades, the hobby is limited, and the greatest growth in "wild mushrooms" is likely to occur when these foods become cultivated and therefore perceived as safe to consume.

Gary Alan Fine

The genera of fungi of greatest importance to humans with respect to natural poisoning outbreaks are *Aspergillus*, *Penicillium*, and *Fusarium*. The *Aspergillus flavus* group produces aflatoxins (at least eighteen types known) that are considered the most important from the viewpoint of a direct hazard to human health. *Aspergillus flavus* is a common fungus that is found in soil, air, and decaying plant residues. Infection by *A. flavus* and subsequent aflatoxin production can occur in the field, in transit, or in storage. Most reports indicate that infection occurs in the field, while aflatoxin production can occur whenever the product is exposed to favorable conditions, either in the field or in storage.

Control of aflatoxin includes prevention of fungal growth, removal of toxins, and inactivation of toxin. Most control efforts have been directed toward control of aflatoxins in peanuts and corn. Hand picking, electronic sorting, and air classification accomplish control of aflatoxin in processed peanut products. Removal of shriveled, rancid, or discolored kernels has proven the most practical way of limiting aflatoxin contamination in peanuts.

In areas of the country with cool weather and heavy rainfall, mushroom collecting is a full-time occupation. These brothers make a living collecting a variety of mushrooms in Oregon's coastal forests. © DAN LAMONT/CORBIS.

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Daniel J. Royse

FUSION CUISINE. Fusion cuisine is the deliberate combination of elements from two or more spatially or temporally distinct cuisines. Transcending conventional geographical and historical boundaries, it is a unique form of cuisine particular to today's postmodern world. The precise origin of the term "fusion cuisine" is uncertain although "culinary globalization," "new world cuisine," "new American cuisine," and "new Australian cuisine," all other names for fusion cuisine, have their roots in the 1970s in the emergence in France of nouvelle cuisine, which combined elements of French and, primarily, Japanese cooking (Sokolov, 1992). As nouvelle cuisine spread to other nations, it combined with elements of the foods of the host country. As Adam Gopnik has observed, while the Enlightenment of new cooking took place in France, the Revolution occurred elsewhere. Indeed, fusion cuisine has emanated primarily from the United States and Australia, but has spread to other parts of the world as well. Fusion cuisine may have taken off in the United States and Australia, because of those countries' short history relative to the rest of the world, their unique immigration histories, their lack of a cuisine that is clearly recognized by other parts of the world, and, most importantly, their lack of a culinary tradition.

As fusion cuisine evolves, many more ethnic and regional cuisines beyond French are being combined to form new hybrids. Exemplars of fusion cuisine include Pacific Rim cooking predominant in Australia and New Zealand, and Norman Van Aken's New World Cuisine (combining Latin, Caribbean, Asian, and American elements) found in the United States. An example of a specific fusion dish that combines classic Chinese recipes with French techniques and Mexican ingredients is Susanna Foo's pan-seared sweetbreads with veal dumplings made with ancho chili and served with Sichuan pickled relish and crispy shallots.

Fusion cuisine is distinct from historical combinations of cuisines, such as those that occurred in the sixteenth century when foodstuffs from the New and Old worlds mixed. It is also different from Creole cooking, which combines elements of French, African, Acadian, and Native American cooking. Geographers have described the long history of foodstuffs crossing geographical borders and the ways in which food is socially constructed through various processes (Cook and Crang, 1996; Bell and Valentine, 1997). Earlier forms of cuisine that combined elements from different regions or ethnic groups were reactive, rather than proactive, as is today's fusion cuisine. These cuisines emerged slowly from the everyday cooking practices that occurred within individual households and local communities. In contrast, fusion cuisine has developed rapidly and has found its way into everyday kitchens and restaurants as a direct consequence of the concerted and conscious activities of cultural intermediaries in the form of professional cooks, celebrity chefs, and cookbook authors. Fusion cuisine is an innovative and experimental process that demands from its practitioners the constant creation or re-creation of elements into novel food forms.

The social and cultural conditions that have contributed to the development of fusion cuisine, as well as most forms of contemporary cuisines, include increasing processes of globalization, increasing cultural flows through media and travel, the rise of a consumer culture, the modern food system, the expansion of the cookbook industry, the increased prominence of chefs throughout the world, the growth of the food and restaurant industry, and a greater concern with healthy lifestyles. Images constantly bombard the world, increase consumer knowledge, and escalate demand. Further, advances in technology have made foodstuffs from around the world available to all at any time. Boundaries are eliminated through the Internet, television, and the convenience and affordability of travel. Further, as consumers become increasingly concerned with living healthier lifestyles, the idea of mixing the healthiest elements from a variety of cuisines becomes appealing. For example, steaming and grilling may replace frying as a method of cooking, while herbs and spices are used in place of butter. The combination of these cultural and economic elements increases the likelihood that many culinary forms and combinations will exist.

Described as a blend of flavors and ingredients from different cultures, of different presentation styles, even of different cooking techniques, fusion cuisine has become a popular modern metaphor for hotel cookery around the world. Whether East has met West (or vice versa) successfully has been an ongoing discussion among food critics. PHOTO BY ANDRÉ BARANOWSKI.

Fusion cuisine, like fusion music and religion, appeals to multiculturalism, diversity, and novelty; it is also quite easy to market. It is an expression of the contemporary world of images and actively promotes a blending and diversity of cultures. It is a global cuisine in the sense that its elements are representative of cultures from around the world. One of the most interesting developments associated with fusion cuisine is that no single culture, with the exception of the French, dominates. Fusion cuisine combines elements of what are traditionally referred to as ethnic or regional cuisines, and may provide an opportunity to mainstream various ethnic and regional cuisines as well as provide opportunities for immigrant and minority chefs. Additionally, because of the hegemony of French cooking that persists in the culinary world, combining elements of French cooking may elevate the status of various ethnic and regional cuisines in a way that might not be accomplished otherwise.

Fusion cuisine has been met with mixed reactions because it is characterized by its lack of rules, or perhaps more accurately, by the precept that the rules ought to change constantly. Fischler claimed that contemporary gastronomy might be better thought of as "gastro-anomy" increasingly characterized by its lack of normative structure. Critics argue that practitioners of fusion cuisine deconstruct French and other cuisines (which do have codified culinary traditions and are clearly understood as unique culinary languages), and reassemble them into "new culinary sentences" that are not grammatically correct. Another related and frequently echoed criticism of fusion cuisine is that it is a haphazard mixing of cultures that lacks a respect for tradition. Further, particular cuisines become more or less popular as part of the hybrid, depending upon what is "hot" at the moment and not necessarily upon what tastes good. Because of increasing processes of globalization and consumerism, it is unlikely that fusion cuisine is going away any time soon. There are limitless possible combinations yet to be created.

See also **France: Tradition and Change in French Cuisine**; **Nouvelle Cuisine**; **United States: Ethnic Cuisines**.

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Julie L. Locher

G

GADGETS, KITCHEN. *See* **Kitchen Gadgets.**

GAME. The importance of nondomesticated animals, or game, in the human diet is unclear. Some anthropologists have argued that the advent of hunting game with tools was the critical development in the evolution of humans, resulting in such cultural characteristics as male aggression, sophisticated tools, and the sexual division of labor. The role of game in the human diet can more clearly be understood in light of ecological, nutritional, evolutionary, and cross-cultural information.

Except in the high latitudes occupied by peoples such as the Inuit, plants are generally the most abundant food source. Game is rarer than plants due to the second law of thermodynamics: As one moves up the food chain from plants, to herbivores, to carnivores, one finds that there is less to eat at the higher levels because energy is lost at each step in the chain. Not only is game rarer than plant foods, it may also be more difficult to obtain. Plants may protect themselves with thorns or toxins, but they do not hide or run away as animals do. These two points suggest that people might always choose plants over game as food sources. However, due to a process called biological magnification, game provides more concentrated packages of nutrients than do plants. In addition, some plant foods are difficult to digest without processing. Hence, some anthropologists classify game as "high-quality" foods and plants as "low-quality" foods.

Human nutritional requirements and digestive physiology suggest that at least some game is required in the diet. With the exception of vitamin B_{12}, humans can obtain all the nutrients they require from plant foods. Vitamin B_{12} can only be found in animal products. Humans require only 2.4 micrograms of vitamin B_{12} per day and can generally store sufficient amounts for up to twenty years, but a chronic lack of vitamin B_{12} in the diet may cause pernicious anemia, fatigue, and damage to the nervous system, and in children compromise growth. The need for protein is often the basis of arguments that humans require meat in their diet. While for humans game is a good source of protein, the required amino acids may be obtained from a mix of plant foods. In some regions, such as the Arctic, there is relatively little plant life; thus, humans there generally require game to meet their protein requirements. Although humans are clearly capable of digesting game, their gut has a long digestion time similar to that of apes, which are primarily folivorous (Milton, 2000). In addition, it is possible that too much game may compromise human health. Game is generally leaner than meat from domesticated animals, and too much lean meat increases a person's metabolic rate such that ingested energy is used entirely to digest the food eaten. Consequently, lean meat must be eaten with energy-rich foods such as fat or carbohydrates. Furthermore, high-protein consumption may exceed the liver's ability to metabolize amino acids.

Human nutritional requirements and digestive kinetics are a function of the evolutionary history of the species. Therefore, an understanding of game in the human diet requires a consideration of the diets of human ancestors. It should be borne in mind that the role of game in the diets of human ancestors may be overemphasized, because plant food remains are less likely to be preserved in the fossil record than animal food remains. In addition, any plant food remains that do exist may have been overlooked by early researchers working with the perception that hunting was paramount in the subsistence strategies of human ancestors.

Hominids in Africa 4 to 2.5 million years ago did not leave archaeological traces such as "kitchen middens" and stone tools. Consequently, little is known of their diets. In lieu of archaeological data, dietary inferences have been made on the basis of paleoecological reconstructions, craniodental morphology, dental wear, chimpanzee behavior, and stable isotope analyses of their remains. Paleoecological reconstructions, craniodental morphology, and dental wear suggest that these first hominids subsisted primarily on fleshy fruits and leaves. Using chimpanzees as models for the behaviors of the first hominids also leads to the conclusion that they had a diet that was primarily vegetarian with an occasional animal product. This agrees with a stable isotope analysis of the bones of a three-million-year-old *Australopithecus africanus* from South Africa that indicates this hominid ate fruits, leaves, large quantities of grasses and sedges or animals that ate these plants, or both (Sponheimer and Lee-Thorp, 1999). Interestingly, the researchers suggest that these hominids may have been capable of procuring game prior to the development of stone tools.

The evidence of 2.5 million years ago in Tanzania's Olduvai Gorge points to both tool makers and the consumption of game. Animal bones with cut marks indicative of butchering found in association with these tools indicate that the hominids who lived there ate game. How these bones were obtained is a subject of debate, because cut marks on the bones are sometimes found overlying tooth marks of carnivores, suggesting scavenging by the hominids. Some researchers argue for hunting or for confrontational scavenging in which groups of people drove carnivores off still-fleshy animals. Others argue that these people practiced passive scavenging from carcasses that had already been largely consumed. While evidence that might resolve this debate is sparse, the simplicity of the Oldowan tools may favor more passive scavenging (Klein, 2000).

Around 1.8 million years ago *Homo erectus* appears in the fossil record with a greatly expanded brain and more refined tools. The expansion of the brain dramatically increased the energy requirements, as the brain uses energy as much as ten times faster than average body tissue. Hence, it has been argued that increased access to high-quality, readily digestible flesh and marrow may have been essential for brain enlargement. However, corms, tubers, and other subterranean plant foods might have provided equal or greater nutrition for effort, and most historically recorded African hunter-gatherers exploited them heavily (Klein, 2000). Moreover, while there are many animal bones associated with *H. erectus* sites, there are few cut marks on the bones and a lot of carnivore teeth marks, suggesting that the fossil assemblage may not be due to human activity but to people inhabiting the same waterside sites as those favored by other animals.

The use of fire renders game a more viable food, as heating makes the tissue more digestible. So archaeological evidence of fire might help determine the consumption of game. The earliest possible site for fire is Locality 1 in Zhoukoudien, China (600,000–400,000 years ago), but this has been disputed due to the lack of mineral ash in deposits. To date, the earliest undisputed sites are deposits from 200,000 years ago in African, West Asian, and European caves.

The origin of Neanderthals around 130,000 years ago brings clear evidence of hunting of game. This conclusion is reached on the basis of faunal remains associated with Neanderthal living sites, wear patterns on their tools, and the analysis of stable isotopes and trace elements in their skeletal remains. Stable isotope analysis has been used in particular to compare the diets of Neanderthals with subsequent *Homo sapiens.* Such an analysis of nine *H. sapiens* and five Neanderthals from the European mid–Upper Paleolithic (about 20,000–28,000 years ago) indicates that the Neanderthals had diets composed primarily of large terrestrial herbivores, whereas *H. sapiens* had a broader diet with a heavy reliance on freshwater resources (Richards et al., 2001). M. P. Richards and colleagues conclude that this transition was made possible by refined technology that made it easier to capture freshwater game. Stable isotope analysis of *H. sapiens* skeletons from sites in Israel dating from 70,000 to 10,000 years before the present reveals an increase in plant foods in the diet 20,000 years ago (Schoeninger, 1982). The change, it is argued, was due to refined technology for processing plant foods.

Hunter-Gatherers

While anatomically near-modern people were present in Africa by 130,000 years ago, not until around 10,000 years ago were plants and animals domesticated. This means that for at least 77 percent of the time the species has been in existence, humans have obtained food by hunting and gathering. Hence, many of behavioral propensities, dietary requirements, and biocultural responses to food likely evolved prior to the advent of agriculture (Bogin, 2001). Given this, ethnographic and archaeological data concerning the diets of hunter-gatherers help explain the role of game in human diets.

As with the paleoanthropological data, studies of hunter-gatherer diets are biased by the perception among early researchers that hunting was the most important subsistence strategy. An additional problem in describing the natural or ideal diet of hunter-gatherers is the tremendous variation documented for such diets (Jenike, 2001). Despite the cultural and geographic diversity of hunter-gatherers, spanning from the rainforests of central Africa to the Arctic tundra of Baffin Island, similarities exist across these groups (Bogin, 2001). First, foragers consume a diverse array of food items; 105 species of plants and 144 species of animals among the !Kung San of southern Africa's Kalahari Desert, 90 species of plants and animals among the Ache of Paraguay's tropical forest (Hill and Hurtado, 1989), and 10 species of plants and 33 species of animals among the Dogrib of subarctic Canada (Hayden, 1981). Second, gathered rather than hunted foods are the primary source of dietary energy for most foragers. Richard B. Lee (1968) reported that, among 58 foraging societies, the primary subsistence base was gathering for 29, fishing for 18, and hunting for 11. Of those who relied on fishing or hunting, almost all were north or south of the fortieth parallel, a region researchers believed was not occupied by Paleolithic foragers. A review of the data in 2000 for 229 hunter-gatherer groups concluded that animal protein and fat provided up to 45 to 65 percent of the energy consumed and that 73 percent of these groups acquired as much as 56 to 65 percent of the energy they consume from animal foods (Cordain et al., 2000). When greater than 35 percent of the energy is from animal foods, the extra is from aquatic game.

The importance of game in the diets of many hunter-gatherer groups is apparent in paleoecological reconstructions as well. Tim Flannery (2001), for example, writes that 13,000 years ago in North America, a sparse human population drove much of the megafauna to extinction by hunting.

Nonhuman Primates

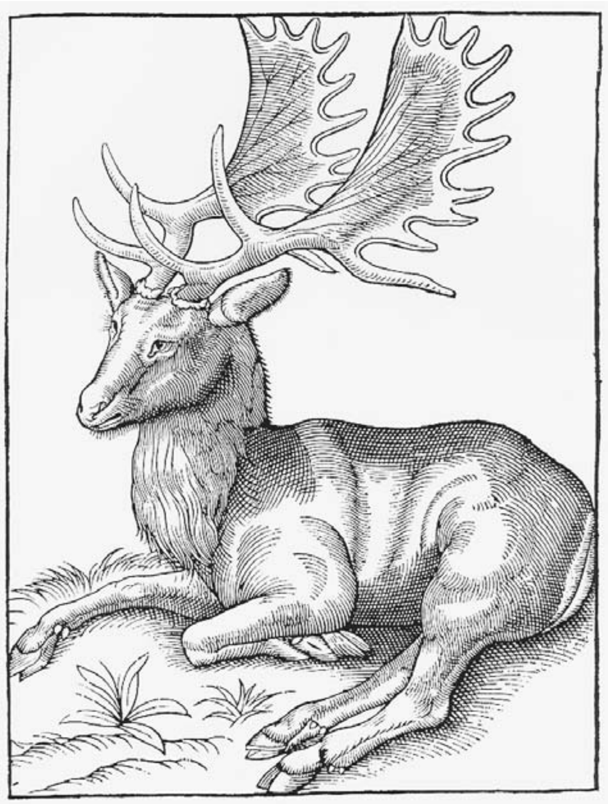
Given humans' close evolutionary relationship with apes and monkeys, a final line of evidence to consider is the importance of game in the diets of nonhuman primates. In general, most nonhuman primates appear to eat little animal matter because of the difficulty of obtaining it and a gut poorly suited to the digestion of animal matter (Milton, 2000).

This is not to say that game does not form an important part of the diet of some nonhuman primates. For example, observations of chimpanzees in different African sites reveals that they hunt often (Mitwani et al., 2002). The vast majority of the game hunted and eaten is red colobus monkeys, hunted primarily by males four to ten times per month with a success rate greater than 50 percent. The hunts entail a high cost in both energy expended and risks taken. Once caught, the meat is selectively shared with members of the troop. Interestingly, the chimpanzees do not appear to hunt to meet a nutritional need, as they hunt primarily during the seasons when fruit is abundant. Rather, among chimpanzees, game may be a political tool used to increase one's genetic contribution to subsequent generations (Mitwani et al., 2002). By sharing the meat, the hunter builds alliances within the troop. These alliances enable a chimpanzee to establish and maintain a high rank that appears to confer mating and reproductive advantages.

Ecological factors suggest that if humans were to choose their diet on the basis of availability alone, they would choose one composed primarily of plant foods. But, given the concentration of nutrients found in game and the difficulty of digesting some plant foods, they would likely wish to complement the plant foods with game. Nutritional considerations indicate that at least some game is required in the diet.

Conclusion

Paleoanthropological data reveal that human ancestors of 4 to 2.5 million years ago ate primarily plant foods and possibly some game. Only at 2.5 million years ago does definitive evidence of the consumption of animals, obtained via scavenging or possibly hunting, appear. The expansion of the brains of human ancestors 1.8 million years ago does not necessarily mean they increased their consumption of animal foods. Rather, they may have increased their energy intake via the consumption of energy-rich plants. The Neanderthals of 130,000 years ago were the first hominids for whom game was a staple of the diet. *H. sapiens* also consumed game, albeit a greater variety and less focused on megafauna. Data from hunter-gatherers indicate they consumed a wide variety of plants and animals and that, by and large, plant rather than animal products provided the bulk of the calories consumed. Studies of nonhuman primates document that game is regularly consumed among some species. Although the nutritional implications of this behavior are not clear, it does appear to have cultural implications among chimpanzees, where meat is shared by males to enhance their reproductive potential. Each line of evidence considered here suggests that, beginning 2.5 million years ago, game formed part of the diet of human ancestors, and that plant foods have provided the bulk of human calories. In short, game was a part of the diets of early hominids and hunter-gatherers, but plants predominated in the diet. The evidence is insufficient to clearly evaluate the impact of this subsistence strategy on human behavior.



The fallow deer as depicted in Edward Topsell's *Historie of Fourefooted Beasts* (London, 1658). The fallow deer was one of the most prized game animals of the medieval hunt. ROUGHWOOD COLLECTION.

See also **Agriculture, Origins of**; **Evolution**; **Hunting and Gathering**; **Mammals**; **Prehistoric Societies**.

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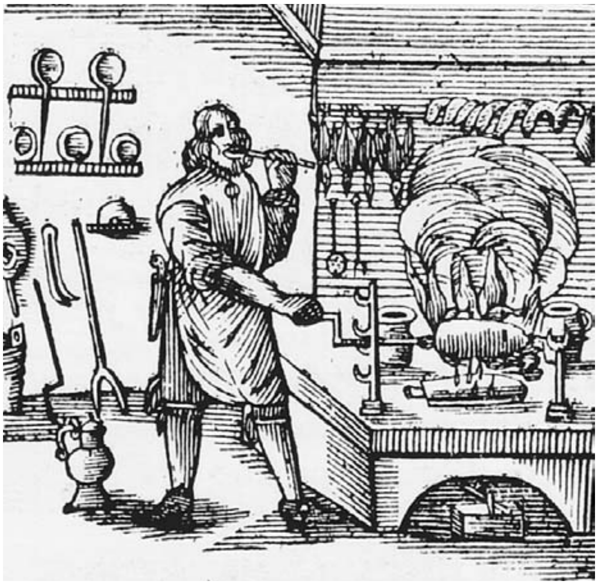
Warren M. Wilson

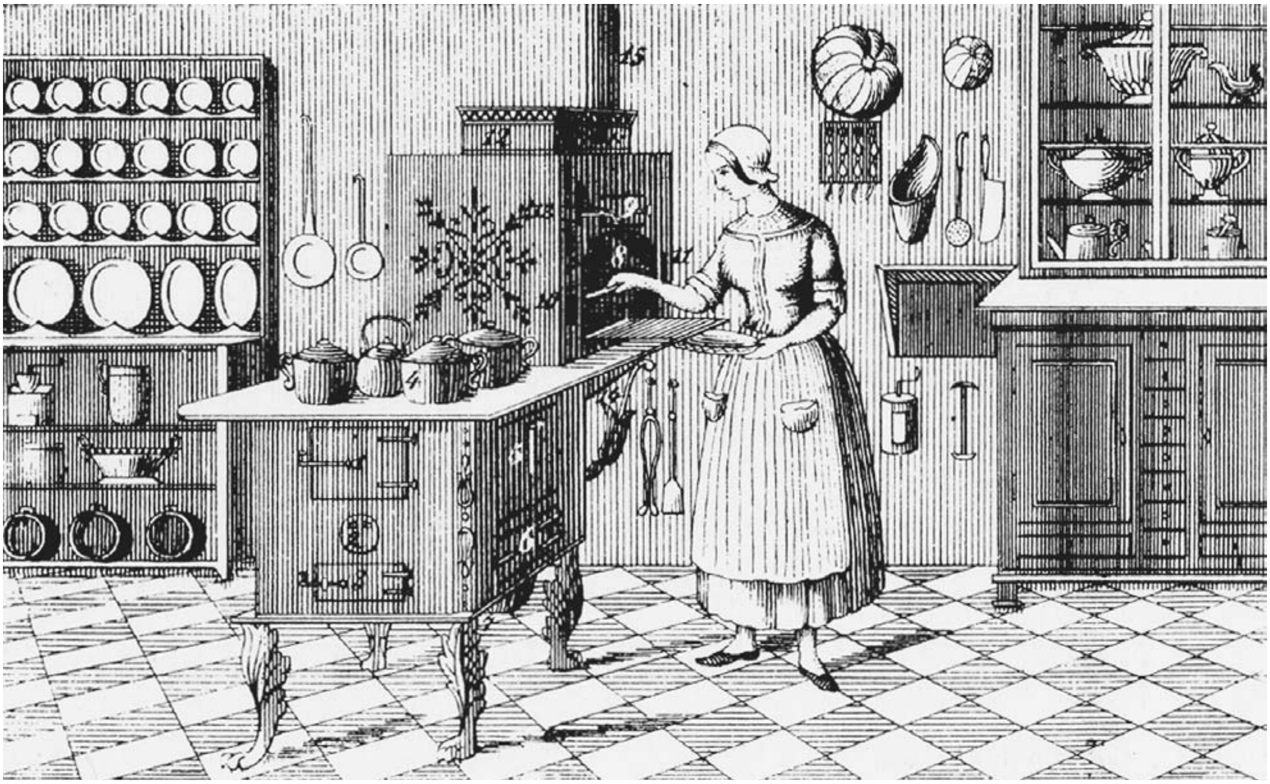
GAMERITH, ANNI. Anni Gamerith (1906–1990) was one of the most famous European food ethnologists, known for her fieldwork and her theoretical insights. Born in Austria and a teacher by profession, Gamerith received her doctorate late in life at the University of Graz. The same university later gave her an honorary professorship for her scientific achievements. Her theory about the structure of traditional cookery was put forward for the first time at the First International Symposion of Ethnological Food Research held at Lund, Sweden, in 1970. This immediately won her international recognition. She proposed that there was an interdependence between food, cooking utensils, and cooking processes on the one hand and the fireplace on the other.

In essence, the type of food produced by a culture was dependent on one of two basic technologies. In former times, before the so-called *Sparherd* (literally "fuel-frugal" kitchen range) was invented, kitchen fireplaces were designed either for an open fire (hearth) or for a cooking oven. The hearth with its open fire could be close to the floor (where the cook had to bend down) or as high as a table (where the cook could stand upright while cooking). The food was boiled in the hot water of an iron kettle (hanging over the fire) or fried in the hot fat of an iron three-legged pan (standing over the fire). The food prepared in this way included both meat, which was often boiled, and various kinds of pancakes, with the dough fried in different ways. During the whole process of preparing the food on the hearth, the cook could intervene at any time.

Preparing the food in the cooking oven was another matter. Here, the food was cooked in the superheated air of the oven. Once the food was placed in the oven, the oven door was shut, and the door stayed shut to avoid having the oven cool down. The pots and pans used in this case were ceramic and were placed in the oven through the small hole in front by special devices called "pot forks" (*Ofengabel*) or "pot forks with wheels" (*Ofenwagen*). The food systems connected with the hearth and the cooking oven as the two main places of food preparation were structurally different and, according to Gamerith, could be referred to as "hearth food" (*Herdkost*) and "cooking oven food" (*Ofenkost*). In former times a region was characterized by one category or the other.



Woodcut from the *Neu-vermehrtes künstliches Koch-Büchlein* [New, Improved Artful Manual of Cookery] published anonymously about 1650. While the cook turns a roast on a spit, sausages are being smoked above the fire. Leaning against the wall is a pot fork for moving hot cookpots on the hearth. COURTESY HANS WEISS. ROUGHWOOD COLLECTION.



This 1840s Austrian woodcut shows a newly installed cast-iron cooking range with a bake oven in the back. The iron pots on the stove have undergone a radical redesign to account for the new technology. COURTESY HANS WIESS. ROUGHWOOD COLLECTION.

The *Sparherd* or kitchen range changed the situation completely. The incentive for its invention was the necessity of saving wood (hence the name, German *sparen* meaning 'to save'). The kitchen range combined the two formerly separate principles of preparing food: the hot surface of this stove is equivalent to the open fire (allowing boiling or frying), while the baking oven corresponds to the cooking oven (where one could bake or braise). With this innovation, the two previously separate food systems could be combined, and the former differences between areas where one method or the other was dominant disappeared.

Gamerith had encountered these exclusive systems in her fieldwork and was finally successful in finding the theoretical explanation. She also found a classification for the many different kinds of gruel and concerned herself very early with old methods of processing cereals from the aspect of nutrition. She was involved to a great extent in the organization of the museum at Feldbach, Austria, with its special attention to rural material culture in general, including many objects that were relevant for ethnological food research. In the museum at Stainz, Austria—again due to Anni Gamerith—food plays an important role.

See also **Germany, Austria, Switzerland; Hearth Cookery; Preparation of Food.**

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Edith Hörandner

GARDENING AND KITCHEN GARDENS.

The purpose of the kitchen garden is to supply the household to which it belongs with culinary herbs, fruit, and vegetables. There are, however, different types of households, and likewise different kinds of kitchen gardens. This entry deals mostly with the walled kitchen gardens that were created in northern Europe, and in particular in Great Britain, during the eighteenth, nineteenth, and early twentieth centuries.

Types of Kitchen Garden

The earliest garden of any kind was surely one that supplied its owner with edible and, to a certain extent, medicinal or useful household plants. People created

An organic kitchen garden at the Centre for Alternative Technology, Machnylleth, Wales. © JULIE MEECH; ECOSCENE/CORBIS.

such gardens in prehistoric times and they are still made today, albeit on a small scale and with fewer medicinal or household plants.

A productive garden requires certain essential elements that are common to all: They are usually situated close to the homestead; they need fertile soil, a supply of water, shelter from the worst of the weather, and protection from thieving birds, beasts, and people. Kitchen gardens with these basic requirements can be found in rocky, compost-filled craters on tropical islands; on cold, windswept seaside beaches; on rooftops in the center of huge towns; on narrow strips of land beneath ancient city walls; on river islets; and on terraced mountainsides. Security is provided by low stone or mud walls, hedges of thorns or spiky cacti, wooden or reed palings, ditches or moats, old bedsteads, and wire netting. Water comes from nearby springs, streams, rivers, or pools. In spite of the ingenuity required to make them productive, the produce of these gardens is likely to be erratic, as they are dependent on the seasons both for clement weather and rain; for this reason, and also because they usually have no supporting structures such as glasshouses, work sheds, or storage rooms, these gardens must be termed "primitive."

The country dweller's cottage kitchen garden forms another category. Lying somewhere between the basic, or primitive, kitchen garden and the much larger, walled kitchen garden, the typical cottager's garden forms the very surroundings of the cottage itself with flower beds, fruit trees, narrow paths, and small lawns as well as an open, cultivated vegetable patch. It might include a little orchard, bee hives, a pigsty, and a poultry house. The whole would be surrounded by a stout hedge, fence, or low wall. Before the arrival of modern piped water on tap, water would have been supplied by a well or a pump. The amount of produce grown on the vegetable patch might be sufficient to provide the family with a surplus of staples for storing over the winter, but the area would not necessarily be big enough to grow vegetables in succession, and the owners might not be able to afford a glasshouse, heated or unheated, for out-of-season luxuries. It could though, be laid out in a decorative manner, with a mixture of flowers and vegetables, trained fruit trees, and topiaried hedges.

The decorative kitchen garden, one designed as much for beauty as utility, is a constantly recurring theme in kitchen gardening. In the early twentieth century, when the fashion for this kind of kitchen garden had a little revival, it was referred to by English-speaking gardeners as the *potager*, an affectation that simply means "kitchen garden" in French.

Although well suited to it, the *potager* style of gardening is not confined to the cottage garden; it can be carried out on a vast scale as, for example, in the gardens of the Château of Villandry on the Loire in France, and it was often seen in walled kitchen gardens, too. In spirit the *potager* is poetic, inspired by classical Roman works such as Virgil's *Georgics* (see especially *Georgic* 4) and *Hortulus*, a poem on gardening written about 840 by the monk Walafrid Strabo. Renaissance gardens, too, with their vine- and jasmine-covered arbors, statues, urns, and fountains; clean sandy walks lined with clipped box, pinks, or herbs; little pavilions or gazebos at each corner overlooking the countryside beyond; and juxtapositions of fruit, flowers, and vegetables within were as pleasant to look at, contemplate, and walk in as they were useful. The theme continues into the seventeenth and eighteenth centuries, with the gradual removal of the kitchen garden from close proximity to the house and the separation of the garden as a whole into various compartments. The essayist Sir William Temple in his *Epicurus* of 1685 describes this arrangement: "so as to be like one of the Rooms out of which you step into another." By the end of the eighteenth century, kitchen gardens in many of the larger estates had been removed to a considerable distance from the house. George Carter in his catalogue for the exhibition of the work of the landscape designer Humphry Repton notes that Repton wished the walk toward the kitchen garden to be as ornamental as the kitchen garden itself (pp. 67–68). Once there, the visitor would find features similar to those described in sixteenth- and seventeenth-century manuals on gardening: gazebos, fruit trees trained over hoops to provide shady walks, and beds lined by flowers with the more ornamental kinds of vegetable on show, the commoner kinds concealed. In winter, the visitor could seek the warmth and beauty of the glasshouses.

The garden at Villandry is a Renaissance pastiche; it was created on a sixteenth-century site in the twentieth century, and is based on contemporary designs for *parterres* by Androuet de Cerceau—not that there is any evidence that de Cerceau used vegetables in this way. In practice, in many a modern *jardin potager*, the *parterre*-like layout of the beds, and the heights and colors of the plants therein are of more importance than the supply of food to the household. When the cropping of one cabbage can jeopardize the beauty of a whole row, this type of kitchen garden begins to look like a plaything.

For town-dwellers, fruit and vegetables have always been available from shops, itinerant tradesmen, and markets. These outlets were supplied with produce grown in outlying commercial market gardens, many of which specialized in only one or two kinds of fruit or vegetable (asparagus, strawberries, mushrooms, or grapes, for example). From the late nineteenth century onward, produce markets depended increasingly on stuff imported from abroad, and it is this factor—plus the relative cheapness of bought food compared to the cost of growing one's own—that has contributed to the demise of the great walled kitchen gardens. On the other hand, with the creation of the allotment system in the early nineteenth century, town-dwellers (ranging from wealthy tradesmen to artisans of the working class) were, and still are, enabled to raise a few fruits, flowers, and vegetables of their own on communal, rented plots provided either by philanthropists, speculators, or the municipality on the outskirts of towns. The original purpose of the allotment system was to offer a healthy pastime for heads of households who might otherwise squander their time and money in public houses and other dens of vice. Ten such gardens would occupy one acre and in 1835, according to William Howitt, in *Rural Life in England*, there were, on the outskirts of the English manufacturing town of Nottingham alone, "upwards of 5000 gardens, the bulk of which are occupied by the working class" (pp. 550–553).

Allotment gardens, traditionally equipped with little huts or summer houses, are still in use throughout Great Britain and Europe, providing their tenants, as they did in the past, with welcome retreats from the noise and dust of the city, as well as a healthy occupation and a supply of wholesome fresh food. Market gardens, with their vast glasshouses and forcing beds are not, for the purposes of this article, strictly kitchen gardens, although they supply similar produce, but the allotment garden is definitely in the kitchen garden category, being private and noncommercial.

Walled kitchen gardens invariably formed part of the gardens attached to any substantial country house. Unlike the other domestic kitchen gardens described above, these gardens were huge, occupying anything from one to twenty acres, commensurate in size with households often consisting of more servants than family, and capable of providing enough produce for feasts, balls, banquets, and numerous staying guests as well.

By the beginning of the twentieth century, kitchen gardens had reached the peak of perfection: the rarest and best of fruits, flowers, and vegetables were to be found here, raised by teams of highly skilled gardeners who used the latest in horticultural technology. This is not to say that the wealthier classes were alone in their love of luxury—plus a degree of natural curiosity and competitiveness—but peaches, melons, muscats, and pineapples cannot be raised in one's own garden without considerable financial means.

These gardens supplied their masters with a succession of fruits and vegetables all year round, both delicacies and staples, and with ornamental plants and flowers for the house and for personal adornment. Indeed, the demise of these great gardens, which began after World War I, and was virtually complete by the end of World War II, is largely due to such fruits and vegetables being cheaply available to everyone in a supermarket. The modern shopper might be surprised to learn that from the late eighteenth century onward, glasshouses in these walled gardens were providing heat and shelter for tropical fruits and orchids as well as more temperate plants. Forcing beds ensured that there would be new potatoes, asparagus, and strawberries for Christmas and in early spring; mushrooms were grown in dark, heated sheds, to be available at all times; insulated and ventilated storage rooms kept grapes, apples, and pears in perfect condition over winter and into springtime. Common roots and vegetables such as onions, cabbages, and pumpkins were likewise stored in specially constructed cellars and attics. Garden produce was even frozen, and kept in ice-houses. The kitchens made surpluses into pickles and preserves, and if the family was staying in town, fresh fruit, flowers, and vegetables—washed, trimmed, and packed in hampers—were sent up as required by the gardeners.

Design

In layout, walled kitchen gardens show a marked similarity to one another; this is due to their being essentially working gardens, the design of which is led by function and has evolved through practice. Ideally they are rectangular, with the longest walls facing the sun; lean-to hothouses are ranged against the sunny side of the northernmost wall; sheds behind them (known as "back sheds") house boilers or furnaces to heat the glasshouses, workrooms, storage rooms, and tool rooms, the men's mess room, the head gardener's office, his seed room, the mushroom house, and sometimes a *bothy* or hut for the unmarried gardeners. The head gardener is given a house for himself and his family, often built onto the walls themselves, and always as close as possible to the hothouses, so that he can keep a close watch on them and their contents. Forcing pits, frames, and hot beds occupy a separate yard beside or behind the back sheds, as does an enclosure for packing materials, poles and posts, fuel, composts, and manures. The "slip garden" (the area outside the main walls) was also cultivated, usually with the more robust vegetables or with soft fruits. The slip in front of the southernmost wall was sometimes used as an ornamental flower garden, especially if it was the garden through which visitors from the house might pass on their way to view the kitchen garden.

With the exception of glasshouses, which were not seen in kitchen gardens until the early eighteenth century, and then only rarely, the monastic, royal, and aristocratic gardens of medieval Europe were very similar; they were modeled on treatises written by classical authorities such as Pliny, Cato, Varro, and Columella. Situated conveniently close to the back kitchens and the stables or home farm (which provided dung), stoutly defended by walls of mud, brick, or stone (depending on the locality), they were laid out if possible on land sloping toward the sun, on a four-square grid, with long, narrow raised beds.

The layout of the beds and paths was dictated by a watering system in which the paths between the beds acted as channels, the water coming either from central ponds, reservoirs beyond the garden, or wells, tanks, and cisterns within it. It was distributed in water carts, or by pumps and water wheels. The invention of the hydraulic ram in the mid-nineteenth century allowed gardens to be made on higher ground than would have been possible before. The invention of the horse-drawn seed drill in the late seventeenth century, whereby seed was sown in rows on flat ground, was taken up at first by farmers and then by market gardeners, effectively doing away with raised beds in the larger gardens of the more northern parts of Europe.

Diversity of Plants

The variety of plants grown in the earliest kitchen gardens was dependent on locality; those known to thrive in the wild were taken in and "improved" by selective breeding, fertile soil, shelter, and abundant watering. Travelers, merchants, nurserymen, and itinerant seedsmen introduced novelties from further afield. With the voyages of discovery made by Europeans from the fifteenth century onward, plants from across the world were brought into Spain, Portugal, France, Italy, the Netherlands, and Britain. They were taken to the gardens of botanists and apothecaries, as well as the kitchen and flower gardens of enthusiasts, to be assessed as much for their economic or medicinal values as for their edibility or beauty.

These introductions were challenging to the gardener. Many of them needed protection over winter and heat in order to survive. The hot bed, a flat-topped mound of warm, fermenting horse dung covered by a bed of rich, sifted soil and surmounted by a protective frame, was introduced to Moorish Spain by the Arabs in the eleventh century, but was not used in the rest of Europe until four centuries later, when it was used for raising the seedlings of exotics, melons, cucumbers and out-of-season salads. Orangeries (also known as conservatories or greenhouses) were used for conserving citrus fruits and other exotic greens. Originally a dark, well-insulated overwintering shed, the orangery gradually evolved into a high-windowed ornamental building, with heat provided by small smoky stoves. Dutch gardeners led the way in seventeenth-century stove and glasshouse development. They made their orangeries lighter by giving them sloping glass fronts; they improved ventilation and perfected a system of underfloor heating by means of hot-air flues heated by small furnaces at the back of the house. With the discovery toward the end of the seventeenth century of how to raise pineapples, they introduced the use of hot beds heated by fermenting tan bark, in place of horse dung.

By the 1720s, British gardeners had overtaken the Dutch in horticultural invention. Gripped by a mania for growing pineapples, they developed glazed, heated pits and glasshouses expressly for that fruit, eventually adapting the system to suit vines, peaches, and tropical plants. With the industrial revolution, which began in Britain, came the invention of the steam boiler and later the hot water boiler, as well as the glassworks and foundries for the manufacture of iron-framed glasshouses in which to raise these plants, and a new, industrial wealthy middle class to enjoy them.

Even before the sixteenth century, Flemish and French gardeners were masters in the cultivation of fruit. They raised innumerable varieties of hardy fruits such as plums, apples, pears, and cherries, as well as figs, grapes, and the more tender, early-flowering apricots, almonds, peaches, and nectarines. They were experts in grafting and in training trees to grow as fans, espaliers, cordons, and free-standing dwarfs. With the arrival in Britain of the Dutch King William III, in 1688, this style of fruit growing became fashionable in British gardens where, until then, fruit growing had been concentrated mostly on hardy orchard fruits. As on the Continent, dwarf fruit trees, pruned to form decorative balls, goblets, spindles or pyramids, were used ornamentally in beds lining the kitchen garden paths, or were even given a *jardin clos*, an enclosed fruit garden of their own. Fruit trees with branches trained as horizontal bars (espaliers), as single, double, or treble stems, either upright, oblique, or horizontal (cordons), or as branches trained into a flat palm or fan shape (fans) needed the support of free-standing trellises or high walls. Walls were especially needed too, to accommodate the more tender wall-fruits.

An Industrial Quality

Thus the walls surrounding the kitchen gardens of northern Europe and Great Britain increased both in height and extent. Gardens of more than four acres were divided and subdivided by yet more walls, some of which were heated by horizontal, serpentine flues running from small fireplaces situated at the back.

High garden walls were beneficial to wall-fruits, created a benign, sheltering microclimate within the garden, provided support for taller, more extensive glasshouses and back sheds, and hid the whole process of growing kitchen produce from sight, giving the place a secretive air. It should be noted, though, that this complex was the headquarters of the gardens as a whole; it was where the entire workforce assembled and received orders, where the garden boys were educated by the head gardener, where equipment was kept, and all the choicest plants raised and nurtured.

It was also becoming increasingly industrial. For a visitor to an early-nineteenth-century kitchen garden, as described by Jane Austen in *Northanger Abbey*: "The walls seemed countless in number, endless in length; a village of hot-houses seemed to arise among them, and a whole parish to be at work within the inclosure." She does not mention the numerous smoking chimneys perched above hot walls and glass houses—or how, on a windy day, strawy dung from frames, pits, and hot beds would be blowing about and there would be a noticeable smell of rotting cabbage leaves, celery, onions, and leeks. These aspects, and even the very sight of "a whole parish" going to and fro with their barrows and carts, were less pleasing to eighteenth- and nineteenth-century gentlefolk.

The Landscape Movement

Apart from the sensibilities of its owners, the landscape movement was to some extent responsible for the removal of the kitchen garden with its high walls to some distance from the house. If it could still be seen, it was screened by beds of tall, ornamental shrubs or, if the screen was to act as a shelter belt as well, by tall forest trees. "If from your best room windows any objects should intercept your sight," wrote landscape designer J. Trusler in his *Elements of Modern Gardening* (1784), "go to the top of the house and from thence select the best distance and background, preserving in the piece such of the buildings and plantations as will suit the composition. . . ." Not everyone agreed; the political reformer William Cobbett, in his *English Gardener* thought it "the most miserable taste to seek to poke away the kitchen garden, in order to get it out of sight" (p. 8).

At the beginning of the twenty-first century, these arguments seem trivial, for the gardens are in ruins, with little but the walls to be seen. But there is some hope for their revival. Local communities see them as sources of fresh, organic produce; others will use them as living museums in which to teach old horticultural skills, and display long-forgotten fruits and vegetables.

See also **British Isles: England; Fruit; Food Production, History of; Horticulture; Organic Farming and Gardening; Vegetables**.

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Susan Campbell

GARLIC. *See* **Onions and Other Allium Plants.**

GASTRONOMY.

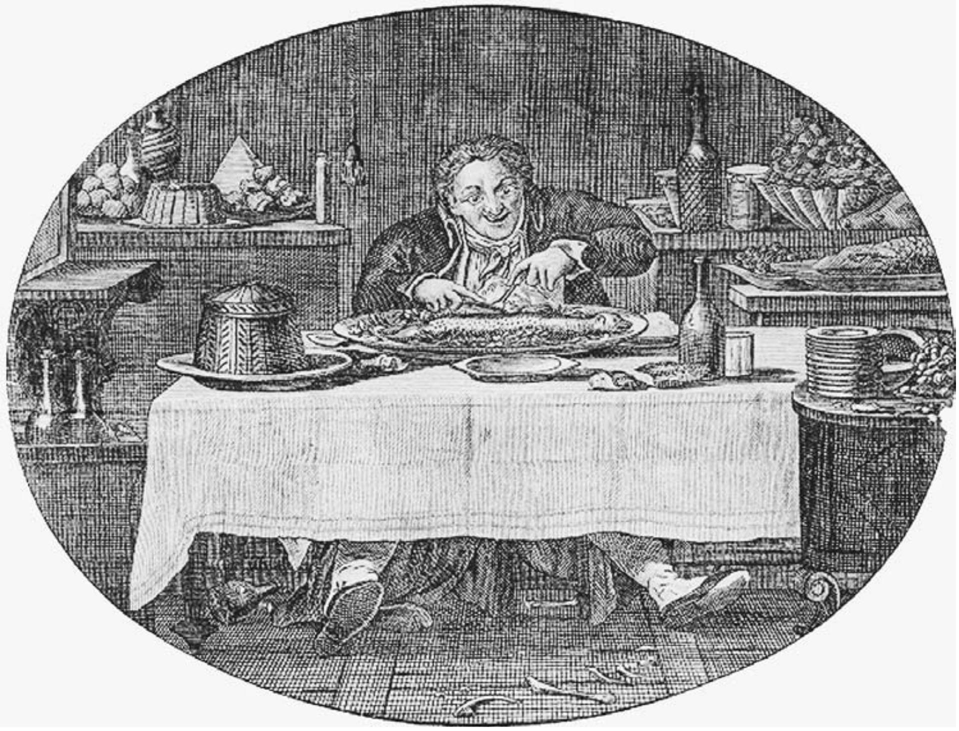
Most dictionaries define gastronomy as "the art and science of good eating," or "the art and science of fine eating." The etymology of the word is generally attributed to the title of a poem by French attorney Joseph Berchoux, "Gastronomie" (1801). Early descriptive writings often assume gluttony. One versed in gastronomy is said to be a gastronome, while a gastronomist is one who unites theory with practice and thus becomes a gourmand (gourmet).

The original suffix root of gastronomy derives from the Greek word *nomos*, meaning 'laws that govern', which led to the notion that gastronomes are those who only dwell upon classic and haute cuisine. Implied too is that "the art and science of good eating" is confined to expensive, lavish, and complex meals requiring equally expensive silver and china. Fortunately, as is the case with so many rules and regulations, such rigidity of form can become uncomfortable. One so-called early proponent of gastronomy asserted that a true gastronomist should shun diversity—a rather narrow footnote by today's understanding.

Gastronomy has evolved from its original dictionary meaning to the point that it really would be best studied broken down into subsets by culture.

A further denotation of *nomos*, 'the sum of knowledge of a specific subject', gives gastronomy a meaning that includes a person's command of the totality of knowledge regarding the art and science of good food and eating. Rather than just beautifying the ritual of consumption, gastronomy now entails an appreciation and understanding of the many avenues of cooking and food production. For example, today's gastronomist would do well to have some knowledge regarding food chemistry and physics, food history, foodways, and culinary anthropology, including a link to the many cultures of the world via computer technology.

One should seek a better understanding of agriculture, aquaculture, and the technology of newer cooking



Copper engraving called "Au Gourmand," used as a letterhead on an 1816 bill of Paris *traiteur* Corcellet at the Palais Royal. This bill was charged to Anthony Morris of Philadelphia, who was visiting Paris at the time. ROUGHWOOD COLLECTION.

methods and equipment, as well as information on the impact of eating and diet upon health, including foodborne disease and worldwide ecology. Gastronomy should promote lessons on how to taste, savor, and fully sensualize the dining experience, whether it is a family meal at home or a special dining-out event.

Simpler repasts should be enraptured alongside the grandest banquets. Standing at a seaside fish market and savoring a freshly shucked oyster just harvested and chilled from the sea can be savored as much as the expensive three-hour feast served in a banquet hall.

There is a tendency to judge food and cooking solely by what it looks like. When dining out, taste and aroma are demoted in favor of stylistic architecture. People, especially Americans, are losing the ability and sensibility of how to taste. Americans no longer savor or appreciate the joy and satisfaction of eating. Entertaining and pleasant conversations over dinner seem to have disappeared; food fads come and go before ever having had a chance to even establish an identity. It is time to relearn or reemphasize how the senses can be used to fully appreciate and relish the hedonistic pleasures of life. People are equipped with the necessary anatomy and physiology to elevate a boring biological function to one of life's greatest pleasures.

See also **Appetite**; **Brillat-Savarin, Anthelme**; **Catherine de' Medici**; **Eating: Anatomy and Physiology of Eating**; **Icon Foods**; **Larousse Gastronomique**; **La Varenne, Pierre François de**; **Pleasure and Food**; **Sensation and the Senses**; **Slow Food**.

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Fritz Blank

GELATIN.

Gelatin (also gelatine, jelly in Britain, jelly powder in Canada, and *gelée* in France) is a flavorless, transparent thickener derived from animal collagen that dissolves when heated and congeals when cooled, allowing foods to set. This versatile ingredient provides unique textural and sensory properties to both savory and sweet foodstuffs such as mousses, gummy bears, Turkish Delight, nougat, jellied soups, Bavarian cream, aspic, and Jell-O.

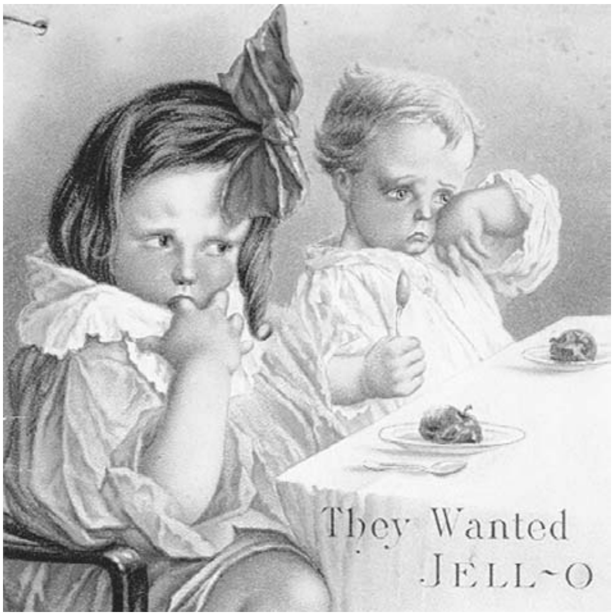
Gelatin is composed of protein molecules, made up of chains of amino acids. When placed in liquid, the molecules swell and then dissolve, and the chains separate. After cooling, they re-form as tightly as before. In the warmth of the mouth, they melt, providing excellent flavor release. This property and gelatin's easy digestability and absorption by the body makes gelled desserts appropriate for children, invalids, and the elderly.

Nutritional value of gelatin was recognized as early as the Napoleonic Wars (1800–1815) when the French used it as a source of protein during the English blockade. Commercial gelatin contains no fat or cholesterol and few calories, making it popular with people who have diet and heart concerns. Commercial manufacturers claim that gelatin promotes nail and hair growth, as well as flexible joints and healthy bones. However, the protein in gelatin is missing an amino acid and thus is not absorbed as a complete protein by the body.

Making Gelatin

The discovery of gelatin was probably serendipitous: When animal bones and hides are boiled in water, the broth that results will set upon cooling. From the Middle Ages through the eighteenth century, making gelatin was a daylong, laborious process in which cattle hooves were boiled for six hours. The stock was clarified as it dripped through a jelly bag, boiled again, and then allowed to sit. Not surprisingly, production was limited to wealthy households with many servants. Another early

Copper molds for gelatin became extremely ornate in the nineteenth century. Different colors of gelatin, as well as different flavors, were often layered together in molds to create elaborate patterns for the table. Copper molds from England, circa 1870. ROUGHWOOD COLLECTION. PHOTO BY CHEW & COMPANY.



Part of the early success of Jell-O was its strong marketing appeal to children. This 1908 Jell-O brochure shows two disappointed children who have just been served baked apples instead of the Jell-O they expected. ROUGHWOOD COLLECTION.

source of gelatin in the Middle Ages was hartshorn (antlers of the hart deer).

Today, the substance is manufactured commercially all over the world. In the United States most gelatin is derived from pig skin. Strictly speaking, this is not a kosher practice (although interpretations vary), and it is not permissible under Islamic dietary law. An alternative, isinglass (made from the air bladders of sturgeon), is acceptable to the religious and vegetarians. Another alternative is agar, made from a variety of red seaweed, commonly used in Japan where it is known as *kanten* and used in the manufacture of ice cream. Cattle form the basis of gelatin in France and Britain, raising safety concerns about transmission of mad cow disease even in the United States where some gelatin is imported from Europe.

Commercially manufactured gelatin is packaged in ¼-ounce envelopes of desiccated granules; paper-thin sheets, known as leaves (used in jelled Central and Eastern European desserts and aspics); and meltable blocks (Great Britain). In Latin America, gelatin is often mixed with milk or cream instead of water for the popular creamy desserts. In Russia, gelatin encases pigs' feet and other meats.

Aside from home and restaurant cooking, gelatin has wide application in the food industry where its functional properties are used to gel, thicken, stabilize, emulsify, bind, film, foam and whip prepared foods. Among other items, gelatin is incorporated into marshmallows, cake mixes, frostings, bakery glazes, meringues, ice cream, coffee, and powdered milk.

JELL-O

Jell-O has become a cultural icon in the United States. Invented by Pearle Bixby Wait in 1897, (the name Jell-O was coined by his wife, May), this flavored gelatin's longevity is credited to its convenience for dessert, its popularity, especially with children, and its ability to inspire smiles, jokes, and playfulness. Beginning with strawberry, raspberry, orange, and lemon, Jell-O in the early twenty-first century comes in twenty-three flavors, including white sparkling grape, watermelon, and passion fruit. Strawberry is the best seller. Over a million boxes are sold every day; Salt Lake City, Utah, is the number-one consumer city.

Aside from thousands of inventive serving ideas (including one from 1930 for forcing set Jell-O through a potato ricer), Jell-O has spawned collectors (of original boxes, early advertising, recipe booklets, molds, glasses); Jell-O shots (alcoholic treats made by mixing in liquor); Jell-O wrestling (sometimes in the nude in large vats); the Jell-O Museum in Le Roy, N.Y.; an attempt to measure the brain waves of Jell-O; and countless websites.

Not everyone thinks Jell-O is benign. During the 1950s, when femininity was defined as docility, complicated molded constructions with fruits precisely placed according to pattern were popular, raising questions about a foodstuff that controls and keeps things in their place. One researcher claims that the marketing of Jell-O depicts women as inept homemakers. It is hard not to wonder about the larger social message of "perfection salad," a prescribed concoction of cabbage, celery, and red peppers in tomato Jell-O, popular at the turn of the twentieth century. Such prescription becomes a symbol of conformity and stifles creativity.

Medieval Beginnings

Elaborate molded jellies began to grace aristocratic British banquet tables in the fourteenth century. In the Late Medieval period (the 1400s) through the 1500s, cooks made savory and sweet jellied dishes using meat, chopped fine, mixed with cream or almond milk that was flavored with spices, rosewater, or sugar to fashion creations known as cullis, gellys, or brawn. In 1754, the first English patent for the manufacture of gelatin was granted. During the Victorian era, copper, and later aluminum, molds were introduced, which made possible the presentation of tall, shimmering creations. Unflavored dried gelatin became available in 1842 from the J and G Company of Edinburgh, Scotland.

Gelatin had an esteemed role in classic French cuisine. Escoffier's legendary *Guide Culinaire* (1903) includes a chapter on aspic jellies (savory gels) in which the great chef named two kinds: one flavored with champagne; the other with sherry, Marsala, or Madeira. Surprisingly, he mused that aspics might be even more important than stock, the bastion of Gallic cooking, because a cold meat, poultry, or fish entree (known as *chaud-froid*) is nothing without its glimmering coating of aspic. He warned that the value of the aspic decreased in direct proportion to its increasing firmness. The ideal was a softer consistency so aspic could even be served in a sauceboat. Gelatin also figured in many classic French desserts like blanc-mange, charlottes, mousses, and Bavarian creams.

Gelatin in the United States

In America, in 1845, Peter Cooper, inventor of the steam locomotive, secured a patent for a gelatin dessert powder called Portable Gelatin, requiring only the addition of hot water. The same year, the J and G Company began exporting its Cox Gelatin to the United States. The new formulas never gained much popularity, however, and as late as 1879 when the classic *Housekeeping in Old Virginia* was published, editor Marion Cabell Tyrer, while admitting that jelly made of calves and hogs was "more troublesome," claimed it was more nutritious than Cox's or Nelson's desiccated formulas. Plymouth Rock Gelatin Company of Boston patented its Phosphated Gelatin in 1889. In 1894, Charles Knox introduced granulated gelatin, making the brand something of a household word. This opened the way for a plethora of American recipes that gained popularity, particularly during the 1950s when chiffon pie and tomato aspic (made of gelatin and tomato juice) became staples.

Although Jell-O is considered déclassé in upscale restaurants, gelatin was resurrected and frenchfied by American chefs in the late 1990s, who reverted to calling the sweets "gelées." These creative formulas have been limited only by imagination since virtually any liquid can be used—coffee, champagne, grape and beet juice, rosé wine, sangria, and fruit poaching liquids. What began in the Middle Ages as an elite food has come full circle and returned to gourmet status.

See also **Escoffier, Georges-Auguste**; **Medieval Banquet**; **Proteins and Amino Acids**; **Icon Foods**; **Women and Food**.

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Linda Murray Berzok

GENDER AND FOOD. Across many cultures and epochs, people have constituted, expressed, and bridged gender differences through foodways—the beliefs and behaviors surrounding the production, distribution, and consumption of food. Through the division of labor, alimentary exchanges, access to food, and the meanings surrounding eating, men and women have enacted their identity, roles, and power.

Gender and Food Production

In many cultures, men and women define their economic relationships in food-centered productive roles. In hunting-gathering and pre-industrial farming cultures, men and women share in food production but have distinct roles. Among the !Kung of the Kalahari Desert, for example, women gather vegetable foods and men hunt animals. Although women produce the great majority of the food, men produce highly desired meat, and thus the contributions of both sexes are relatively equally valued, which contributes to the gender egalitarianism that is a hallmark of the !Kung. In Wamira, Papua New Guinea, men and women contribute to growing taro at different stages in the agricultural cycle: men prepare the soil and plant the tubers; women weed the gardens and tend the growing plants; men harvest the mature tubers (Kahn, 1986). They promote gender interdependence and mutual respect by symbolically linking their complementary roles in the production of taro to those in the reproduction of children. Among share-cropping peasants in Tuscany in the first half of the twentieth century, men focused on producing grain, grapes, and olives, while women took care of the family vegetable garden and the courtyard animals. Women also helped harvest the major crops, gathered wild foods, and preserved and prepared key comestibles. Because women's productive work was associated closely with their taken-for-granted reproductive roles in the home, it was less highly valued than men's contributions to food production.

Around the globe, women predominate in the lowest status, lowest paying, and most servile roles in agribusiness and the food industry as fieldworkers, waitresses, fast-food servers, and cannery and meatpacking workers. In rural Iowa, for example, women were almost completely excluded from the pork-packing industry when jobs were unionized and pay was good. They entered the industry in increasing numbers in the 1980s,

The tension between male and female views of food and cookery is satirized in this picture of the helpless husband and the amused wife. © H. Armstrong Roberts/CORBIS.

when wages were falling, and at the end of the twentieth century they were still almost always relegated to the poorest paying packing and cleaning jobs in the plant rather than the better-paying cut and kill jobs (Fink, 1998).

Women are almost universally in charge of cooking and feeding, starting with breast-feeding the newborn. Through breast-feeding, women forge deep bonds with children and give them the best possible food, yet across the globe, breast-feeding has declined under the flood of commercial formulas. While formula has been beneficial to some women who cannot or do not want to breastfeed, it lacks the many benefits of breast milk and has contributed to the disempowerment of mothers who have lost confidence in their bodies and control of their children's food (Blum, 1999; Van Esterik, 1989; Whitaker, 2000).

Women's labor to produce, preserve, prepare, serve, and clean up food sometimes brings recognition and value, as among Ecuadorian peasants. But often women's food roles are devalued, especially under conditions of capitalist economic development, as in late-twentieth-century central Italy, where women's food roles became isolated in the home and separated from valued, public production. Florentine women struggle to balance their desire to work outside the home with traditional expectations that they prepare elaborate meals for both lunch and supper. They suffer conflicts that men, free from culinary expectations, do not face. As in Italy, in England and the United States women's food roles in the home are sometimes problematic because they are "naturally" assigned to women and the labor involved is both underestimated and undervalued. Women are obligated by custom and culture to cook and please their husbands while subordinating their own desires (Charles and Kerr, 1988; DeVault, 1991). In lesbian and gay households, feeding work is undervalued and confers low status, so many couples tend to minimize its significance and the implicit subordination of the partner who does it (Carrington, 1999).

Gender and Food Consumption

Food consumption signifies gender and sexuality in diverse cultures. Eating often stands for intercourse, foods for sexual parts. Among the Wamira, taro represents male virility, and the size and fullness of the tubers stand for the potency of their producer. Male and female identities are expressed through association with foods and rules about consumption. The Hua of Papua New Guinea classify foods into two main categories: *koroko*, or female foods, are wet, cold, fertile, soft, and fast growing; *haker'a*, or male foods, are dry, hot, infertile, hard, and slow growing. Hua men and women believe they can gain some of each other's powers and attenuate gender differences by eating each other's foods (Meigs, 1984). In other cultures, however, rules about food consumption promote hierarchical conceptions of gender. In nineteenth-century American bourgeois homes, women were discouraged from eating meat, which was believed to stimulate excessive sexual appetite. Late-twentieth-century U.S. college students still believed that men should eat lots of meat and women should eat lighter foods, such as salads. They valued hearty appetite and big bodies in men, but preferred dainty eating and small bodies in women, thereby forcing women to deny their appetites and reduce themselves (Brumberg, 1988).

In Western cultures for at least seven centuries, women have much more commonly than men practiced extreme fasting and compulsive eating to communicate unspoken longings for autonomy, control, and power. A significant number of medieval women used food refusal and miraculous emissions of breast milk as expressions of piety and spiritual power. Middle-class nineteenth-century American girls refused food to demand attention and speak their needs for full personhood. Many U.S. girls at the turn of the twenty-first century struggle for control by pursuing excessive thinness through extreme fasting or bingeing and purging, while others eat compulsively to numb the pain of abuse. Yet women from many cultures have forged positive relationships with their bodies that allow different and more ample forms of body beauty. In cultures as disparate as Fiji and Florence, people decry thinness as evidence of social neglect and celebrate women's plumpness as a reflection of well-being and fertility.

Male Cooks in the Mid-Twentieth Century

Insights into the gender-based division of labor in American culture are beautifully illustrated by cookbooks that were written by men for other men in the first half of the twentieth century. Among other things, they illustrate that, just like women, men had to deal with the consequences of being fettered by other people's notions of what was a permissible interest or occupation. Men were expected to do important, well-paying work, and if they happened to be interested in cooking, they were expected to be executive chefs. Men who wrote cookbooks could write without embarrassment about the pursuit and preparation of wild game, perhaps, or the perils of outdoor barbecuing, but everyday home cooking was understood to be women's work.

Nevertheless, men interested in writing recipes for home cooks managed to do so without losing their self-respect, but in order to pull it off they had to set themselves apart from women. Authors had to prove that male cooks were more creative and inspired than women, who were understood to be more concerned with the mundane task of getting three meals a day on the table. Male cooks had to convince themselves and others that, unlike women, their approach to food was spirited and adventurous, not weighted down by frets over level measurements or undue concerns about nutrition. The concern of the male cook, of course, was to appear masculine enough not to be mistaken for a sissy or the least bit effeminate; he would prove his legitimacy by establishing his superiority over women.

Certain American foods have been linked either to men or to women, creating stereotypes that designate light, sweet foods such as jams, jellies, and cupcakes as female, while male food is heavy and spicy, with the only acceptable vegetable being potatoes.

Male gourmets were happy to see the prohibition of alcohol lifted in 1933 so that they could occupy themselves with matching good food to good wines. Seeking like-minded companions, they formed societies to share their interest in fine food. J. George Frederick, founder and first president of the New York Gourmet Society, established his leadership by creating "A Gourmet's Code of Modern Dining," published in his book, *Cooking as Men Like It* (1939).

Frederick has clear ideas about differences between men and women in their approaches to food. While he credits women with having made some striking advances in their cooking, he finds them too occupied with cleanliness, purity, and nutrition, rather than what is "savory and tasteful" or "varied and succulent," the priorities of men.

While old ways of thinking tend to persist, new styles of eating would suggest that at the start of the twenty-first century, men who like to cook and bake can do so without feeling their manhood challenged, and women who have no interest in domesticity will perhaps no longer be considered unnatural.

See also **Cookbooks; Division of Labor; Time; United States: African American Foodways.**

Barbara Haber

Gender and Food Distribution

In food exchanges, men and women create meaningful relationships and demonstrate wealth and power. In many agricultural and hunting-gathering societies, men give away food to acquire and demonstrate political leadership. In Wamira, Papua New Guinea, men gain allies and shame enemies through massive food feasts. Women in many cultures exercise influence over family members by giving or withholding food, and they contribute to establishing hierarchy in the family by allocation of delicacies. When serving the soup, Ecuadorian Indian peasant women show favor by distribution of the prized chunks of meat, and they express ire at husbands by failing to prepare dinner, a grave insult and social transgression (Weismantel, 1988). In many cultures, women and men initiate relationships by eating together—whether as a date among Western college students or as a marriage proclamation by sharing yams among the Trobriand Islanders. Feasts celebrate community and gender cooperation across all cultures. For example, in Tresnuraghes, Sardinia, for the feast of Saint Mark, shepherds donate sheep, which their wives cook and distribute—solidifying community, demonstrating wealth, and sharing food widely.

In many cultures, gender hierarchy is expressed through access to food. Often women have less access to food than men, a practice supported by their economic dependence, by beliefs that they need less, and by pregnancy food taboos. The Mbum Kpau, for example, prohibit women from eating chicken or goat lest they die in childbirth or suffer sterility, a major tragedy because of the importance of childbearing to these women. While in practice the prohibitions have little effect on daily consumption, they reinforce men's power by emphasizing their right to meat and other preferred foods (O'Laughlin, 1974). Under conditions of food deficiency, women are particularly vulnerable to hunger, along with children and the elderly, because they generally have less power over food and other resources than men. In Malawi, under normal conditions, women controlled grain stores and lived close to their relatives in matrilineal and matrilocal households. But in the 1949 famine, crops failed and women had no grain to control. Wage labor, exclusively practiced by men, was the only way to gain access to food, but many men left their wives' households to search for food in the villages where they were born, so women lost access to men's labor and wages while still being responsible for feeding children, the elderly, and themselves (Vaughn, 1987). Under conditions of food insecurity, male power over food is particularly salient, but even under conditions of food security, gender relations play an important role in food production, distribution, and consumption across cultures and time periods.

See also **Anorexia, Bulimia; Anthropology and Food**; **Division of Labor; Lactation; Milk, Human; Sex and Food; Symbol, Food as; Taboos; Time; Women and Food**.

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Carole M. Counihan

GENE EXPRESSION, NUTRIENT REGULATION OF.

The human genome (or genetic material) is comprised of deoxyribonucleic acid (DNA) that encodes information required for all life processes, including growth, development, reproduction, and even cell death. The functional units within the genome are called genes. Genes are hereditary regions of DNA that encode functional molecules, either proteins or ribonucleic acid (RNA) species. The human genome encodes approximately 100,000 genes on 23 chromosomes. DNA resides in a specific compartment within the cell, known as the nucleus. Each nucleated human cell within an individual, regardless of its origin, contains identical DNA. However, the genetic code is expressed or read differently in each cell type. Gene expression refers to the processes in which the genetic code is deciphered to produce a functional macromolecule, either protein or RNA. While some genes are expressed in all cells, others are expressed exclusively in certain tissues or organs. This selective reading of the code imparts very different chemical, functional, and morphological properties to each cell type and ultimately defines the function of a tissue or organ. Genes can also display temporal specific expression. For example, some genes are expressed only in the fetus, while other genes are not expressed until puberty or adulthood. Therefore, human DNA not only contains all of the genes required to assemble a human organism, but also encodes information that directs where, when, and how much an individual gene will be expressed.

Mechanisms of Gene Expression

Genes encode proteins. Proteins are polymers of amino acid building blocks that serve a variety of biological functions. Proteins can function as intracellular scaffolds that maintain cell integrity; others are transporters that permit specific nutrients and other small molecules to enter the cell. Proteins also can be enzymes that catalyze the many chemical reactions required for cell survival. While DNA is present in the nucleus, protein synthesis occurs in the cytoplasm, a separate compartment within the cell. Therefore, an intermediate molecule is needed to transfer the genetic information from the nuclear compartment that contains the code to the cytoplasmic compartment where the code is read. This intermediate molecule is termed “messenger RNA,” and it is a short-lived functional copy of the genetic code. The process by which the genetic code, DNA, is copied to make a messenger RNA molecule occurs in the nucleus and is termed “transcription.” The process of reading the genetic code from a messenger RNA molecule occurs in the cytoplasm and is termed “translation.” The end product of translation is a protein molecule.

The expression of some genes is predetermined and cannot be altered. However, the expression of other genes, particularly those involved in nutrient storage, processing, and metabolism, is dynamic, and can be influenced by the cell’s environment. Therefore, in some instances, gene expression can be an adaptive process. It is now well established that the expression of many genes is, in part, constrained by the nutrient environment—giving credence to the old adage, “you are what you eat.” There are more than forty nutrients that are essential for mammals, and deficiencies in any of these nutrients have direct impacts on health. The cellular demand for these nutrients can vary as a function of growth, development, age, reproductive status, and immunity. However, for many organisms, the availability of nutrients can vary daily, weekly, and, in some cases, seasonally without notable changes in health. This is because organisms adapt to nutrient supply by altering gene expression. This alteration, in turn, enables cells to increase their storage capacity for certain nutrients, alter the absorption or excretion of certain nutrients, use alternative metabolic pathways, or reprogram metabolic pathways.

FAMILIAL HYPERCHOLESTEROLEMIA

Familial hypercholesterolemia is a disease that results from genetic mutations in the low-density lipoprotein (LDL) receptor. It is one of the most common inborn errors of metabolism. Individuals with one mutated copy of the gene (referred to as heterozygotes for this mutation) number about one in five hundred, whereas one in a million individuals carry two mutated copies of this gene (referred to as homozygotes for a mutation). LDL receptors are necessary for transporting LDL into cells from serum. LDL is a major cholesterol transport lipoprotein in human plasma, and individuals with LDL receptor mutations accumulate LDL in serum because LDL transport into cells is impaired. Plasma cholesterol levels from affected heterozygotes range from 350 to 550 mg/dl, and these values can exceed 1000 mg/dl for affected homozygotes. Individuals with elevated serum cholesterol have a high risk for developing heart disease at very young ages.

Cholesterol is an important component of cell membranes, and it serves to decrease their fluidity. Mammals can synthesize cholesterol in the absence of sufficient dietary cholesterol, but the endogenous biosynthesis is tightly regulated and inhibited by dietary cholesterol supply. A transcription factor known as SREBP (Sterol Response Element Binding Protein) regulates the expression of a gene that encodes a key enzyme that is necessary for cholesterol biosynthesis. When dietary intake of cholesterol is adequate, this transcription factor is sequestered in the membranes of the Golgi compartment of the cell and is inactive. When cellular cholesterol levels fall, however, the membranes in the Golgi become more fluid. This results in the liberation of SREBP from the membrane and enables it to travel to the nucleus, where it can activate the expression of genes that are necessary for cholesterol biosynthesis. Through this regulation, cholesterol biosynthesis occurs only when dietary sources are limited. However, this mechanism of gene regulation fails in familial hypercholesterolemia. Because LDL cholesterol is not effectively transported into cells, the cells cannot sense extracellular cholesterol levels, and therefore cellular SREBP activity and cholesterol biosynthesis is constantly activated. Activated cholesterol biosynthesis serves to further increase serum LDL concentrations in affected individuals.

Nutrients as Informational Molecules

If organisms have evolved the ability to reprogram themselves for optimal utilization of the available nutrient resources, then the implication is that a nutrient is not merely a chemical component required for a particular metabolic function, but also that it plays an informational or signaling role in the cell. As with any system that transmits

TABLE 1

Nuclear receptors and their associated ligands

Ligands	Nuclear receptors
Hormone Activating Ligands	
3,5,3'-L-triiodothyronine	TR
testosterone	AR
progesterone	PR
aldosterone	MR
cortisol	GR
17β-estradiol	ER
androstanol	CARβ
pregnenolone-16-carbonitrile	PXR
25-hydroxycholesterol	SF1
Vitamin Activating Ligands	
dihydrovitamin D3	VDR
all-trans retinoic acid	RAR
9-*cis* retinoic acid	RXR
Metabolite Activating Ligands	
leukotriene B4	PPARα
8(S)-HETE	PPARα
15-deoxy-12,14-prostaglandin J2	PPARγ
22(R)-hydroxycholesterol	LXR
CDCA (bile acids)	FXR
palmitoyl-CoA	HNF-4

information, the signal must have a sensor or receiver that can accept, decode, and relay the information that has been transmitted. Cellular proteins that receive and transmit this information are termed "receptors." The receptors then must relay this information via a transducing mechanism to the part of the cell that is capable of reprogramming the cell to adapt to the new environmental conditions. This reprogramming can occur in the cell nucleus or cytoplasm. It can involve changes in the expression of genes (transcription and translation), the stability of messenger RNA and protein, or the activity of proteins. The key principle behind nutrient control of gene expression is specificity. Each receptor must have the capability of binding a nutrient-signaling molecule with specificity and should initiate an adaptive change.

Nutrient Control of RNA Synthesis

The best-understood signaling molecules are hormones such as estrogen and testosterone. A hormone is produced by a particular tissue and causes a specific biological change in the same tissue or a different tissue located elsewhere in the body. In some cases, these molecules can enter a cell and bind to a particular protein molecule, termed a "nuclear receptor." The receptor-hormone complex then travels to the nucleus, binds very specific regions of the DNA, and turns on the expression of genes not normally expressed in the absence of the hormone. This change in gene expression imparts new functional roles to individual cells, which can impact the entire organism greatly. In this manner, diverse biological processes can be initiated, including puberty or menstruation. Certain nutrients can also influence gene expression in a similar manner. Nutrients, including vitamin A, vitamin D, and certain fatty acids, bind nuclear receptors and influence the expression of genes. These nutrient receptors enable cells to sense their nutrient environment and adjust cellular metabolism accordingly by altering the expression of genes.

Nutrient Control of Protein Synthesis

Nuclear receptors are effective in reprogramming DNA transcription to adapt to nutrient environments. Other mechanisms exist to alter gene expression without changing rates of DNA transcription. In fact, alteration of translation is a common mechanism that permits cells to adapt rapidly to changing nutrient environments. Iron is the paradigm for nutrient regulation of gene expression at the level of translation. Iron is a critical component of many metabolic proteins and enzymes involved in oxygen transport, energy metabolism, and DNA synthesis. Iron deficiency results in several disease states, including anemia. Therefore, the body must retain sufficient iron stores to stave off such pathologies. However, iron is also a potent oxidant and, if not bound by proteins in the cell, it can destroy DNA and proteins, and catalyze events that initiate cancer. Therefore, the body must store iron, but in such a manner that prevents the iron from destroying the integrity of its cells. Cells are protected from the deleterious effects of iron by sequestering it in a protein shell called ferritin. Cellular iron is stored in ferritin until required. Ferritin synthesis is rapidly induced when cells are exposed to iron and this increased synthesis is directly regulated by iron. Cells contain an iron-sensing protein called the iron regulatory protein (IRP). This protein binds either iron or ferritin messenger RNA but cannot bind both molecules simultaneously. When iron is not available to the cell, the intracellular concentration of nonprotein-bound iron is very low and IRP does not contain bound iron. This results in IRP being available to bind ferritin messenger RNA, which stops new ferritin synthesis. However, when cells are exposed to iron, IRP contains a bound iron molecule and cannot bind ferritin messenger RNA, and ferritin synthesis occurs. In this manner, the iron storage protein ferritin is only synthesized when it is required to store new iron.

Permanent Adaptation to Nutrient Supply

There is accumulating evidence that prenatal and postnatal nutrition can permanently alter cellular metabolism by altering gene expression throughout adulthood, a phenomenon termed "metabolic imprinting." Low birth weight, which occurred in infants born to survivors of the Dutch Famine of 1944–1945, has been linked to an increased risk of chronic disease later in life, including adult obesity, insulin resistance, hypertension, and cardiovascular disease. The susceptibility to these disease states is influenced both by dietary habits as well as one's genetic predisposition or heritage. Although the biological basis for metabolic imprinting is not yet proven, the suggestion that gene expression can be programmed by fetal and postnatal nutrient environment has far-reaching implications. For many adult chronic disease states, dietary management is an important component of the therapy. If metabolic imprinting occurs, dietary management early in life may also be advantageous in preventing numerous chronic disease states that do not surface until adulthood.

Nutritional Modulation of Gene Expression in Health and Disease

The relationships between nutrient availability and adaptive changes in gene expression are critical to understanding the role of nutrition in health and disease. For many nutrients, either dietary insufficiency or excess can result in or contribute to disease onset. Nutrient modulation of gene expression serves to protect the cell from the deleterious effects of both under-nutrition and over-nutrition. Hereditary hyperferritinemia-cataract syndrome is a human disorder associated with altered regulation of iron homeostasis. Affected individuals have mutations in a ferritin gene that result in the synthesis of a ferritin messenger RNA that encodes a normal functional ferritin protein, but the mutation does not permit IRP to bind to the messenger RNA and stop translation. Therefore, these individuals can no longer regulate ferritin levels in response to changes in iron intake. As a result of this mutation, these individuals contract early-onset bilateral cataract associated with a progressive decrease in visual acuity. Ongoing research is identifying many other nutrient-related disease states that result from disregulation of nutrient control of gene expression.

See also **Cholesterol; Combination of Proteins; Genetic Engineering; Genetics; Malnutrition: Protein-Energy Malnutrition; Nutrients; Proteins and Amino Acids**.

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Patrick J. Stover

GENETIC ENGINEERING. Genetic engineering involves the directed alteration of an organism's DNA (deoxyribonucleic acid)—that is, its genetic material. This technology has been applied to microbes, plants, and animals, and consequently used to modify foods, animal feedstuffs, and food-processing reagents.

Domestication and improvement of plants and animals for agriculture initially relied on identification of individuals with desirable characteristics from among natural populations. Applying knowledge of genetics to the breeding of plants and animals resulted in more rapid progress and remains vitally important to agricultural development. Traditional breeding, however, is constrained by the boundaries of sexual compatibility, which limits the choice of parents that can be used as sources of genes and traits to improve a specific crop or animal to those that can produce progeny through sexual reproduction. Genetic engineering expands the source of genes that can be used to modify the characteristics of plants and animals.

Technology of Genetic Engineering

Genetic engineering requires three fundamental technologies: the ability to isolate and modify the DNA of specific individual genes; an understanding of the mechanisms that regulate how genes function and how these can be manipulated; and the capacity to transfer genes into an organism. These have all been developed following the discovery of the structure of DNA in 1953. Genetic engineering of microbes was first reported in 1973, followed in the next decade by similar achievements in plants and animals. Because DNA is the genetic material in all organisms, genes for genetic engineering can be taken from any source, or even synthesized. Modification of genes may be necessary, particularly in regions that control how they operate, in order for the genes to function effectively in the recipient organism. *Agrobacterium tumefaciens*, a bacterium that transfers DNA into plant cells as part of its normal life cycle, is used commonly to transfer genes into plants, although other methods such as the "gene gun" also have been developed. Genetically engineered plants are technically "transgenic organisms," as they contain transferred genes. However, they are frequently referred to as "genetically modified organisms," or GMOs, and the products derived from them are described as "genetically modified," or GM foods. These terms can be confusing, as essentially all cultivated plants have been genetically modified through breeding and selection—for example, the many varieties of cultivated onions possess numerous qualities that distinguish them from each other and especially from the wild onions from which they originated.

Application of Genetic Engineering in Agriculture

The first genetically engineered crops were planted on a large scale in 1996. By 2001 more than fifty million hectares were planted worldwide with transgenic crops. The first generation of these crops has been altered in ways that improve the efficiency of crop production by modifying the tolerance of plants to herbicides and insect pests. Broad-spectrum herbicides are able to kill almost all plants. A prerequisite for using chemicals to control weeds in a crop is that the crop itself must be resistant to the herbicide. Genetic engineering has been used to develop plants (specifically soybean, canola, corn, and cotton) with resistance to two broad-spectrum herbicides, glyphosate and glufosinate, which are sold under the trademarks Roundup and Liberty, respectively. Glyphosate-tolerant soybeans have been adopted rapidly in some countries, notably the United States and Argentina, and accounted for approximately 46 percent of the soybean acreage worldwide in 2001. Herbicide use has not declined in these crops but the specific herbicides that are used have changed.

Insect pests can damage crops during the growing season and also after harvest. A variety of methods, including cultural practices and insecticides, are used to control insect damage. Genetic engineering has provided novel approaches to this problem. The bacterium *Bacillus thuringiensis* (*Bt*) produces proteins that are toxic to some types of insects, and *Bt* spores have been used as insecticides for decades. Genes encoding *Bt* toxin proteins have been isolated, modified so they function in plants, and transferred into crop plants including corn, potato, and cotton. These engineered *Bt* crops are more resistant to such insects as the European corn borer, Colorado potato beetle, and cotton bollworm than are their nonengineered counterparts. The introduction of *Bt* cotton has resulted in reduced use of insecticides on this crop in some regions of the United States. Growers of *Bt* crops are required to plant a portion of their acreage with varieties that do not carry the *Bt* gene, in an effort to delay the development of insect populations with resistance to *Bt* toxins.

The Flavr Savr tomato, developed in the 1980s by Calgene, a biotechnology company in California, was the first food produced from a genetically engineered plant. These tomatoes ripened more slowly and had an extended shelf life. However, for a number of reasons—including production problems and consumer skepticism—this product was not a commercial success and was withdrawn in 1996, after less than three years on the market. Melons and raspberries have also been engineered to have delayed ripening but have not been produced commercially. Transgenic papayas with resistance to ring spot virus also have been developed. These were grown successfully in Hawaii, where the papaya industry was devastated by this debilitating disease. A similar approach was used to produce virus-resistant summer squash and against other viruses affecting a wide variety of foodstuffs.

The first generation of transgenic crops for the most part were designed to improve the efficiency of crop production, an ongoing objective for genetic engineers. Additionally, the techniques of genetic engineering can be used to alter the nutritional composition of foods. The transfer into rice of three genes that function to produce beta-carotene in the seed resulted in "golden rice." Once consumed, beta-carotene can be converted to vitamin A, the degree of this conversion being dependent upon a number of factors that relate to the source of the beta-carotene, the diet, and the individual consumer. In less-developed countries, vitamin A deficiency is widespread among those with a restricted diet, and is responsible for increased mortality and blindness in children. Although the efficacy of transgenic rice in reducing disease has not been established, it demonstrates the potential use of genetic engineering for nutritional enhancement in many crops. Other applications of genetic engineering of animal and human foods include removing allergens from foods such as peanuts, increasing the level of essential vitamins and nutrients in foods, and producing foods possessed of vaccines and other beneficial compounds.

Genetically engineered microbes also are used to produce proteins for food processing. Chymosin (or rennin), an enzyme used in cheese production, traditionally is obtained from the stomach of veal calves. However, the gene encoding this enzyme was transferred into microbes, and the enzyme now can be produced in bulk by purifying it from large microbe cultures. Chymosin prepared from transgenic microbes has more predictable properties than the animal product and is used to produce more than fifty percent of hard cheeses in the United States. Other enzymes used in food processing are produced by similar methods. For example, bovine growth hormone (BGH) is produced in large quantities from transgenic microbes and is given to cows to increase milk production.

Regulation of Genetic Engineering

In the United States, three federal agencies—Food and Drug Administration (FDA), Environmental Protection Agency (EPA), and Department of Agriculture (USDA)—are involved in regulating transgenic crops. Similar systems are in place in other countries as well. Companies that have developed this technology generally are supportive of the current regulatory framework. Nevertheless, the development of transgenic crops and the introduction of foods that contain products from these plants in the 1990s generated tremendous controversy, notably in Europe. Proponents of genetic engineering have argued that the addition of one or two well-characterized genes into crop plants that have a history of safe use is unlikely to affect materially the properties of these plants. Opponents suggest that this technology has not been tested adequately and the public should not be exposed to unknown and unnecessary food-based risks.

Safety concerns include the possibility that this technology will reduce the nutritional content of foods and introduce novel allergens or other toxins into foods. Opponents have sought more extensive testing and mandatory labeling of products that contain genetically engineered foods so that consumers can choose whether or not to eat such items. The impact of transgenic crops on the environment also has been questioned. Pests are likely to develop resistance to toxins produced by transgenic plants, raising doubts about the sustainability of this approach. However, transgenic technology also has the potential to reduce the use of chemical pesticides for crop production, which most regard as a positive development. Transfer of genes from engineered crops to other plants might also occur—for example, making weeds resistant to a specific herbicide or expanding the range of a plant so that it can grow in new locations.

This new technology also brings forth social, economic, and ethical issues, many of which are reflected by a wide political debate. One subject of concern is that most of the technology enabling genetic engineering of crop plants is controlled by a small number of companies. Much of this control is achieved through ownership of intellectual property, such as patents on genes, methods to produce transgenic plants, and the plant material that is the basis for crop improvement. Companies that manage agricultural inputs, such as seeds, pesticides, and fertilizers, as well as food processing and retail operations, function increasingly on a global scale. Opponents of globalization have criticized genetic engineering as one factor that is contributing to this trend and have expressed concern that both farmers and consumers will have limited choice in who supplies their needs. Opposition to genetic engineering also has come from religious groups who believe that tampering with genes in this way is unnatural—that is, inconsistent with the divine domain of nature—and should not be allowed.

Development of methods to genetically modify plants that extend beyond the limits of normal sexual reproduction has the potential to change many aspects of food production. Some of the first generations of products of this technology were adopted readily by most farmers but, as with other new technologies, there are many opponents. If this technology eventually receives widespread acceptance, it is likely that genetically engineered products will be found in almost everything that humans and domesticated animals eat.

See also **Additives**; **Agronomy**; **Biotechnology; High-Technology Farming**; **History of Food Production**.

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WHAT IS THE FDA TRYING TO FEED US?
STOP GENETICALLY ENGINEERED FOODS!
Should your refrigerator be condemned?
DA
Give Me TRU

Genetically engineered foods have caused widespread concern, even open protest, as in the case of this demonstration against the Federal Food and Drug Administration in Chicago. Much of the concern is not centered on the science itself, but on the social and ethical ramifications, the economic implications, and the lack of accountability for "genetic pollution." PHOTO COURTESY OF AP/WIDE WORLD PHOTOS.

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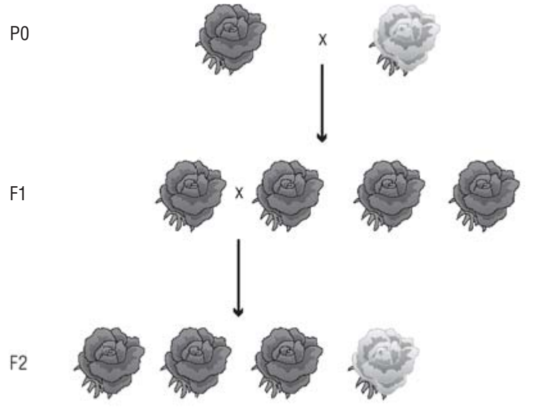
Peter Goldsbrough

GENETICS. Since the first efforts were made to cultivate plants, humans have employed genetics to breed crops with improved taste, hardiness, or yield. The long history of genetics and nutrition can be felt even today, and permeates many aspects of our daily life. Home gardeners can purchase seeds that will grow in particular soils, produce fruit at various times of the year, or grow in sunshine or shade. Local supermarkets sell supersweet varieties of corn and fruits such as the tangelo, made from crossing grapefruits with tangerines. The "Green Revolution," which began with the identification of a high-yield strain of wheat, has resulted in dramatic increases in food production around the world. With the advent

FIGURE 1



Phenotype of Mendel's plants. Mendel crossed "pure-breeding" purple-flowered plants with pure-breeding white-flowered plants. These parental plants (P0 generation) were derived from plant stock that always gave rise to purple- or white-flowered plants. When crossed to one another, however, they only produced purple-flowered plants in the F1 generation. When two F1 plants were crossed, Mendel was able to recover white-flowered plants. Mendel repeated his results for other traits as well, including plant height, pea shape, pea color, pod color, leaf position, and pod shape.

of genetic engineering, new, disease resistant crops have been developed, with the promise of reducing requirements for pesticide use.

Plants are not the only organism to be subjected to genetic breeding programs by humans. Yeast strains for baking bread or producing alcoholic beverages have been cultured for centuries. Meatier turkeys and cows that give more milk are the product of animal breeding efforts. Some have argued that the genetic manipulation of foodstuffs has gone too far, emphasizing crops that can withstand long storage times, transportation to markets, and handling by the consumer over any selection for flavor. Others worry that genetic engineering gives us unprecedented, and perhaps dangerous, opportunities to mix and match desired traits. It is nevertheless apparent that genetics has had an enormous impact upon society.

What is genetics? Simply put, genetics is the study of hereditary variation. This variation, in essence, is the diversity of life as it exists in all its forms on earth. For example, there are perhaps some 300,000 different species of flowering plants. What makes each of these plants different from one another? Perhaps even more amazing than this variation between species, there are astounding levels of variation that can be found even within a species. There are, for example, some 6,000 different varieties of apples alone. Genetics aims to understand how this variation occurs between species as well as within species. The term "phenotype" is used to describe any differences that can be observed or measured. For example, the possession of yellow kernels is a phenotype of a particular strain of corn, which distinguishes it from strains that possess white kernels. The two may have phenotypes in common (e.g., they both have white flowers or are supersweet) in addition to the differing phenotype of yellow and white kernels. Genetics examines the ground rules regarding how these phenotypes are passed on, or inherited, from one generation to the next.

Gregor Mendel, the Father of Genetics

While genetic breeding has been practiced for many hundreds of years, the true science of genetics began with Gregor Mendel, an Austrian monk who published his seminal work in the mid-1800s. At the time, genes had not been identified; indeed, the term itself would not be coined until 1909. How traits could be inherited from one generation to another was entirely unclear. Charles Darwin himself proposed the pangenesis theory, in which traits from the parents are passed to their children in a process that "blends" them together. In this theory, children represent a melding of the two parental sets of traits. They in turn would pass their traits on to their children, further blending together the traits of their respective parents. This model of how genetics operates can be contrasted with the particulate theory, in which traits are retained on small particles passed from one generation to the next. While Darwin's model would seem to be consistent with what we can observe in our own children, Mendel's carefully performed and insightful experiments clearly supported the particulate theory, and laid down the basic principles of the inheritance of phenotypes.

Mendel discovered his principles working with pea plants, which were raised not only for their experimental value but also as a food source for the monastery. Mendel's seminal idea was to identify clearly defined and distinct traits among these plants, and determine how these phenotypes were passed from one generation to the next. For example, Mendel identified plants that possessed either white flowers or purple flowers, but not both. He then crossed these two different variants with one another (the "parental," or P0 generation), and examined the flower color of the resulting progeny plants in the filial, or F1, generation. If the blending theory were correct, one might expect pink flowers to be produced in the F1 plants. Instead, Mendel obtained only purple flowered plants. If these F1 purple-flowered plants were then interbred with one another, producing an F2 generation of plants, Mendel saw once again pea plants with white flowers. Thus, even though this particular trait (white flowers) had not been seen at all in the F1 generation, it had been retained, and could be recovered in the F2 generation. These results clearly supported the particulate theory.

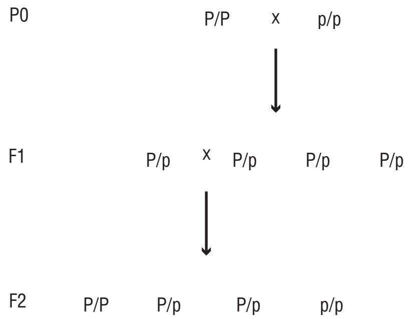
To obtain his results, Mendel studied the transmission of seven distinct phenotypes among some 28,000 pea plants, and synthesized them into a mathematical model of genetic inheritance. In doing so, he did what had never been done before; he quantified his results. From an analysis of his data, he was able to infer several key principles. He argued that there must exist determinants that specify particular phenotypes, a feature we now recognize as genes. He also argued that these determinants are located on particles, one of which is donated by the father, and one by the mother. These particles, now known to be chromosomes, produce a progeny plant that has one determinant for flower color donated by the mother, and one determinant for flower color donated by the father. The phenotype of the progeny plant will depend upon the particular combination of determinants it receives from its parents. Mendel deduced that the determinant for the production of purple flowers (represented as "P") is dominant over the determinant to produce white flowers (represented as "p"). Conversely, the white flower determinant is recessive in the presence of the purple-flower determinant. Two copies of the purple-determinant (P/P) in a plant, one maternal and one paternal, results in purple flowers. One purple and one white flower determinant (P/p) still produces purple flowers. Only if a plant receives two white flower determinants (p/p) will it possess white flowers.

Mendel's results were not widely known at the time. Some thirty-five years later, his work was "rediscovered" by geneticists who had repeated his results in other organisms. The implications of Mendel's work were revolutionary. For the first time, it was possible to observe the patterns of inherited phenotypes of a plant, animal, insect, or bacterium, and deduce, with mathematical precision, the expected genotypes of these organisms. It is a tribute to the work of Mendel and others of his time that their results were obtained despite not knowing that genes were encoded by DNA or how genes act to produce the observed phenotype.

Single Gene Effects

Part of Mendel's success was due to his implicit recognition that there are two primary types of variation: discontinous and continuous. In discontinuous variation, a particular phenotype can be found in a population in at least two distinct forms. For example, Mendel's peas possessed purple or white flowers, and not both. On the other hand, in continuous variation, a range of similar phenotypes can be observed in the population. An example of this among humans might be the observation that noses come in all shapes and sizes. In most instances, genetics has focused predominantly upon discontinuous variants, as the associated phenotypes can be clearly recognized and categorized. As it turns out, many of the phenotypes that fall into this group can be associated with alterations in the function of a single gene. In our purple versus white flower example, the gene that is normally responsible for giving the plant its purple color has been mutated, such that it no longer functions. In the absence of this gene, white, or uncolored, flowers are produced. The different forms of this same gene (P, indicating normal or wild-type function, and p, indicating altered or mutant function) are called alleles. If an allele is widely represented in the population, as is the case among white or purple flowers in pea plants, they are termed polymorphisms.

FIGURE 2

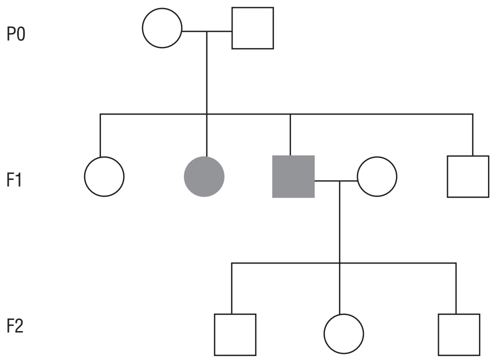


Genotype of Mendel's plants, as shown in Figure 1. As the parental plants are pure-breeding, they must each carry two identical determinants—either two copies of the "P," or purple flower determinant, or two copies of "p," the white flower determinant. Their progeny in the F1 will receive one determinant from each parent, so that all plants will carry a P and a p determinant. In the F2, plants can receive either a P or a p from either parent. Those receiving two p determinants will have white flowers.

Polymorphisms can be identified in other organisms as well. However, in humans, there are also additional issues of ethnicity and race. A common polymorphism among Asians, for example, is a particular allele of the alcohol dehydrogenase 2 (Adh2) gene. This allele negatively affects the enzyme's ability to metabolize alcohol, and is possessed by more than 90 percent of the Japanese population. In the European population, on the other hand, less than 10 percent have this allele. Similarly, lactose intolerance is due to allelic variation in the lactase gene. An allele that leads to low activity of lactase following early childhood is common in Africans and Asians (>80 percent), and rarer in Caucasians (17–50 percent). These relatively common polymorphisms are just a few of the many thousands of alleles known to exist in humans.

Why these polymorphisms exist is not clear, although it can be hypothesized that they either do no harm to individuals who harbor these particular alleles, or, if they are in fact somewhat harmful, are nonetheless still of some benefit. This can be described as the fitness of the allele. For example, as many as 10–20 percent of the European population bears a polymorphism in the gene encoding methylenetetrahydrofolate reductase (MTHFR). These individuals have a greater risk of neural tube defects, such as spina bifida, due to the fact that this allele affects folate metabolism. Why then, is such a polymorphism maintained in such a high percentage of the population? The answer may lie in the observation that individuals with this polymorphism have an increased efficiency of blood clotting. As mortality resulting from bleeding after childbirth was a common occurrence, this would be beneficial to individuals bearing this polymorphism. While it is often dangerous to speculate why a polymorphism exists, if this reduction in risk is substantiated, it would

FIGURE 3



Hypothetical family history of patient with PKU. Circles represent females, and squares represent males. Filled-in shapes represent individuals with PKU. Note that the parental generation and F2 generation do not exhibit disease.

obviously be of benefit both to the individual and the population as a whole.

While we have centered this discussion around polymorphisms, on occasion, an allele will arise that affects only a small percentage of the population. Although these rare variants are uncommon (<1 percent of the population), they make up a large proportion of the patients that are hospitalized for medically related conditions. One such example would be phenylketonuria, which occurs in one out of every 10,000 births. This medical condition is due to a mutation in the phenylalanine hydroxylase gene, and leads to a failure to metabolize phenylalanine containing compounds, such as aspartame. If unrecognized, infants with PKU invariably develop mental retardation. This can be avoided by monitoring dietary intake to eliminate phenylalanine-containing compounds. How is PKU inherited from one generation to another? The fields of medical genetics and genetic counseling encompass the analysis of family histories, so as to better treat individuals who are at risk from these illnesses. If we examine the family history of a typical patient that has PKU, we might observe the following:

In this case, neither parent in the P0 generation suffers from the disease, but some of their children do. Applying principles learned from Mendel's work, we can infer the genotype of the family members from this phenotypic analysis:

From the study of this family history, it is clear that PKU is inherited in a recessive manner. Adults who are heterozygous for mutations in the phenylalanine hydroxylase gene (K/k; possessing one wild-type or normal allele and one mutant allele) do not have PKU. Only those with two mutant copies (k/k) display the condition. Thus, Mendel's laws apply equally well to humans as they do to peas. Interestingly, however, while the phenotype of PKU patients indicates a recessive inheritance of this condition, an analysis of the genotype of these patients and the population in general reveals the existence of more than 400 alleles of the phenylalanine hydroxylase gene. This astounding degree of allelic heterogeneity indicates that most PKU patients indeed possess two mutant alleles of the hydroxylase gene, but that these two alleles are likely to be completely different. The phenotypic effect is the same; elimination or severe alteration of the normal function of the gene leads to PKU. The molecular basis of this defect, however, is dependent upon the specific alleles that are involved. It is plain to see that the field of molecular genetics, which examines the actual genes responsible for these defects, is an important complement to more traditional genetic phenotypic observations.

While the examples we have looked at so far have comprised diseases or phenotypic traits that are inherited in a recessive fashion, many diseases are inherited in a dominant manner. In these instances, a single copy of the mutant allele is sufficient to confer, at least partially, a medically associated condition. An example of this might be familial hypercholesterolemia, which is associated with an inability to properly metabolize cholesterol. A family history of patients with this affliction might appear thus:

Compare the rate of occurrence of this condition with that of PKU. Only a single copy of the mutant allele is required to produce at least some phenotype in cases of familial cholesterolemia. In many of these dominantly inherited diseases, individuals that possess two mutant alleles are much more strongly affected than individuals with one mutant and one wild-type allele. In familial hypercholesterolemia, homozygous patients (those with two mutant alleles; H/H) rarely live past the age of 30. These individuals are rare, however, occurring in perhaps one in one million. Heterozygous individuals (those with one mutant and one wild-type allele; H/h), on the other hand, are extremely common, and are present in perhaps one in 500. These individuals have a higher propensity for premature heart disease due to the buildup of atherosclerotic plaques, but without the severity of phenotype exhibited by homozygous individuals.

These examples illustrate just a few of the more than 1400 single-gene disorders that have been identified. It has been estimated that in any one individual, perhaps 20 percent of all genetic loci are heterozygous. This suggests that a striking degree of individuality exists at the genetic level. This allelic variation may explain, for example, the differential response of individuals to environmental, dietary, or pharmacological effects.

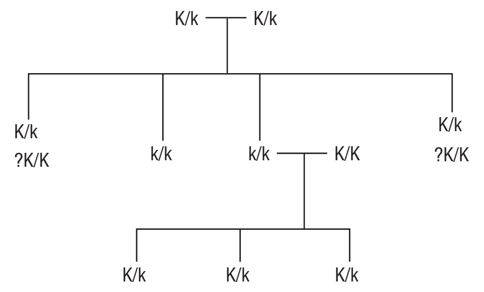
Multiple Gene Interactions

So far, we have discussed examples of phenotypes that can be traced to alterations of a single gene. While great strides have been made in identifying genes that are associated with a particular phenotype, it is clear that we are far from understanding how genes interact with one another as a whole. For example, many genetic disorders are thought to result from the interplay of multiple genes with epigenetic, or environmental, influences, such as diet. One means of trying to understand these multifactorial disorders and how genes and the environment interact is to examine at a molecular level how genes function. While Mendel derived his results from observing the phenotype of his plants, a molecular geneticist might ask, what is the actual gene that is responsible for production of purple pigment? What is its sequence? How does it function in the plant cell to produce color? With what other genes does it interact?

DNA has often been called the "blueprint of life," and indeed, DNA is the thread that ties almost all life on earth together. Rules that govern the replication of DNA and its transmission to daughter cells (e.g., during cell division) are the same in nearly all organisms. But if DNA is DNA whether or not it is found within a fly or a human, how is it possible to obtain such diverse organisms? The answer, of course, is that the genes that exist within DNA are different from flies to humans. One might suspect that these two diverse organisms would possess radically different sets of genes, separated as they are by over 600 million years of evolution. With the advent of the Human Genome Project, it has become possible to directly test this hypothesis. Once the entire sequence of human DNA was known, it was compared to the sequence of *Drosophila melanogaster*, a fruitfly that has been used for over one hundred years as a genetic model. This comparison revealed an astonishing 40 percent of all genes in the human have similar counterparts in the fruit fly. While this figure is still tentative, and gene number is hardly an adequate means of comparing differences among species, it underscores yet again that genetic principles learned in model organisms, such as the fruit fly, can have important theoretical and practical applications in understanding human genetics.

If variation between species is accomplished, at least in part, by genes that are unique to flies or humans, how does variation occur within a species? All cells in the human body, with the exception of those involved in the production of sperm or ovum, contain identical DNA sequences, and therefore identical sets of genes. How is it then, that a skin cell will develop differently from a hair cell, if both contain the same DNA? The answer is that each cell may contain the same genes, but not all the genes will be expressed in each cell. Current estimates suggest that there are approximately 50,000 genes in the human genome. Any given cell type, however, is thought to express some 15,000 of these genes. Thus, a hair cell will express 15,000 genes, but these genes will be somewhat different from the 15,000 that are expressed by a skin cell. It is this differential gene expression that leads to the differences in observed phenotype between the two cell types. In a similar vein, two noses located on the faces of two different individuals may well be specified by the same 15,000 genes, but slight differences in their expression from one individual to the next may well explain the somewhat petite nose on one and the rather large proboscis on the other. The growing field of genomics aims to study, at a global level, the interactions of all of the genes that contribute toward a particular phenotype.

FIGURE 4

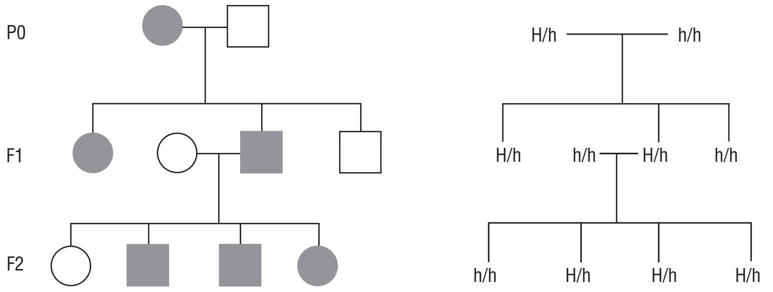


Genotype of family history shown in Figure 3. It is unclear whether the two siblings in the F1 generation that do not have the disease are **heterozygous** (one wild-type and one mutant; K/k) or **homozygous** (two wild-type alleles; K/K) without any additional information.

If it does indeed require 15,000 genes to produce any given cell in the body, then mutant alleles that arise in any one of these genes may, or may not, strongly affect the development of that cell. Alleles of certain genes may alter the color of the cell, or perhaps its ability to metabolize phenylalanine-containing products. Or it is possible that an alteration in just one gene among 15,000 may have no discernable effect at all. How these thousands of genes interact with one another to produce a given trait is perhaps the biggest challenge that faces the molecular geneticist studying genomics today. Moreover, these genetic interactions are often complicated by epigenetic influences as well. Nutrition, in particular, has very strong effects on gene expression. Many multifactorial diseases, such as diabetes, are thought to be associated with both genetic and environmental risk factors. A given family history may, to the medical geneticist, indicate a predisposition towards diabetes, but other factors, such as diet and exercise, are also thought to influence the development of this disease.

One particularly fascinating example of the link between nutrition and genetics is the effect of diet upon aging. Unusual longevity in humans has often been attributed by these self-same individuals as directly associated with the manner in which they have lived their life. Whether it is a glass of wine each day, eliminating red meat, or ingesting large quantities of vitamin C, these individuals claim to have identified the reason behind their advanced years. How much can truly be attributed to these epigenetic influences, and how much is based upon the individual's particular genetic makeup? Research in model organisms such as the fruit fly has identified a handful of genes that seem to strongly affect the lifespan of the fly. Mutations in the methuselah gene, for example, allows flies to survive more than 35 percent longer

FIGURE 5



Hypothetical family history and genotype of dominant inheritance of familial hypercholesterolemia. Note in this case, only a single copy of the dominant allele ("H") is required to produce the phenotype, and the wild-type, or normal allele ("h"), is recessive.

than their normal lifespan. This astonishing result suggests that aging may actually be strongly influenced by a limited number of genes, many of which are involved in metabolism. On the other hand, it has long been known that reducing the calorie intake of rodents by 40 percent can also markedly increase their lifespan. The new field of genomics has begun trying to identify the molecular basis for this increase in longevity, by comparing how many genes are differentially expressed between calorie-restricted rodents and their non-restricted counterparts. It was found that hundreds of genes had been affected, including a large number known to be involved in metabolic processes. Thus, the effects of nutrition on aging can be profound. How much of this is due to our genes? How much can attributed to single genes? How much is due to our caloric intake? The answer to this "age-old" question remains to be determined.

A similarly tantalizing example demonstrating the link between nutrition and genetics lies in the area of control of bodyweight. Mice that are homozygous mutant for a particular allele of the obese gene (ob/ob) are grossly overweight. The excitement that surrounded this result centered around the possibility that weight gain might be strongly influenced by individual genes, and that no amount of dietary control or exercise can alleviate its effects. This, of course, has been shown to be a gross oversimplification, and it is clear that many genes are involved in the regulation of body weight. Nevertheless, it is apparent that the field of genetics is gradually beginning to unravel some of the major problems in nutrition and biology today.

Conclusions

The practice of genetics is as old as the human race, and yet as a science, it is still in its infancy. The study of genetics stretches across all of biology, and has grown to include many sub-specialties within the field. Cytogenetics, for example, is the study of chromosomal defects, such as trisomy 21. Molecular genetics is the analysis of individual genes, such as Adh2, and their function within the cell. Population genetics studies the frequency with which polymorphisms of Adh2 occur within large subsets of individual organisms. Medical genetics searches to identify patterns of inheritance of diseases within patients, and the effect of epigenetic influences such as diet and exercise. And finally, genomics tries to understand how genes behave as a whole to specify particular cell types or phenotypes. Together, these diverse but interrelated fields aim to understand how variation is established and maintained within biology.

See also **Agriculture since the Industrial Revolution; Crop Improvement; Gene Expression, Nutrient Regulation of; Genetic Engineering**.

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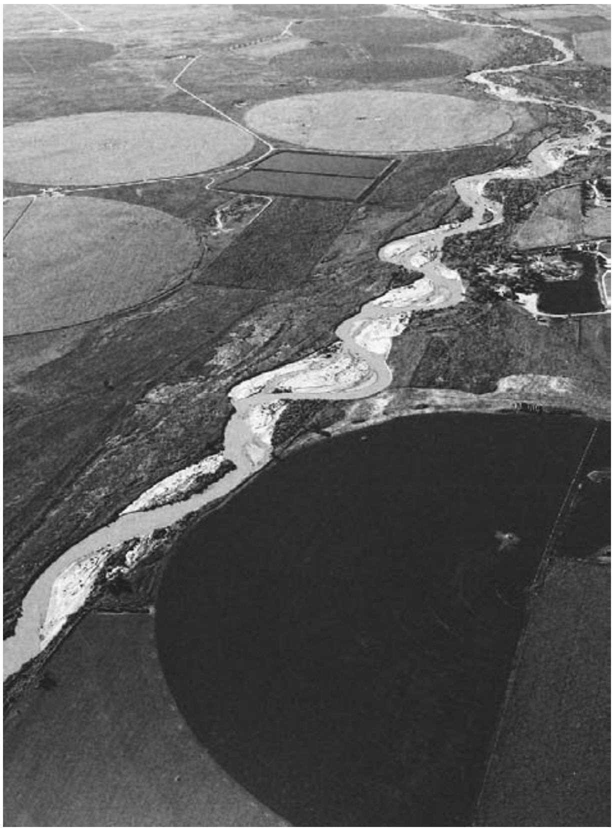
David Ming Lin

GEOGRAPHY. Food is grown in a one place, distributed to another place, and eaten in yet another place. Food is affected by culture, by economics, and by politics. Food affects our bodies, our relationships with other people, and our relationship with the land. This is the "food system," a system that encapsulates where and how food is produced, how it reaches our mouths, and why we eat what we do.

Anthropologists, nutritionists, historians, sociologists, and philosophers have long been concerned with different aspects of the food system. So too—and increasingly—are geographers.

Geography has a lot to say about food. A subject often misconceived as being concerned solely with maps and mapping, it is actually a philosophically and topically pluralistic discipline that is concerned with spatial processes in the human and physical environment. With a focus on both the spatial aspects of human existence and natural features, geographers are uniquely qualified to study a system that is, as Atkins and Bowler say in *Food in Society* (p. 13), "squeezed into a fault line between environment and society." Geographers seek to conceptualize the food system as a spatial construct that is driven in part by processes that operate from one physically definable and socially constructed space to another. Scale-dependent concepts such as regional, local, and global, location, place, and space, are the basis of questions geographers ask of the food system: Where is food grown and why? What are the processes controlling the movement of food from place to place? Why do we eat what we do? Why do we buy food where we do? How is food consumption related to production? Why is food consumption high in some parts of the world and low in others? Geographers think spatially. They also think systematically, theorizing about the relative roles of the environment and human beings as participants in the system under study and how they interact.

In the academy there are many different types of geographers, all of whom have a potential interest in food. Physical, economic, social, urban, rural, cultural, medical, and agricultural geographers all have their respective emphases on the analysis of the food system. All told, they study the production, consumption, provision, and distribution of food, from the local to the global, from feast to famine. And, as a tool, geographers can use relatively new computer-aided mapping techniques, especially geographical information systems (GIS) to map and analyze spatial data as it pertains to food systems.



The influence of food production on geography is clearly evident in this aerial view of Kansas farmlands. Circular fields designed to accommodate irrigation systems cluster around a free-flowing river while open grasslands occupy the intervening space. COURTESY OF AP/WIDE WORLD PHOTOS.

Food production and how and why it varies over space is studied in physical and human geography. Physical geographers seek to explain the spatial arrangement of food crops throughout the world by analyzing the environmental factors that limit or promote food production, such as climate, soil, and topography. Human geographers look to the explanatory power of history, economics, and politics and place a greater emphasis on the role of agricultural (food production) systems in affecting how much food is produced and where. They seek to describe the systems—whether as subsistent, intensive, extensive, or industrial—and ask how social, organizational, and technological changes within the system are affected by spatial processes and how they in turn affect spatial outcomes. Geographers have helped pioneer the understanding of food production as an "industrialized" system, a system bound up with processes of economic development that subsequently affects where and how much food is produced.

Food production also has an impact on the environment. One of the first disciplines to recognize the human impact on the environment, geography has long identified the environmental impact of modern agriculture. Hydrologists and soil scientists measure the impact of fertilizers, pesticides, and irrigation on water and soil quality. Desertification and deforestation are environmental issues identified by geographers as outcomes, in part, of food production. In turn, rural and developmental geographers take up the challenge of assessing the impact of environmental changes on local people and national economies.

In terms of food consumption, geographers argue that "place matters" in what people eat. Traditionally, geography has looked at regional patterns of diet, but over the past three decades focus has shifted to the symbolic meaning and cultural identity of food—to the way, in other words, that human beings use food to construct a place-related identity, either real or imaginary. Cuisines create a sense of identity; restaurant locations indicate spatially spreading food trends; the perception of what is "ethnic" and "local" food reveals the way we see ourselves fitting into society socially and geographically.

Food provision and retailing are another aspect of consumption studies within geography. Geographers seek to explain the spatial patterning of food retailers: Why, in many cases, do certain neighborhoods have very few food stores while others are supersaturated? Using the notion of "competitive spaces," geographers in the United Kingdom have been able to identify supermarket locating decisions as a response not only to state-imposed locational regulations, but to the market advantage of locating in a "competitive space."

Geography also asks how spaces of food consumption are linked with spaces of food production. An inherently geographical phenomenon, food is distributed in a variety of ways: national transportation systems, global trade, or local exchanges. Geographers have extended the study of these food distribution networks by seeking to uncover the relations between the site of raw food production and the site of consumption. Using the conceptual approach of "commodity chains," geographers trace food items from the point of consumption back through the chain of retail, wholesale, processing, and agricultural production, taking into account transportation, labor processes, technology, and politics. And in the related "food network" concept, institutional intermediaries such as state regulation and international agreements are added into the chain. Developments in this field have been spurred by increasing worldwide interest in the trend toward the replacement of national by international institutions, global sourcing of products, and the centralization of strategic assets, trends often conceptualized by the term "globalization." Geographers have highlighted, in particular, the local, regional, and national response to globalization, often finding that globalization in some way strengthens the local nature of food production.

Linking food production and consumption in terms of supply and demand is also very much part of the geographical tradition. Geographers ask why it is that in some regions and communities of the world people do not have enough to eat, whereas in others there is overnutrition. Some geographers analyze the spaces of hunger in terms of economics and social relations, others in terms of population growth and environmental limits on food production. Again, geographers are uniquely poised to ask questions about society and the environment. Space, it seems, unites them both.

See also **Distribution of Food**; **Environment**; **Food Production, History of**; **Population and Demographics**.

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Corinna Hawkes

GEOPHAGY. Geophagy, the consumption of earth, is widespread in various animal taxa, including birds, reptiles, and mammals. Among the latter it is reported in rats, ungulates, and primates, and in many human populations. The most frequently consumed soils are generally rich in clay, and the qualities of clay appear to be the stimulus for geophagy. The prevalence of this practice suggests that it is not aberrant behavior, but rather that it may have some functional significance related to diet and ecology. Several overlapping hypotheses have been proposed to explain the existence of geophagy, and clay consumption in particular: (1) clay provides supplemental minerals that may be lacking in the routine diet; (2) clay has the capacity to adsorb toxic secondary compounds widely distributed in plant foods; (3) clay protects the gastrointestinal tract from chemical and biological insult, and thus counters gastrointestinal disease. Support exists for all of these hypotheses depending on ecological context and taxon and indicates that geophagy is likely to be associated with positive biological effects.

The unique chemical structure of clays allows them to have these biological functions. Clays are associated with a variety of soil types, and are formed by routine weathering forces. All clays have similar properties: a large surface area, which derives from the organization of silicon-oxygen tetrahedrons in hexagonal networks, and an ability to bind and exchange minerals because of the dense localization of hydroxyl ions and oxygen in the tetrahedron structures. Clays are commonly composed of aluminum, magnesium, iron, and calcium, which can engage in mineral exchanges. Clays also have colloidal properties that make them adsorbent of water and other organic compounds. Commonly consumed clay types include: kaolin, smectite, montmorillonite, halloysite, and allophane.

Geophagy is well-described among ungulates, which seem to derive significant mineral nutrition (especially sodium, calcium, and magnesium) from eating earth, and among rats, who appear to use clay to detoxify a highly omnivorous and opportunistic diet. Gilardi and others found that parrots in Peru consumed large amounts of clay-rich soils, which served to detoxify a seed-based diet that was high in secondary compounds and to protect the cells that line the gastrointestinal tract from these toxic chemicals. Within the primate order, apes and monkeys consume soils that contain valuable minerals along with the clay metahalloysite, which counteracts diarrhea.

Among humans, the consumption of clay takes a variety of forms. In some cultural contexts, clay is an integral part of cuisine. Timothy Johns has documented the use of clay sauces with potatoes among highland Andean populations. Consumed in this way, clay adsorbs the toxic glycoalkaloid (solanine) in the potato cultigens that are the staple foods of this region. Clay is also used in the production of acorn bread by both Native Americans and Sicilians (Johns and Duquette, 1991). In this example, baking with clay reduces the toxicity of tannins in acorns, and improves the overall nutrient composition of this food. Clay is also used for specific medicinal purposes, most often to counteract gastrointestinal illness such as nausea, heartburn, or diarrhea (Vermeer and Ferrell Jr., 1985). Consumed in tablet or liquid suspension (as in Kaopectate®), clay has these effects by slowing gastrointestinal motility, binding toxins or pathogenic microorganisms, and buffering acids of the upper gastrointestinal tract. It is important to note that since clay can adsorb a variety of chemical compounds, it can also interfere with the absorption of pharmaceuticals such as antimalarial drugs (chloroquine).

Beyond the routine use of clay in cuisine, clay consumption is often correlated with pregnancy in humans (Lagercrantz, 1958). The practice is reported most frequently among Africans and African Americans, although it is found in many other populations. Women report that clay eases the nausea and vomiting that often occur during the first trimester. This is likely due to the ability of clay to buffer the gastrointestinal tract and adsorb toxins, to which the embryo is especially vulnerable during early development. Clay consumption often continues throughout pregnancy, and clay may provide supplemental calcium, the demand for which increases during pregnancy to form the fetal skeleton. Support for this analysis comes from Andrea S. Wiley and Solomon H. Katz's study (1998) of geophagy in African populations, which demonstrated that clay consumption was significantly more common in populations that did not consume milk and that relied heavily on toxin-rich plant foods. Hence clay may serve as a detoxicant as well as a source of calcium; both are particularly important for nondairying, agricultural populations. Many sub-Saharan African clays (especially those derived from termite mounds) have been found to be rich in calcium (Hunter, 1993). Importantly, clays are frequently baked before consumption, thus reducing the potential for microbial contamination. When clay is not readily available, laundry starch is sometimes consumed by pregnant women, although this is not likely to be associated with the same health benefits as clay.

ACORN BREAD

Processing of acorns for consumption is laborious and time-consuming, but the large quantity of tannins in acorns makes them inedible unless some mechanism for their removal is employed. In traditional Native American cuisine, acorns were first hulled (sometimes after boiling, to make it easier to extract the nutmeats) and pounded into a coarse flour with a stone mortar and pestle. Then, a variety of leaching techniques could be employed, including putting the flour in a basket or woven bag or digging a hole in a sandy bank along a river and allowing water to flow through the flour for up to several days. Or the flour could be put in a hole in the ground that was lined with leaves or pine boughs; water was then poured over it numerous times. The leaching removed the bitter tannins, thereby making the acorn flour both more palatable and more digestible. The flour was then placed into a tightly woven basket with water and very hot rocks to make a boiled acorn mush. It could also be molded into patties and fried, or the flour could be dried and then made into a stiff dough and slowly baked in a smoldering fire to produce bread. In contexts where leaching was not practiced or was insufficient to reduce the bitterness of acorns, acorn meal was mixed with clay and water and baked in an earth oven for several hours to produce acorn bread.

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Andrea S. Wiley

GERMANY, AUSTRIA, SWITZERLAND. These three nations represent the heartland of German-speaking Europe, although their present borders by no means demarcate the farthest geographical extent of German culture and its historical influence. Modern Germany came into existence in 1871 out of an amalgam of petty dukedoms and small kingdoms that traced their origins to the Holy Roman Empire of the Middle Ages. Modern Austria was created in 1918 out of the German-speaking provinces of the former Austro-Hungarian Empire. Its borders have been stable since then. Switzerland's political independence began in 1291 with an uprising led by William Tell, but the long struggle was not complete until 1412, when peace was made with the House of Habsburg. The Habsburgs, who later created the Austrian empire, were originally Swiss, and the ruin of their castle can still be seen in Canton Aargau. While the political evolution of German-speaking Europe is complex, the culinary divisions are far more distinctly defined.

The largest division is based on religion. Northern and eastern Germany are mostly Protestant (Lutheran), while the South is Roman Catholic. Austria is predominantly Roman Catholic. Switzerland is Roman Catholic and Protestant Reformed (Calvinist). These religious differences have had a great influence on foodways and eating habits. In the Protestant areas of Germany, many older religious festivals were discarded. One of the most important changes, however, was the abolishment of fasting except during Lent. The Protestants also gave up the big Carnival processions and the feasting that accompanied them. The German Pietists in particular abjured drinking, gluttony, and carousing with dance. Thus, northern Germany's food habits became markedly different from those of the South. Differences in religion also affected the movement and acceptance of various new customs such as the Christmas tree, which slowly moved south into Bavaria and Austria during the nineteenth century.

While religion has created an overlying framework for the culinary culture of German-speaking Europe, geography has played a fundamental historical role. The Rhine River Valley, which begins at Lake Constance in Switzerland, has been a major cradle of culture for thousands of years. It was the homeland of the ancient Gauls, whose preference for pork and beer is still deeply embedded in German culture. The Rhine Valley became the most important military region of the Roman Empire, and for a short period of time, Trier, Germany, was the capital of the Empire. The vestiges of Roman culture, such as viticulture, sausage making, pretzels, gingerbread, even half-timbered architecture, have all come to represent core features of traditional culture in these three countries. The most significant geographic feature, however, is the Alps, rugged mountains that form a physical barrier between German-speaking Europe and the Mediterranean. The high mountain regions of Bavaria, Switzerland, and western Austria have evolved a cuisine that is quite distinct from that of the rest of German-speaking Europe. Its focal point is dairying, with milk products and cheese forming the major components.

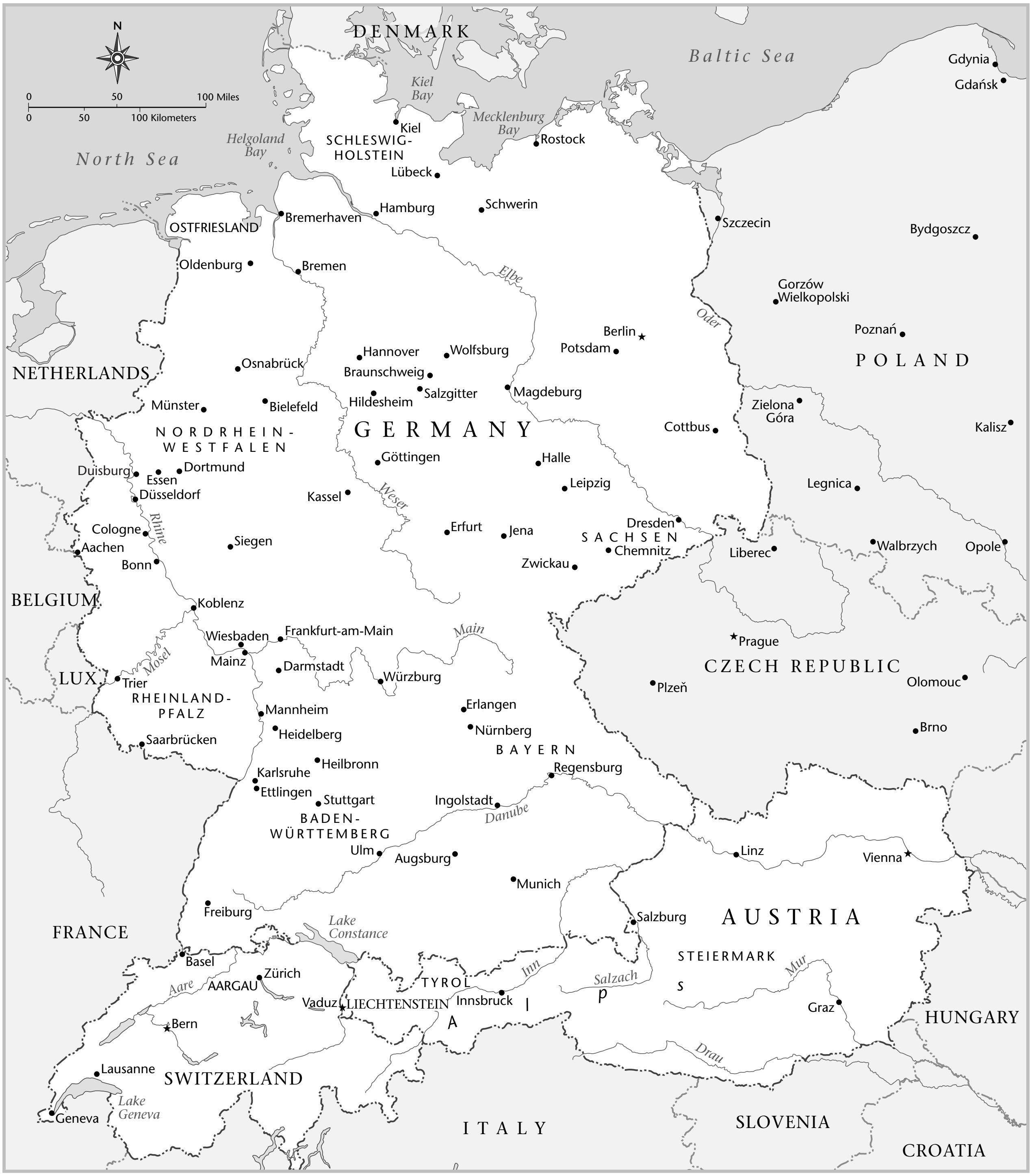
While the geographic barriers are significant, it is also important to keep in mind that German-speaking Europe is not one monolithic culture. It is composed of many regional cultures and dialects. Alemannic-speaking southwest Germany, Alsace, and Switzerland are home to a very distinct food culture—and the richest agricultural regions—while the Plattdeutsch area of northern Germany, centered on the swampy lowlands bordering the North Sea and the Baltic, offers yet another culinary identity: tea drinking, fish cookery, beer, foods using oats or buckwheat, and very dark rye breads.

Since the 1970s, there has been a revival of interest in dialects and regional cookery and an impressive outpouring of cookbooks exploring local cuisines and food products. This has been a revival in the most literal sense because scholars in all three countries began studying regional foods and foodways in the 1840s; thus the accumulated food literature is extensive and a full century ahead of what has been undertaken in the United States. The *Wörter und Sachen* (Terms and Objects) movement of the early 1900s was particularly active in recording traditional foods and terminologies. Unfortunately, the National Socialist Party, which came to power in Germany in 1933, employed this research toward political ends. Since 1945, the words *ethnisch* ('ethnic') and *Volk* ('folk') in German have carried such a pejorative association with Nazi propaganda that their use is now generally avoided in serious scholarly writings about food.

There is also a sharp dichotomy between the culinary writings of scholarship and the culinary writing of popular cookbooks. Mass-market cookbooks have created the idea of a national German or Austrian cuisine, whereas food scholars have decried this as artificial and misleading, since there are only regional or highly localized cooking traditions, which do not represent the political boundaries of the country. These local traditions often overflow the borders into adjoining countries such as France, Slovakia, Slovenia, and even northern Italy.

Germany

The present Federal Republic of Germany came into being in 1945 out of the ashes of the Third Reich. It was assembled from the western German states then under Allied occupation, specifically the forces of the United States, Britain, and France. The eastern German states were occupied by the Soviet Union and became the German Democratic Republic. In 1989, with the fall of Communism, the eastern and western states were reunified. The former German states of Silesia, Pomerania, East and West Prussia, and the city state of Danzig (modern Gdansk) are now permanently incorporated into Poland. Since the ethnic Germans living in those areas were evicted in 1945, the culinary cultures of the German regions incorporated into Poland are a matter of history,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Rostock
Lübeck
Hamburg
Schwerin
Bremerhaven
OSTFRIESLAND
Szczecin
Bydgoszcz
Oldenburg
Bremen
Elbe
Gorzów Wielkopolski
Oder
Berlin
Potsdam
Poznań
Hannover
Wolfsburg
POLAND
NETHERLANDS
Osnabrück
Braunschweig
Salzgitter
Magdeburg
Hildesheim
Münster
Bielefeld
Zielona Góra
Kalisz
NORDRHEIN-WESTFALEN
GERMANY
Cottbus
Göttingen
Halle
Duisburg
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Dortmund
Düsseldorf
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Bonn
Zwickau
BELGIUM
Koblenz
Wiesbaden
Frankfurt-am-Main
Main
Prague
Mosel
Mainz
Darmstadt
Würzburg
CZECH REPUBLIC
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Trier
Plzeň
Olomouc
RHEINLAND-PFALZ
Mannheim
Erlangen
Heidelberg
Nürnberg
Brno
Saarbrücken
BAYERN
Heilbronn
Regensburg
Karlsruhe
Ettlingen
Stuttgart
Ingolstadt
Danube
BADEN-WÜRTTEMBERG
Ulm
Augsburg
Linz
Vienna
Munich
Freiburg
Salzburg
AUSTRIA
FRANCE
Lake Constance
Basel
STEIERMARK
Mur
Zürich
AARGAU
Aare
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Salzach
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Graz
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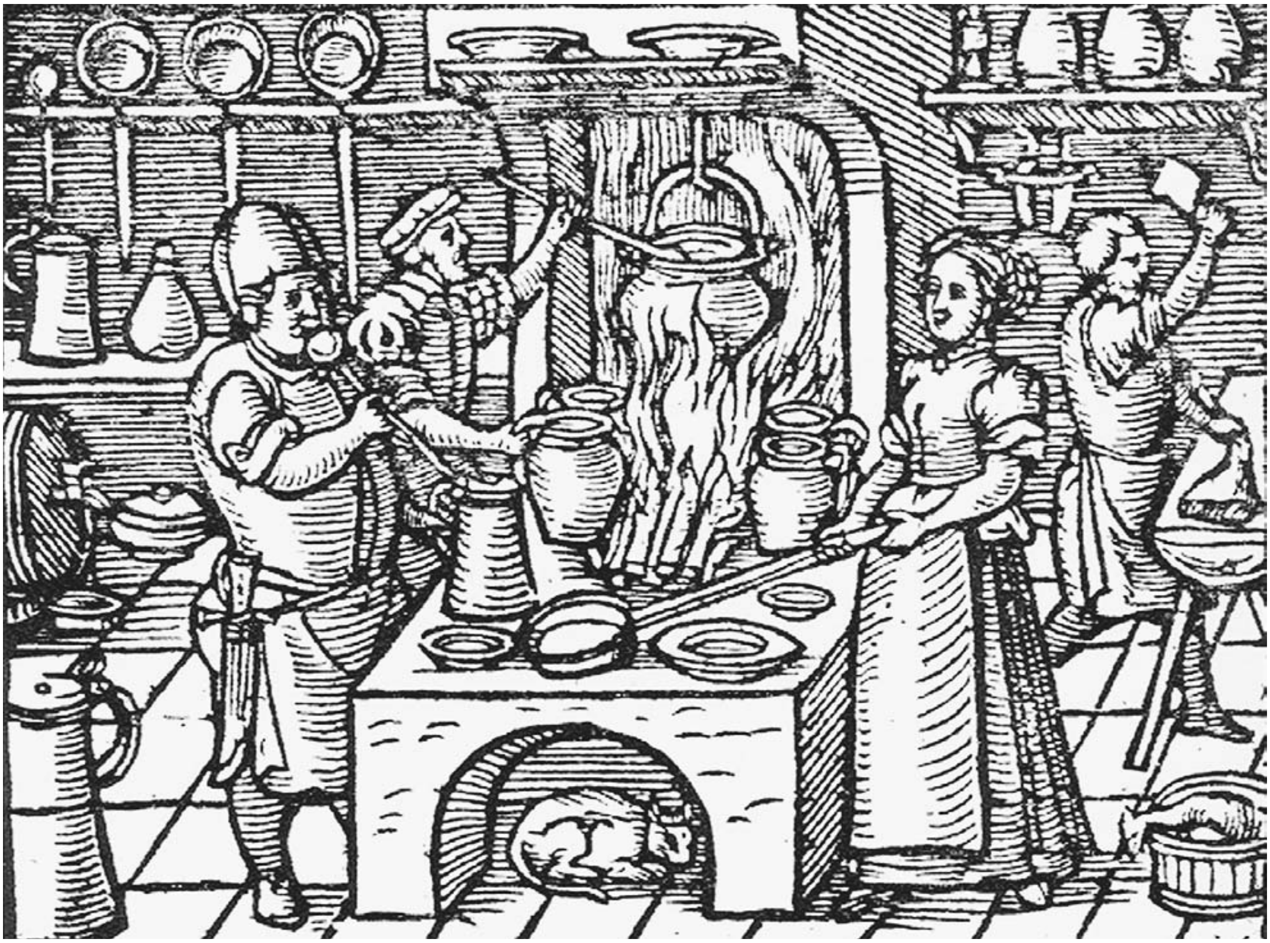
Drau
Lausanne
SWITZERLAND
Lake Geneva
Geneva
ITALY
SLOVENIA
CROATIA

although considerable ethnographic material has been preserved from the pre-1945 era. Many traditional recipes from this region, such as *Königsberger Klopse* (Königsberg dumplings) still appear in many German cookbooks. Refugees from these regions have tried to keep their dialects and cooking styles alive through cooking clubs and similar organizations.

There are now thirteen states comprising modern Germany. They include, from north to south: Schleswig-Holstein, Mecklenburg-Vorpommern, Niedersachsen, Brandenburg, Sachsen-Anhalt, Sachsen, Thüringen, Hessen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Baden-Württemberg, and Bayern (Bavaria). Each of these states is further subdivided into smaller regions,



The German Renaissance kitchen as depicted in Balthasar Staindl's *Ein künstlich vnd nützlichs Kochbuch* [An Artful and Useful Cookbook], first printed at Augsburg in 1544. COURTESY OF HANS WEISS. ROUGHWOOD COLLECTION.

some with very distinct local cuisines. For example, the wines and foods of Franconia in northern Bavaria are quite different from the rest of the state; the Pfalz, the southernmost area of Rheinland-Pfalz, is world famous for its wines, and locally well-known for its figs and chestnuts and its onion pies.

It is important to know these German states because popular cookbooks tend to treat regional cookery on a statewide basis—thus, there are Bavarian cookbooks, Saxon cookbooks, and so on. The most detailed cookbooks in terms of local cuisine, however, are the ones that focus on a particular valley or county (*Kreis*), such as Annelene von der Haar's *Das Kochbuch aus Ostfriesland* (The East Frisian cookbook), which deals with an area bordering on the Netherlands. The Frisians are the brunt of many German jokes about gluttony and thickheaded farmers, so this cookbook carries far more symbolism for the German reader than it would for outsiders. A unifying theme in most of the regional cookbooks written today is nostalgia for rural life in the village and a closer tie to nature, even to wild foods. In reality, preindustrial Germany was a harsh place for peasants, and recurring famine was commonplace.

Dietary patterns of preindustrial Germany. Until the beginning of the nineteenth century, mass poverty and famine were integral parts of daily life in most of German-speaking Europe. The majority of the population subsisted on grains that were either eaten in the form of thick gruel cooked in milk or water or converted into flat cakes, coarse breads, a variety of small rolls, dumplings, noodles, and thick soups. (Baker's goods, such as *Lebkuchen*, *Gugelhupf*, *Strudel*, and Austrian *Nockerln*, were rarely made in the home and were eaten only on special occasions.) The grains were rich in carbohydrates and, when consumed in quantity, covered daily energy requirements. Fava beans, lentils, and peas helped to offset the shortage of protein in the grain-based diet. Analysis of the diet in poorhouses and hospices for which records survive has underscored anecdotal evidence of a widespread lack of many vital vitamins and minerals. Thus, various degrees of malnutrition were common in the countryside.

Meat, fish, and butter, as well as eggs, were reserved for special occasions. In general, it was much more common for peasants to sell these food products at market than to eat them themselves. As a result, urban dwellers consumed much more meat, fish, butter, and eggs than their rural cousins. Meat was held in such high esteem that it was viewed as a prerogative of only the well-off and persons of high social rank. It was also abundant only for short periods of time (such as in the fall) and remained expensive well into the nineteenth century. The high status of meat consumption became so ingrained in German culture that today, now that Germans have a high standard of living, meat in some form is usually consumed with every meal. This is nowhere more evident than in the flesh-rich pages of the late Hannelore Kohl's *Culinary Voyage through Germany* (1997), which is a fair representation of what middle-class Germans like to eat.

Most German historians today agree that, by 1800, many of the rural poor and a large portion of the urban working class expended 70 to 80 percent of their income on food, normally in the form of barter. This imbalance was exacerbated by the low consumption of fresh fruits and vegetables until the 1860s. The full value of these foods was not recognized by popular cookbook writers until the 1920s, when there was a large surge of interest in raw foods, fruitarian diets, vegetarianism, and spa cuisine. The German cinema shifted concepts of physical beauty by featuring women who were obviously thin, whereas in the past, a Rubenesque figure had been considered the desired norm. Many books like Sophie Sukup's 1927 *Iss Dich Schlank*! (Eat yourself thin!) proclaimed a new dietary regime based on raw and garden-fresh foods.

Until that time, most fruits and vegetables had been consumed in preserved form, which lowered the vitamin content. Cane sugar was well known to confectioners, and the rich used it in ample quantities, but it never played a role in the German working-class diet. Sugar did not enter that diet in a large way until the introduction of beet sugar. Most German sugar-based products today employ beet rather than cane sugar. Gram for gram, beet sugar is now so much cheaper than meat that it has replaced meat in the form of junk and snack foods.

Until the end of the nineteenth century, a large majority of the rural population in German-speaking Europe was self-sufficient in terms of supplying daily food needs. Most households oriented their menus according to what could be obtained in the nearest market, and these menus did not vary greatly through the course of the year. Regional customs and the season determined the rhythm of consumption, but by today's standards, this cooking would be considered monotonous, nutrient-deficient, hard to digest, even at times disgusting because of the heavy-handed use of lard and other animal fats. It is ironic that with the prosperity which Germany has enjoyed since World War II, culinary writers have painted a picture of the past that is much rosier than what actually occurred—a truism for most European peasant cookeries. Rich dishes that were only eaten on rare occasions are now treated like daily fare, and restaurants specializing in traditional cookery, especially establishments catering to tourists, provide menus that resemble old-time wedding banquets rather than typical meals. This is not to say that German Europe has not created a cuisine with many noteworthy dishes, yet it is true that these dishes have lost much of their original cultural context.

Germany's food revolution. German Europe's gradual transition to a modern diet began in piecemeal fashion. In parts of Prussia, in some of the more enlightened dukedoms and principalities, cottage and small-scale industries were encouraged during the late 1700s. This created a cash economy that allowed the workers more freedom to purchase luxury items like tea, coffee, and chocolate. Northern Germany's dynastic ties to the British crown opened northern ports to English colonial goods. It is not surprising then that port cities like Hamburg and Lübeck now fall within the German "tea belt," while southern cities like Munich are solidly within the confines of the *Kaffeeklatch*.

Tea drinking in the north also brought with it a new preference for white bread and butter as a side dish, and this culinary troika soon displaced the traditional gruels served at breakfast and during main meals. In the south, coffee drinking moved northward out of Austria, accompanied by a preference for sweet pastries eaten with the coffee. This trend also pushed aside traditional gruels, substituting in their stead such innovations as coffee soup (*Kaffeesuppe*), where bits of bread or cake were crumbled into the coffee so that it could be eaten with a dainty spoon.

The rise in white-bread consumption tied to coffee and tea revolutionized German milling practices and changed German agriculture. The growing bread demand caused a shift away from traditional grains like millet, buckwheat, barley, and oats in favor of rye and wheat. Oats underwent the largest decline in consumption even though they were often the grain of choice in many German-speaking regions for hundreds of years. They have continued as a crop largely for cattle fodder, although they are beginning to return as a health food. In spite of the large shift to bread, there were pockets in rural areas where the older gruel-based eating patterns persisted into the early twentieth century.

The second factor in the German food revolution was the coming of the potato. Potatoes had been known in Germany since the 1500s and were grown as curiosities in many botanical collections. Some of the earliest European depictions of the potato appeared in German herbals, yet the plant was largely despised even as cattle feed. Only after the devastating famines of 1770–1771 and 1816–1817 did the potato achieve widespread acceptance. This occurred in concert with efforts by several German

Alpine butter mold from the Tyrol, circa 1890. These molds, which depict mountain deer, edelweiss, and other symbols of alpine culture, were made as mementos for Victorian-era tourists. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

monarchs to encourage the peasantry to rely on potatoes rather than grains and bread as a mainstay of the diet. This promotional effort was in part self-serving since the governments at that time realized that potatoes were cheaper than bread, easy to store, and more reliable than grain, especially in Germany's climate. In terms of yield, potatoes also fed more people per acre than grain. Thus, for a combination of reasons, the potato became one of the "pillars" of modern German cookery, especially in the north. In the south, where flour-based dumplings were a dietary mainstay, the potato never quite achieved the same central dietary role. To this day, the potato is still only a side-dish food in southern Germany, Austria, and Switzerland. It is also converted into dumplings in those regional cuisines.

The third factor that played a decisive role in the German food revolution was the increase in alcohol consumption, especially in the form of spirits or hard liquor. Grain and fruit alcohol was distilled by many peasants in the seventeenth century, but this was mostly to make good use of the residues from wine pressing or from cider. Furthermore, the distilled beverages were treated more as medicine than as social drinks. Around 1800, German chemists discovered that spirits could be distilled from potatoes, and this opened the door to what is known in Germany as the "Brandy Plague" (*Branntweinseuche*). The plague spread in step with the rising popularity of potato production, especially among the large land holders in northeastern Germany. The benefits were obvious: potato *Schnaps* provided yet another source of income for the landowner. Furthermore, the potato scraps left over from distilling could be used to fodder pigs (yet another sideline business). But cheap *Schnaps* weaned peasant drinkers away from beer to such an extent that production ceased in many areas of Germany, with the result that beer brewing became concentrated in the hands of large urban breweries. The unspoken side effect of the Brandy Plague was the concomitant rise in alcoholism. However, in traditional wine-growing regions, old drinking habits prevailed. The Brandy Plague never touched the Mosel Valley, the Pfalz, or the vineyard villages of Swabia.

After its establishment in 1871, the Second German Reich experienced rapid industrialization and a tremendous population explosion. The growth in the population of cities was accelerated by migration of labor from the countryside. Due to technological improvements in agriculture, the food supply throughout German Europe increased dramatically, and meat consumption rose with it. Fear of food shortages and famine very quickly disappeared almost within a generation. Only after World War I and during World War II did Germany suffer again from widespread food shortages. Today there are roughly 230,000 registered food products available in German stores on a daily basis.

All of these sociological and economic changes in German diet did not go unnoticed by cookbook writers. German-speaking Europe, like England, has a long tradition of middle-class cookbooks that may be studied as barometers of culinary change. The first of these is doubtless the *Kuchenmeistery*, a pamphlet cookbook first printed in Nürnberg about 1485.It was not until the latter part of the eighteenth century, after the appearance of a number of general reflections on the culture of eating, that a true "bourgeois cuisine" began to take shape in German culinary literature. This is referred to in German as *bürgerliche Kochkunst*, a concept which has no precise analogy in English.

The underlying themes of this literature were economy, rational meal preparation, taste improvements over traditional recipes, and new meal regimes under the rubric of *Hausmannskost* (fare for the working husband). This new literature for "plain kitchens" as opposed to aristocratic kitchens appealed to urban housewives. The great German classic of this genre was the *Kochbuch für die gewöhnliche und feinere Küche* (Cookbook for plain and elegant cookery) written in 1845 by Henriette Davidis, the daughter of a Westphalian minister. This book passed through new editions almost every year until 1900—long after the author's death in 1876. Davidis also wrote the first cookbook on the preparation of horsemeat in 1848, and a collection of her recipes was published for German-American immigrants in Milwaukee during the 1870s. She was in every respect reigning queen of the kitchen of imperial Germany.

Towards the end of the nineteenth century, there was a growing recognition in Germany, Austria, and Switzerland that cookbooks had become a mirror of the whole culinary culture. This led to a realization that the peculiarities of regional cookeries promoted feelings of regional identity and even a sense of nationalism. Cooking literature turned abruptly away from French cuisine in favor of regionalisms, even regional dialect food terms. In some cases, this genre has evolved even further, as in the case of Swabian cookbooks printed entirely in Swabian dialect.

It is possible today to dip into these regional cookbooks to extract a few examples of some of Germany's best-known traditional dishes: *gefüllter Saumagen* (stuffed pig's stomach) of the Pfalz; *Specktorte* (bacon tart) of Saarbrücken; *Panhas* (scrapple) and *Rievkooche* or *Reibekuchen* (shredded potato patties) of Nordrhein-Westfalen; *Schleizer Bambser* (sugary potato dumplings) of Thüringen; Christmas *Stollen* (fruit cake) of Saxony; Nürnberg *Lebkuchen* (gingerbread), *Schmalznudeln* (deep-fried yeast dough), and Franconian *Blaue Zipfel* (sausage stew) of Bavaria; *Käsespätzle* (cheese spaetzle) and *Schupfnudeln* (finger dumplings) of Baden-Württemburg; *Pommischer Mandelkringel* (ring-shaped almond cake) of Mecklenburg-Vorpommern, and *Rote Grütze* (pudding of mashed tart fruit with oatmeal and cream) of Hamburg and Schleswig-Holstein. Not the least of course are *Sauerbraten* and the German pretzel. German pretzel bakeries have even gone so far as to underwrite the continued growing of spelt wheat (*Triticum dicoccum*, var. *spelta*), the ancient grain associated with pretzel making since the early Middle Ages. Spelt, under the label of *Grünkern* (dried unripe whole grains) has also become a symbol of the latest wave in German cookery: green cuisine or ecological fare.

***Green cuisine* (Ökokost).** This concept came into being through the German Ecological Movement (called the "Greens"), which promoted a total reassessment of the food chain and its connection to the environment. The movement had its roots in German health-reform movements of the late nineteenth century but adjusted those concepts in more modern terms. Essentially, green cuisine is a cookery in which all agrarian products must be free of artificial ingredients, additives, and chemical taints; only food in its most natural form is acceptable. In general, this type of food is grown by farmers who follow organic growing methods and is very closely connected with the mainstreaming of vegetarianism. Although the Green Party has many followers in Germany and wields considerable influence in several regional parliaments, the overall market for such food was small until 1999. The outbreak of hoof-and-mouth disease and mad cow disease caused a large drop in meat consumption and sent many German consumers in the direction of *Ökokost*. The market sector for this type of food has now trebled, but it is still not the choice of a majority of Germans.

German cookery today. Prior to World War II, Berlin was Germany's cultural and culinary capital, although Munich was arguably the "Berlin of the South." With the massive destruction of Berlin's downtown area during the war and the movement of the capital to Bonn, the center of gravity shifted decisively to Munich. Munich remains today the country's most energized culinary center and has attracted many new and creative chefs. It is also home to the *Oktoberfest*, which is known throughout the world for its beer and sausages. The *Oktoberfest* began in the early nineteenth century as an agricultural fair showcasing the products of Bavaria. It was intended to encourage Bavarian agriculture and a sense of national pride (at the time, Bavaria was an independent kingdom). Today, the event has become a tourist mecca and the conduit for a type of tourist cuisine called "Bavarian cooking" that has been replicated in mini-*Oktoberfests* all over the world.

Contemporary German cooking is undergoing reinvention in the hands of chefs influenced by French nouvelle cuisine. This study in tomato soup as food and art was prepared at Die Ente Restaurant in the Hotel Schwarzbauch, Wiesbaden, Germany. © BOB KRIST/CORBIS.

The best German cookery is found in small restaurants and inns, often in the countryside and not far from vineyards. There has been an attempt by many chefs to lighten up the traditional cuisine, to explore unusual local produce, and to reinterpret recipes according to new dietary demands, such as less fat and smaller portions of meat. Whether this trend will lead to yet another German food revolution, only time will tell.

Austria

The Republic of Austria was created in 1918 out of the German-speaking provinces of the former Austro-Hungarian Empire. Modern Austria consists of eight provinces plus the capital city of Vienna, which for elective purposes is treated as a province. From east to west, the provinces include Burgenland, Niederösterreich, Oberösterreich, Steiermark, Kärnten, Tyrol, Salzburg, and Vorarlberg. Each of these regions is remarkably different from the other in spite of the small size of the country. Much of the western part of the country straddles extremely high mountains, and this alpine environment has played an important role in the development of regional foods and foodways.

The economic development and general trends experienced by Germany during the nineteenth century also occurred in much of the Austro-Hungarian Empire, with famine and poverty widespread in the countryside. Much of the wealth was concentrated in large cities, especially Vienna, Budapest, and Prague, where the landed aristocracy congregated. When Vienna was cut off from its Slavic and Hungarian provinces in 1918, much of the former industrial development lay outside the borders of the new country. The great imperial city found itself at the hub of a wheel with only a few remaining spokes. Due to the rugged terrain of the western provinces, that region continued to be largely agricultural and pastoral and remains so even today, although tourism and skiing are important sources of local income.

Any discussion of the food culture of Austria must first take into account the enormous historical influence that Vienna has had on the foods and eating habits of the country. But Vienna's role in this culinary evolution is relatively recent. The city was not a capital during the Middle Ages, and during the eighteenth century, when it was home to the Habsburg monarchy, it was still a small town by European standards. It was not until the Congress of Vienna in 1815 that the city established itself as a major center of culinary activity. Vast sums of money were spent during that period and gave rise to the lighthearted party life for which the city became famous. This reputation continued to grow rapidly as Vienna's wealth attracted culinary talent from all over Europe, yet the city did not take on the grand imperial appearance it has today until after the medieval city walls were demolished in 1857. However, several cultural themes came together in a unique way that gave rise to a distinctively Viennese way of life.

The first of these was coffee. There is a degree of murkiness about the origins of coffee drinking in Vienna, yet there is solid archival evidence that it was being drunk in private homes as early as 1665. The first public coffeehouse opened in 1683 and after that, coffee (along with chocolate and tea) became a common beverage in Viennese establishments frequented by men. It is fairly clear that the coffee habit came to the Viennese via the Turks living in areas then occupied by the Ottoman Empire, but the reasons for coffee's eventually preempting other exotic beverages cannot be ascertained from the historical record. Perhaps it was the association with Turkish luxury, or the fact that coffee could be consumed with very sweet foods to offset the bitterness. Whatever the reason, coffee found a natural marriage with sweet pastries in Vienna, and this union of bitter-and-sweet became the keystone of the Viennese coffeehouses of the nineteenth century. Furthermore, Vienna became the gateway for coffee drinking throughout the Upper Danube Basin. The coffee habit also moved west into southern Germany and Switzerland—accompanied by the silver trays of rich pastries.

Viennese pastries were not invented in Vienna, although they were undoubtedly refined and perfected there. Most of the pastries trace their cultural origins to Bohemia or Hungary or to some other far-flung part of the old Austrian Empire. It was the coming together of these various festive foods that made the Viennese dessert table so distinctive. It was, in fact, a cornucopia of the best Central Europe had to offer. The idea that Vienna had acquired a cuisine of its own began in cookbook literature intended for women who lived in more provincial parts of the empire but who wanted to be thoroughly up-to-date. Anna Dorn's *Neuestes Universal-oder Grosses Wiener-Kochbuch* (Newest universal, or large Viennese cookbook), issued in 1827, is one example of this genre. It lies halfway between the older aristocratic cookbooks composed by royal cooks or anonymous noblewomen and the later *bürgerliche Kochkunst* of Germany. Like the first Polish cookbook, Austria's first cookbook was written by an aristocrat, although the author is as yet unidentified. The cookbook was called *Ein Koch- und Artzeney-Buch* (A book of cookery and household medicine). It was published at Graz in Steiermark in 1686.

Another theme in Vienna's culinary evolution was the creation of a furniture and decorative style now called Biedermeier. It took shape during the 1830s and drew upon neoclassical themes for its inspiration. Vienna produced some of the most extraordinary furniture during this period, combining blond Hungarian oak with dark woods from the hinterlands, and then furnishing coffeehouses and restaurants with the most voluptuous combinations of color and classical ornament. This style of design found its counterpart in foods, and many surviving cookbooks, especially the hand-illustrated ones for professional bakers and chefs, offer an amazing array of richly ornamented dishes so refined in appearance that they must have startled the country bumpkins accustomed to seeing only dumplings and tarts on special occasions. Viennese cooking continued to evolve throughout the nineteenth century, but it never escaped its core identification with Biedermeier style. If this essence of Viennese cuisine could be expressed in a few words, then it has been captured succinctly in Joseph Wechsberg's essay "Tafelspitz for the Hofrat," which describes in minute detail the art of preparing a very special Viennese, and only Viennese, cut of beef.

The third theme in the evolution of Viennese cookery is the *Heurigen*. These are extremely informal family-owned snack-houses whose primary function is to sell light foods to accompany year-old local wines. Authentic *Heurigen* are owned by small-scale vintners who sell their own wines and no other. When the houses are open, the owners hang a pine branch or a wreath of evergreens over the door. Menus consist of cold cuts, bread, sausage, walnuts, perhaps even some home-cooked food, but the meals are not considered dinner. After the close of the business day, Viennese flee to the countryside to spend a relaxed evening in their favorite *Heurigen*. This social institution is very firmly established, but there are also *faux Heurigen* whose primary clientele is tourists seeking out "the *Heurigen* experience." These houses are easy to spot because they are surrounded by buses and cars with foreign license plates.

There are over 140,000 acres of vineyards throughout Austria, mostly planted in the native *Grüner Veltliner* (for white wine). This has given rise to *Heurigen* far beyond the Viennese countryside. While this development is doubtless good business for small places in out-of-the-way locations and is especially beneficial to large commercial wineries, the two institutions are not the same. For Viennese, the *Heurigen* experience represents a momentary return to the countryside, a reality check against the oversophistication of city life and an opportunity to taste "real" Austrian food of the sort grandmother used to make. This interest in culinary roots is something that took shape after World War I, after the country shrank to its present size, and especially after the coming of the automobile, which made evening trips to the country possible.

It is significant that Katharina Prato's great Austrian classic *Süddeutsche Küche* (South German cookery), which first appeared at Graz in 1858 and passed through more than seventy editions, made no mention of Austrian cuisine. Prato was from an aristocratic family, and her world view, like that of other Austrians of her day, encompassed the empire and its most refined culinary riches, not the food of the peasants. By degrees, the *Heurigen* have taken this view in the opposite direction, and this has moved hand-in-hand with Austrian scholarship on the country's most interesting traditional foods and customs.

The list of individuals who have contributed to the formation of a new Austrian culinary identity is indeed long, but two names do stand head and shoulders above the rest. They are Ernst Burgstaller and Anni Gamerith. Both were scholars with an ethnographic approach to their subject, although Gamerith was also intensely interested in traditional horticulture and actively helped to preserve endangered heirloom food plants. Burgstaller's *Österreichisches Festtagsgebäck* (Austrian festive breads and pastries) is a model of what can be learned about a country by studying its foods on a village-by-village basis. Burgstaller's maps outlining regional customs and foods have formed the basis for many regional food studies that have followed, such as Brigitte and Siegfried W. de Rachewiltz's *Tiroler Brot* (Tyrolean bread). On the other hand, Gamerith's literary output was huge, and many of her studies take a holistic approach to food. *Lebendiges Ganzkorn* (Living grain) followed the entire story of whole-food grains in Steiermark, their agricultural history, the old horticultural knowledge surrounding their planting and harvest, the old methods of milling and storage, and finally, their conversion into food and bread, including recipes.

Food in Austria today. Gamerith's approach may have been influenced to some extent by the writings of Rudolf Steiner, whose theories on biodynamic agriculture not only originated in Austria, but are still widely practiced there to one degree or another. Because of the lack of large open agricultural lands, Austrian farmers have concentrated on intensive agriculture on small plots of land. Organic farming is extremely popular, and the country supplies a large amount of its own food. Interest in heirloom fruits and vegetables is high and is well-coordinated under the grass-roots organization *Arche Noah* (Noah's Ark), which is headquartered at Schloss Schiltern. The most recent trend in Vienna's leading restaurants has been a turn away from the old imperial cuisine so popular with tourists, and the placement of new emphasis on seasonal local produce and traditional cooking methods. Thus the cuisine of the countryside is now finding new status on high-end menus in the creative hands of numerous young chefs.

Tourism still plays an important role in Austrian cookery, but the differences between native Austrian fare and what tourists consume are growing ever wider. Travel writers and food journalists created a Viennese experience that the tourist still seeks out, such as a requisite slice of *Sachertorte*, a dish of *Kaiserschmarrn*, coffee at Demels, and the ever-present tins of *Mozartkugeln* (chocolate balls). This is culture for outsiders, a caricature of Austria as highly packaged and as devoid of "authenticity" as the blaring echoes of *The Sound of Music* that roll through the cobblestone streets of Salzburg every summer day.

Switzerland

Modern Switzerland began in 1291 with the confederation of the three original cantons: Uri, Schwyz, and Unterwalden. After that the confederation grew piecemeal fashion with the addition of several new cantons after the Swiss declared independence from foreign domination in 1648. The last cantons to join the confederation were Neuchâtel, Valais, and Genève in 1815. This created the modern borders of the country. Today there are twenty-three cantons, the largest being Graubünden, Ticino, Valais, Berne, and Vaud. While the country has four official languages (French, German, Italian, and Romansh), German is the dominant language, especially since it is the language of business and banking. However, it is not the oldest language of the country.

Romansh or Rhaeto-Romance is a relic language surviving from Roman times. A mixture of Latin and Celtic, it was at one time spoken over a much larger part of Switzerland than the present Engadin region in Graubünden where it is now centered. The Romansh Badrutt family brought this cultural milieu to world attention when it established luxury hotels at St. Moritz. However, sister dialects of Romansh were spoken in Austria and, during the early Middle Ages, over much of what is now Bavaria and Baden-Württemberg. In culinary terms, it is the Romansh culture of Switzerland that provides a direct link to the cookery of ancient Helvetia. When the Swiss think of the roots of their culture, and about symbols of cultural identity, it is Romansh and the ancient Helvetians that come to mind. This is their idea of Swissness and is the reason the country's currency bears the name of the Helvetic Confederation.

In spite of the fact that the Swiss gained political independence in 1648, the country never evolved a national food identity. Today, most outsiders probably think of fondue or Emmenthaler cheese when they think of Switzerland, but the Swiss are fiercely loyal to their cantonal identities; thus it is much more reasonable to discuss the cookery of Bern, or of Vaud, or of Zürich, than to lump everything together into one pot. While it may be overly simplistic to break the food story down into the major Swiss language groups, it is true that the cookery of the German-speaking cantons is different from the cookery of the French and Italian cantons—yet with a great deal of overlapping.

The peculiarities of Swiss cuisine have been studied in minute detail by the Swiss themselves, and there are innumerable books tackling the subject. For example, Werner Meyer's *Hirsebrei und Hellebarde* (Millet mush and halberds) traces the shifts in Swiss diet that occurred during the late Middle Ages and the 1500s. From a cantonal standpoint, the best studies thus far are those by the Swiss food historian Albert Hauser, who launched a series of cantonal food histories with the publication of *Vom Essen und Trinken im Alten Zürich* (Eating and drinking in old-time Zurich) in 1961. This was followed by similar studies of Bern and other cantons.

Since the Renaissance came early to Switzerland, and since Basel became a great center for the study of humanism, Swiss books dealing with culinary topics have appeared steadily since the 1500s. Yet a peculiarly Swiss identity did not begin to appear until the eighteenth century. Mostly it took the form of cookbooks written for the wives of rich burgers, as in the case of the anonymous *Bernisches Koch-Büchlein* (Little Bernese cookbook), which is known from its second edition of 1749 (and recently reprinted in facsimile). It first appeared about 1720, although no copies have survived of that edition. The contents of the cookbook, while Swiss in the use of the Bernese dialect of German, make no effort to cover Bernese culinary specialties. It is more of a guide to what was then fashionable, with many adaptations of French recipes.

The same could be said of other cantonal cookbooks, such as Crescentia Bohrer's *Freiburger Kochbuch* (Freiburg cookbook), published in 1836. It was not until later in the nineteenth century that the word "Swiss" begins to appear in cookbook titles, no doubt the result of a rising sense of nationalism. One of these books was Jenny Lina Ebert's *Die Schweizerische Köchin* (The Swiss cook), which was published in 1870 and 1871. Like Bohrer's, Ebert's cookbook embraced *bürgerliche Kochkunst*, and the fact that she used the feminine *Köchin* is significant. This was a book intended for housewives.

The overwhelming body of Swiss culinary literature has been written by men for professional cooks. This phenomenon is due to one very important contribution the Swiss have made to the food world: the development of the hotel industry and hotel cookery. The English discovered Switzerland's Alps during excursions to Italy. The romantic landscapes, the quaint chalets, yodeling peasants, hillsides covered with goats, windswept meadows, glaciers—it was a universe far removed from the apple orchards of Kent. It began with the English renting rooms in farmhouses, but the astute Swiss were quick to observe that more rent-paying Englishmen and their families could be packed into country inns with expanded sleeping and dining arrangements, and thus the hotel industry was born. The construction of the Swiss railroad system made it possible for middle-class tourists to reach most parts of the country. By the 1860s, Switzerland was dotted with hotels situated in scenic locations, and considerable advertising copy was devoted to the fact that the fresh mountain air, the crystal-clear glacial waters, and the fresh cheese and butter were far healthier for the constitution than the thick coal smogs of London. In order to run these hotels profitably and efficiently, the Swiss also established training schools in management and in hotel cooking. They are still masters of this industry, and hotel chefs the world over are quick to mention their Swiss diplomas.

In concert with the movement of tourists into the country there was a movement of Swiss talent abroad. Overcrowding of farmland, food shortages, and economic downturns convinced a number of Swiss to emigrate and to apply their talents elsewhere. Dolf Kaiser has traced this migration in his book *Fast ein Volk von Zuckerbäckern?* (Almost a nation of confectioners?), which outlines in great detail how Swiss from Graubünden came to manage the great hotels, confection shops, and cafés of Europe. This emigration included the Delmonico family, which established a well-known restaurant in New York, as well as many, many other famous names in the world of food: Café Josty in Berlin, the restaurant Köhl in

The *Stube* or stove room was the center of family life in the old German farmhouse. The *Eckbank* (corner bench) along the wall served as seating for the one-pot meals eaten from a common bowl. This photograph from about 1900 shows the interior of a south German farmhouse *Stube*. ROUGHWOOD COLLECTION.

Odessa (Russia), the Café Chinoise in St. Petersburg, Café Tosio in Warsaw, Klainguti & Company in Genoa, and the Café Gilli in Florence, to name a few. If there were one cookbook that served as a text for this expatriate Swiss food network, it was Giacomo Perini's richly illustrated *Der Schweizerzuckerbäcker* (The Swiss confectioner), which was published at Weimar, Germany, in 1852. Because it was written for a small circle of confectioners and thumbed to shreds, very few copies now survive, and it is today one of the rarest of all Swiss cookery books. Furthermore, the term "Swiss" in this context does not refer to a national style of cooking, but to an established reputation among Swiss confectioners for a high level of professionalism.

Swiss confectioners were especially renowned for their chocolates. In 1876 the Swiss confectioner Daniel Peter created milk chocolate by combining milk powder with the chocolate formula. His powdered milk had been manufactured by Henri Nestlé as a product for babies, but it became obvious from this discovery that greater money could be made with this new kind of chocolate. Nestlé's name has been associated with milk chocolate and instant chocolate ever since. Nestlé is now a large international corporation headquartered in Vevey, Switzerland. Another Swiss contribution came from Rodolphe Lindt, who in 1880 developed the technique for conching chocolate, a process that permitted much firmer and more highly ornamental candies, as well as the ability to insert fillings.

Swiss cooking today. Tourism has to some extent "decantonalized" modern Swiss cooking. In order to meet the expectations of foreign visitors, Swiss hoteliers and restaurateurs are quick to supply a roster of well-known menu items like fondue, raclette, *rösti* (grated potato pancakes), Basler *Leckerli* (Basel-style gingerbread), Zürich Hotpot (*Gumbis*), and a long list of recipes based on lake fish. In Swiss home cooking and in the cooking of the small inns frequented by the Swiss themselves, especially places where there is a fixed *Stammtisch* (reserved tables for regular local customers), the food is decidedly different and at times far superior to hotel fare. There is also a strong movement to capture traditional dishes in cookbooks with a highly localized focus. Fritz Gfeller's *Rezepte aus dem Emmental* (Recipes from the Emmental) represents an attempt by the chef of a popular country inn to take the farmhouse cookery of his famous valley and put it into a cultural context with stories about each recipe and the rather remarkable local characters connected with them. Dialect recipe titles like *Zueguet-Schnitzu* (Schnitzel in the style of a Zueguet farm) tell us that this is a cookbook intended mostly for Swiss eyes.

Likewise, *Aargauer Rezepte* (Aargau recipes) by Dora Schärer, Betty Pircher, and Yvonne Fauser is also a collection of local recipes, but one assembled by three instructors in schools of home economics. They have taken rustic traditional foods and revamped them according to modern cooking techniques and food presentation. This is an important strand in domestic Swiss cooking because it is an attempt to insulate the nation's cuisine from the homogenization of the European Union, to which Switzerland does not belong.

Finally, it goes without saying that some of the most famous French restaurants in the world are not inside France. The Swiss penchant for high professionalism and artistic creativity in food are perhaps strongest in *Suisse romande*, in the French-speaking cantons facing Lake Geneva. One of the recent culinary heroes of that region is Fredy Girardet, a native of Canton Vaud, whose restaurant in the village of Crissier has been recognized as one of the world's great culinary meccas.

See also **Balkan Countries; Central Europe; Chocolate; Christmas; Cookbooks; France; Gamerith, Anni; Gingerbread; Italy; Low Countries; Middle Ages, European; Pastry; Potato; Sausage; Shrove Tuesday; United States,** *subentries on* **Ethnic Cuisines** *and* **Pennsylvania Dutch Food.**

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William Woys Weaver
with material on Germany from Hans-Jürgen Teuteberg

GINGERBREAD. The word "gingerbread" has evolved in English over the past five hundred years to include a highly diversified range of ginger-flavored foods. In its original medieval meaning, gingerbread was characterized as a "bread stuff," which meant something edible, a dry finger food consumed as an adjunct to the meal, although in this case unusual in taste and texture, and commonly eaten as a medicine due to its effect on the bodily humors. The earliest references to gingerbread in medieval English cookery books are quite clear on this point, since they refer to brittle gingerbread preparations made mostly of ginger and sugar. In short, medieval English gingerbread was a medical candy, but parallel to this was a large family of honey-based cakes or cookies known in German as *Lebkuchen. Lebkuchen* are the central subject of this discussion. In English they were known as honey cakes.

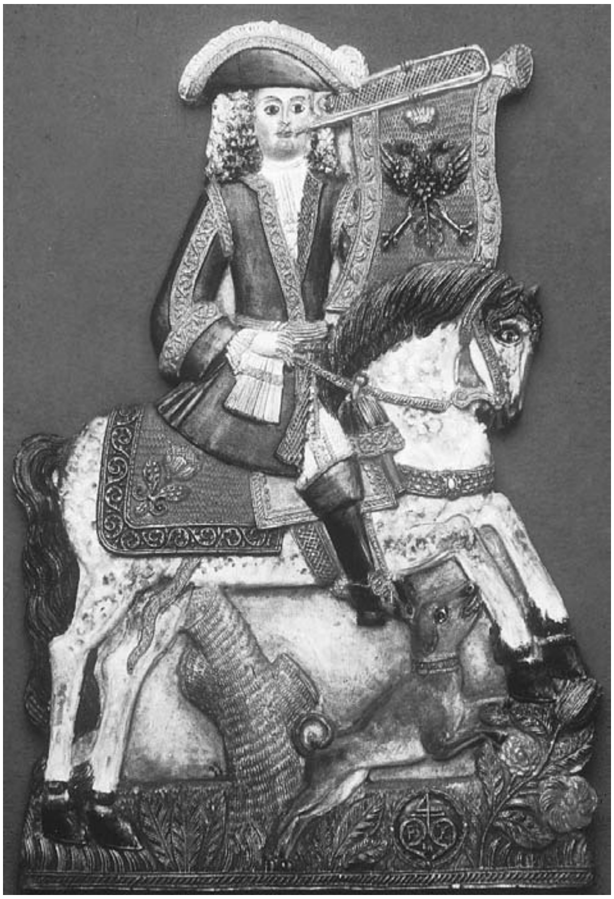
Honey cakes trace their ancestry to ancient Rome. Among food historians the general consensus is to define the *Lebkuchen* as a highly spiced honey cake baked in a *clebanus* or portable oven. The literal meaning of *Lebkuchen* is thought to be 'clebanus cake', something baked originally in the ancient Roman dining room and served directly to the guests. The Romans often baked honey cakes in the shape of a heart, and for this reason their honey cakes were associated with weddings and, by extension, were edible love tokens on a par with the modern box of luxury chocolates. Gingerbread has branched out into several types of cakes or cookies, not all of them sweetened with honey.

By the 1500s English gingerbreads had evolved into highly spiced crisp cookies, like the German *Lebkuchen* ornamented with stamped designs or cut into innumerable shapes and patterns. These cookies were popular during the winter months and were usually dipped in wine or cider when eaten. This is the so-called crisp ginger cake of colonial North America, which survives in the commercial ginger snap cookies. Gingerbread cookies were also popular as Christmas tree ornaments. With the introduction of inexpensive tin cookie cutters during the late nineteenth century and the ease with which cookies could be baked in cast-iron stoves, ornamental gingerbread cookies became a fixed feature of domestic cookery.

The introduction of saleratus and other chemical leavenings during this same period also changed American gingerbread, and soft gingerbread or gingerbread cake developed. In the United States the term "gingerbread" is more commonly associated with a chemically leavened spice cake than with the crisp cookies of the eighteenth and nineteenth centuries.

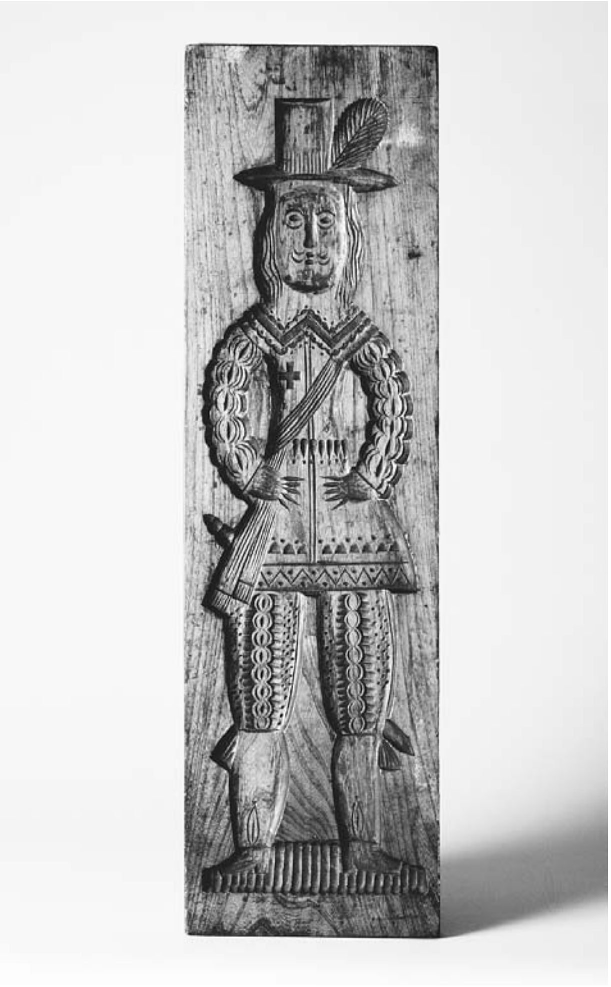
Prior to becoming a branch of domestic cookery, gingerbread baking of all kinds was generally the preserve of the professional baker. In many European countries gingerbread bakers were a distinct subunit of the bakers' guild. Since no guilds existed in America, this pattern was not continued there, yet in the German-speaking communities of Pennsylvania and Maryland individuals continued this specialized tradition until the beginning of the twentieth century.

One of the important adjuncts of professional gingerbread baking was the carving of the molds used to stamp the cookies with patterns. Both the carving of molds and the baking of the gingerbreads were male tasks, although the baker's wife and daughters often worked as decorators. The most elaborate gingerbreads were also iced, so the ornamental images were not only raised on the surface of the cookies but were also visually colorful. Bakers called this "applying makeup." Cookies were also gilded with gold leaf, the origin of the idiom "to take the gilt off the gingerbread." The decorated gingerbreads were often kept rather than eaten, used as wall decorations or put on display in a glass cabinet. Many bakeries made show cookies of giant sizes for their shop windows as part of Christmas advertising. The gingerbread bakers of Belgium and Holland were well known for such large cookies, and considerable literature describes the various schools of mold carving that once existed in those countries.



Iced gingerbread from a 1680s mold showing how these cookies looked when fully ornamented. Cookie and icing by William Woys Weaver.

A discussion of gingerbread and its history invariably turns to a discussion of the molds because the finest ones represent a branch of popular art that has been recognized and studied by numerous European museums. Some of the best-known centers of mold carving were Lyon (France), Nürnberg (Germany), Ulm (Germany), Toruń; (Poland), Pesth (Hungary), and Prague (Czech



Gingerbread mold depicting Willem III (1650–1702) of the Netherlands. Early-nineteenth-century copy of an older design. The stadtholder was a popular theme with Dutch gingerbread bakers. This mold yields cookies about 36 inches tall, and was only used by professional bakers who had ovens large enough to accommodate cookies of this size. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Republic). The Bread Museum in Ulm, Germany, and the Ethnographic Museum in Toruń, Poland, possess two of the largest mold collections in Europe.

Molds were an important means for mass producing a design. But to make honey cakes, bakers had also to process honey by removing it from the combs. Thus in the workshops where honey and beeswax were processed, two different types of molds were used, one for gingerbreads and one for wax figures. For the production of gingerbreads, the molds were carved into wooden blocks. The wood had to be hard, for example, oak or boxwood, since a single mold had to serve for the production of thousands of gingerbreads.

Carved molds were made either by special carvers or by the gingerbread bakers themselves. The bakers had to learn how to carve molds during their apprenticeships and as journeymen. Of course not everyone had great talent for carving, but at least every baker could produce molds as they were needed, for instance, when a mold was too worn out for further use and had to be replaced, when a new motif was in demand, or when a special design had to be made to order.

The characteristic ingredients for the gingerbread dough were honey, flour, and potash. The dough was normally made in the fall and allowed to undergo an enzyme reaction over a period of two or three months. The dough became soft and rubbery, but it was also rather dry in texture and required considerable strength to be handled. It was pressed into the mold and then "beaten out," that is, the baker slapped and punched the backside of the mold until the gingerbread relief fell out. One journeyman or the master baker produced hundreds of cookies a day. In the oven the cookies with their raised patterns were dried at a low temperature rather than baked in order to preserve the image and keep it from warping.

The range of motifs was wide, and even a simple workshop in the country had a number of different motifs in stock. Foremost among them were hearts, babies, and riders, which can be called classical motifs. Next are the motifs referring to the great feasts of the Christian calendar, such as Christmas and Easter, and the great events in human life, especially the wedding, which was the climax in the life cycle for the individual as well as for the community. When noble families combined forces by marrying their children, usually a so-called "allied coat of arms" was created and carved. Stamped gingerbreads showing this motif were handed out among the wedding guests. Producing offspring was a main aim of marriage, therefore the bride could be presented with gingerbreads showing babies, tokens of well wishing and wishful thinking at the same time.

As far as the Christian calendar feasts were concerned, Christmas motifs took the lead. Among them, the Nativity and the Adoration of the Three Kings were most frequent, but other aspects, such as the feast day of Adam and Eve on 24 December, were represented also. The depiction, especially of these Christmas motifs, was often in the Baroque style because the designs reached their most elaborate forms during the 1600s. However, when such molds had to be replaced, the new carvings were often copies of the worn-out pieces, even including the dates of the originals. Thus a gingerbread mold made as late as the middle or even the second half of the nineteenth century can show all the stylistic criteria of two hundred years earlier.

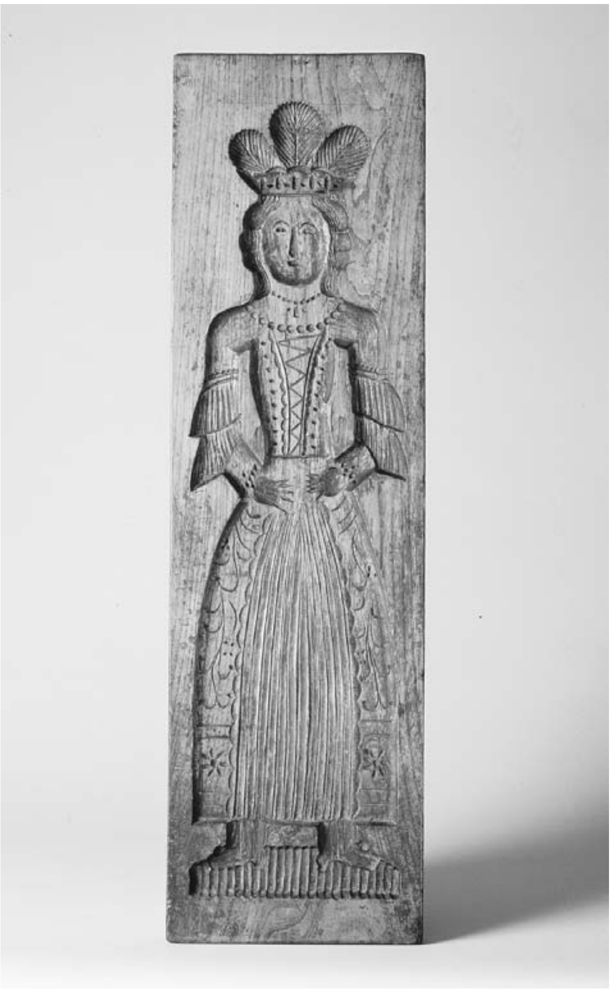
In Catholic areas the range of religious motifs also included various saints and places of pilgrimage. The religious gingerbread reliefs were bought for the respective occasions. The big Christmas and Easter gingerbreads were shared by the family. The name day (saint's day) was more important than the birthday (the name day was interpreted as the day of the heavenly birth); consequently a gingerbread relief of the patron saint was often presented to a person as a present on his or her name day. Going on a pilgrimage was a common and regular event. A gingerbread depicting the miraculous image of the place of pilgrimage was carried home. (The custom survives, with paper replacing the gingerbread memento.)

A considerable number of gingerbread motifs were dedicated to news, and gingerbreads served as a kind of history book or newspaper. The "portraits" of emperors and kings or empresses and queens (for example, of Empress Maria Theresa of Austria-Hungary or of Emperor Charles the Great) were presented to the public in gingerbread images as well as in copperplate engravings. There were pictures of the giraffe the Egyptian ruler Mehemed Ali gave to the Austrian emperor in 1828 and of the first steamship on the Danube, the *Maria Anna*, as well as a portrayal of the 1817 European famine that was actually a sociocritical parody of the exorbitant prices of grain. These images represented the big news of the day.

The gingerbreads were sold in the workshops and on the markets. The producers went to the seasonal markets during the year but also set up their stalls on the place before the church on Sundays. The churchgoers were regular customers attending Mass and market together. Gingerbread reliefs were presented to children and grown-ups alike. For children they were sweets and toys (especially babies, riders, soldiers, swords, pistols, trumpets, animals, and at the beginning of the school year, alphabets and school scenes).

Gingerbread molds are no longer produced or in use commercially. Plain gingerbreads, that is, without reliefs, are common. Saint Nicholas, visiting the children on the evening of 5 December, always has gingerbreads among his gifts, and gingerbread hearts with written axioms ("With Love!" "For Friendship!") can be bought at fairs. Gingerbread molds have become collector's items and often are quite expensive since few have survived.

See also **Baking**; **Bread**; **Cake and Pancake**; **Candy and Confections**; **Christianity**; **Christmas**; **Easter**; **Feasts, Festivals, and Fasts**.



Reverse side of the mold above depicting Willem III's wife. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

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Edith Hörandner

GOAT.

Goats are one of the earliest domesticated animals, providing humankind with milk, meat, hides, and fiber. They include several species of small, cloven-hoofed ruminants constituting the genus *Capra*. Similar to other ruminants, including cows and sheep, goats process plant roughage through a fermentation process within their compartmentalized stomachs, and they chew regurgitated, partially digested food known as cud.

The Land of Milk and Honey

The Talmud explains that the biblical description of a land "flowing with milk and honey" actually refers to goats foraging in fig trees. The figs were so ripe that sweet juice (called fruit honey) dripped everywhere, and the goats were so well-nourished their udders overflowed with milk. The milk and honey literally spilled across the land.

—Ketubot *111b*, Megilla *6a and* Ramban, Shmot *3:8*.

*

The Old French word for slaughtering and cutting up meat is *boucheron,* from the term for a he-goat, *bouc.* It is also the root of the English words "butcher," "buck" (a male goat), and, perhaps, the slang term "butch."

Unlike other ruminants, goats are agile browsers, preferring to reach upwards for foods such as the leaves, fruit, and bark of small trees rather than grazing on grasses. When the desired foods are unavailable, however, goats will consume any plant material accessible. It is this foraging ability and flexibility of diet that has secured the importance of goats as a food source in the world's subsistence economies.

Domestication

Wild ancestors of modern goats, known as Persian or Bezoar goats (*Capra aegagrus*) once roamed from South Asia to Crete. It is believed human goatherding began 10,000 years ago in the Zagros highlands of western Iran, as evidenced through selective slaughter of young males. DNA studies support that domestication began at that time due to the rapid growth of the goat population. Domesticated goats (*Capra hircus*) demonstrate remarkable genetic uniformity worldwide. Genetic analysis suggests that goats were a commonly traded in ancient times, which dispersed the population to Europe, Africa, and Asia. Later, they provided a convenient source of milk and meat aboard the ships of European explorers, who introduced goats to the New World.

Breeds

Selective breeding of goats has resulted in animals smaller than their ancestors, and with greater diversity of coat length, texture, and color. Noses are straight or convex; ears vary from negligible external organs to pendulous and droopy. Both males (bucks) and females (does) are horned. Hornless (polled) animals have been bred, though the recessive polled trait is associated with infertility. (Goat horns are frequently removed after they bud to prevent accidents.) One characteristic that has not changed with domestication is goat intelligence, judged superior to that of dogs. Numerous breeds have been developed for meat, milk, and fiber (including angora for mohair, and cashmere), in addition to being bred for hardiness and suitability to specific geographic regions.

Distribution

The Food and Agriculture Organization of the United Nations estimates that in 2001 close to 693 million goats were kept worldwide, with 95 percent of all stock found in developing countries. This compares to 1.3 billion cattle and 1 billion sheep. Regionally, South Asia has the most goats, with 205 million head, followed by East and Southeast Asia, due largely to the 157 million in China. Other nations with significant goat populations (in descending order) are India, Pakistan, Bangladesh, Iran, Nigeria, Ethiopia, Burkina Faso, Brazil, Indonesia, Kenya, Mali, Mexico, Mongolia, and Somalia.

Official statistics on goat meat and milk greatly underestimate production since many goats are raised for personal family use. Primarily nations with large numbers of animals accounted for the most meat: over one-third of the global supply in 2001 came from China. Other significant producers include India, Pakistan, Bangladesh, Nigeria, Sudan, and Iran. Commercial milk production did not correlate so closely with number of head, however, reflecting cultural differences in dairy food use. In 2001, major producers were India, Bangladesh, and Sudan, followed by Pakistan, Somalia, Spain, Russia, France, and Greece.

Goat Products

Meat. Goat meat has a taste similar to mutton, with a slightly gamy flavor. It is lower in fat than either beef or mutton (due to a fat layer exterior to the muscle rather than marbled through it), and can be drier. The United States Department of Agriculture describes quality goat meat as firm and finely grained. The color can vary between females and males, from light pink to bright red. Kids, defined as under one year old, are often slaughtered at three to five months of age. Their meat is less flavorful and juicy, but more tender than the meat of older goats.

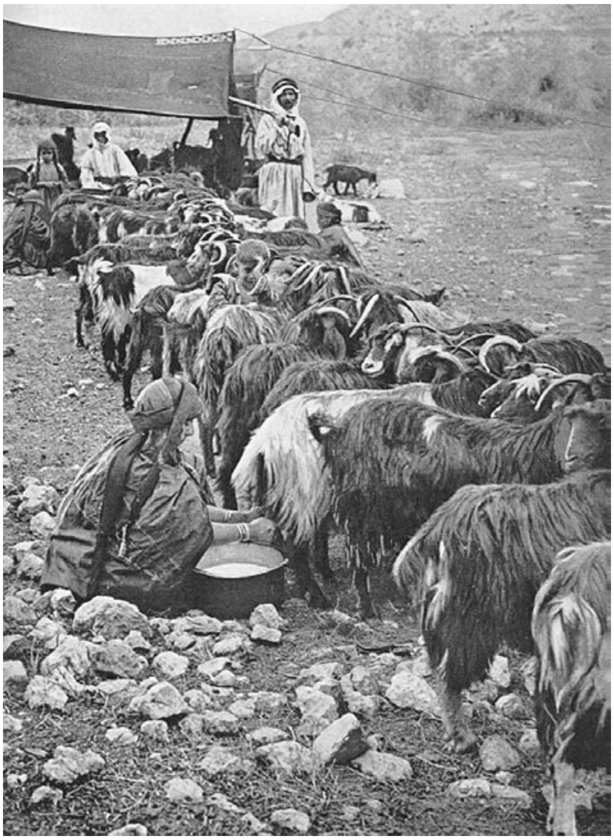
Goat meat is an important protein source in South Asia, the Middle East, and Africa. It is consumed regularly in some parts of Latin America, such as the Caribbean, Mexico, and Brazil, and is regionally popular in China, Korea, Indonesia, the Philippines, Greece, Italy, Portugal, and Spain. The entire goat is usually consumed. An eviscerated carcass is typically cut, flesh and bone, into cubes for stewing, used in dishes such as curried goat and garlic-flavored *caldereta*, a Spanish specialty found also in Latin America and the Philippines. Roasted goat is popular worldwide, often considered a special-occasion food. In Saudi Arabia, the cavity is stuffed with rice, fruits, and nuts. Jerked goat leg, heavily seasoned before cooking over allspice wood, is a Jamaican specialty.

Organ meats are eaten, too. Goat's head soup is prepared in most regions where the meat is consumed. The dish is known as *isiewu* in Nigeria; the eyes are considered a delicacy. In Morocco, kidneys, liver, heart, lung, and pancreas are added to the meat to make goat *tagine*. In Kyrgyzstan, the testicles are roasted separately over the fire for consumption by men, and washed down with vodka. In the Philippines, *paklay* is an Ilocano specialty that combines goat intestines with sour fruits, such as unripe pineapple.

There are few taboos regarding goat meat, and it is accepted by all major religions that permit eating meat. Jewish consumption is often dependent on kosher processing, and for Muslims it must be slaughtered according to *halal* rules. In some regions goats, especially kids, are associated with certain religious holidays, particularly Passover, Easter, and Ramadan. Goat meat is usually classified as a hot or *yang* food in the Chinese philosophical system of yin/yang, and preferentially consumed during the winter months.

Goat meat is not well-accepted by a majority of Americans due to negative associations with garbage-eating and the unpleasant odor of the buck during rut. Exceptions are found among ethnic populations and in the Southwest, where Spanish-Mexican influences have popularized barbequed or pit-roasted *cabrito* (suckling kid). Enterprising goat ranchers in the United States market goat jerky and sausages as *cabrito*, or as the more French-sounding *chevon*.

Dairy Foods. Goat's milk is traditionally consumed fresh, fermented as yogurt, and processed into butter and cheese. While goat's milk is a significant protein food in areas where grazing land is limited, goats lactate seasonally and produce lower quantities of milk than do cows, reducing availability. Fresh milk is a common beverage in South Asia, parts of the Middle East, and Greece and is an occasional dietary addition in other goat-raising nations (with the exception of China and Korea). In Europe, evaporated, canned, and powdered goat's milk products are popular. Cow's milk desserts are occasionally made from goat's milk as well, such as ice cream or the Latin American caramelized milk sweet known as *dulce de leche* or *cajeta*.



Milking a goat herd in Palestine, circa 1915. While men or boys may have tended the goat herds, it was the traditional role of the women to milk the goats and to make goat cheese. ROUGHWOOD COLLECTION.

Goat's milk cheeses are favored in the Middle East, and in parts of Europe and Latin America. They are processed and classified similarly to cheeses prepared from other milks. Soft and semisoft unripened (unaged) cheeses predominate, often home-made. Most are delicate, spreadable, snowy white in color, with a light, tart flavor. Many are marketed under the generic term *Chèvre* (French for goat's cheese) and may be named for their shape, such as buttons or pyramids. Fewer firm and ripened (aged) goat's cheeses are produced; examples are *Crottin* and *Sancerre*. Some cheeses traditionally made with goat's, cow's, or sheep's milk blends include Feta, *Fromage Frais*, *Gjetost*, *Kaseri*, and *Queso Fresco*.

Health Value

Meat. Goat meat is nutritionally notable for combining the advantages of red meat with those of white meat or poultry. Goat meat provides similar amounts of protein when compared to the composite nutritional value for beef, but is 80 percent lower in total fat, most of which is unsaturated. Goat meat is also lower in fat than pork, lamb, and skinless chicken breasts. Iron content in goat meat is 70 percent higher than in beef and 200 percent higher than chicken. Cholesterol levels are similar to beef, pork, and lamb, however.

Milk. Goat's milk is a vitamin- and mineral-rich protein food (see Table 1), shown to be a suitable substitute

Goats metabolize and process the yellow- and orange-colored carotenes found in plants much more efficiently than do cows, which is the reason the milk is white, not cream-colored, and the fat is colorless (a drawback for butter).

*

Xanadu cheese, which blends a mixture of cow's and goat's cheeses, was popular in the American South during the nineteenth century. It was a staple food for the Union Army while in the South, and was so disliked it was banned from consumption after the South was defeated.

for cow's milk in feeding malnourished children. Yet, it is the differences in the fat, protein, and carbohydrate composition of goat's milk that account for its reputation as a healthy food. The fat contains a high proportion of small- and medium-chain fatty acids, which increases absorbability and contributes to the tangy flavor. It is lower in casein proteins than is cow's milk, resulting in much smaller curd (protein clump) formation in the stomach, another factor in digestibility. Goat's milk is naturally homogenized because it also lacks the protein agglutinin, so the fat stays dispersed in the milk and does not form cream at the top. Lactose, a sugar found in all milks, is slightly lower in goat's than in cow's milk, so individuals with lactose intolerance (the inability to digest lactose, resulting in intestinal discomfort) may tolerate goat's milk better.

Goat's milk is often touted as an alternative for individuals with allergies to cow's milk. Goat's milk may be better tolerated, yet it can cause adverse reactions in individuals who are extremely sensitive to caseins or other proteins, such as lactoglobulins. Conversely, individuals who tolerate cow's milk may show sensitivity to goat's milk. Some parents of infants and toddlers prefer goat's milk to cow's milk or formula due to its superior digestibility, but nutritional adequacy is dependent on fortification, particularly folate. Use of unpasteurized (raw) goat's milk or dairy foods has serious health risks, including brucellosis, listeriosis, staphylococcus infection, salmonella poisoning, and toxoplasmosis.

See also **Cheese**; **Dairy Products**; **Meat**.

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Pamela Goyan Kittler

TABLE 1

Selected nutrients in milk

(1 cup/244 grams)

	Calories	Protein (g)	Fat (g)	Carbohydrate (g)	Calcium (mg)	Potassium (mg)	Vitamin A (IU)	Vitamin D (IU)	Folate (mcg)	Vitamin B-12 (mcg)
Goat	168	8.9	10.1	10.8	326.9	487.7	451.4	29.3	2.4	0.2
Cow	149	8.0	8.1	11.4	290.4	370.9	307.4	97.6	12.2	0.9

GOITER. *See* **Iodine.**

GOODFELLOW, ELIZABETH. Elizabeth Goodfellow (1768–1851) was an American pastry cook, confectioner, and cooking school instructor. Her full married name was Elizabeth Baker Pierson Coane Goodfellow. Through her daughter Sarah Pierson, the wife of the French Quaker Michel Bouvier, Goodfellow was an ancestor of Jacqueline Bouvier Kennedy Onassis. Illustrious connections aside, Goodfellow's antecedents remain obscure, though she was probably born in Maryland, and the source of her extraordinary culinary training is unknown. Yet as an advocate of native ingredients and of an American style of cooking, she was one of the most creative forces in American cookery during the early nineteenth century. She was a teacher, friend, and mentor to Eliza Leslie, who expounded Goodfellow's culinary philosophies in all of her highly successful cookbooks.

By the time of her third marriage, to the Philadelphia clockmaker William Goodfellow in 1808, Elizabeth Goodfellow had established herself as one of the leading pastry cooks and confectioners in the city and had become well known throughout the country for her cooking school, which she operated in association with several boarding schools for young girls. In her cooking school Goodfellow prepared budding debutantes for marriage by teaching them recipes for rich sideboard dishes, like beef à la mode, and innumerable pastries and cakes for formal teas, including her own inventions Spanish buns, Indian meal pound cake, rose jumbles, and perhaps her most famous dish, lemon pudding, the prototype for the American lemon meringue pie.

Carte de visite with the photo portrait of Elizabeth Goodfellow. Copied from a daguerreotype about 1851 and probably given out as a memento to guests at her funeral. This rare portrait was discovered by genealogist Francis James Dallet and acquired by the Roughwood Collection in 1997. COURTESY ROUGHWOOD COLLECTION.

"Mrs. Goodfellow's Indian Meal Pound Cake"

The structure of this recipe is pure Goodfellow. Even though the ingredients are not listed in the order in which they are used, a certain logic emerges, since the weights of the dry ingredients depends on the eggs. The Indian meal referred to was a coarse, starchy flour made from Menomonee white flour corn that resembled *masa harina.*

Eight eggs
The weight of eight eggs in powdered sugar
The weight of six eggs in Indian meal, sifted
Half a pound of butter
One nutmeg, grated, or a teaspoonful of cinnamon

Stir the butter and sugar to a cream. Beat the eggs very light. Stir the meal and eggs, alternately, into the butter and sugar. Grate in the nutmeg. Stir well. Butter a tin pan, put in the mixture, and bake it in a moderate oven. (Leslie, 1828, p. 61)

The core of Goodfellow's lectures survives in Leslie's *Seventy-five Receipts for Pastry, Cakes, and Sweetmeats* (1828) and in numerous manuscript cookery books compiled by other Goodfellow students. Unlike her contemporary and business competitor Hannah Hungary Widdifield, Goodfellow never published a book. One of her former students from the South issued a cookbook in 1853 called *Cookery as It Should Be* and claimed that it embodied all the best of the Goodfellow school of cookery. It did not, as Leslie curtly pointed out in a contemporary review, since Goodfellow would have been "horrified" by the use of chemical leavens and other glaring culinary flaws.

Leslie's work preserves Goodfellow's maxims, such as the one relating to pound cakes: "Up-weight of flour, and down-weight of everything else" (p. 520). One of Goodfellow's most important contributions was to insist that, in recipe writing, all ingredients be listed first. On this point alone she was many years ahead of her times.

See also **Cookbooks; Education About Food; Leslie, Eliza; Recipe; United States.**

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William Woys Weaver

GOURDS. *See* Squash and Gourds.

GOUT. *See* Health and Disease.

GOVERNMENT AGENCIES.

National governments often play a major role in the production, distribution, trade, and safety of food. Nowhere is the government food system as elaborate and extensive as in the United States. Bureaucracy in every type of political system has been built up around food regulations and laws; inspection, quarantine, laboratory analysis and certification; epidemiology and surveillance of food-borne disease; and systems management. Which agency performs which function varies among governments.

In any country, there is a fundamental need to sustain as much production as possible in order to feed the population. Government-controlled price-support systems are often put in place to guarantee a certain amount of commodity production. These systems stabilize income for farmers, who supply essential crops, and they allow for competition in domestic and global marketplaces. A Ministry of Agriculture usually performs farm-aid services, in which plant and animal production are combined, or such tasks may be undertaken by a more comprehensive Ministry of Agriculture, Fisheries, and Forests, which also oversees fishing and wood production. The function of such agencies may include introducing new technologies to enhance production, as well as educating consumers about new products, such as those derived from agricultural biotechnology. Agricultural agencies may also dispense government-subsidized seed stocks, license plant hybrids, and manage national grain reserves to protect the country against famine. Agency experts or advisory committees made up of outside experts may compile government manuals of good agricultural practices. Regulatory officials in such agencies are responsible for defining regulations that assure food safety and high-quality products for trade. Such officials may also represent national trade interests and work to harmonize international regulations with officials from other countries in arenas like the World Trade Organization or Codex Alimentarius.

It is often said that hunger and food-supply problems in many countries in the developing world are not the result of a lack of food but of a lack of infrastructure for the equitable dissemination of food. Effective governmental management of distribution systems (roads, railroads, etc.) through a Ministry of Transportation can be of vital importance in feeding a population efficiently. A Ministry of Commerce may also assist both in domestic distribution, through oversight of the marketplace, and in international distribution, through a system of import and export regulations, tariffs, permits, and certification, which may also be the tasks of a Ministry of Trade.

A Ministry of Public Health may be involved in issues of food safety and nutrition. This agency is usually responsible for licensing or running analytical laboratories and may be involved in tracking food-borne disease outbreaks. International trade standards enforce low tolerances for agricultural chemicals and pesticides, filth, toxins, and contaminants. Thus, foods that enter into international trade may be of higher quality than those that are relegated to the domestic marketplace, thereby creating a double standard for food production. As a result, domestic consumers in developing nations may receive inferior-quality food, in addition to insufficient amounts of food. A Ministry of the Environment may be a governmental player in the food production arena as well, since pesticides and chemicals used in food production may exert a negative impact on the environment.

Traditionally, this multi-agency situation in governments has set one agency against another, vying for political support and the finances to run programs, especially when resources are extremely limited. A government that encourages interaction among various agencies is often more successful. Due to the heavy emphasis that has been placed on food safety in most nations, there has been a trend toward the establishment of single national food-safety agencies. The trendsetter in this regard was Canada, which is serviced by the Canadian Food Inspection Agency (CFIA). The CFIA combined into one agency the authorities of four traditional departments involved in food-safety regulation and quality control of food production and processing; export certification; and import permits and quarantine. The French Food Safety Agency (AFSSA) and the new Belize Animal Health Authority (BAHA) are two other examples of consolidated agencies.

The effective performance of all functions involving the food-supply chain is vital to sustaining leadership in government. Without an adequate or safe food supply or a viable economy resulting from ample agricultural production, a hungry public may challenge or overthrow that leadership. The appointed officials who lead these governmental agencies face intense political pressures. Thus the tenure of such an official may be quite brief, with Ministers of Agriculture staying in office an average of fourteen months in Latin America in 2000. First in Great Britain and then in several other European countries, the leadership and structure of agencies responsible for food safety were completely changed in the wake of "mad cow" disease scandals. Public confidence in the government's ability to protect public health plunged to new depths, and whole parties in power were overthrown. In a world where information flows quite freely, governmental agencies are expected to function transparently and keep the public well informed of issues involving the safety of their food supply.

A relatively new tool for regulatory decision making in regard to food production and processes is risk assessment. To appease a wary public and facilitate operations, some governments are adding new agencies to provide such scientific analysis and make recommendations for risk management and communication. The European Union (EU) is setting up an umbrella food-safety agency, the European Food Safety Authority (EFSA), which will provide risk assessment and scientific advice to the European Commission, its Parliament, and member states, as well as to the public. Japan is also setting up an independent scientific risk-assessment authority to reestablish public confidence in that government.

The extent of a government's food-agency infrastructure depends on the importance of agriculture to a national economy and, of course, the size of that economy. Thus, in the developing world, agencies that exist may be extremely important but may have limited capacity and resources. Food agencies in such countries may rely heavily on private sector partnerships where some functions, particularly those involving trade, may be performed by cooperatives of producers working in their own best interests. An example is the Association of Exporters of Chile (ASOEX), which devised a quality production system for Chilean fruits and financed legal costs associated with allegations of grape dumping in the United States.

WORLD HEALTH ORGANIZATION

The World Health Organization (WHO), an agency of the United Nations, addresses food safety and foodborne illness, among many other issues. It focuses largely on providing national governments with expert and technical advice on food regulation and the improvement of food safety programs. Along with the Food and Agriculture Organization (FAO), the WHO created the Codex Alimentarius Commission, which publishes guidelines for production, processing, and manufacturing of foods to facilitate international commerce. The WHO also develops and publishes information for food handlers and consumers in an effort to prevent foodborne illness. It collects data on foodborne illness to help guide national and international policies and interventions.

The WHO examines new technologies, such as food irradiation to kill pathogenic organisms, by investigating and publishing reports on the benefits and drawbacks of the technologies. In conjunction with overseeing Codex activities, the WHO seeks to reduce barriers to the world food trade caused by unnecessary or unscientific regulations.

The WHO provides advice to travelers on the consumption of food and water, including the dictums "Make sure your food has been thoroughly cooked and is still hot when served" and "Cook it, peel it, or leave it" for fruits and vegetables. In addition the organization provides information regarding what to do if the precautions fail and the traveler develops diarrhea. The WHO has published "Essential Safety Requirements for Street-Vended Food" to address a common but largely unregulated worldwide food distribution system. It also publishes "Guidelines for Drinking-Water Quality" and technical reports on food additives, drug and pesticide residues in food, and the development of dietary guidelines, among other topics.

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See also **Codex Alimentarius; Commodity Price Supports; FAO (Food and Agriculture Organization); Food Security; Food Supply and the Global Food Market; International Agencies; National Cuisines, Idea of; Political Economy.**

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GOVERNMENT AGENCIES, U.S. Several departments and agencies of the United States government have responsibility for various aspects of food production, marketing, regulation, safety, and consumer protection. Government agencies serve a multiplicity of purposes, but the net effect of U.S. government policy is to provide an abundance of food at relatively low cost.

The United States Department of Agriculture (USDA) has prime responsibility for encouraging agriculture and food production, which it does through a host of programs aimed at the farm community. It administers a program of price supports for major commodities, such as corn, wheat, rice and soybeans, which makes payments to farmers if the market prices fall below target levels. The program is viewed as a "safety net" for farmers and as a boon to consumers since it calls forth abundant supplies of basic commodities. It has the potential of costing the government billions of dollars per year, the actual amount depending on market prices. The existence of such enormous subsidies is often an issue with the United States's international trading partners, despite the fact that many of them also subsidize their farmers.

Prices of other goods, such as milk, are supported through federally enforced marketing orders that set minimum prices paid to farmers. Programs for specific crops of fruits, vegetables, and nuts are intended to stabilize supplies and market prices. Some crops, from almonds to avocados, and some animal products, such as beef, pork, and milk, have programs supported by producers and enforced by the government to raise money for advertising and marketing.

Food safety is a major concern of several agencies, including the USDA's Food Safety and Inspection Service (FSIS), the Food and Drug Administration (FDA), and the Environmental Protection Agency (EPA). FSIS provides mandatory, carcass-by-carcass inspection of slaughtered livestock and poultry to ensure that meat and poultry products are wholesome and not adulterated. At the turn of the twenty-first century, more than seven thousand FSIS inspectors work in meat and poultry plants across the country; some states have equivalent, federally recognized programs in which the inspectors are employed by the state. FSIS also monitors processing plants for cleanliness and the avoidance of known hazards (such as foreign matter in meat and poultry). The agency also oversees labeling; no statements or claims can be made on meat and poultry packaging that are not first approved by FSIS.

The Agricultural Marketing Service offers a voluntary but widely used grading program for meat and poultry, fruits and vegetables (both fresh and processed), milk and dairy products, and eggs. Only products with the top grade in each category are normally sold at retail. Producers pay for the grading inspections.

Food products other than meat and poultry are generally the responsibility of the FDA's Center for Food Safety and Applied Nutrition (CFSAN), which sets standards for products other than meat and poultry. Because, as of 2001, CFSAN employs fewer than eight hundred inspectors to monitor more than fifty thousand processing plants, it relies mainly on sampling and oversight of quality assurance systems to ensure product safety.

The federal agency with primary responsibility for seafood is the National Marine Fisheries Service (NMFS) of the National Oceanographic and Atmospheric Administration (NOAA) in the Department of Commerce. NMFS offers a voluntary seafood inspection program to the industry that allows products to carry the mark "Processed Under Federal Inspection" and/or a seal "U.S. Grade A." NMFS estimates that about 17 percent of the seafood consumed in the United States is certified under the auspices of the seafood inspection program.

FDA also regulates the labeling of food packages according to the name of the product, its ingredients, and nutritional value, among other information. It regulates the meaning of label terms such as "light" or "low-fat." Data developed or reviewed by the FDA and USDA provide the basis for the Nutrition Facts labels required on packaged food.

The Environmental Protection Agency sets tolerances for pesticide residues in or on food products or in animal feeds. These tolerance levels, which are set at very low levels, are enforced by CFSAN and FSIS through random sampling of food products and feed.

As a major player in the world food trade, the United States participates in Codex Alimentarius, the international body that fosters trade by creating widely recognized standards. The U.S. office of Codex is housed at the USDA's Food Safety and Inspection Service, and officials from FSIS, FDA, and EPA coordinate Codex activities for the U.S. government.

USDA's Food and Nutrition Service administers food assistance, programs intended to help the economically disadvantaged get more to eat and to understand better the importance of proper nutrition. The food stamp program is one of the nation's largest welfare programs, providing benefits to needy people to increase their food purchasing power. The Special Supplemental Nutrition Program for Women, Infants, and Children, known as WIC, provides nutritious food supplements and nutrition counseling to pregnant women and to the mothers of infants and children up to five years of age. Low-income schoolchildren are provided with free or low-cost breakfast and lunch, and the milk program provides milk to children in schools and child-care institutions that do not have federally supported meal programs.

USDA's Center for Nutrition Policy and Promotion works with the Department of Health and Human Services to promote the Dietary Guidelines for Americans and the Food Guide Pyramid, which provides general advice on how much people should eat from the various food groups to achieve nutritional balance.

The Federal Trade Commission has the power to take action against false and misleading advertising of food as well as other products through an administrative action or by seeking a court injunction. It can also investigate mislabeled products not covered by other federal laws, such as milk jugs not filled as stated on the label.

Foods contaminated with pathogenic microorganisms or toxins pose a significant risk of illness and death in the United States. The Centers for Disease Control and Prevention (CDC) of the Department of Health and Human Services (HHS) investigates major outbreaks of food-borne illness and collects data on outbreaks from local and state health departments.

Foods imported into the United States are legally required to meet the same standards as those produced in the United States. As with domestic products, imports other than meat and poultry are regulated by the Food and Drug Administration, which can conduct product sampling to ensure that the foods meet health, safety, and labeling standards. Meat and poultry is regulated by the FSIS, which inspects processing plants in other countries to determine if they meet U.S. requirements. FSIS also determines whether the foreign country's inspection system is equivalent to that of the United States. Countries meeting those requirements can export food products to the United States, subject to quotas, tariffs, and other restrictions, and subject to inspection by U.S. officials upon arrival in the country.

Agents of the Department of Agriculture and the U.S. Customs Service enforce regulations on food items carried by travelers to the United States. Travelers are prohibited from bringing in fresh, dried, and canned meats and meat products from most foreign countries. Some fruits, vegetables, and plants may be brought into the United States without advance permission, but they must be declared, inspected, and found free of pests.

The United States is a major donor to international relief efforts. The U.S. Agency for International Development (USAID) operates the Food for Peace (FFP) program under Public Law 480. The agency donates commodities such as wheat, corn, rice, and soybean meal to private voluntary organizations, cooperatives, and international organizations, such as the United Nations World Food Program.

The Special Trade Representative (USTR) negotiates food trade agreements (along with non-food agreements) with foreign countries and, in so doing, relies on the expertise and information of the USDA's Foreign Agriculture Service (FAS). FAS also provides information on trade opportunities to U.S. exporters.

The U.S. government regulates food at virtually every stage of production, processing, and marketing. Federal programs in place since the 1930s encourage the production of food and fiber. Consumer issues, food safety most prominent among them, have been an important topic of federal regulation since the passage of the Pure Food and Drug Act in 1906 and have become even more important in recent years with the rise of consumer consciousness.

See also **Codex Alimentarius; Commodity Price Supports; FAO (Food and Agriculture Organization); Food Safety; Food Stamps; Food Trade Associations; Government Agencies; Inspections; International Agencies; Labeling, Food; Toxins, Unnatural, and Food Safety; WIC (Women, Infants, and Children's) Program.**

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GRAIN RESERVES. Grain is the foundation of the world's diet. Since the beginning of agriculture, farmers have recognized the need to manage stocks of grain to prevent starvation in times of scarcity. In the Hebrew Bible, the Egyptians were directed to stockpile seven years of harvests in preparation for seven years of famine. In North America, early Indians overwintered grain reserves in woven baskets within pits dug into soil. Now, most grain is stored in metal bins or warehouses on or near the farms that produce the grain. Good sanitation is important, since significant grain losses may occur due to spoilage, rodents, and insects. The primary purpose of grain reserves is to help cope with food emergencies, but grain reserves are also used to stabilize grain prices and as a loan commodity.

Food Security

Food security in the fullest sense would mean that all people at all times have access to adequate quantities of safe and nutritious food. To ensure food security, many countries stockpile strategic grain reserves (SGRs). Grains are an easy-to-store and nutritious way to provide the basic needs of a population facing a food emergency until alternative food supplies can be arranged. Countries with abundant supplies of grain will frequently sell or loan their stores of grain to countries without an adequate supply. SGRs are costly to establish and maintain. The United Nations Food and Agriculture Organization (FAO) and the World Bank recommend a grain reserve sufficient to cover three or four months' consumption, plus a cash reserve to import food. In the United States an SGR of up to 4 million metric tons of wheat, corn, sorghum, and rice is reserved for international humanitarian purposes.

Some countries—for example, India—are able to reserve large quantities of grain but lack the distribution system necessary to supply all areas of the country. In contrast, sometimes too much grain is reserved. In 1999 and 2000, China accumulated large stocks of low-quality grain at a time when consumers were demanding higher-quality grain. In response, China discarded its low-quality, low-value grain reserves.

Food emergencies can result from natural causes, such as pest outbreaks sparked by drought, floods, storms, earthquakes, or crop failures, as well as from war and terrorism. Due to advances in agricultural science, between 1950 and 1980 grainland productivity (yields per unit acre) and world cultivated acreage increased significantly, resulting in an abundance of world food. However, since 1980 the rate of food production increase has slowed, while population growth has continued to rise. Many countries are facing both population increases and shortages of resources that are important to agriculture—such as oil, topsoil, water, and undeveloped farmland.

Stabilizing Grain Prices

In the United States, grain reserves have been used to protect farmers from wheat and feed grain production shortfalls and to provide a buffer against unusually sharp price movements. For example, under a farm commodity program administered by the USDA Consolidated Farm Service Agency (CFSA) in 2002, farmers place their grain in government-managed storage and receive an extended loan or advance deficiency payment against a target grain price.

Ceres

Since 1930, atop the Chicago Board of Trade building, a 6-ton cast aluminum statue of Ceres has held a bag of corn in her right hand and a sheaf of wheat in her left. Ceres was created by sculptor John Storrs and is a symbol of the close association between the Chicago Board of Trade and agriculture. According to Roman mythology, Ceres (Demeter in Greek mythology) is the goddess of food grains and patroness of corn trade. She is associated with the ground from which crops spring, the bread produced from grain, and the work necessary to raise crops. Ceres presided over the distribution of grain to the urban poor. The word "cereals" is derived from her name.

See also **Agronomy; Cereal Grains and Pseudo-Cereals; Commodity Price Supports; Wheat.**

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GRAINS. *See* **Barley; Cereal Grains and Pseudo-Cereals; Wheat.**

GRAPES AND GRAPE JUICE.

There is culinary potential in nearly every part of a grapevine: the skins (food coloring), the pulp and juice (jams, vinegars, wines, and brandies), the seeds (oil), the leaves (dolmas), and even the wood, which makes aromatic fuel for grilling and smoking.

In size, shape, color, flavor, texture, sweetness, acidity, astringency, and relative seed presence, the grape is almost infinitely variable. French ampelographer (vine expert) Pierre Galet counts more than 9,600 varieties among the nearly twenty million acres of grapes grown on all continents except Antarctica (Galet, 2000). And, although many older varieties have disappeared from commercial production, new varieties are constantly being created and tested by breeders.

Approximately 50 percent of all commercial vineyards are in Europe. Over half of all grapes are used for wine production. The rest are consumed fresh; canned; as raisins, jams, or juice; or distilled (Monette, 1988).

Grapes are unique in their ability to achieve Epicurean heights in an astonishing range of conditions: fresh, dry, unripe (sparkling wines like champagne), overripe (dessert wines like port), frozen (the vinous nectar *Eiswein*), evaporated and acidified (balsamic vinegar), slimed over with yeast (sherry), and even rotten with mold (another vinous nectar, sauternes).

No other fruit has reached so broadly or deeply into human culture as the grape. Art, history, psychology, medicine, politics, world trade, and religion are all infused with the imagery and substance of vineyards (John-

TABLE 1

Grapevine "family tree."

Genus and Species	Selected Varieties	Comments
(American) *Vitis* or *Muscadinia rotundifolia*	Scuppernong, Magnolia	The fruit and flavor of muscadines is virtually unknown outside the southeastern United States. Relatively low sugar, low acid, very thick skin, few large berries per bunch that ripens very unevenly. Fruity dessert wines are traditional, although some newly developed varieties have more neutral flavors and can be made into table wine.
(American) *Vitis aestivalis*	Norton, Lenoir	This is the American species most suited to dry table wine. The fruit is late-ripening but has high sugar, high acid, low pH, thick skin, unstable color, vinous flavor, and is always seeded. There are relatively few small berries per bunch
(American) *Vitis labrusca*	Catawba, Concord, Isabella, Niagara, Steuben. Note: these varieties may not be pure species	This species has relatively low sugar, low acid, low pH, soft pulp with thick skin, few moderate-size berries per bunch. Best suited for consumption fresh or as juice and jelly. Not suited for dry table wine, but can make pleasant sparkling, aperitif, and sweet fruity wines. Fruit flavors described as foxy or like passion fruit.
(American) *Vitis berlandieri, riparia,* and *rupestris*	Riparia Gloire, Rupestris du Lot, SO4, 5 BB, 3309C, 110 R	These species are used mostly as phylloxera-resistant rootstocks to replace the tender roots of *V. vinifera,* but they are also in the parentage of European-American hybrids. *Riparia* berries are small, mostly black, contain high acid, and being early ripening can achieve fairly high sugar and herbaceous flavor.
(Eurasian) *Vitis vinifera*	Chasselas, Flame Seedless, Muscat blanc, Sangiovese, Sauvignon blanc, Syrah, Riesling	High sugar content, sometimes seedless, colors of many hues. Bunch and berry size is highly variable, but mostly better-filled bunches than American types. Table grapes that ship well, all types of wine grapes from mundane to sublime, and the best raisins.

son, 1989). Before the advent of modern medicine in the nineteenth century, unhealthy water was often rendered harmless and limbs saved from amputation by the antiseptic properties of wine. All forms and transformations of the grape enliven basic foods and are not only healthy but therapeutic.

Grapes and Their Origins

Wild vines are common around the globe. In the family Vitaceae, there are more than a thousand species divided among sixteen living and two fossil genera, including *Ampelopsis*, *Parthenocissus* (both used for ornamental purposes), and *Vitis*, the "grapevine" genus. The French botanist J. P. de Tournefort first defined the genus *Vitis* in 1700, and it was one of the first plant genera studied by the great botanist Linnaeus (Galet, 1979). The word *vitis* means 'vine' or 'centurion's staff' in Latin. It derives from the verb *viere*, meaning 'to braid or weave together', and is descriptive of climbing vines entwined with tree branches.

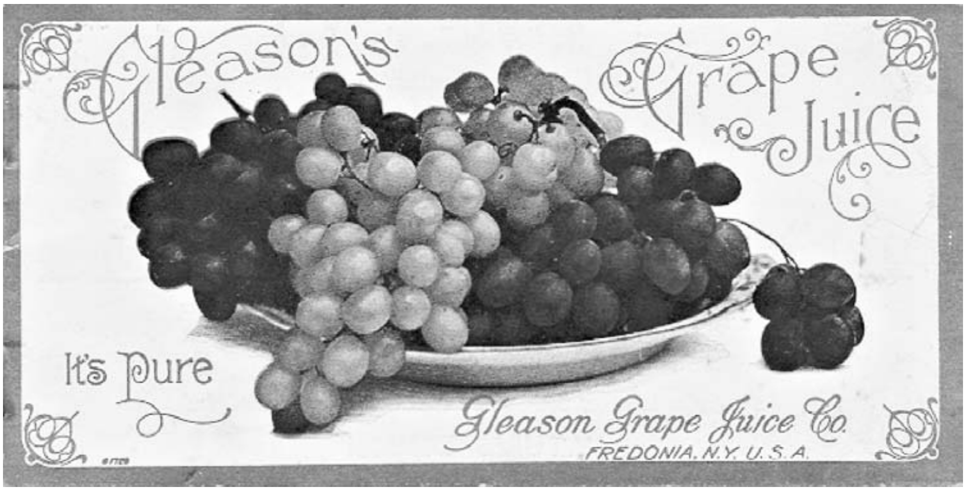
There are approximately sixty-five named *Vitis* species native to the temperate zones of Asia, Central America, and North America. A majority of the approximately two dozen North American species are found east of the Rocky Mountains. Unlike *Vitis vinifera*, which has a long (more than seven-thousand-year) history of cultivation, native American species remained largely in a wild state until European colonists began to select among them for their fruit quality and disease resistance.

Grape seeds carry the embryo of genetic material from two parents, thus every seedling is genetically unique. Purposeful and natural crosses have led to improved varieties over time (Morton, 1985). As food, grape seeds are high in fatty acids yet low in their effect on blood cholesterol levels. With a high smoking point, grapeseed oil is the secret to truly French "French fries."

As the source of food and drink, the grape is generally divided into two camps—the Eurasian (*Vitis vinifera*) and the North American (see Table 1).

Sine Qua Non: American Roots for European Grapes

It was only after the phylloxera (plant louse) crisis in 1860s Europe that the roots of American vines became far more precious than their fruit, and hybridization became as important to the creation of new rootstocks as it had been to the creation of interesting new grape varieties. Technically speaking, a hybrid is the offspring of two individuals that differ by at least one gene and can be the progeny of crosses between varieties of the same or different species—and rarely of different genera, as is the case with *Vitis* × *Muscadinia* crosses. Hybrids between American and European types—for example, Foch,


Gleason's Grape Juice
It's Pure
Gleason Grape Juice Co.
FREDONIA, N.Y. U.S.A.

The Temperance Movement raised the popularity of table grapes and especially of grape juice. It was even used by some churches for Communion wine. This circa 1904 brochure promotes grape juice from the Finger Lakes Region of New York, where viticulture was already well established. ROUGHWOOD COLLECTION.

Chambourcin, Seyval, and Vidal Blanc—can be good choices for vineyards where cold temperatures or fungal disease pressures make growing vinifera varieties difficult or uneconomical.

Grape Juice

Raw grape juice, with help from passing yeasts, naturally ferments into wine first, then turns into vinegar. In fact, only timely and deliberate action prevents this from occurring. Pasteurization is the most common method for keeping grape juice from infusing itself with alcohol or acetic acid. American varieties make strongly flavored and deeply colored single-strength juice. By comparison, vinifera grapes would be quite insipid and cloying because of their high sugar content. This can be corrected by acidifying the grape juice with lemon juice, ascorbic acid, or tartaric acid. Most grape juices benefit from dilution with water or seltzer. Adding ginger ale to Concord grape juice creates the approved designated-driver libation "purple passion." One would think that muscat varieties would make charming grape juice, but their special aromas and flavor do not survive the pasteurization process. (Cirami, 1996).

Grape juice is adept at transmutation. The juice of very unripe grapes, known as verjuice or green juice, is an acidic substitute for citrus called for occasionally for sauces or deglazing. Slightly unripe grape juice can be used for sparkling wine.

Highly acid but ripe grapes are the main ingredients for a potable grape foam produced in the French appellation of Crépy, just over the border with Switzerland. Fresh Chasselas must is put into a small stainless steel keg along with a few family-secret ingredients. By New Year's, when the tap is opened, white foam will blast out into waiting flutes. Consumption begins immediately, as it is considered bad luck to allow the foam to settle into a liquid of young wine.

Food writer Harry Nickles (1969) describes another use for grape juice—a sweetmeat made in a village near Sparta from fresh unfermented grape syrup (*epsima*) and flour. The process involves boiling the juice to reduce the volume and increase the sweetness, then adding the ashes of burned vine canes to clarify the juice as it settles. After decanting the sediment and straining, the liquid is further reduced by boiling. Finally, flour is added and the mixture is poured into a shallow pan where it cools into a chewy confection known as *grouta.*

In France fresh juice is boiled down into a syrup and simmered with other fruits to create a jam without sugar called *raisiné.*

Dried Grapes

Dried grapes are known as sultanas or raisins (both seedless and seeded), and even as currants. They are found in recipes for many types of food—from meat stuffing to vegetarian couscous, from teetotaler baked goods to sauces and fruitcakes soaked in rum, port, or brandy.

Whereas it is generally fermented or distilled in Europe, grape sugar is particularly important in the cuisine of the Middle East. Sun-dried raisins are one form of portable grapes. Drying causes grapes to lose their water, but they retain their minerals, vitamins, fiber and about 324 calories per 100 grams. Another method of concentrating grapes for transporting is to repeatedly dip a string into grape juice and allow it to dry. Eventually many layers of dried grape juice will create sort of grape sugar candle.

Black Corinth or Zante (from the Ionian island of Zákinthos) currant grapes are a classic product of Greece. Without treatment with growth regulators such as gibberellin, the vines produce tiny, mostly seedless grapes, which make soft, tart little raisins that lend themselves to baked goods and stuffings.

Currants often join pine nuts and rice in a cocoon of grape leaves or dolmas. These leaves can be harvested any time in the growing season and briefly blanched before using. Or they can be found preserved in a saline and acid solution in glass jars at specialty shops. Generally speaking, the leaves of vinifera table grapes are ideal for this purpose, whereas the leathery and hairy-backed leaves of native American vines are not.

Vines Beyond the Grape

Grapevines can provide welcome shade to patios. To avoid bees at the barbecue, however, one should consider planting male-rootstock varieties—such as Riparia Gloire or SO4—with large leaves (also good for dolmas) and no fruit. After the leaves have fallen, the canes from these patio vines can be woven into durable and functional wreaths and baskets for the kitchen. Chopped sections of grape canes can be stored in small paper bags for later addition to the smoker along with hickory or fruitwoods. The smoke has a strong flavor, so a little goes a long way.

See also **Beer; Fermented Beverages other than Wine or Beer; Fruit: Temperate Fruit; Wine.**

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Lucie Morton

GRAVY. The term "gravy" first appears in Middle English as *gravé* and is presumed to derive from French, since the word may be found in numerous medieval French cookbooks. The original medieval meaning was precise: the *gravé* consisted of the natural cooking juices that flowed from roasting meat. By implication, this meat was spit-roasted, and therefore two important implements were required to make and collect the gravy: a flesh fork for piercing the meat in order to increase the flow of drippings, and a dripping pan beneath the roast, designed to collect the gravy for use at table. Normally the gravy was skimmed of fat, salted, and then sent up as a sauce, although presalting was not necessary, since this could be accomplished to taste at table. The term in this sense has been replaced today by *jus*, as in beefsteak *au jus*.

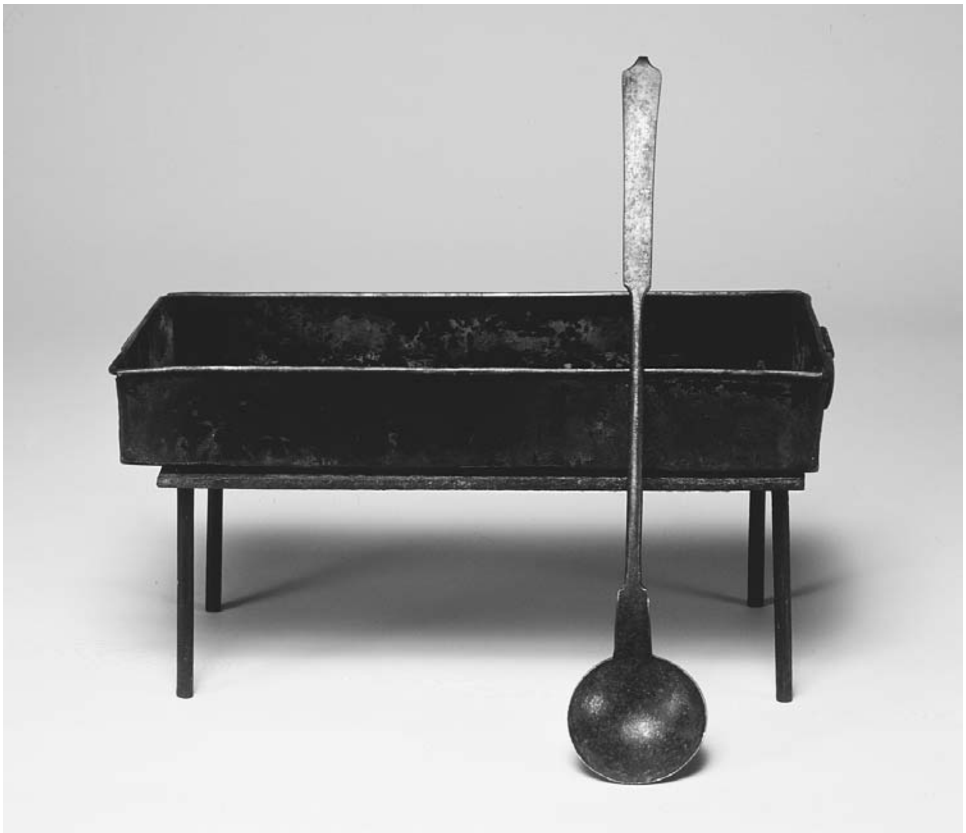
The medieval roasted meat with *gravé* was generally served rare and not likely to have a counterpart in contemporary Byzantine cookery, since the Eastern Church forbade the consumption of blood or bloody food. Among Byzantine Christians, the gravy of pork, mutton, goat, and the mouflon of Cyprus (a species of wild goat prepared like venison) was often reduced over high heat and mixed with *garum* (fish sauce) or wine, as reported by several medieval travelers. The preparation was then served as a dipping sauce, since the meat was cut up into small pieces and eaten with a fork. The idea of treating gravy as a sauce base is extremely old and may in fact trace back to antiquity. The debate among purists as to whether gravy with additional ingredients constitutes a sauce has not been settled, and probably never will be.

With the revival of sauce cookery in seventeenth-century France, gravy underwent numerous sophistications with the addition of herbs, wine, and other highly flavored ingredients. The English custom of boiling mint or calendula blossoms with clear mutton gravy dates from this same period and was brought to colonial America. The most common addition to gravy, however, was drawn butter, which remained popular into the nineteenth century.

In his *Cooks and Confectioners Dictionary* (London, 1726), John Nott used the term "gravy" in several senses, including the meat stock or bouillon known as a "restaurant," or restorative. His recipe for Gravy Broth (served as a soup course) is typical of the period in its blurring of the distinctions between gravy, soup, and sauce:

> Take a fleshy Piece of Beef, not fat, spit it and roast it; and, when it begins to roast, slash it with a Knife to make the Gravy run out, and keep it continually basting with what comes from it, mix'd with Claret; cut it often, and baste it 'till all the Gravy be come out, put this Gravy into a Sauce-pan over a few Coals; put some Salt, whole Spice, and Lemon-peel, and let it simmer: Put some Sippets in a Dish, pour in your Gravy, garnish your Dish with Oranges and Lemons, and serve it up.

Sippets were small triangular pieces of toasted bread, and the orange and lemon slices were placed around the



Dripping pan (Russian iron), stand (wrought iron), and basting spoon (wrought iron), some of the traditional implements for making gravy. All of the utensils are American and date from the 1790s. The pan was placed under a joint of meat turning on a spit so that the drippings could be collected and used as gravy. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

rim of the dish. The whole spices and lemon peel were strained out before the gravy broth was poured over the bread. The use of spices, vegetables, and other ingredients to heighten the flavor of gravy became common in English household cookery by the Victorian period. For example, in Eliza Acton's *Modern Cookery* (Philadelphia, 1848) adapted for the American market, there are fifteen recipes for gravy, most of them somewhat complex and more typical of what might be found in an urban rather than rural household.

In rural cookery of this period, it became common practice both in England and America to add flour or roux (cooked flour and fat) to gravy in order to thicken it. This was especially common for dishes served at breakfast or supper. Some period writers considered this an adulteration, while others treated it as an economical and practical way to extend the pan drippings. The Gravy for Chops, which appeared in *Cookery as It Should Be* (Philadelphia, 1855) is typical and resembles the type of gravy most Americans associate with the Victorian era:

> Take out your chops when cooked; keep a large spoonful of fat in which they were cooked, in the pan; dredge in as much flour as will make it a paste; rub this well together over the fire, until a light brown; then pour in as much boiling water as will reduce it to the thickness of cream, and add a tablespoonful of mushroom catsup and a little salt; let this simmer five minutes, and pour it through a sieve over the steak.

This type of quickly made gravy became popular in the United States as a fast food, especially after the Civil War, once iron cookstoves became a standard kitchen fixture. Milk was also commonly added to create a genre of white gravies as opposed to the common brown ones of the past. Chicken gravy over waffles, hashed beef gravy over fried potatoes, red bean gravy on ham, fried tomato gravy—the list of preparations is long with many, many regional variations. Easy to make, they became popular adjuncts to camp cookery and dishes prepared by men in hunting lodges, boat outings, and other outdoor activities.

The demand for convenience soon led to the development of commercial products imitating the homemade preparations. Thus we find prethickened gravies sold in cans, jars, and even in powder form to be reconstituted with boiling water. In America, the term has came to sig-

Tomato Sop

Slice firm, ripe tomatoes; roll in flour and fry in equal parts of lard and butter until brown on both sides. Remove several slices to a platter, stir those remaining with flour and small lumps of butter: then thicken with milk and season to taste. Sop with bread or toast.

FROM: C. Mac Sheridan, *The Stag Cook Book: Written for Men by Men* (New York: George H. Doran Co., 1922), 95.

nify any kind of homemade sauce, from the giblet gravy served with turkey at Thanksgiving, to tomato sauce made by Italian Americans for pasta. In this sense, the word "gravy" has been employed in advertising to imply that the commercial product tastes homemade. But one feature has never changed. Real homemade gravies always contain the essential juices of the thing being cooked, whether pan drippings from a pork chop or the juice that runs out of a tomato.

See also **Restaurants**; **Sauces**; **Soup**.

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William Woys Weaver

GREECE, ANCIENT. The appreciation of food in ancient Greece—by those who had the time and money—marks the beginning of what is known today as gastronomy. Greek literary texts (especially comic plays) of around 350 B.C.E. present detailed discussions of which foods were consumed, how much they cost, and how they would be prepared. From the same period one can trace the beginnings of the idea that each city would have its own local food specialities and its own distinctive wine. Adherents of the medical tradition begun by Hippocrates were developing dietary theories and compiling handbooks that dealt with the contribution made by individual foodstuffs to human health.

An interest in food and wine is evident in the oldest Greek literature. Alcman, lyric poet of Sparta, in a surviving verse fragment, lists five fine wines of the southern Peloponnese; in another, hot bean soup is jokingly demanded as payment for poetry. Hesiod's *Works and Days*, a poem of farming and practical lore, tells of the hot June days when "goats are fattest and wine best and women lustiest and men weakest. . . . Then we need rocky shade and Bibline wine and creamy barley mash and the last milk of the goats, and the meat of a foraging cow that has not calved . . . and from an ever-flowing unpolluted spring to pour three of water and to make the fourth be wine" (*Works and Days*, lines 587–596). Many of the focal events in the two great Homeric epics, the *Iliad* and the *Odyssey*, take place around shared meals of roast meat and red wine. Odysseus's description of the palace of Phaeacia is a reminder that fruit was prized and seasonal varieties had been developed: "Outside the yard is a big orchard on both sides of the gates . . . where tall trees spread their leaves, pears and pomegranates and shiny-fruited apples and sweet figs and leafy olives; their fruit never fails or falls short, winter or summer, all the year, but the West Wind, blowing, fertilises some and ripens others" (*Odyssey*, Book 7, lines 112–119). These texts were written before 600 B.C.E., and they set the scene for later gastronomy. Most notably, they also highlight olives (for olive oil) and wine. Archaeology shows that these two products already had been important in Greece for well over a thousand years: they remained essential components of the Greek diet throughout ancient times and are still so today. From prehistoric sites, including the Minoan palace at Knossos in Crete, there are vats and plentiful storage jars for oil and wine. From Classical times there are many fine paintings on cups and wine jars showing the olive and grape harvests, the marketing of oil, and the joys of wine. The god Dionysus, with his train of drunken male satyrs and ecstatic female maenads, features in many such paintings, as if to remind the viewer that wine and its pleasures are a divine gift.

In Greek terms any proper meal had three components, *sitos* (the staple: wheat bread or barley mash or one of the pulses), *opson* (the relish: fish, meat, vegetable, cheese, or just olive oil) and *oinos* (wine, the universal drink). The trouble with ancient Greek gourmets was that they were largely *opsophagoi*, "relish-eaters": they put too much emphasis on fine fish and other relishes, and not enough on simple, wholesome bread. Even worse were the frequent meat-eaters, like the greedy god Heracles and the north Aegean peoples (Macedonians, Thracians, and Greeks of Thessaly), or excessive wine-drinkers—a "barbaric" habit reputed by many Greeks to have killed Alexander of Macedon in 323 B.C.E.

Barley grew well in Greece, but it did not make good bread; nor did emmer, the wheat species that grew best locally. Broths, porridges, and mashes were made with these. Athens and some other cities imported bread wheat from Sicily, North Africa, and the northern Black Sea

A *pithos* in the palace of Minos at Knossos, Crete. These pottery jars, often five feet tall, were designed to store grain, oil, and wine. Ropes were run through the lug handles on the sides so that a team of workers could move it to another location in the royal cellars. © Roger Wood/CORBIS.

coasts, and the Athenian market became famous for its fine industrially baked bread.

In Athens and many other Greek cities, fish was available at the market—expensive, as fine fish still is in Greece, but very fresh. Europe's first gourmet writer, Archestratus (c.350 B.C.E.), wrote extensively on the types of fish that should be sought in specific cities, during which season, at what price, and the manner in which it should be cooked. "The bonito, in autumn when the Pleiades set, you can prepare in any way you please. . . . But here is the very best way for you to deal with this fish. You need fig leaves and oregano (not very much), no cheese, no nonsense. Just wrap it up nicely in fig leaves fastened with string, then hide it under hot ashes and keep a watch on the time: don't overcook it. Get it from Byzantium, if you want it to be good. . . ." Some later readers knew Archestratus's poem under the title *Gastronomia* (Rules for the stomach), the origin of our modern word "gastronomy." A stone inscription dating to the third century found in the small city of Acraephia, not far north of Athens, sets out an official market price for over twenty kinds of fish, a sign of the close interest that governments took in this trade.

Meat was a different matter—expensive, like fish, but in short supply. Livestock was not, and will never be, abundant in much of Greece, owing to the mountainous topography and the consequent shortage of good pasture land. In addition, animals could not simply be killed but needed to be sacrificed to a god. Meat was thus a relatively small part of the diet, a rarity enjoyed at city festivals (free to citizens), celebrations, family events (when participants spent as much as they could afford), and other special occasions. The sacrificial butcher-priest, the *mageiros*, who was always male, served also as cook on these occasions; the art of cookery was named for this profession, *mageirike techne* (sacrificer's art).

Imported flavorings included *garos* (fish sauce), from the Black Sea coasts; *rous* (sumach, from Syria); and *silphion*, a now-extinct spice from North Africa, similar to asafetida. Coriander, cumin, and many other native aromatics were in use. Mastic, native to the island of Chios, was used to aromatize bread and spiced wine, and also as a natural chewing gum to freshen the breath. A rich source of information on classical Greek food is *The Deipnosophists* (Professors at dinner), written by the scholar Athenaeus around 200 C.E.

In the Classical period, the fifth and fourth centuries B.C.E., Greeks ate two meals a day: a lighter *ariston* (breakfast) late in the morning and a fuller *deipnon* (dinner) in the evening. Breakfast called for bread and olive oil, perhaps with fresh or dried fruit, and red wine. Dinner was a more serious matter, and might well be followed by a *symposion* (symposium, drinking party). Typically dinner consisted of two courses. The first was a selection of tasty small dishes, some of them resembling modern Greek *mezedes* (appetizers): shellfish, such as oysters, mussels, and clams, other seafood, salads and cooked vegetables, and fresh fruit. The main course might have included fine fresh fish dishes, delicacies such as sliced salted tuna, and perhaps meat. No wine was taken with dinner. A libation of neat (or undiluted) wine (offered to the gods and tasted by humans) marked the beginning of the symposium, with dried fruits and nuts, cakes perhaps flavored with sesame and saffron and drenched in honey, and plenty more wine, always diluted with water: how much water was a matter for endless discussion.

At both dinner and symposium the proper custom was to recline, a fashion that Greeks had learned from the Near East. At all meals at which guests might be present, men and women ate separately. At sacrifices and open-air meals they formed separate circles (but some religious ceremonies were for women only or for men only). At home only male diners used the *andron* (dining room), which literally means "men's room."

Conversation languished while the business of eating went forward. The symposium was the occasion for talk, both serious and lighthearted; it was also a time for composing and reciting poetry, and for music and dance performed by the participants or by hired artists (usually slaves), including the ubiquitous *auletrides* (flute-girls). These performers, along with other entertainers and *hetairai* (courtesans), breached the rule of separation of the sexes. Symposia might continue all night, drunkenness supervening slowly but surely, since one could not prop-

Greek *calyx krater* from the sixth century B.C.E. These vessels served as mixing bowls for wine and water and held about six to seven gallons. They were the focal point of the ancient Greek symposia, or drinking parties. COLLECTION OF THE METROPOLITAN MUSEUM OF ART. © BETTMANN/CORBIS.

erly refuse to drink; inhibitions disappeared. While some symposia turned into orgies, others formed the backdrop for some of the greatest intellectual achievements of Greece. A symposium just like those described here is the setting for the philosophical discussion of love that is recorded in Plato's *Symposium*.

Were symposia only enjoyed by an elite? This question is controversial, and the meager evidence can be read in more than one way. Certainly there were great differences in access to food between the rich, who could spend time on eating and entertainment and could have as much meat and fine fish as they wanted, and the very poor, who subsisted largely on pulses (chickpeas, fava beans, and others less nourishing), green vegetables, and roots and fruits (and maybe snails) gathered from the wild. In famine years, many citizens were reduced to such a diet.

See also **Ancient Kitchen, The; Gastronomy**; **Mediterranean Diet**; **Rome and the Roman Empire**; **Table Talk**; **Wheat: Wheat as a Food**; **Wine in the Ancient World**.

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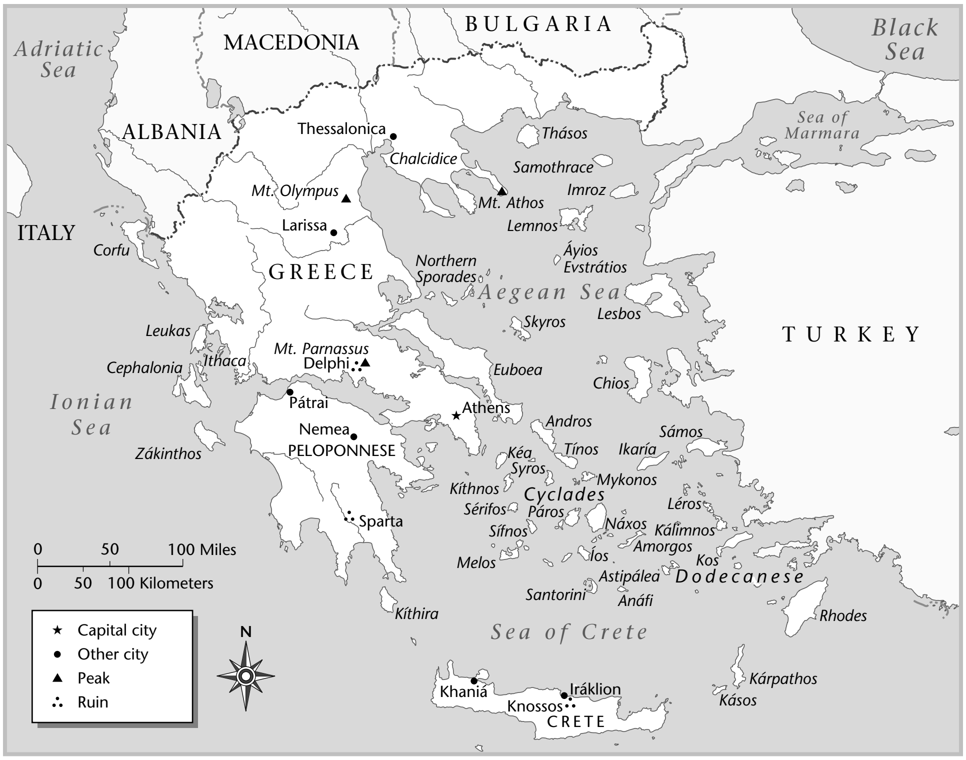
Andrew Dalby

GREECE AND CRETE. Greeks, until recently, have been mainly vegetarian not by choice but by necessity. In the mountainous Greek countryside it was not possible to pasture large herds and provide meat for everybody. In ancient times and even recently, meat was


Adriatic Sea
MACEDONIA
BULGARIA
Black Sea
Sea of Marmara
ALBANIA
Thessalonica
Thásos
Chalcidice
Samothrace
Mt. Olympus
Mt. Athos
Imroz
Lemnos
Larissa
ITALY
Corfu
Áyios Evstrátios
Northern Sporades
GREECE
Aegean Sea
Lesbos
Skyros
Leukas
TURKEY
Mt. Parnassus
Delphi
Cephalonia
Ithaca
Euboea
Chios
Ionian Sea
Pátrai
Athens
Andros
Sámos
Nemea
PELOPONNESE
Zákinthos
Kéa
Tínos
Ikaría
Syros
Mykonos
Kíthnos
Cyclades
Léros
Sérifos
Páros
Sparta
Náxos
Kálimnos
Sífnos
Amorgos
Kos
Melos
Íos
Astipálea
Dodecanese
Santorini
Anáfi
Rhodes
Kíthira
Sea of Crete
0 50 100 Miles
0 50 100 Kilometers
★ Capital city
● Other city
▲ Peak
∴ Ruin
N
Khaniá
Iráklion
Knossos
CRETE
Kárpathos
Kásos

a rare, festive dish, consumed on Sundays, at Easter and Christmas, and for important family feasts. The traditional Greek diet and the similar diet of the people of Crete—Greece's largest island—are mainly based on regional and seasonal agricultural produce: vegetables, leafy greens (*horta*), various kinds of dandelion and chicory, mustard greens, both sweet and bitter, and amaranth shoots in the summer. The greens are either foraged from the hills and fields or cultivated. Grains, mainly in the form of homemade bread, were the basic staple, complemented with fruity olive oil, olives, beans and other legumes, local cheeses, yogurt, occasionally fresh or cured fish, and sometimes meat.

Typical dishes are vegetable stews—green beans, zucchini, artichokes, or leafy greens cooked in olive oil with onions or garlic and fresh or canned tomato or lemon juice during the winter. Tomatoes, zucchini, and eggplants are also stuffed with rice, sometimes with the addition of ground meat. Beans, chickpeas, and lentils are made into soups, while all seasonal vegetables and greens are also used to make the stuffing for pies wrapped in homemade or commercial phyllo pastry. *Hortopita* (greens pie), also called *spanakopita* (spinach pie), is probably the most common example. Lots of flat leaf parsley and the intensely fragrant dried wild oregano are the most common herbs used in Greek cooking. Celery, dill, and wild fennel are also used fresh, while mint is added to some dishes, fresh but also dried. Bay leaves flavor meat stews, and cinnamon is used in most tomato sauces and meat stews, sometimes together with cloves. *Stifado* (rabbit, hare, or veal stew with pearl onions in red wine sauce) is scented with bay leaves, cinnamon, and cloves.

Only after the mid-1960s, as the country became more affluent, did meat gradually begin to play a significant role in people's everyday diet. Around that time, the Greek demographic structure changed. At least four out of ten middle-aged Greeks who, in the early twenty-first century, lived in the big cities—Athens and Thessaloniki—came originally from agricultural areas. They moved with their families to the cities during the last forty years of the twentieth century, bringing with them the cooking and culinary habits practiced in the villages by their mothers and grandmothers.

Most people have kept their ancestors' village homes and visit them on long weekends, summer holidays, and at Christmas and Easter. Many have also kept much of their land, so it is common for Greek families to produce the olive oil they consume—about forty pounds per person each year. And when they don't produce it themselves, they buy it from friends who have a surplus. This reflects Greek society's largely agricultural past. Olive oil is not just the primary fat used in Greek cooking, but is also basic to Greek people's identity. It is tied to every ritual, both folk and religious, that marks the crucial events in the cycle of life. Priests anoint infants with olive oil when they are christened, and the bodies of the deceased are embalmed with olive oil and wine prior to burial.

The roasting of lambs at Easter is a community-wide festivity. The women of a village near Corinth are shown here preparing the huge outdoor barbecue in 1994. © DAVID G. HOUSER/CORBIS.

Bread was the basic staple food up until the mid-1960s, as it used to be in ancient and Byzantine times. Although now they can afford a great variety of foods, Greeks still consume enormous quantities of bread. Traditional breads are often made with a combination of wheat, barley, and sometimes corn flour, using sour old-dough starter as leavening. Barley, easily growing in the dry and difficult climate of southern Greece and on the islands, was for many centuries the staple food of the ancients. It was ground and eaten as porridge or made into flat breads. Today in Crete and on the other islands, *paximadia* (rusks)—slices of twice baked and completely dry barley bread, which need to be briefly soaked in water to soften them—are still very popular. *Paximadia* keep well for many months and were the ideal food for sailors. They were only baked every two or three months, so they made good use of the oven heat, as wood was always in short supply in most arid Greek islands.

Lunch, eaten around 2 P.M., and dinner, eaten after 8:30 P.M. and often at 10:00 at night or even later, are the two principal meals of the day. Breakfast is usually just a cup of coffee, occasionally accompanied by a cookie or biscuit. Meals include a salad of fresh raw or blanched seasonal vegetables or greens, and end with seasonal fruits. Wine accompanies most meals. Greece has many old indigenous varieties of grapes that produce wonderful wines that have now started to be exported and appreciated by connoisseurs. Some of the best-known Greek grape varieties are *Xinomavro*, which produces the deep red wine of Macedonia; *Aigiorgitiko*, which produces the red from Nemea in the Peloponnese; *Asyrtiko*, which produces a fruity white from the island of Santorini; and *Moschofilero*, which produces the fragrant fruity white from Mantineia in the central Peloponnese.

Sweets were originally part of the festive table, which almost always involves meat, usually lamb on most occasions. Now, of course, sweets tend to be eaten at all times of the day.

With its many islands, Greece probably has more boats per capita than cars. Nevertheless, fish and seafood have never been plentiful enough to become a staple for the people who live near the sea. The fish and seafood of the Aegean are exceptionally delicious but scarce, and the best fish that islanders manage to catch is sold to the big cities for much-needed cash. Red mullet, sea bream, grouper, mackerel, bonito, swordfish, smooth hound, sardines and anchovies, spiny lobster, octopus, calamari, cattlefish, and cockles are the most common of the many kinds of fish one can find in the market, especially in the winter.

The Venetians and Genoans, who ruled most of the country during the Middle Ages, and later the Ottoman Turks, who made Greece part of their empire and remained the rulers of northern Greece and Crete until the early 1900s, have all left their marks on Greek cooking. (The use of yogurt in cooking and baking, more prominent in Crete, is the result of the Ottoman influence.) But the rules of the Greek Orthodox Church are by far the most important element in shaping people's eating habits. Even nonreligious Greeks often abstain from

Woman baking rusks at Karpathos, Dodecanese, Greece. These rings of hard-baked rye dough are kept for use the year around for dunking in coffee or wine. © FRANZ-MARC-FREI/CORBIS.

foods deriving from animals—meat, dairy products, and eggs—during the fast days that precede Easter, Christmas, and other religious occasions. It is notable that even the McDonald's restaurants in Greece serve special menus during those days. This is the reason that many traditional dishes, such as stuffed vegetables and phyllo-wrapped pies, come in two versions: one with meat (sometimes called the "festive") or with cheese, and one without, for the fast days.

The numerous religious holidays are scattered throughout the year. These holidays have often evolved from ancient celebrations. Easter, Greece's most important feast, seems to have its roots in the pagan agricultural spring festivals of antiquity. Celebrated in the open country, amid fragrant herbs and multicolored flowers, the Easter table features tiny, succulent locally raised and fed spit-roasted lamb or kid and salads of wild greens, tender raw artichokes, and fresh fava beans. The traditional Easter sweets are made with *myzithra*, a generic name for the various regional creamy fresh sheep's milk cheeses of the season.

Many dishes are still closely related to religious holidays, although pizza and hamburgers, as well as *gyro* and the ubiquitous "Greek Salad" tend to banalize modern Greek food. *Magiritsa*, a delicious soup made from chopped lamb's innards, scallions, and dill, with a tart egg-and-lemon sauce, is only eaten after the midnight Resurrection Mass on Good Saturday. Pork is associated with the Christmas and New Year tables. Christmas has become a major holiday only during the past forty years. Pigs are raised by most families, especially on the islands, and are slaughtered in December to make sausages and other smoked or salted meats that are used as flavorings in vegetable or legume dishes throughout the year. At the festive table, one finds head cheese and stewed pork with winter vegetables such as celeriac and greens, often cooked with *avgolemono* (egg and lemon sauce). Ground pork is the stuffing for *lahanodolmades* (cabbage leaves), the Christmas dish in Macedonia. Fish, a symbol of Christianity, is consumed on Annunciation Day (25 March), and always at the solemn meals that follow funerals.

Greek food follows the seasons. In the homes cooks do not make stuffed tomatoes or *melitzanosalata* (eggplant dip, made by mixing chopped grilled eggplant with garlic, olive oil, lemon, and parsley) in the winter, although these vegetables are now available all year round. The frugal Greek cooks ingeniously combine seasonal ingredients to create dishes that modern dieticians now use as

Greece is known as the land of olives, as the great variety found in any market will easily attest. Thirteen different types of olives are available at this stand in the Central Market in Thessaloniki in northern Greece. © JOHN HESELTINE/CORBIS.

models for the famed healthy Mediterranean Diet. This highly recommended diet was the result of a study by an American, Dr. Ancel Keys, and his associates, who compared the daily food intake and the overall health condition of the inhabitants of seven countries in the early 1960s. They found that the Greeks, and more specifically the inhabitants of Crete, fared best of all.

See also **Christianity: Eastern Orthodox; Mediterranean Diet.**

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GREEN REVOLUTION. The Green Revolution was the notable increase in cereal-grains production in Mexico, India, Pakistan, the Philippines, and other developing countries in the 1960s and 1970s. This trend resulted from the introduction of hybrid strains of wheat, rice, and corn (maize) and the adoption of modern agricultural technologies, including irrigation and heavy doses of chemical fertilizer. The Green Revolution was launched by research establishments in Mexico and the Philippines that were funded by the governments of those nations, international donor organizations, and the U.S. government. Similar work is still being carried out by a network of institutes around the world.

The Green Revolution was based on years of painstaking scientific research, but when it was deployed in the field, it yielded dramatic results, nearly doubling wheat production in a few years. The extra food produced by the Green Revolution is generally considered to have averted famine in India and Pakistan; it also allowed many developing countries to keep up with the population growth that many observers had expected would outstrip food production. The leader of a Mexican research term, U.S. agronomist Norman Borlaug, was instrumental in introducing the new wheat to India and Pakistan and was awarded the Nobel Peace Prize in 1970.

Borlaug (b. 1914) was hired in 1944 to run a wheat-research program established by the Rockefeller Foundation and the government of Mexico in an effort to make that country self-sufficient in the production and distribution of cereal grains. Borlaug's team developed varieties of wheat that grew well in various climatic conditions and benefited from heavy doses of chemical fertilizer, more so than the traditional plant varieties. Wheat yield per acre rose fourfold from 1944 to 1970. Mexico, which had previously had to import wheat, became a self-sufficient cereal-grain producer by 1956.

The key breakthrough in Mexico was the breeding of short-stemmed wheat that grew to lesser heights than other varieties. Whereas tall plants tend both to shade their neighbors from sunlight and topple over before harvesting, uniformly short stalks grow more evenly and are easier to harvest. The Mexican dwarf wheat was first released to farmers in 1961 and resulted in a doubling of the average yield. Borlaug described the twenty years from 1944 to 1964 as the "silent revolution" that set the stage for the more dramatic Green Revolution to follow.

In the 1960s, many observers felt that widespread famine was inevitable in the developing world and that the population would surpass the means of food production, with disastrous results in countries such as India. The United Nations Food and Agriculture Organization calculated that 56 percent of the human race lived in countries with an average per-capita food supply of 2,200 calories per day or less, which is barely at subsistence level (cited by Mann, p. 1038). Biologist Paul Ehrlich predicted in his 1968 bestseller *The Population Bomb* that "hundreds of millions" would starve to death in the 1970s and 1980s "in spite of any crash programs embarked upon" at the time he wrote his book (Ehrlich, p. xi).

In 1963, just such a devastating famine had threatened India and Pakistan. Borlaug went to the subcontinent to try to persuade governments to import the new varieties of wheat. Not until 1965 was Borlaug able to overcome resistance to the relatively unfamiliar crop and its foreign seeds and bring in hundreds of tons of seed to jump-start production. The new plants caught on rapidly. By the 1969–1970 crop season—about the time Ehrlich was dismissing "crash programs"—55 percent of the 35 million acres of wheat in Pakistan and 35 percent of India's 35 million acres of wheat were sown with the Mexican dwarf varieties or varieties derived from them. New production technologies were also introduced, such as a greater reliance on chemical fertilizer and pesticides and the drilling of thousands of wells for controlled irrigation. Government policies that encouraged these new styles of production provided loans that helped farmers adopt it.

Wheat production in Pakistan nearly doubled in five years, going from 4.6 million tons in 1965 (a record at the time) to 8.4 million tons in 1970. India went from 12.3 million tons of wheat in 1965 to 20 million tons in

Norman Borlaug, the acknowledged "father" of the Green Revolution. © AP/WIDE WORLD PHOTOS.

1970. Both nations were self-sufficient in cereal production by 1974.

As important as the wheat program was, however, rice remains the world's most important food crop, providing 35–80 percent of the calories consumed by people in Asia. The International Rice Research Institute in the Philippines was founded in 1960 and was funded by the Ford and Rockefeller Foundations, the government of the Philippines, and the U.S. Agency for International Development. This organization was to do for rice what the Mexican program had done for wheat. Scientists addressed the problem of intermittent flooding of rice paddies by developing strains of rice that would thrive even when submerged in three feet of water. The new varieties produced five times as much rice as the traditional deepwater varieties and opened flood-prone land to rice cultivation. Other varieties were dwarf (for the same reasons as the wheat), or more disease-resistant, or more suited to tropical climates. Scientists crossed thirty-eight different breeds of rice to create IR8, which doubled yields and became known as "miracle rice." IR8 served as the catalyst for what became known as the Green Revolution. By the end of the twentieth century, more than 60 percent of the world's rice fields were planted with varieties developed by research institutes and related developers. A pest-resistant variety known as IR36 was planted on nearly 28 million acres, a record amount for a single food-plant variety.

In addition to Mexico, Pakistan, India, and the Philippines, countries benefiting from the Green Revolution included Afghanistan, Sri Lanka, China, Indonesia, Iran, Kenya, Malaya, Morocco, Thailand, Tunisia, and Turkey. The Green Revolution contributed to the overall economic growth of these nations by increasing the incomes of farmers (who were then able to afford tractors and other modern equipment), the use of electrical energy, and consumer goods, thus increasing the pace and volume of trade and commerce.

As successful as the Green Revolution was, the wholesale transfer of technology to the developing world had its critics. Some objected to the use of chemical fertilizer, which augmented or replaced animal manure or mineral fertilizer. Others objected to the use of pesticides, some of which are believed to be persistent in the environment. The use of irrigation was also criticized, as it often required drilling wells and tapping underground water sources, as was the encouragement of farming in areas formerly considered marginal, such as flood-prone regions in Bangladesh. The very fact that the new crop varieties were developed with foreign support caused some critics to label the entire program imperialistic. Critics also argued that the Green Revolution primarily benefited large farm operations that could more easily obtain fertilizer, pesticides, and modern equipment, and that it helped displace poorer farmers from the land, driving them into urban slums. Critics also pointed out that the heavy use of fertilizer and irrigation causes long-term degradation of the soil.

Proponents of the Green Revolution argued that it contributed to environmental preservation because it improved the productivity of land already in agricultural production and thus saved millions of acres that would otherwise have been put into agricultural use. It is estimated that if cropland productivity had not tripled in the second half of the twentieth century, it would have been necessary to clear half of the world's remaining forestland for conversion to agriculture (Brown, *Eco-Economy*).

However, the rates at which production increased in the early years of the program could not continue indefinitely, which caused some to question the "sustainability" of the new style. For example, rice yields per acre in South Korea grew nearly 60 percent from 1961 to 1977, but only 1 percent from 1977 to 2000 (Brown et al., *State of the World 2001*, p. 51). Rice production in Asia as a whole grew an average of 3.2 percent per year from 1967 to 1984 but only 1.5 percent per year from 1984 to 1996 (Dawe, p. 948). Some of the leveling-off of yields stemmed from natural limits on plant growth, but economics also played a role. For example, as rice harvests increased, prices fell, thus discouraging more aggressive production. Also, population growth in Asia slowed, thus reducing the rate of growth of the demand for rice. In addition, incomes rose, which prompted people to eat less rice and more of other types of food.

The success of the Green Revolution also depended on the fact that many of the host countries—such as Mexico, India, Pakistan, the Philippines, and China—had relatively stable governments and fairly well-developed infrastructures. These factors permitted these countries to diffuse both the new seeds and technology and to bring the products to market in an effective manner. The challenges were far more difficult in places such as Africa, where governments were unstable and roads and water resources were less developed. For example, in mid-1990s Mozambique, improved corn grew well in the northern part of the country, but civil unrest and an inadequate transportation system left much of the harvest to rot (Mann, p. 1038). According to the report by David Gately, with the exception of a few countries such as Kenya, where corn yields quadrupled in the 1970s, Africa benefited far less from the Green Revolution than Asian countries and is still threatened periodically with famine.

The Green Revolution could not have been launched without the scientific work done at the research institutes in Mexico and the Philippines. The two original institutes have given rise to an international network of research establishments dedicated to agricultural improvement, technology transfer, and the development of agricultural resources, including trained personnel, in the developing countries. A total of sixteen autonomous centers form the Consultative Group on International Agricultural Research (CGIAR), which operates under the direction of the World Bank. These centers address issues concerning tropical agriculture, dry-area farming, corn, potatoes, wheat, rice, livestock, forestry, and aquatic resources, among others.

Future advances in agricultural productivity depend on the development of new varieties of plants such as sorghum and millet, which are mainstays in African countries and other less-developed areas, and on the introduction of appropriate agricultural technology. This will probably include biotechnology—the genetic alteration of food plants to give them desirable characteristics. For example, farmers in Africa are plagued by hardy, invasive weeds that can quickly overrun a cultivated plot and compel the farmer to abandon it and move on to virgin land. If the plot were planted with corn, soybeans, or other crops that are genetically altered to resist herbicide, then the farmer could more easily control the weeds and harvest a successful crop. Scientists are also developing a genetically modified strain of rice fortified with vitamin A that is intended to help ward off blindness in children, which will be especially useful in developing countries. While people have expressed concern about the environmental impact of genetically modified food plants, such plants are well established in the United States and some other countries and are likely to catch on in the developing world as well.

See also **Agriculture since the Industrial Revolution; Biotechnology; Crop Improvement; Ecology and Food; FAO (Food and Agriculture Organization); Food Safety; Food Supply and the Global Food Market; Food Trade Associations; Government Agencies; High-Technology Farming; Horticulture; Hunger, Physiology of; Inspection; International Agencies; Political Economy**.

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GREENHOUSE HORTICULTURE.

Plant cultivation is influenced by various factors, such as soil quality, water availability, and climatic conditions. Techniques have been developed either to adapt food crops to their environment (as by breeding and selecting plants more resistant to drought or with shorter production cycles), or to adjust the environment (for example, temperature, nutrient supply) to meet plant needs. Practical means of modifying the environment surrounding the plants have involved methods such as the use of windbreaks, mulches, plant or row covers, and cold frames. These methods of protecting plants may be described as passive methods since they only raise barriers between the plants and their environment, and do not control the environment. Some types of garden frames (hotbeds, heated frames) may be heated by artificial means, but do not actually provide for any control of the environment.

The only method of food crop production that makes use of control of the environment is greenhouse production. Modern greenhouse production is also referred to as controlled environment agriculture (CEA). With the use of a greenhouse, it is possible to cultivate food-producing plants in locations and at times when climatic conditions would adversely affect them or even prevent them from growing. Also, when climatic conditions allow outdoor plant cultivation, greenhouses can be used to protect crops against weather phenomena (such as wind, excessive rain, or hail) that would negatively affect them. For the purpose of this article, the term "greenhouse" is defined as a structure covered with a transparent or translucid material, in which environmental conditions can be modified or controlled, for the cultivation of plants. Tunnels are also used to modify environmental conditions for plant production, but are not usually considered greenhouses. Since the distinction between greenhouses and tunnels is not always clear in the literature, both structures, when high enough for people to move and work freely in them, will be considered together.

Food Produced in Greenhouses

Although greenhouses have been in existence since 1800 (or earlier), and greenhouse food production started to develop as an industry in the second half of the nineteenth century, the largest growth and expansion of the greenhouse industry occurred throughout the world following World War II. Today, food production in greenhouses can be found in all continents. Most popular food crops grown in greenhouses are tomato (beefsteak, cluster, Italian, cherry), cucumber, and sweet pepper. Other greenhouse grown vegetables include watermelon, muskmelon, summer squash, zucchini, lettuce, eggplant, snap beans, celery, cabbage, radish, Welsh onion, and asparagus. Fruits such as grapes, strawberry, banana, pineapple, papaya, orange, mandarin, cherry, and fig, as well as culinary and medicinal herbs, are also grown in greenhouses.

Today's Greenhouses

Covering materials. The main greenhouse covering materials are glass and polyethylene (PE). Glass has been used since the early days of greenhouses. The introduction of PE film after World War II was the main reason for the expansion of greenhouse production around the world, and it is now the most widely used covering material in the world. Glass-covered greenhouses are concentrated mainly in northern Europe and North America. The low cost of the PE greenhouse is the main reason for its high popularity, especially in developing countries. In recent years, the use of PE-greenhouses has even spread to northern regions. Research has shown that, under Canadian climatic conditions, heating costs of a double-layer PE-greenhouse are 20 to 30 percent lower than for a glass-covered greenhouse. Most of the greenhouses built now in Canada are covered with PE. Standard PE film blocks the ultraviolet, but not the infrared radiation, and has a short durability. However, improved PE films retain the infrared, but allow the ultraviolet, radiation (necessary for the bees, used for pollination of plants, to orient themselves)in the greenhouse, and are more durable. Polyvinyl chloride (PVC), another plastic film used to cover greenhouses, is used mostly in Japan. Other covering materials for greenhouses include rigid plastic acrylic, fiberglass, polycarbonate, and PVC panels, but their use is generally limited because of their high cost, compared to PE. Beside glass and PE, polycarbonate is often used on the sidewalls of polyethylene greenhouses in northern regions because of its good insulation, durability, and reasonable cost.

Technology in the greenhouse. Greenhouses come in many styles and sizes, from the original houses with minimal climate control (furnace and vents) to the modern 10-ha (25-acre) or more, multispan greenhouses with high-tech climate controls (sophisticated and powerful heating system, CO_2 enrichment, evaporative cooling pads, exhaust fans, roof vents, thermal/shade curtain, computer controls, light sensors). Most sophisticated greenhouses are generally found in the developed, northern countries. Phytotrons are highly sophisticated structures that allow for accurate control of environmental conditions including light, and are generally used for scientific research in universities and research institutes. However, phytotrons cannot be considered greenhouses since they are not covered with a transparent material.

The degree of environment control needed depends on various factors. The first factor is the location of the greenhouse (local climatic conditions). Northern regions are characterized by cold winters and warm summers. If the objective is to grow plants all year long, then such large differences in climatic conditions between winter and summer require a high-tech greenhouse. In regions such as the Mediterranean (Spain, Italy, Morocco, Greece), the mild winter climate does not require the use of powerful heating systems, and low-tech greenhouses are sufficient for winter production. However, these regions have very hot summers, and the use of a low-tech greenhouse may not provide satisfactory temperature control to grow plants during summertime.

The production schedule also affects the level of environment control and thus the level of technology. A greenhouse in northern regions may require a high level of climate control if the objective is to grow crops all year long (or long-season crops). If the objective is only to extend the production season (e.g., one early crop in spring), then a less sophisticated greenhouse could be satisfactory.

Optimal growing conditions differ from one species to another. For example, lettuce prefers cooler temperatures than cucumber. Thus, the crop grown in the greenhouse may influence the level of environment control needed or desired. A low-tech greenhouse may provide

TABLE 1

Estimated greenhouse area (ha) and important food crops grown in greenhouses worldwide

Country	Total area	Food crops area	Hydroponic	Important food crops		
China	360 000	(-)[z]	140 [y]	Cucumber (-)[x]	Tomato (-)[x]	Sweet pepper (-)[x]
Spain	55 000	> 50 000	4 000 (10)	Melons (-)	Tomato (-)	Sweet pepper (-)
Japan	52 571	43 950 (84)	655 (1.5)	Tomato (15)	Cantaloupe (13)	Strawberry (13)
Italy	26 000	21 000 (81)	400 (1.9)	Tomato (-)	Zucchini (-)	Sweet pepper (-)
Korea	21 061	(-)	(-)	Cucumber (-)	Chinese cabbage (-)	Tomato (-)
Western North Africa[w]	11 400	> 7 900	(-)	Tomato (47)	Sweet pepper (25)	Cucumber (8)
Turkey	10 800	9 000 (83)	(-)	Tomato (-)	Cucumber (-)	Melon (-)
The Netherlands	10 800	4 335 (40)	2 895 (72)	Tomato (30)	Sweet pepper (23)	Cucumber (16)
France	9 100	6 500	(-)	Tomato (-)	Cucumber (-)	Strawberry (-)
United States	5 000	300 (6)	300 (100)	Tomato (-)	Cucumber (-)	Lettuce (-)
Greece	4 620	3 790 (82)	60 (1.6)	Tomato (-)	Cucumber (-)	Eggplant (-)
Middle East[w]	4 300	3700 (86)	(-)	Tomato (65)	Cucumber (21)	Sweet pepper (10)
Germany	3 300	(-)	(-)	Tomato (-)	Cucumber (-)	Lettuce (-)
Belgium	2 250	1 600 (71)	850 (53)	Tomato (38)	Lettuce & herbs (19)	Cucumber (5)
United-Kingdom	1 600	(-)	(-)	Tomato (-)	Cucumber (-)	Lettuce (-)
Canada	1 470	756 (51)	600 (80)	Tomato (56)	Cucumber (24)	Sweet pepper (16)
Arabic peninsula[w]	(-)	1930	(-)	Cucumber (53)	Tomato (28)	(-)
Eastern North Africa[w]	(-)	1700	(-)	Cucumber (38)	Sweet pepper (34)	Tomato (20)
Mexico	(-)	350	17.5 (5)	Tomato (-)	(-)	(-)
Brazil	(-)	(-)	50	Lettuce (-)	Arugula (-)	Watercress (-)

[z] Value in parenthesis: percentage of greenhouse area used for food crops in each country, calculated over total greenhouse area; (-) = unavailable data.

[y] Value in parenthesis: percentage of greenhouse area with hydroponic systems in each country, calculated over greenhouse area for food crops; (-) = unavailable data.

[x] Value in parenthesis: percentage of greenhouse area for major crops in each country, calculated over greenhouse area for food crops; (-) = unavailable data.

[w] These regions include the following countries (in order of importance of their greenhouse industry): Western North Africa: Morocco, Algeria, Tunisia; Eastern North Africa: Lybia, Egypt; Middle East: Jordan, Lebanon, Syria; Arabic peninsula: Saudi Arabia, Kuwait, United Arab Emirates, Iraq, Bahrain, Qatar.

sufficient climate control for lettuce but not for cucumber, depending on the location of the greenhouse and the production schedule.

Economic development also plays a role in the level of technology used in the greenhouse. In developing countries, growers may not be able to afford the most sophisticated equipment, and may lack technical expertise and technical support.

Greenhouses in desert regions. Although greenhouses were developed in northern regions as a means of protecting crops against cold temperatures, and are therefore generally associated with cold climates, they are also used in arid regions such as Saudi Arabia. In such regions, the objective of the greenhouse is to protect plants from the excessive solar radiation and temperature, and to prevent excessive water loss by plants (especially since water resources are generally limited in those regions). Therefore, technology in greenhouses in these regions is directed toward cooling.

Artificial lighting. In northern countries, high-tech greenhouses can provide optimal growing conditions (temperature, humidity, carbon dioxide) for vegetable crops even during the coldest winter months. However, even with excellent climate control, yield and quality of crops grown during these months are low due to the low light level available. Research has shown that it is possible to produce good yield of high-quality produce during the winter months by using artificial light to supplement the natural radiation. The most common artificial lighting is the high-pressure sodium lamp. The high cost of electric energy in many regions is the most important factor preventing an increased use of artificial light.

Production Systems

Growing in soil. Since the early days of greenhouses, plants have been grown in soil or in soil-filled containers. The first technique for fertilizing plants, which is still in use today in organic production, was the use of manure. Today, fertilization of plants can also be accomplished by incorporating chemical fertilizers in the soil, or by distributing fertilizers dissolved in water (so-called fertigation) to plants with a drip (trickle) irrigation system. Intensive and repetitive cultivation of crops on the same soil generally results in a degradation of soil properties and fertility. Salt accumulation may be another problem in soil cultivation. Incorporation of manure, compost, and other organic materials into soil can be used to improve its structure and replenish its fertility. However, ensuring perfect fertilization of plants grown in soil is still a difficult task. Furthermore, intensive and repetitive cultivation of crops on the same soil can also result in insect or disease infestation. Soil replacement and soil fumigation are two solutions, but the first technique is expensive and the second is not always successful. Greenhouse production in soil is still used widely.

TABLE 2

Estimated area (ha) of protected crops per region and type of structure

	Greenhouses + Tunnels		
	Plastic	Glass	Total
Asia	440 000	3 000	443 000
Mediterranean	97 000	8 000	105 000
Americas	15 600	4 000	19 600
Europe*	16 700	25 800	42 500
Africa + Middle East*	17 000	-	17 000
Total	586 300	40 800	627 100

*Excludes European countries on the Mediterranean Sea.

Growing without Soil

In order to better control fertilization for optimizing plant growth and yield, and also to avoid the problems occurring in soil, growing systems that do not use soil (soilless) were developed for the cultivation of greenhouse crops. These soilless systems can be classified in two groups: liquid (water) and solid (artificial substrates that are either inorganic or organic). Systems using water as a growing medium are the nutrient film technique (NFT), deep flow technique (DFT), and aeroponics. Common inorganic media are rockwool, vermiculite, perlite, and clay pellets. Organic substrates are peat, coconut coir, sawdust, and straw. Inorganic and organic substrates are usually contained in bags, and plants are irrigated with a complete nutrient solution distributed by a drip irrigation system. The excess of nutrient solution can either be allowed to leak into the ground or is recuperated and recirculated (after treatment) to plants. In liquid systems, plant roots are continuously exposed to nutrient solution, which is not leaked into the ground.

Growing methods using artificial substrates or water are known as soilless culture or hydroponics. Hydroponics is literally defined as the growing of plants in water, but the plants are actually grown in a complete nutrient solution. Ideally, the term *hydroponics* should be reserved for water culture, and the term *soilless culture* for plant cultivation on artificial substrates. In practice, the terms *hydroponics* and *soilless culture* are used indiscriminately to describe water and substrate-based systems.

Although official statistics are unavailable, hydroponic systems are known to be used extensively for food production in greenhouses. The most popular soilless medium for hydroponic vegetable production is rockwool. The nutrient film technique is also often used, but to a much lesser extend than rockwool. In some regions, the availability of low-cost materials may provide alternative substrates. For example, in British Columbia, sawdust, a residue of the large forestry industry, is commonly used as a substrate. Both aeroponics and DFT remain in little use today.

Insect and Disease Control in Greenhouses

One objective of hydroponics is to avoid insects and diseases that may occur in soil. In a soilless culture system, such as rockwool, it is easy to remove infected plants. However, spread of diseases can occur very quickly in systems where nutrient solution is recirculated. Methods such as filtration of the nutrient solution, and disinfection with ozone or ultraviolet light, have been developed to eliminate pathogens that may be present in the nutrient solution. However, these methods are often expensive and not completely effective.

Greenhouses are used to create and maintain an environment ideal for plants. However, this environment is often favorable for insects and pathogens too. In the past, the control of insects and diseases in greenhouses was accomplished with the use of pesticides, but over time both insects and diseases have developed resistance to such pesticides, while consumers have begun to demand pesticide-free produce. Biological agents are now used to control whitefly, thrips, aphids, and two-spotted spider mite in greenhouses; few reliable biological agents are currently available for the control of diseases.

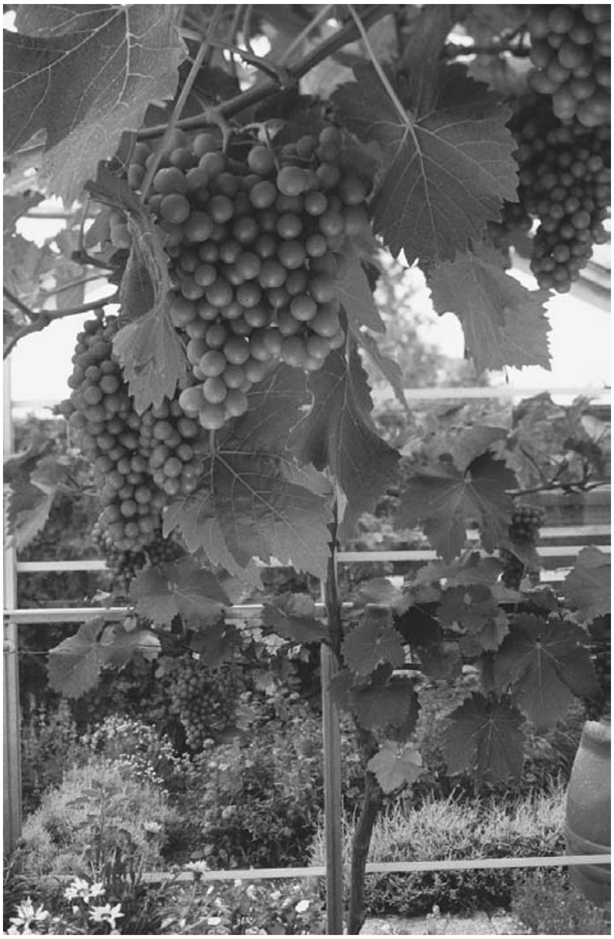
Research on Greenhouse Food Crops

In countries or regions where greenhouse production is an important industry, government and universities are generally involved in research on greenhouse production. The general objective of the research is to improve yield and quality of produce and profitability of production, by investigating all aspects of greenhouse production: greenhouse design and covering materials, growing methods, environment controls, substrates, plant nutrition, plant pathology, and insect control. Grower associations may also be involved in the development of research priorities, and may contribute financially to the expenses of research.

Due to the presence of a large and technologically advanced greenhouse industry in the Netherlands, the most notable research institutions are found there. The Research Station for Floriculture and Glasshouse Vegetables (under the Ministry of Agriculture, Nature Conservancy and Fisheries) has five sites. The other important Dutch institution is the University of Wageningen.

In the United Kingdom, Horticulture Research International (HRI), the largest horticultural research establishment in the world, maintains an active research program on greenhouse crops and provides its services (from fundamental research to technology transfer) to research councils, government departments, growers, and commercial industries, in the European Community (EC) and other countries.

In the Americas, the Greenhouse and Processing Crops Research Centre (GPCRC; Agriculture and Agri-Food Canada) is the largest research facility specializing in greenhouse vegetables. The GPCRC is a leading mem-



Organically grown greenhouse grapes at the Henry Doubleday Research Association's headquarters in Ryton, England, near Coventry. During the Roman period, England's climate was considerably warmer, and grapes could be cultivated into the Midlands. Today, grapes can be grown only in Kent, in southeastern England; otherwise, table and wine grapes must be raised under glass. © MICHAEL BOYS/CORBIS.

ber of the Canadian Network for Greenhouse Vegetable Research.

Japan, Spain, and Israel are some of the other countries with important research programs in horticulture, including greenhouse food production.

The International Society for Horticultural Science (ISHS) is an international organization of horticultural scientists, which aims at promoting research in all branches of horticulture, including greenhouse food production. Within the ISHS, there are various commissions and working groups related to greenhouse production.

Future of Greenhouse Food Production

As the world population continues to increase, and more agricultural land is lost to urban development, intensive food production in greenhouses may play a more important role in food production. Furthermore, improving economic conditions in developing countries and an increasing preoccupation with health and nutrition will increase demand for high-quality food products. Through controlled climate and reduced pesticide use, greenhouses can meet this consumer demand. Foods with improved health characteristics or containing nutraceuticals (substances with pharmaceutical or health-beneficial properties that can be extracted or purified from plants) can be grown pesticide-free in greenhouses.

See also **Chili Peppers**; **Crop Improvement**; **Cucumbers, Melons, and Other Cucurbits**; **High-Technology Farming**; **Horticulture**; **Tomato**.

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GREENS. *See* **Leaf Vegetables; Lettuce; Salad; Vegetables.**

GRILLING. Grilling is a fast, dry method of cooking tender cuts of meat and vegetables with radiant heat directed from below or from above. Its chief benefit is that it provides for the maximum amount of browning. In addition, a well-seasoned grill imparts a distinct flavor of its own to food cooked on it.

Virtually every American man either feels himself to be a master of outdoor grilling or experiences a twinge of guilt at falling short. The backyard barbecue has become for many the epitome of the suburban good life.

Grilling owes part of its appeal to its apparent simplicity: humans, fire, and meat. But many people are deceived by what looks like a simple process, and a lot of good food ends up ruined unnecessarily. Worse yet, some of the most delicious uses of the outdoor grill are ignored.

It is important to understand that grilling is not the same as barbecuing, even though both can be done on the same covered grill wheeled out of the garage on Sunday afternoons. Barbecue is an indirect slow-cooking process that uses long periods of exposure to low heat to tenderize tough cuts like brisket and chuck steak. It is generally agreed that the correct barbecue temperatures are from 180°F to 300°F. During the hours of cooking, extra flavor can be imparted from the smoky character of the grill, from the fuel used, and from sauces that are applied regularly. It is possible to get and satisfy a sudden impulse to grill. Barbecue, on the other hand, is a matter that requires planning, careful thought, and the provision of some form of amusement for the chef.

Methods of Grilling

Grilling can be divided into three major cooking styles, depending on how the heat source is configured. But all agree that the heat used must be above 500°F. The under-heat technique and grill roasting have the advantage of flavor enhancement from the grill itself; other methods only simulate some of the attributes of grilling.

In traditional or under-heat grilling, food is placed on a rack or grill bars over a gas or charcoal grill. Because of the fast nature of the cooking process, it is necessary to preheat the grill and the racks.

In top-heat grilling or broiling, used mostly in restaurants, the food is placed under a salamander, a professional overhead cooking oven. Again the grill (broiler) must be preheated, for quick searing. The process does produce a fine grill quality, but falls short in two areas. It does not leave the distinct grill marks so prized by many chefs and grill fanatics alike, and it also does not impart a smoke flavor.

Pan grilling, the third main method, is suitable for the most tender cuts. The food is cooked directly on a heavy cast-iron pan or ridged griddle pan. The cooking surface should be lightly seasoned to avoid sticking. One advantage of this method is that the food can be seared on a ridged pan, then finished in the preheated oven. This professional method is practical when preparing banquet menus, because the chef can be sure of consistently cooking to the same degree of doneness.

Other techniques. Grill roasting or indirect grilling is a hybrid technique. The procedure uses a conventional grill in a nontraditional way: fire is ignited under part of the grill, the food is placed over the unheated or coolest part of the grill, and the grill lid is closed. Some of the flavor of the grill is imparted to the food, which is usually browned over the heated part. Grill roasting is best for foods that are already tender but have a larger mass; birds and fish are good candidates.

Grill smoking is another variation on indirect grilling. Before you start to grill, place a metal dish or foil package containing moistened wood chips or herbs below the grill and over the fire. The heat will make lots of smoke that will fill the closed grill and flavor the food. This is a particularly good technique to use with brined foods.

Grilling Basics

In terms of grilling tips, simple common sense is the rule. Always trim excessive fat off meat; this will help stop flare-

Grilling is a popular method of cooking for outdoor meals, especially during the summer. Entire menus can be created from grilled vegetables, meats, and fish. There is also a shift in the gender of the cooks, since grilling is commonly perceived as a male task. PHOTO BY ANDRÉ BARANOWSKI.

up, which adds a combustion taste to grilled foods. Always remove silver skin and connective tissue; silver skin does not dissolve when cooking, and connective tissue can cause meat to warp on the grill as the elastin shrinks.

As is true with all high-heat cooking, the best results come from food of uniform thickness. Trim the tapered ends from chicken breasts and vegetables and cook separately or reserve for another use. If grilling a vegetable—asparagus, for instance—try to select pieces that are of uniform thickness. Cutting other vegetables on a mandoline—a compact, hand-operated wood- or stainless steel-frame slicing and cutting machine with various adjustable blades—makes uniform thickness easy to obtain.

Dry ingredients that are exposed to high heat brown, their protein transformed by a series of changes called the Maillard reactions. Browned meats are much more flavorful, and when people say that they love the smell of cooked meat, they are in fact admiring the aromas that accompany browning. Maillard reactions take place only at temperatures well above the boiling point of water, so it is essential to pat meat that is wet or marinated dry before grilling. Meat and vegetables can also be brushed with oil or rubbed with infused oil. This actually facilitates browning while it adds flavor and prevents items from sticking to grids.

Season at the last minute. Never (except when braising) let meat sit in a coat of salt. Instead, add salt or salt-and-spice mixtures immediately before cooking. If salt is left on the surface it draws out the juices and toughens the meat. Be careful not to burn spices. With dry herb-and-spice rubs used to impart flavor, brush off excess before grilling; an option is to brush over the surface with oil before cooking, to prevent burning dry-rub ingredients.

When using natural fuel (charcoal) make sure coals are the correct temperature, and burnt down. A two-second hand count (meaning you can't hold your hand over the grill for more than two seconds) is the rule for a grill between 450°F and 500°F. Nothing imparts a bad resin flavor like charcoal that is not fully ignited and a cool grill.

The Science of Grilling

Some understanding of cooking chemistry helps in grilling. Chefs are reexamining the use of brining or salting to produce juicy items today, and it is only a matter of time before the consumer catches on to this technique.

Brining—soaking lean cuts in salted water—preserves moisture. For fish, pork, chicken, or shrimp, prepare a brine with one cup of kosher salt per gallon of water (some brines also call for a small amount of sugar). Soak chicken in brine for two to twenty-four hours, other foods for as little as an hour. Rinse well, pat dry, and use the indirect method described above. The science behind the brine is simple; meat proteins are made up of amino acids, some of which are highly charged. They interact with the salt ions in the brine to open their structure and to dramatically increase their water-holding capacity. The salt actually moves into the meat, and extra water is also absorbed; on the grill, the salt in the meat holds on to the moisture, and so does the protein. The result is a juicier product, even from the high heat of the grill or the medium-high heat of grill roasting. Another way to impart flavor is by use of marinades and basting. Before cooking, meat proteins and vegetables may be marinated in mixtures of oil with vinegar, wine or citrus juice, herbs and spices, and other ingredients to help tenderize and add flavor. Marinades should always be blotted dry before grilling.

The process of grilling must also be defined in terms of the fuel used. There are several different types of grills, but gas and charcoal are by far the most common. They are also the source of the great grill debate: efficiency versus flavor. Today, gas grills represent about 60 percent of sales to household consumers. It is clear that they have their advantages, the most touted being ease of use, not having to add more fuel during long cookouts, and a juicy end product. Grilling purists, however, argue that hardwood charcoal gives a better flavor, and a smoky, drier character. The fuel source for charcoal grills has been recognized for at least five thousand years. No one is certain who discovered charcoal, but evidence of early use has been found all over the world. What most consumers may not know is that charcoal is actually wood; it is created by heating wood to high temperatures. Charcoal does provide a distinctive flavor that is not easily reproduced. And with the use of hardwoods like hickory, cherry, and mesquite, the flavor profile of the final product may have infinite variety. It is a tough decision for many people: the convenience of a gas grill against the flavor of charcoal.

See also **Barbecue; Broiling; Hearth Cookery; Marinating and Marinades; Meat; Roasting.**

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GRIMOD DE LA REYNIÈRE. Named Alexandre-Balthazar-Laurent by an aristocratic mother and a farmer father, Grimod de la Reynière (1758–1837) was a rich eccentric with extravagant ways. He began a career as a theater critic but became one of the first to develop French gastronomic literature through the eight volumes of his *L'Almanach des gourmands*, which he published from 1803 to 1812. He originated the double genre of food critic and restaurant guide, providing practical information as well as critical standards. These were formulated by his jury of tasters, twelve friends who met weekly at the five-hour dinners he staged in his Paris home.

In 1808 his *Manuel des amphitryons*, a condensation of the material of the almanac, established the idea that the consuming public wanted guidance from an authoritative judge. The application of judge and jury to table matters was appropriate to the chaos of post-Revolutionary Paris and to the beginning of public restaurants during the transition from "ancient" to modern French cuisine. Such autocratic judgment created enemies and, forced to leave Paris in 1812, La Reynière sent out a public notice of his death and staged a funeral banquet in order to predict, accurately as it turned out, how very few friends would attend. He spent the rest of his life in retirement in the countryside, married to the actress who had been his mistress.

La Reynière's influence in creating a critical guide for bourgeois consumers and gastronomes in the newly de-

Grimod's fondness for the flesh of game and that of actresses is evident in this fanciful recipe:

> "Stuff an olive with capers and anchovies and put it in a garden warbler. Put the garden warbler in an ortolan, the ortolan in a lark, the lark in a thrush, the thrush in a quail, the quail in a larded lapwing, the lapwing in a plover, the plover in a red-legged partridge, the partridge in a woodcock—as tender as Mlle Volnais, the woodcock in a teal, the teal in a guinea fowl, the guinea fowl in a duck, the duck in a fattened pullet—as white as Mlle Belmont, as fleshy as Mlle Vienne, and as fat as Mlle Contat, the pullet in a pheasant, the pheasant in a duck, the duck in a turkey—white and fat like Mlle Arsène, and finally, the turkey in a bustard."

—*Larousse Gastronomique*, *p. 532*

> "The local wine, a dinner at your friends' house, and music performed by amateurs are three things to be equally dreaded."

—*Larousse Gastronomique*, *p. 531*

mocratized theaters of the table, in houses and in restaurants, extends to this day. While the prose and outlook of his contemporary gastronome, Brillat-Savarin, were more humane, Grimod's delight in staging dining scenes that were theatrically absurd and macabre, a sort of *cuisine noire* (black-comedy cuisine), is peculiarly modern.

See also **Brillat-Savarin**; **Chef**; **France**.

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Betty Fussell

GROCERY STORES. *See* **Retailing of Food.**

H

HALLOWEEN. Halloween (also Hallowe'en) is thought to have derived from a pre-Christian festival known as Samhain (pronounced "Sah-wen") celebrated among the Celtic peoples. The various peoples whom we now refer to as "Celts" once lived across Europe, but in time came to inhabit the areas known today as Ireland, Scotland, Wales, Brittany, and Cornwall. Modern Irish, Welsh, and Scots peoples are the descendants of these peoples, as are their Gaelic languages.

History

Samhain was the principal feast day of the year; it was the New Year's Day of a year that began on 1 November. Traditionally, bonfires were lit as part of the celebration. It was believed that the spirits of those who had died during the previous twelve months were granted access into the otherworld during Samhain. Thus, spirits were said to be traveling on that evening, as the Celtic day was counted from sundown to sundown.

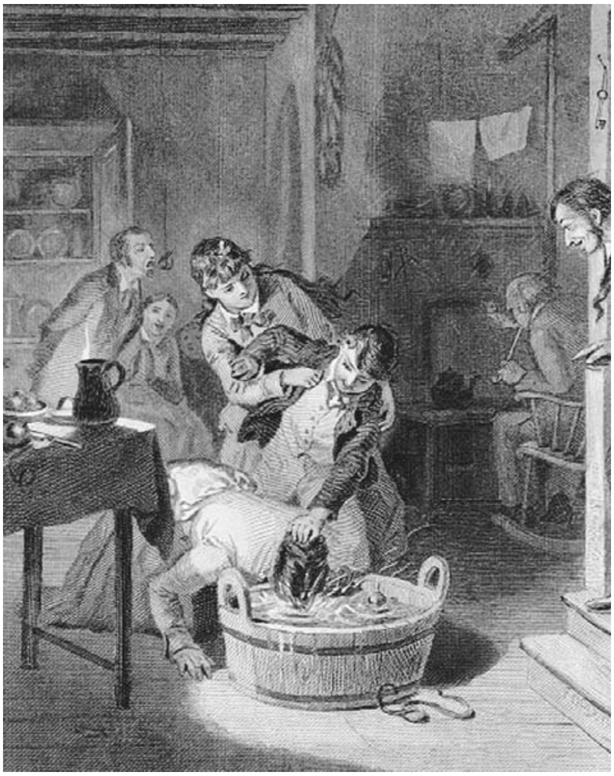
Scholars know little about the actual practices and beliefs associated with Samhain. Most accounts were not written down until centuries after the conversion of Ireland to Christianity (c. 300 C.E.), and then by Christian monks recording ancient sagas. From the evidence, we know that Samhain was a focal point of the yearly cycle, and that traditions of leaving out offerings of food and drink to comfort the wandering spirits had joined the bonfire custom. Also, the tradition of mumming—dressing in disguise and performing from home to home in exchange for food or drink, as well as pranking, perhaps in imitation of the wandering spirits, or simply as a customary activity found throughout Europe—had become part of the occasion. With the acceptance of Christianity, the dates of the pre-Christian festivals were used as occasions for church feast and holy days. The first day of November became, in the sixth century, the Feast of All Saints, or All Hallows. Many of the folk traditions surrounding this occasion continued, and the Eve of All Hallows, Hallow Evening, has become conflated into the word "Hallowe'en." In the ninth century, 2 November was assigned the Feast of All Souls, a day set aside for prayers for all the faithful departed who had died during the previous year.

Halloween was brought to North America with Irish and British colonists, although it was not widely observed until the large influx of European immigrants in the nineteenth century, especially the Irish fleeing the potato famine in the 1840s and thereafter. In the United States, Hallowe'en, celebrated on 31 October, was a time for parties and pranking. As a festival of autumn, the fruits, vegetables, and foods associated with it are those of the harvest. Games were and are still played with apples, and the primary symbol of Halloween is the jack-o'-lantern, the great, carved pumpkin. Likewise, both apple pie and pumpkin pie are commonly served.

Samhain in Ireland

In Ireland, however, Halloween is much more a harvest festival than it is in the United States, where Thanksgiving has become the official day of thanks for abundance. As Samhain, November Eve was one of the four great quarter days of the year, each one marking the beginning of a new season. Samhain also marked the start of a new year. Halloween commands a place of honor in Ireland today greater than in the United States. And in fact it functions much like Thanksgiving does here. Family meals and a gathering of relatives are common. There is pranking throughout the season, and Halloween rhyming, in which young people go from door to door for weeks in advance of 31 October, present a rhyme or perform a song of some sort, in return for nuts, apples, or money. The money is spent on fireworks. Also well in advance of the actual day, lanterns are carved out of large turnips, called swedes, or rutabegas in the United States. These are given a face and a handle, and are carried about or set on walls to create a spooky atmosphere. When the old tradition of the turnip lantern was brought to the new world, settlers found the already hollow pumpkin to be preferable to the hard turnip, and so the pumpkin replaced the turnip in the United States. But the pumpkin is a fruit introduced to Europeans by Native Americans and is not native to Ireland, Great Britain, or the rest of Europe.

By carving a face on a turnip or a pumpkin, one transforms the organic item into a cultural one. The jack-o'-lantern is the wandering spirit of a man who was refused entry into either heaven or hell in the afterlife. He is condemned to wander this earth, carrying a lantern to guide his way. He is a trickster; he will lead hapless souls who follow his light to no good. The turnip lantern is said to represent the spirits of the dead—ghosts. The organic



Apple dunking was a popular Halloween activity in nineteenth-century America, as shown here in an 1879 engraving. ROUGHWOOD COLLECTION.

items are made to reference the supernatural. Also, they are turned into another kind of cultural item: food. Pumpkin pies and mashed turnips are foods of the season, and represent domestic aspects of Halloween. The wild, unpredictable outside and the safe, nuturing inside are two poles of this festival. Halloween combines danger and safety, as when trick-or-treaters in the United States are invited in for cider and doughnuts. In Ireland, the inversive elements usually precede the day itself, which is given over to parties, special meals, and traditional games. These games are often played with the seasonal foods, such as dunking for apples, but they are also used in a playful way as divination games. For instance, Halloween in Ireland is also known as Nut Crack Night, because a common game is to place two nuts together near the hearth, name them for an adolescent or courting couple, then see what the effect of the heat is on the nuts. If they explode and pop away from each other, their relationship is doomed.

Divination and Halloween food come together in the apple tarts (pies) and the cakes known as barm brack. Barm brack means speckled bread. It is a corn loaf, and it is baked with tokens inside, usually a ring, but also a thimble, or a button. To get the ring means you will be married; the button suggests bachelorhood for a man, and a thimble, spinsterhood for a woman. There may be other tokens as well. The apple tart is also baked with charms, usually a coin (preferably silver). This means good luck for the recipient. These food customs are widespread in Ireland—one sees the bakeshops advertising their apple tarts and barm bracks "with rings and mottoes." Likewise, in the supermarkets, quantities of apples, hazelnuts, peanuts in the shell (called monkeynuts), and even coconuts are displayed alongside soft drinks and false faces.

Many are the divination games and rites of Halloween. It is said, for instance, that one should peel an apple continuously, so that the peel is in one long piece, and then toss it over one's left shoulder. The peel will land and form the initial of one's future love. Typically, these games are played by girls, to whom the indoor, domestic, nurturing realm is given, while the adolescent boys collect bonfire materials and engage in games of macho daring with firecrackers. Halloween is in these ways very gendered.

According to some accounts, the Halloween supper has featured a roast fowl or even meat, but as the day before a Holy Day of Obligation in the Catholic Church, Halloween has traditionally been a day of abstinence from meat. The dishes most associated with Halloween in Ireland—colcannon, champ, and boxty—are all made from root vegetables and earthy harvests such as potatoes and cabbage. Champ is mashed potatoes, frequently with leeks, and served with a pool of melted butter in the top. Colcannon is potatoes and cabbage. Boxty is mashed potatoes mixed with grated raw potatoes, onion, and cabbage, which are then boiled, cut into portions and fried.

These traditional foods are emblematic of Halloween for many in Ireland. Sometimes, portions were left out for the fairies. In an article published in 1958, K. M. Harris quotes a man who recalls his mother putting salt on the head of each child to prevent them from being taken away by the "wee people" on Halloween. He also recounts her placing a thimble-full of salt on each plate. If the salt fell down that person would die in the next twelve months. These beliefs indicate the continued association of food with the supernatural, and perhaps echo the "old" new year's day of Samhain in the idea that what happens on this night affects the next twelve months.

Periods of transition and seasonal change frequently are felt to be times when the barriers between the natural and the supernatural—between our world and the otherworld—are opened. During such times, spirits and otherworldly creatures such as fairies are especially active. They are dangerous and must be appeased; thus the offerings of food. But they are also tricksters, and can be imitated, thus lending an air of inversion to Halloween.

Halloween in the United States

In the United States, 31 October has become a major celebration that appeals to adults as well as children, as shown by the elaborate homemade and store-bought decorations people use to decorate their homes, and also by the adult street festivals, masquerades, and parties found all over the United States. Commercially, Halloween has become second only to Christmas in the amount of revenue it generates.

Ironically, by the mid-twentieth century, Halloween in the United States had become almost exclusively a children's event. The custom of trick-or-treating (the American version of Halloween rhyming) seems to have been introduced in the 1930s as an alternative to the children's pranking activities—sometimes dangerous, such as logs in the road; always a nuisance (Tuleja, 1994). Trick-or-treating became a widespread activity after World War II. While treats could include apples and homemade sweets, the favored treat was commercially produced candy. In the United States, then, Halloween has always reflected the commercial culture of capitalism. Apocryphal stories known as "urban legends" have circulated about poisoned treats and apples with razor blades hidden in them. While there has been no substantial verification of the stories, the belief is widespread. The result is that homemade treats and natural fruits are looked at suspiciously—many communities offer Halloween treat X-raying services. Now so more than ever, the commercially produced sweet is preferred (Ellis, 1994).

By the late twentieth century, as the generation that had enjoyed Halloween as children became adults, the holiday returned to being one in which different age groups engaged. College students hosted large costume parties. Cities such as New York, Boston, Washington, D.C., and San Francisco had major street festivals. As a day of public costuming and inversion, a time when people confronted images of the taboo—representations of death, evil, and chaos, Halloween had long been used by the gay population as a "safe" time to parade in drag, to publicly display an identity that they must keep hidden the rest of the year. By the end of the twentieth century, the rest of the population joined them to create a kind of national Mardi Gras. Unlike the actual Fat Tuesday, however, this carnival is in the autumn, and it combines seasonal images of the harvest with images of human death (ghosts and skeletons) as well as other unspeakables. Halloween is a time when it is safe to play with our fears, to allow our demons to come out from under the bed and take center stage once a year.

See also **British Isles,** *subentries on* **England** *and* **Ireland**; **Christianity**; **Day of the Dead**; **Feasts, Festivals, and Fasts**; **Holidays**; **Shrove Tuesday**.

The most recent development in the evolution of the American Halloween is the costumed trick-or-treater. It began in the 1920s and has become a national custom, especially for children. © ED BOCK/CORBIS.

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Jack Santino

HAMBURGER. Humans have consumed beef in scraped, chopped, hashed, and minced forms since the domestication of the cow. Its main advantage was that it was an efficient way of using many smaller parts of the cow, including fat, organs, brains, and so on. To this

First Located Hamburg(er) Recipe?

To make Hamburgh Sausages

Take a pound of Beef, mince it very small, with half a Pound of the best Suet; then mix three Quarters of a Pound of Suet cut in large Pieces; then season it with Pepper, Cloves, Nutmeg, a great Quantity of Garlic cut small, some white Wine Vinegar, some Bay Salt, a Glass of red Wine, and one of Rum; mix all these very well together, then take the largest Gut you can find, stuff it very tight; then hang it up a Chimney, and smoke it with Saw-dust for a Week or ten Days; hang them in the Air, till they are dry, and they will keep a Year. They are very good boiled in Peas Porridge, and roasted with toasted Bread under it, or in an Amlet.

SOURCE: Hannah Glasse. *Art of Cookery Made Plain and Easy.* 6th ed. London, 1758, p. 370.

mixture could be added parts of other animals, plants, spices, flavorings, and adulterations. The resulting product can be easily shaped into different forms and prepared in a variety of ways—raw in steak tartare, molded into flat cakes or croquets, baked in a loaf, boiled and served in soups, barbecued or roasted and served on a bun, fried into meat balls, or stuffed into sausages with spices and herbs for later consumption.

Origin of Hamburger

The invention of the twentieth-century hamburger sandwich is the result of long developmental processes. Beginning in the fifteenth century, minced beef was a valued delicacy throughout Europe. In northern Germany, lightly fried chopped meat was called *Frikadelle.* Similar words are found in other European languages, and the root may be "farce," deriving from Latin *farcere* (to stuff). In English the term "forcemeat" was defined by Randle Holme in "The Academy of Armory" (Chester, 1688) as "meat with a stuffing of herbs, or other things made to that purpose."

Hashed beef was made into sausage in several different regions of Europe. In places such as Bologna, Russia, and Hamburg, beef was often combined with other meats and other ingredients. The German city of Hamburg was known for its beef sausage, which migrated to England by the mid-eighteenth century. One recipe, titled "Hamburgh Sausage," appeared in Hannah Glasse's 1758 *The Art of Cookery Made Plain and Easy*. It consisted of chopped beef, suet, and spices. Although the author recommended that this sausage be served with toasted bread, no evidence suggests that the sausage was served as a sandwich.

Hannah Glasse's cookbook was also among the most common in Colonial America, although it was not published in the United States until 1805. This American edition did contain the "Hamburgh Sausage" recipe with slight revisions.

The frequently cited "Hamburg Steak" on the Delmonico's restaurant menu dated 1834 was neither served as a sandwich nor composed of ground beef. With the popularization of the meat grinder in America about 1850, ground beef became a possibility. Recipes for it appeared in cookbooks from other countries, such as in Henriette Davidis's *Praktisches Kochbuch für die Deutschen in Amerika.* In American cookbooks, these recipes were frequently called "Beefsteak à la Hamburg." This recipe was so associated with the United States that the 1899 edition of Blüher's *Rechtschreibung der Speisen und Getränke* reported without explanation that chopped beefsteak was called "Hamburg steak" in America. Ground beef was also called "Salisbury steak," which was named in honor of the American physician James H. Salisbury (1823–1905), who wrote *The Relation of Alimentation and Disease* (New York, 1888). Salisbury believed that scraped lean beef, flattened into cakes and broiled, was among the best foods for those who were ailing. As scraping beef was a difficult task, common recipes for it just recommended grinding the beef, a process not recommended by Salisbury. Scraped or ground, Salisbury steak could be served with toast, but it was not served as a sandwich.

The Sandwich

The sandwich—a filling between two slices of bread that can be consumed by hand—is said to have been popularized by the Fourth Earl of Sandwich (1718–1792). This mode of eating became so popular in England that it was mentioned in several diaries and in Samuel Johnson's 1755 *Dictionary of the English Language*. Shortly thereafter, cooks and hosts began experimenting with various fillings other than sliced beef.

Sandwiches migrated to the United States before the Civil War. In the mid-nineteenth century, sandwiches consisted of a filling composed of lean slices of cold meat between two thin pieces of bread flavored with mustard and ketchup. They were served in bars and saloons, where patrons could easily consume them without the need of knives, forks, or plates. During the late nineteenth century, interest in the sandwich rapidly expanded to include boned fish, sardines, cheese, boiled eggs, stewed fruit, chopped nuts, mushrooms, chicken, watercress, sardines, and jelly and jam. Many salads, such as chicken and lobster, were converted into sandwiches. By 1900, hundreds of different fillings were consumed in sandwiches.

Hamburger Sandwiches

Several legends have grown up concerning who first served hamburger sandwiches in America. A hamburger sandwich is defined as a hot ground-beef patty between two slices of bread. It is not likely that any of the early claims put forth are accurate: sandwiches were composed of thin bread requiring thin fillings. Thin bread would also not have been able to contain the juices exuded from hot ground hamburger.

The first known published reference to a "hamburger sandwich" appeared in an article in the *New York Tribune*, which noted that this "new innovation" was served at the 1904 St. Louis Exposition. While it is possible that hamburger sandwiches were constructed well before this date at small stands and diners, the fair gave them national exposure and national diffusion resulted.

Hamburgers served in stands and diners in many regions of the United States attracted the working class. In a diner in Wichita, Kansas, a short-order cook named J. Walter Anderson flattened the meat balls and placed them in a bun; he developed the first commercial bun for hamburgers. In 1916 Anderson opened his own hamburger stand and sold them at five cents apiece to attract customers. To sell sandwiches at this price, Anderson streamlined his operation. To make certain that his clients were aware of what was contained in his hamburger, he ground his own beef and let his customers watch him doing it. His business was so successful that he opened three additional stands within four years. His success brought competitors, and the streets of Wichita had many hamburger stands. In 1921 he went into business with Edgar Waldo "Billy" Ingram. Ingram repackaged Anderson's hamburger stands architecturally into castles, and gave the operation the name "White Castle." Ingram insisted on standardization of all the stands, and he required employees to maintain strict standards of cleanliness, eventually requiring uniforms. This was extremely successful, and White Castle began expanding beyond Wichita. By 1924 the company had expanded to Omaha, then to Kansas City, then St. Louis, and the expansion continued. Ingram declared White Castle to be a national operation with forty-four outlets by 1930. He standardized the operation by opening meat-processing and bun-baking operations.

White Castle imitators, including some with the word "white" in their name, such as White Tower, spread across the United States. Ed Gold launched another hamburger chain, Wimpy Grills, in 1934. This featured the ten-cent "Wimpy" burger named after the cartoon character J. Wellington Wimpy, who immortalized the phrase: "I would gladly pay you tomorrow for a hamburger today" in a Popeye cartoon released in 1929. Wimpy Grills was the first fast-food corporation to expand abroad. Another competitor was Bob Wian, who founded Bob's Big Boy chain in southern California in 1936. He featured an upscale double-patty burger and franchised his operation, which quickly spread from coast to coast.

Within a few decades of the launch of White Castle, the hamburger had become America's national sandwich. Through small hamburger stands and national franchise chains, hamburgers were sold through hundreds of outlets throughout America.

The American hamburger has become a food culture of its own. This humorous sign for the Bun Boy Restaurant was photographed in southern Indiana. © PHILIP GOULD/CORBIS.

McDonald's

The prewar enlargement paled by comparison with the expansion of hamburger establishments after World War II. Returning from the war, many military personnel married, had children, bought cars, and moved to the suburbs. Focusing on those suburbanites with growing families and stretched incomes, Richard and Maurice McDonald designed a hamburger restaurant incorporating assembly-line efficiency into a commercial kitchen. This efficiency helped them to reduce their expenses and therefore permitted them to sell hamburgers at a low price. They hoped that the lower price would increase the number of customers, generating a greater volume with higher profits. To test their ideas, they opened an octagonal-shaped hamburger stand in San Bernardino, California, in 1948. Their operation did not include indoor tables, and it required that customers line up to place their orders and then eat in their cars: this eliminated the need for waitresses, which further reduced their expenses. The McDonalds sped up the process of making hamburgers through a series of innovations. They also decided to concentrate on selling just a few items: hamburgers, cheeseburgers, French fries, sodas, and shakes. These efforts to streamline and mass-produce hamburgers paid off. In 1951, they grossed $275,000.

As efficient as their internal operation was, the McDonald brothers concluded that they needed a new architectural design for the outside of their restaurant. Richard came up with the idea of constructing "golden arches" right through the roof which sloped upward toward the front, thus creating one of the most well-known architectural symbols in the world.

With the success of their newly designed operation, the McDonald brothers made another important decision: they franchised their operation. Franchising permitted others to build McDonald's drive-ins throughout the nation that were based on the design developed in San Bernardino. Those receiving franchises paid the McDonald brothers a fee and a percentage of their sales. In 1953 newly-designed McDonald's franchises opened in Phoenix, Arizona, and Downey, California.

At this time, McDonald's was just one of several new fast-food hamburger chains. In Los Angeles, Carl Karcher started selling hamburgers in 1946. In San Diego, Jack in the Box had been launched in 1951 and sported the first drive-through service. Three years later in Miami, James McLamore and David Edgerton founded Insta-Burger King, which later evolved into the Burger King chain.

To make the shakes quickly, the McDonald brothers purchased Multimixers—machines that mixed six shakes simultaneously. Ray Kroc, a Multimixer salesman, visited the McDonald brothers' operation in 1954 and was so impressed with their efficient operation that he arranged with the McDonald brothers to sell franchises. In 1955, Kroc opened his own McDonald's restaurant in Des Plaines, Illinois, and streamlined the operation even further. By the end of 1957, there were thirty-seven McDonald's. Two years later, the total exceeded one hundred establishments, and this doubled the following year. In 1961 Kroc bought out the McDonald brothers for $2.7 million and opened Hamburger University in Elk Grove, Illinois. McDonald's operations throughout America rapidly expanded.

McDonald's success encouraged competition, and many other fast-food chains adopted methods developed by the McDonald brothers and Kroc. Dave Thomas opened his first Wendy's restaurant in 1962 in Columbus, Ohio. Fast-food establishments underwent tremendous growth beginning in the mid-1960s. By 2000 there were more than 11,800 McDonald's, 6,298 Burger Kings, and 3,721 Wendy's fast-food establishments in the United States. Since there are an estimated 160,000 fast-food restaurants, it is estimated that the first job of one out of ten Americans is in a fast-food establishment.

Problems

Despite the rapid success of fast-food and soft-drink enterprises throughout the world, hamburgers and fast food have been condemned almost from the beginning. Until the arrival of White Castle, many potential customers avoided hamburger stands because of the lack of cleanliness of some establishments. Also, as low cost was an important factor in the hamburger business, many sellers adulterated the ground beef with other ingredients, leading many Americans to consider the hamburger an unhealthy food. In *100,000,000 Guinea Pigs* (1933), Arthur Kallet and F. J. Schlink claimed that hamburgers contained preservatives, which restored the color of the ground beef and destroyed the odor of spoilage.

Another concern has focused on fast-food advertising targeted at youth. McDonald's, for instance, developed cartoon characters such as Ronald McDonald. The "Happy Meal" with toys was launched in 1979. McDonald's has subsequently added children's play areas to many establishments and, like Burger King, has developed numerous tie-ins with major children's motion pictures.

Fast-food chains have been sensitive to a variety of health and environmental issues. For instance, McDonald's has reduced the fat content of its hamburgers, encourages recycling in some restaurants, refuses to buy beef from Brazil, and changed the wrappings of Big Macs and Quarter Pounders to make them more biodegradable.

Eric Schlosser's *Fast Food Nation: The Dark Side of the All-American Meal* maintains that the enormous growth of the fast-food industry has caused conditions in the big slaughterhouses to pose serious health concerns. Schlosser and others also blame fast food for a rise in obesity, which is among America's most serious health problems.

There has been heated criticism of the effects of fast food on local cultures and businesses. Serious nutritional, environmental, and cultural questions about fast food remain. As the homogenization of food choices continues worldwide, some consider the rapid expansion of fast-food chains as examples of an insidious American imperialism that is destroying local cultures and values. McDonald's success abroad has cause deep resentment by others who see the company as a symbol for the United States, and who believe that McDonald's expansion threatens local culinary traditions. In France, a sheep farmer named José Bové demolished a McDonald's restaurant that was nearing completion. Similar actions have occurred in other European countries.

Globalization

Despite condemnation throughout the world, the hamburger sandwich is one of the most successful foods in the world. The attraction of the hamburger is that it is inexpensive, convenient, and filling. Hamburgers are also versatile. At the minimum, hamburger sandwiches consist of just cooked ground beef in a bun. To this can be added hundreds of sliced and diced vegetables, condiments and spices, the most common of which are tomatoes, onions, mayonnaise, ketchup, mustard, pickle relish, salt, and pepper. Hamburger sandwiches with special seasonings and ingredients have proliferated. In 1984, Gyula Décsy's *Hamburger for America and the World* catalogued more than eight hundred hamburgers in the United States alone. These were a small fraction of the variety of hamburgers available today.

Hamburger establishments also caught on quickly in Canada and the United Kingdom. McDonald's opened its first Canadian restaurant in 1967 and created its International Division in 1969. By 1988 McDonald's had

2,600 locations abroad. Six years later, that number exceeded 4,500 restaurants in 73 other countries. In 2002 there were more than 28,000 restaurants in about 120 countries. McDonald's has over 1,000 restaurants in Japan alone. Measured by volume of customers, the most popular restaurant in Japan is McDonald's. France has 538 McDonald's restaurants; Australia, 615; Germany (the home of the original "hamburger"), 743; United Kingdom, 693; and Canada almost 900. The world's largest McDonald's is located near Red Square in Moscow, where a Big Mac lunch costs the equivalent of a week's paycheck. When McDonald's opened its first restaurant in Minsk, over 4,000 Belorussians showed up, forcing the operators to call in the police for crowd control. McDonald's boasts 127 restaurants in China—one of which overlooks Tiananmen Square in Beijing. Today, McDonald's international sales are $15 billion out of a total of almost $32 billion. Of its total revenue, 59 percent of its corporate profits are generated by restaurants in countries other than the United States.

There are many reasons for the success of fast-food chains in other countries. Most chains have adapted to foreign cultures, including revising the ingredients in hamburgers. In addition to efficient service and cultural sensitivity, other factors contributing to this success abroad are cleanliness of fast food establishments, family atmospheres, clean bathrooms, and air-conditioning. At the beginning of the twenty-first century, there were few countries that did not sport a fast-food establishment selling hamburgers. Foreign hamburger establishments are expanding at a faster pace than are hamburger establishments in the United States. With this rapid expansion, hamburgers are now a global food.

See also **Cattle; Delmonico Family; Fast Food; French Fries; Meat; Restaurants; Sandwich; Take-out Food.**

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HARVESTING. Harvesting is the act of removing a crop from where it was growing and moving it to a more secure location for processing, consumption, or storage. Some root crops and tree fruit can be left in the field or orchard and harvested as needed, but most crops reach a period of maximum quality—that is, they ripen or mature—and will deteriorate if left exposed to the elements. While the major factor determining the time of harvest is the maturity of the crop, other factors such as weather, availability of harvest equipment, pickers, packing and storage facilities, and transport are important considerations.

Economic and marketing issues are often even more important than considerations of maturity in deciding when to harvest a commodity. Before the crop can be harvested, the grower must be sure that there is a demand for the crop and that the price is sufficient to make harvesting the crop profitable. If the price is less than adequate to cover the costs of production, harvesting, and marketing, growers are faced with the difficult decision whether to harvest and store the crop, to wait for a better market, or to cut their losses and leave the crop in the field.

The Process of Harvesting

Harvesting can be separated into three steps. The plant part of interest must be identified, detached from the rest of the plant, and then collected in a container suitable for transport from the field. The harvesting of all the major agronomic crops (grains of cereals and legumes) has been mechanized. The resistance of dried cereal and legume seeds (for example, corn, rice, wheat, and soybeans) to physical damage allows the first and second steps to be combined in a threshing machine or combine that separates the seeds from the rest of the harvested plant. The grain (seeds) is then loaded in bulk containers and transported to silos for additional cleaning, grading, fumigation, and temporary storage.

Community Supported Agriculture (CSA) started in Japan in 1965 and has since spread to many parts of the world. Families buy shares of a season's crop and are delivered food on a weekly basis. Some farms allow shareholders to harvest the food themselves. This family is gathering broccoli. © DAVID MARTINEZ/CORBIS.

In contrast to the dry grains and legumes, most horticultural crops (fleshy fruits such as apples and tomatoes, ornamentals, and vegetables) are hand harvested for the fresh market. Some mechanical harvesting is done, but the damage incurred is usually so severe that the fruits and vegetables are only fit for processing. Some fruits (for example, apple, pear, and tomato) evolved to ensure seed distribution by enticing animals to eat the attractive (in appearance, aroma, and flavor) fruit. Therefore, they are almost always attached to the plant by a specialized structure that contains an "abscission zone" which permits the ripe fruit to be easily separated from the tree. Other fruit, such as bananas, citrus, peppers, and all vegetables (for example, cabbage, broccoli, carrots, lettuce, and squash) do not develop an abscission zone and must be cut from the plant.

Only human beings have the unique combination of eyes, brain, and hands that permits the rapid identification and harvest of delicate and perishable materials with minimal loss and bruising. Some mechanical aids such as cherry pickers, ladders, picking bags or baskets, stem clippers, and wheelbarrows are used by harvesters to make their work easier, faster, and safer. Harvesters can be trained to select only those fruits or vegetables that are of the correct maturity, size, or shape, thus greatly reducing the amount of material that must be removed on the sorting and grading line in the packing shed. In fact, many vegetables and berries are harvested directly into retail containers without further sizing or grading. Most other horticultural crops are harvested into field bins that are taken to packing sheds where the commodities are cleaned, sorted, graded, inspected, packed, cooled, and stored before being transported to regional markets.

The Social Importance of the Harvest

The time of harvest is one of the most important phases of the agricultural calendar since it marks a point in time when the crops have survived natural disasters and are ready to be gathered in. The period in late summer just before the harvest could be a time of famine because of poor harvests the preceding season or an inability to store food from the last harvest. It is not surprising then that the fall harvest festivals were such joyous times, for they heralded the end of this all too frequent seasonal famine and ushered in a time of plenty. There have been harvest celebrations for as long as people have gathered seasonally abundant food for storage and later consumption. Cultures as diverse as the Chinese, Egyptian, Greek, Hindu, Mayan, and Roman developed elaborate harvest customs that included songs, rituals, prayers, and special dishes.

Thanksgiving Day is perhaps the most universally observed harvest ritual in the United States and Canada, although these days are not communal in the sense of traditional village feasting. In the United States, Thanksgiving Day celebrates the first harvest of Dutch and English settlers who arrived in America almost four hundred years ago aboard the *Mayflower*. About fifty years before these Pilgrims, the observation of another Thanksgiving Day was started in what is now Newfoundland. Centuries later they were recognized as official holidays in their respective countries. However, for thousands of years before the European invasion, Native Americans had developed many traditional harvest celebrations. The Wampanoag Indians who inhabited the site occupied by the Pilgrims had three thanksgiving harvest festivals during the year: one for the maple tree and its syrup, one for picking berries, and one for the food they had grown and gathered that year.

County and regional fairs were often scheduled after the harvest so local farmers could sell some of their harvest to merchants, exchange experiences about the previous season, learn new farming techniques, exhibit their finest crops, compete for awards, and generally engage in a communal celebration. Other harvest-related events included parades, special religious services, and a large feast with traditional native dishes. In North America these include cranberry sauce, pumpkin pie, succotash, sweet corn, pecan pie, turkey, and wild rice stuffing. Succotash is a native North American dish that can be prepared today by combining whole-kernel sweet corn with Lima or broad beans in a sauce made from cream and flour. The cream (1 cup) and flour (¼ cup) are boiled for a few minutes with constant stirring, and then the sweet corn (one cup) and beans (2 cups) are added and the mixture heated for another 8 minutes. Addition of meat stock, bits of meat, green peppers, squash, and seasoning transforms this basic recipe into the many regional variations consumed throughout Eastern North America.

The Harvest Home celebrations of earlier times are dying out as the number of people engaged in farming declines because of mechanization, and as urban populations become disconnected from the actual growing of crops. In the past, the whole rural community worked together to harvest crops before the storms of late autumn arrived. The first or last fruits of the harvest were often accorded special religious significance and either offered to the gods, or kept safe as a talisman to be used to protect the planting of the crop next season. Cutting of the last sheaf and carrying it in procession to shelter symbolized the bringing of the harvest home, and was greeted with great rejoicing accompanied by music, dancing, and elaborate feasting. One of the traditional Harvest Home dishes was frumenty, a wheat pudding made with boiled milk, almond extract, honey, egg yolk, and raisins. The milk (1¾ cup), almond extract (½ teaspoon), and honey (2 tablespoon) are brought to a boil, the heat reduced, and the cracked wheat (1 cup) added with stirring until all the liquid is absorbed (about 15 min.). The yolk of one egg is then stirred in and ¼ cup of raisins is added. The pudding is served either hot or cold.

See also **Feasts, Festivals, and Fasts**; **Horticulture**; **Thanksgiving**.

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Mikal E. Saltveit

HEALTH AND DISEASE. The relationships among food, health, and disease are myriad and complex. We consume food every day, and it provides the resources we need to carry out life-sustaining functions. Hence it comes as no surprise that one's diet can affect profoundly one's daily and long-term physiological health and well-being. Qualities of a diet and the foods that comprise it have the potential to make one sick, but they also can act to reduce one's risk of acute or chronic diseases.

All of the formal medical traditions of the world recognize a close connection between diet and an individual's health. One theme common to Mediterranean, Middle Eastern, and South and East Asian traditional medical systems is the ascription of humoral qualities to foods (for example, foods that are "heating" or "cooling" to the body). In these traditional systems, an individual's diet is manipulated to include or exclude foods with specific properties in order to correct putative humoral imbalances or disease states. In contemporary biomedicine, the link between food and disease most often is articulated with regard to the compositional qualities of foods and the ways that diets high or low in specific foods (and hence nutrients and other plant constituents) have harmful or beneficial effects on the body.

Benefits of Nutrient Diversity

There are numerous ways in which diets comprised of specific foods containing or lacking a given nutrient contribute to health or disease. For example, a diet that includes few or no animal products may result in anemia due to a deficiency in iron and/or vitamin B_{12}. On the other hand, a diet high in animal products but low in fruits and vegetables may contribute to specific vitamin deficiencies. Scurvy (a disease caused by vitamin C deficiency) was recognized first among sailors on long-distance sea voyages, as they had no source of fresh fruits or vegetables. An unprocessed corn-based diet is known to result in the disease pellagra, caused by a deficiency of niacin, one of the B vitamins. Up through the early twentieth century, there was a well-defined "pellagra belt" through the southern United States, where corn was consumed widely.

A diet comprised of diverse foods generally is considered to be the best way to prevent nutrient-deficiency diseases. Early humans lived by hunting and gathering, and they ate a broad array of plant and animal foods, although this varied by season and geography. Modern hunter-gatherers of the Kalahari Desert in southern Africa are known to exploit more than eighty species of plant foods, and no specific nutrient deficiencies have been reported among these groups. However, with the transition to agriculture, which happened in many parts of the world around 10,000 years ago, dietary diversity declined notably as populations began to cultivate a narrow array of staple crops (such as wheat, rice, potatoes, and millet). Iron deficiencies and severe growth deficits due to undernutrition become apparent in the skeletons of early farmers.

Effects of Food Processing

Some of these nutritional problems were resolved as populations evolved different means of processing staple foods that enhanced dietary nutrient profiles. Indeed, in the postagricultural period, food-processing techniques became crucial for reducing the negative health impacts of reliance on a few foods. Native populations of the Americas that had a long tradition of reliance on maize (corn) prepared it in such a way as to avoid the problem of niacin deficiency. Corn was boiled in a solution containing lime (calcium carbonate, ash, etc.); this process resulted in the liberation of niacin from an undigestible complex, and also improved the food's amino-acid balances. When corn was introduced to Europe during the Columbian period, the lack of a tradition for its processing led to outbreaks of pellagra. A similar example is the leavening of wheat to make bread, or fermentation to make beer. Both of these processes increase the bioavailability of the minerals calcium, iron, and zinc. When soybeans are processed into bean curd, as is common in East Asia, they lose their protease inhibitors, which interfere with protein digestion.

On the other hand, it is also the case that some food-processing techniques—such as heating, boiling, or drying—can destroy vitamins in foods. Vitamin C degrades in the presence of heat and aridity; folic acid and thiamine likewise are sensitive to heat. Some of the other B vitamins break down in the presence of alkaline or acidic conditions. Others, such as vitamins B_6 and B_{12}, are quite stable under most cooking conditions. Milling and polishing rice into smooth white grains, which are valued highly in East Asian cuisine, reduce the protein and thiamine content of rice, and contribute to the risk of the disease beriberi (thiamine deficiency). Industrial processing of foods often reduces their nutrient profile, but many foods, especially those that are consumed widely such as cereals, are enriched to replace lost nutrients. In addition, grilling or broiling meats until they are well-charred has been associated with the production of the chemical compound Benzo(a)pyrene, which has been linked to gastrointestinal cancers.

Nonnutritive Food Components

When diets are derived largely from plant foods, particular combinations of food are known to improve the overall dietary quality, particularly with respect to the balance of essential amino acids. Corn, for example, is low in the amino acids lysine and tryptophan, but in native American cuisine, corn is often combined with legumes that are rich in those amino acids. Likewise, the combination of rice and legumes can provide the full array of essential amino acids. A peanut butter sandwich, a staple in the diet of many American children, contains complementary amino acids from the wheat and peanuts.

However, it is not only the nutrient composition of foods that is relevant to disease. Other qualities of foods —especially plant foods—recently have been found to contain other chemicals that reduce the risk of certain diseases. Phytochemicals derived from plant foods may reduce the risk of some cancers, while others may protect against heart disease and/or diabetes. Some potentially important phytochemicals include polyphenols (in red wine and green tea) and carotenoids (in orange, yellow, and green vegetables). Many of these have been found to have antioxidant effects and may prevent cell damage from oxygen-free radicals. Widespread consumption of red wine has been credited by some with the "French Paradox," the observation that, although the French tend to eat foods high in fat, their consumption of red wine may offset some of the risk of cardiovascular disease usually associated with such diets. Phytoestrogens, a form of isoflavones found in legumes such as soybeans, may reduce the risk of many cancers, especially breast cancer, by binding to estrogen receptors, and these also may reduce bone loss associated with osteoporosis. Proteins in soybeans also may reduce cholesterol levels and thus reduce the risk of heart disease. The organosulfur constituents of garlic may inhibit platelet aggregation and reduce blood lipids, thereby reducing the risk of coronary heart disease. Tannins (found in tea, coffee, cocoa, red wine, and some legumes and grains) and phytates are hypoglycemic, and may contribute to reduced risk of diabetes.

Other plant compounds have links to infectious disease, such as the protozoan disease malaria, which is a common disease (and often life-threatening) in tropical and semitropical areas. Manioc (*Manihot esculenta*; also called cassava or yuca), a widely cultivated root crop in the tropics, contains cyanogens, which appear to inhibit the growth of the malaria parasite in red blood cells. Likewise, fava beans contain vicine, a potent oxidant that disrupts malarial reproduction in red blood cells. However, individuals who are deficient in the enzyme G-6PD (a deficiency most common in Mediterranean populations) are susceptible to the potentially fatal anemia, favism, because their red blood cells are extremely vulnerable to destruction by potent oxidants such as vicine.

Many secondary compounds in plants do not have such salutary effects, or their benefits are tempered by potential negative effects on health. The cyanogens in manioc, lima beans, and other foods can interfere with thyroid function, glucose metabolism, growth and development, and other important physiological functions. Cruciferous vegetables such as cabbage contain thiocyanate compounds that act as goitrogens, and thereby contribute to thyroid disease. Tannins, which are distributed widely among plant foods, inhibit protein digestion and interfere with iron absorption. The ingestion of solanine, a glycoalkaloid found in commercial strains of potatoes that have been exposed to light, or in many wild varieties, can lead to serious gastrointestinal and neurological symptoms. Interestingly, traditional modes of consuming potatoes among Andean populations appear to reduce the risk of solanine exposure; their potatoes are consumed often with a clay-based slurry, which effectively detoxifies them.

Food-Consumption Concerns Linked to Population Profiles

There are cases in which the health effects associated with the consumption of particular foods vary in significant ways among diverse populations. For example, the ability to produce the enzyme lactase (which breaks down the milk sugar lactose) in adulthood is rare among human populations. This ability persists in highest frequencies through adulthood among northern Europeans and pastoral populations in Africa and other areas. Fresh milk consumption played an important role in maintaining health in the history of these populations, and they evolved lactase persistence as a dietary adaptation. When adults with low levels of small-intestinal lactase activity consume fresh milk (the food highest in lactose), they often experience cramps, bloating, diarrhea, and other forms of gastrointestinal distress. This is less of a problem when milk is consumed after processing into yogurt or cheese, as lactose is either fermented or removed during their production.

In populations that only recently have begun relying on wheat production there is a high frequency of celiac disease, an allergic response to wheat protein (gluten). There is some suggestion that African Americans may be more sensitive to salt than are other sectors of the population, and that, consequently, salt consumption by African Americans increases blood pressure and contributes to an incidence of hypertension greater than in other groups.

In the most general sense, both underconsumption and overconsumption of foods can lead to chronic disease. Not surprisingly, these two ends of the consumption spectrum tend to occur in poor and wealthy populations, respectively. It is estimated that more than 1.2 billion people suffer from deficiencies of calories and protein. A similar number suffer from problems related to the overconsumption of calories. Both are associated with deficiencies of micronutrients. It has been suggested that more than half of the world's disease burden derives from nutrition-related sources.

Overconsumption of calorie-rich foods became the norm in wealthy countries during the late twentieth century. Such foods became mass produced, more readily available, and relatively inexpensive. Today supermarket shelves are lined with potato chips, candy, cookies, crackers, soda, and all kinds of other calorie-dense foods. Fast-food restaurants specialize in ever-larger servings of high-calorie foods that are quickly prepared and consumed. Most of these are highly processed, and although they are rich in calories, they are often low in vitamins, minerals, and phytochemicals. It is widely accepted that, when combined with a sedentary lifestyle, diets high in such foods contribute to a broad array of chronic health conditions, most significantly cardiovascular disease (CVD), diabetes, cancer, and hypertension. It is now estimated that more than half of Americans are overweight, and almost one-quarter are obese, which is itself a risk factor for these diseases. In addition, an increasing number of children are now obese, and "adult-onset" (Type 2) diabetes is appearing with alarming frequency in adolescents. More than 75 percent of all mortality in the United States is due to CVD and cancer, but death rates from stroke and heart attacks have declined since the 1970s. This has been attributed, in part, to reduced consumption of saturated fat from red meat, whole milk, butter, and lard. There are several studies indicating that a low-fat diet based largely on vegetables, fruits, whole grains, legumes, with relatively small amounts of animal protein (especially from fish) is associated with increased longevity and reduced risk of chronic disease.

Problems related to the overconsumption of high-calorie foods are not unique to the industrialized world. As countries are integrated into the global economy and populations increasingly become urbanized, there has been a global shift in dietary patterns and health conditions that appear to accompany those new consumption habits. Interestingly, such changes are remarkably consistent across countries, and may reflect a panhuman preference for foods rich in calories, which historically have been quite limited in the diet. Generally the consumption of fats and sweets has increased, and the use of traditional whole-grain foods and traditional modes of processing has declined. Fast-food outlets such as Kentucky Fried Chicken and McDonalds have become ubiquitous in urban centers throughout the world. Active lifestyles are being replaced with sedentism, as people move away from subsistence agriculture into clerical and factory jobs. As a result, the chronic diseases that heretofore had predominated in wealthy industrialized countries are becoming globalized. For example, the global diabetes rates seen in 2000 are expected to double by 2025, with the majority of that growth occurring in developing countries.

On the other hand, undernutrition, also referred to as protein-energy malnutrition (PEM), often occurs under conditions of food scarcity and is associated with a wide range of negative health effects. More than 10 percent of the world's population suffers from chronic hunger, and undernutrition may be responsible for as many as twenty million deaths per year. It is important to realize that hunger is not the result of too little food being produced for too many people in the world; it is essentially a problem with the way that food is distributed unevenly among the world's populations. Children are especially vulnerable to PEM, as they have higher protein and energy needs per unit of body weight than do adults. When calories and protein are chronically scarce in childhood, permanent stunting and retarded development occur. In its acute form, PEM results in wasting (dramatically reduced weight relative to height) and it is potentially fatal. More routinely, PEM increases vulnerability to infectious disease, since energy, protein, and certain vitamins and minerals play crucial roles in immune function. In environmental contexts in which infectious disease (especially diarrheal disease) is common, the combination of PEM and infection can provoke a rapid deterioration of health that can lead to death. A common stage for this progression to manifest itself is weaning, the period when children make the transition away from breast milk (which contains nutrients and disease-suppressing maternal immunoglobulins) to an adult-type diet. It is not uncommon for children to become more vulnerable to infection when they are weaned prematurely and are unable to consume sufficient nutrient-dense foods to maintain growth.

In the 1800s, baby bottles were developed and cow's milk was developed into infant formula as an alternative to breast milk. The practice of formula-feeding peaked in the United States in the years following World War II; breast-feeding is now on the rise again in most parts of the world, although it remains uncommon past the early months in most industrialized countries. Most research amply demonstrates the health benefits of breast-feeding: substitution of formula for breast milk is associated with increased risks of numerous health problems including SIDS (sudden infant death syndrome), ear infections, diabetes, breast cancer, and allergies.

Controversy erupted in the early 1970s over the promotion of formula by multinational corporations in the developing world. Formula was marketed heavily and inappropriately, and health personnel began to encourage mothers to feed their children formula rather than nurse them. Formula, which was costly, often was prepared in dilute form with contaminated water. Its use in this way increased infant morbidity and mortality and generated much attention among the media and international health organizations, ultimately resulting in a ban on formula promotion by multinational corporations.

As the links between diet and disease have become more widely known, there has been a trend toward more healthful eating habits in industrialized societies. However, this trend is not uniform within such populations. Numerous studies have shown that obesity, the eating habits that contribute to it, and the diseases associated with it, especially diabetes, have increased among lower socioeconomic groups. The reasons behind this trend are complex, but as noted above, foods high in starches, fats, and sugars are now cheap and readily available. Those high in protein (meat, dairy products) and fresh fruits and vegetables are relatively less accessible and more expensive, and are consumed less commonly by the poor. Moreover, in the United States, fast-food outlets are locating preferentially in areas serving poorer communities. This has led to the curious, yet commonplace, phenomenon in wealthy countries whereby weight is correlated inversely with wealth. Historically, of course, the reverse would have been the case, as is still evident in many developing countries.

See also **Anthropology and Food; Baby Food; Disease: Metabolic Diseases; Fast Food; Food Politics: United States; Lactation; Malnutrition; Medicine; Milk, Human; Niacin Deficiency (Pellagra); Nutrients; Nutrition; Obesity; Paleonutrition, Methods of; Political Economy; Population and Demographics; Salt; Sodium; Vitamins.**

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HEALTH FOODS. The concept of "health food" is attributed to the 1830s Popular Health movement whose founders included Sylvester Graham, father of graham crackers. Reacting against professional medicine, the movement emphasized temperate living, lay knowledge and health care, and health foods as part of the broader feminist and class struggle. A simple vegetarian diet, including whole wheat, and exercise were promoted for physiological and spiritual reform to a more natural, uncomplicated life. Meat, white flour, and alcohol were among the stimulating sinful foods.

John H. Kellogg and his brother Will were the first to become millionaires from "food faddism" (Herbert and Barrett, 1981, p. 87). The Seventh-Day Adventists founded a religious colony and sanitarium at Battle Creek, Michigan, where Kellogg's clients "detoxified" via enemas and high-fiber diets, including cornflakes. By 1899, the Kellogg cereal company's cornflakes competed with Post Grape-Nuts, the latter a supposed cure for appendicitis, malaria, consumption, and loose teeth. Charles W. Post was a former Kellogg patient. Kellogg and the Post Division of General Foods remain giant cereal manufacturers.

While scientists quantified protein, carbohydrate, fat, and later the vitamin and mineral composition of food in the late 1800s and early 1900s, agriculture and industry augmented production. Public health sanitation and vaccinations minimized infections, and the increased stable food supply fed a growing population more fit to work the factories, farms, and military. As home economists taught the nutritional food groups recommended by the U.S. Department of Agriculture (USDA), profiteers promoted grander elixirs via speeches, newspapers, books, magazines, and doctors, dentists, and chiropractors with dubious degrees.

Beginning in 1906, the Food and Drug Administration (FDA) restricted health claims on food and drug packaging, but marketers could nevertheless exercise free speech by offering information in books, magazines, and brochures. *Prevention* and *Let's Live* magazines began publication in 1950 and 1933, respectively; the latter was initially called *California Health News.* They promoted vitamins, food preparation, and exercise and warned of pollution dangers. In the era of World War II victory gardens, Rodale Press began publication of *Organic Gardening and Farming* in 1942; this later became *Organic Gardening* and then simply *OG*. In 1980, Rodale Press grossed $80 million with 2.4 million *Prevention* and one million *Organic Gardening and Farming* subscribers (Herbert and Barrett, 1981, p. 99). Amway, Shaklee, and Neo-Life used door-to-door sales to distribute high-priced vitamins with brochures and books; in 1980 these three companies grossed about $700 million from food supplements (Herbert and Barrett, 1981, p. 22).

Health Food and the Counterculture

The 1960s and 1970s counterculture youth questioned the political and economic values of capitalism and experimented with alternative lifestyles. University students created community gardens, cooperative grocery stores, health-food restaurants, buying clubs, and organic farms. Ecology and health food became "cool." Notions of balance were sought from formerly less acknowledged ecological studies and from Eastern or Native American philosophies. In the early 1900s, USDA staff had explored sustainable Far Eastern agricultural practices, but these foods and methods received little attention until organic farming became popular in the 1960s and 1970s. Brown rice, wheat germ, honey, nuts, sprouts, and Eastern foods like yogurt, hummus, falafel, tofu, and stir-fried vegetables were considered healthy, and environmentally sound if they were produced locally and organically. Vegetarian diets, of the non-red meat, lacto-ovo, macrobiotic, and vegan varieties, were adopted to eat low on the food chain or to avoid killing animals. Sugar, white bread, and red meat were considered unhealthy.

The health-food business recognized a market in the counterculture. Adelle Davis, with books like *Let's Eat Right to Keep Fit*, promoted vitamins and natural foods to prevent psychological metabolic disorders as well as cancer. The Atkins Diet promised thinness through consumption of protein foods, fruits, and vegetables, but few carbohydrates. While exploring non-Western religions and cultures, youth tried ethnic foods, spices, herbs, and recreational drugs. While ethnic variety entered American cuisine, doctors bemoaned the fact that people were not seeking medical treatment but were using useless or harmful herbs and concoctions. Laypeople sought self-reliance over "the establishment" with traditional natural products to achieve holistic mental and physical health.

The professional certification of Registered Dietitian became required by many states in the 1970s and 1980s. In 1973, the FDA required enriched or fortified foods to be labeled with ingredients and Recommended Daily Allowance values for protein and seven essential vitamins and minerals.

Small-Scale to Global Mass Marketing

By the 1990s, as the counterculture matured, health-food issues saw compromise such as more integration of nutrition and preventative medicine in medical practice, or scientific evaluation of physiological properties in food beyond macro- and micronutrients. International conservation-development projects found wide use of herbal medicines to the extent that the World Health Organization promoted traditional medicine to cut health-care costs. The U.S. National Institutes of Health researched herbal medicine claims. A recent *Physicians' Desk Reference* describes herbal uses and contraindications. FDA food label regulations gradually permitted scientifically tested nutrient content claims (for example, "low-fat," "high fiber"), structure/function claims (for example, calcium aids in the growth and maintenance of bones), and a few health claims (for example, calcium reduces the risk of osteoporosis). In December 2000, the USDA defined national organic food standards to regulate health-food claims and to facilitate national and international trade. U.S. organic food sales increased from $178 million in 1980 to $1 billion in 1990 and $7.8 billion in 2000 (Mergentine, 1994, p. 164; Myers and Rorie, 2000).

Natural product sales (including whole foods, organics, supplements, and household products) grew from $1.9 billion in 1980, to $4.2 billion in 1990, and to $32 billion in 2000 (Spencer, 2001). Small cooperative health-food stores persisted, but large "one-stop" natural grocery stores opened in the 1980s and 1990s. Convenience attracted the "hippie" become "yuppie" professionals who retained health and environmental concerns but had little time to produce, obtain, or cook food. Mergers and acquisitions occurred as conventional food conglomerates bought out natural food product lines or whole companies. Regular chain grocery stores carried more organic foods besides conventional foods. The Internet provided both health-food magazine and retailer advertising as well as access to university and medical school websites. The Internet health-food market was initially profitable, but plateaued with delivery limited to nonperishables. Scientifically verified "functional foods" became popular, whether in regular meals, sports foods, or weight reduction. Consequently, antioxidants, fatty acids, phytoestrogens, flavinoids, pro- and prebiotics, are now promoted in a Functional Food Pyramid, mirroring the conventional USDA food pyramid adopted in 1992. Both nutrition education models acknowledge growing scientific evidence that fruits, vegetables, and grains are important to health, with lower emphasis on animal-derived food, compared to the Four Food Groups model used since 1958.

"Functional food," "designer food," and "nutraceutical" are used interchangeably. This is problematic in global trade regulation since food and drugs are compartmentalized differently in international regulatory agencies. Functional food is conventional food, but demonstrates physiological benefits and/or reduces the risk of chronic disease beyond basic nutritional functions. A nutraceutical is a product produced from foods but sold in pill, powder, and other medicinal forms not generally associated with food and demonstrated to have physiological benefit or provide protection against chronic disease (Stephen, 1998, p. 404). The American Dietetic Association classifies all food as functional at some physiological level, but suggests that "functional food" includes unmodified food as well as modified food. While some sports enthusiasts or dieters favor modified processed foods with higher nutrient content, many Americans and Europeans buy organic foods because they worry about allergic reactions and environmental hazards caused by genetic modification.

See also **Functional Foods; Kellogg, John Harvey; Natural Foods; Nutraceuticals; Organic Foods; Vegetarianism.**

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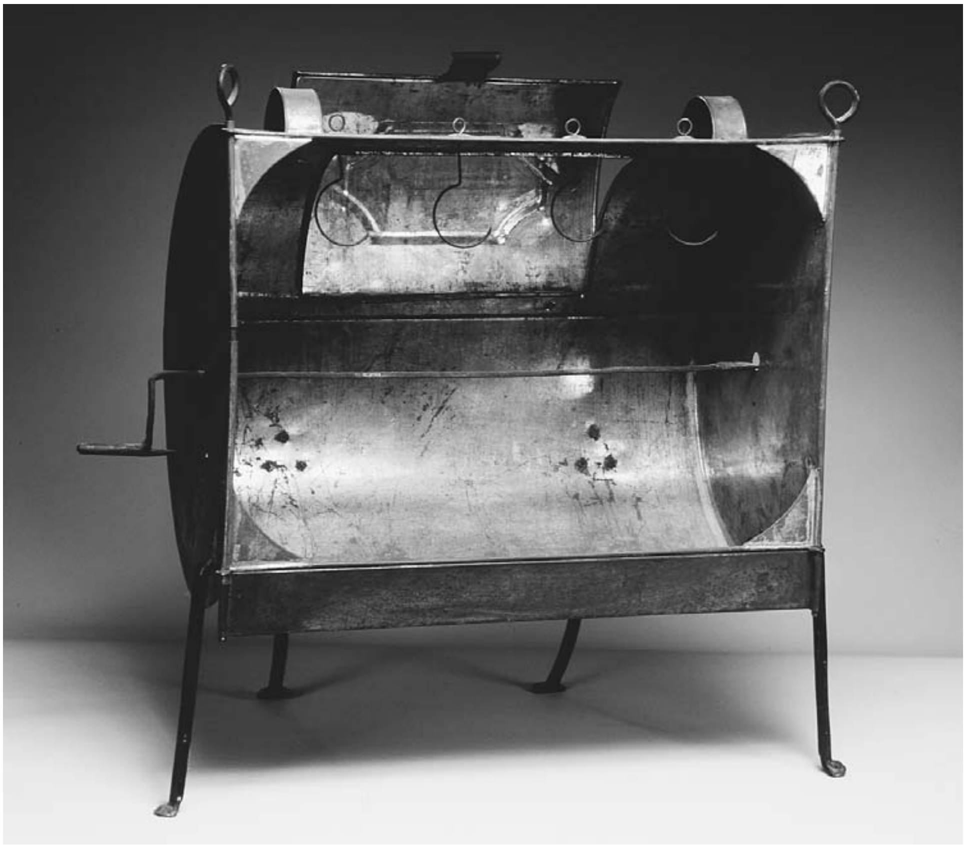
HEARTH COOKERY. The field of hearth cookery, in its most general sense, is immensely broad, encompassing standard kitchen practice from ancient human settlements to present-day cultures throughout the world. The twentieth century has seen the growth of this new study as historians and social and physical scientists worldwide have found it a source of illumination in traditional areas of research. Among them, one thinks of gender and work, family structure, economics and status, technology, ethnicity and acculturation, and health. Growing numbers of interdisciplinary publications attest to its value, as does its use in living history museums throughout the world. The traditional foods of the hearth have become fashionable in barbecue pits and smokehouses of both professionals and aficionados, in the recreated foods of brick-oven pizzas and artisanal bakeries, and in the restaurants of imaginative chefs using their dining-room fireplaces to simultaneously cook for their patrons and entertain them.



Reflector oven for open hearth cooking. Philadelphia, ca. 1855. Tin and cast iron. Joints of meat were roasted on the spit, which was turned by hand. In England, these implements were referred to as Dutch ovens. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Despite vast differences between ethnic cuisines, this far-flung cookery practice may be described as a relatively simple array of basic cooking utensils used at a hearth, or fire-site. The hearth was usually situated at floor level and held the burning fuel (chiefly but not exclusively local wood); the flames, embers, and radiating heat did the work. More the exception than the rule, a few cultures developed convenient raised hearths, often built eighteen inches or so above floor level; despite this variation, the utensils and cookery principles remained the same. Where fuel was abundant, home brick or clay ovens were used as well. Until relatively recent innovations in fuels and technologies, hearth cooking was the predominant way (indeed, often the only way) of cooking.

The American Hearth

American hearths have existed since the Stone Age in various degrees of modernization. Pre-Columbian Native American cookery sites were usually simple, their utensils often fashioned artfully from natural substances—wood, clay, stone, bone, shell, and hide. The family cooking site was generally out of doors and typically consisted of a flat stone-lined shallow pit, sometimes holding a small tripod of stones to support rounded clay pots or stone griddles. This was commonly augmented by deeper cooking pits in which food was buried for steaming, and with smoking and roasting racks of wood. Indoor cookery, appropriate for inclement seasons or for security, was a simplified version in which smoke escaped through the roof.

The earliest Europeans in the New World brought a working concept of the hearth that was in many ways similar and had in common frequent use of clay pots, tripods or legged trivets, large rounded forms, and flat griddles. Major differences were largely a consequence of the Old World metallurgy hitherto unknown in the Americas, and they added clear advantages of strength, transportability, durability, and more subtle heat transmission.

Seventeenth-century American colonists, following European architectural innovation, improved on their earlier floor fires and roof smoke holes by installing fireplaces with extended stone or brick hearths and chimneys. This new workspace was safer, more flexible, efficient, and comfortable, but hardly simple. As temperatures directly over the flames often exceed 600°F

The Dutch Oven

The history of certain pot forms is informed by early recipes. The following cooking directions seem to suggest an early Dutch oven, and what was also known as "bake kettle" technique.

> *"To bake an apple [egg] fritter" . . .*
> place a little fire on the lid and let it bake this way."

—*De Verstandige Kok (*The Intelligent Cook*), Amsterdam, 1683*

One hundred fifty years later, Mary Randolph described the use of a Dutch oven as a *bain marie* in her recipe:

> "To Make Custards
> Fill the custard cups, put on the covers, and set them in a Dutch oven with water, but not enough to risk its boiling into the cups, Do not put on the top of the oven."

—Mary Randolph, *The Virginia Housewife*, 1824, p. 180

(315°C), control of cooking temperatures was a technological challenge. Small three-legged clay, bronze, or iron pots were perched over small subsidiary fires or piles of glowing embers shoveled from the main fire onto the hearth. In addition, horizontal lug poles were installed high in the chimney; and from these hung iron trammels of several designs, their adjustable hooks capable of suspending pots at variable levels. The cook "turned" the temperature up or down by moving pots toward or away from the heat. In the early eighteenth century, innovative swinging cranes added the possibility of adjusting hanging pots and their contents without the work of lifting them.

Fire and Heat Management

Hearth cooking was characterized not so much by the recipes, which varied widely according to time and place, as by general knowledge of fuels and heat regulation and the maintenance of steady heat in the face of ever-changing temperatures. Fires waxed and waned as fuels ignited, blazing up into flames, and then subsided into glowing coals or embers. Good cooks used this varying heat to advantage, shifting pots according to the state of the fire and the needs of the dish. For example, when boiling water, one hung the kettle close to the hottest flames, but when warming milk (which burns easily), one set the pot on the hearth away from the scorching temperatures and, along with stirring, may have rotated it 180 degrees periodically for even cooking.

The experienced cook judged cooking temperatures with sensory clues—visual, auditory, olfactory, and tactile. Heat was estimated repeatedly through the cooking processes by holding one's hand between the fire and the pot, by the sounds of frying or boiling, and by the appearance of the coals.

Fuels

Fire temperatures were regulated by the choice of fuel. Most pine burns cool; osage orange and sassafras are very hot. Hard woods (for example, hard maples, oak, fruit, or nut), aged and split, were most desirable, but not without cost. In the American colonies, where wood was often abundant, firewood production demanded long hours invested in felling trees and then cutting, hauling, splitting, and stacking. Yet even with this apparently unending richness, there were places where people were forced to cook over peat (by the mid-eighteenth century, Long Island had depleted its forests) or buffalo chips (the prairies). These situations paralleled those of Ireland, India, China, and nomadic Asia, where similar substitutions were necessary. Consequently, the roaring kitchen fire, a necessity for producing beds of coals, was desirable but not always standard. Wood for cooking fires was sometimes conserved by fine splitting, which had added advantages of efficiency, faster ignition, and more responsive heat replenishment. In combination with flames and embers, assorted sizes of wood enabled the cook to prepare a number of dishes at one time, each pot at its most appropriate temperature.

In maintaining desired warmth, a variety of techniques involved adding, removing, and resituating fuel. For example, a log set into the flames creates a temporary barrier and a cool spot above it; but as it catches fire, it creates a hot spot. Similarly, enlarging the air channels inside the fire increases its rate of burning, while consolidating the fuel and cutting off air supply slows it down.

The Pots

The pots and their technologies were also players in temperature maintenance. Colonists imported or manufactured the designs from home that traditionally worked well with fire, and incorporated special features that added to their effectiveness. Some pots had their own legs for straddling the coals, or used high cooking trivets for that purpose. Larger kettles also incorporated swinging bale handles that hung them from a trammel and crane S-hooks. Many had rounded or bulbous bottoms that transmitted the heat evenly, without the angular corners in which food could burn. Their long handles allowed the cook to avoid the blasting heat of the central fire, as did a variety of long-handled forged hand utensils (spoons, ladles, skimmers, turners, forks, etc.). Like European antecedents, they were made of iron, brass, bell-metal, copper, tin, and ceramics. One New World adaptation, the cast-iron "American Dutch oven," boasted a heavy deep-rimmed lid to hold coals above and three stilt legs to straddle coals below.

Basic *batteries de cuisine* included assorted cast-iron kettles, water kettles, spiders (frying pans), posnets (saucepans), and griddles, as well as open kettles and pans of cast brass or bell-metal. These heavy pots worked well with wet cooking techniques. However, for dry-heat cookery and high-temperature processes such as frying and broiling, hand-forged metals, being better conductors, were formed into spiders (frying pans) and gridirons (broilers). Tin reflecting ovens made superlative roasters. An array of these pots was common in middling or average kitchens. One's economic status was reflected in the range of utensils: where less fortunate families were perhaps limited to a cooking kettle, water kettle, and frying pan, privileged families owned larger assortments and varied sizes of the basics, supplemented with specialized equipment such as wafer irons, chafing dishes, mounted clock jacks to turn roasts on heavy spits, decorative copper or ceramic molds, or hand-forged geared grinders.

The Cuisine

Cooking with fire has always had the potential for both simple and complex cuisines. The simple hearths of remote and rural areas or those of people of modest means have produced the one-pot dishes (simmered soups, porridges, or stews), roasted meats, and simple baking that have been the mainstay of daily cooking everywhere. At the other extreme are the culinary heights of the Roman and Ottoman empires, Persia, India, China, Mexico, France, and Italy, in which simple equipment and fuel have been no obstacle to fine sauces and elaborate confections. The early introduction of bronze and iron utensils in wealthier and more cosmopolitan urban civilizations enlarged the range of their hearths, enabling such possibilities as the high-temperature deep-fried *kunafa*, a crisp medieval Arabic bread. To this day, the hearth remains the center of food preparation in both primitive and modernized homes throughout the world and figures in such basic preparations as lightly crisped, griddle-baked Mexican tortillas or Moroccan flatbreads.

The average colonial American cook of moderate means had the skills and resources to turn out complex family meals, undaunted by fire-tending, stooping to floor or crane levels, and relatively primitive equipment. Her success actually had little to do with hearth limitations, depending more on the time of year and seasonal homegrown food availability, on access to imported ingredients (in particular, sugars, spices, and other flavorings), and on the amount of time and help she had for preparations. Seventeenth- and eighteenth-century European cookbooks used in the colonies show a wide array of recipes and varied techniques, among them boiling, simmering, roasting, frying, sautéing, fine baking, preserving, and candying.

Fireside Cookery

The following is a selection of wonderful recipes from the original eighteenth- and nineteenth-century sources:

Batter Cakes

"Boil two cups of small hominy very soft and add an equal quantity of corn meal with a little salt, and a large spoonful of butter; make it into a thin batter with three eggs, and a sufficient quantity of milk, beat all together some time, and bake them on a griddle or in waffle irons . . ."

—Mary Randolph, *The Virginia Housewife*, 1824, p. 171

Wafers

"Make a very thin batter with eggs, milk, butter, and powdered loaf sugar, to your taste; pour it into wafer-irons, bake them very quick, without browning; roll them as you take them from the irons."

—Mary Randolph, *The Virginia Housewife*, 1824, p. 173

Not all fireside cookery was that simple. This somewhat more complex dish was offered by Hannah Glasses's *Art of Cookery,* 1747.

A Jugged Hare

"Cut it in little Pieces, lard them here and there with little Slips of Bacon, feafon them with a very little Pepper and Salt, put them into an earthen Jugg, with a Blade or two of Mace, an Onion ftuck with Cloves, and a Bundle of Sweet Herbs; cover the Jugg or Jar you do it in, fo clofe, that nothing can get in, then fet it in a Pot of boiling Water, keep the Water boiling, and three Hours will do it, then turn it out into the Difh, and take out the Onion and Sweet Herbs, and fend it to the Table hot."

—Hannah Glasse, *The Art of Cookery*, 1747, p. 50

By all historical accounts, among them Karen and John Hess's *The Taste of America*, and the experiences of such food historians as Sandra L. Oliver in recreating these recipes today, the food of accomplished early cooks met the highest standards of the modern palate. For example, roasting even unseasoned fowl and red meat in an open tin reflecting oven set against the fire produced a product far superior to that of its modern gas or electric counterpart. The technique produced a juicy and tender texture, good crust or skin, and slight smokiness, and generally enhanced natural flavor. Likewise, one's daily cornbread, prepared in a heavy Dutch oven, boasted

Kitchen Equipment

The nineteenth-century overlap of hearth and cookstove technologies is most apparent in early trade catalogs. For example, *Catalogue of Savery & Co.'s Castings* (Philadelphia: circa 1855) offered assorted stovetop griddles and kettles (flat bottoms, no legs), and various three-legged hearth pots such as skillets, griddles, kettles, Dutch ovens, and spiders (pp. 4–25).

delicate moistness and a wonderful crust unequaled in modern ovens.

American Hearth-to-Cookstove Transitions

In the 1790s, when over 90 percent of Americans were farming, hearth cooking was the sole means of meal preparation in both countryside and city. With the growth of cities in the nineteenth century and the gradual introduction of cookstoves, it survived in closest association with rural life. The new cookstove, developed and popularized in growing cities by 1850, presented a major force in women's changing social roles and the cuisine, but for many years kitchens reflected an overlap in the use of these technologies. Well into the twentieth century there were still communities, notably in remote areas of Appalachia, where hearth cookery sustained life.

The earliest kitchen hearths were associated with relatively small homes in which they were the focus of the house, and the center of much work and socializing. They offered not only cooking heat, but also a warm wintertime house. In time, and with the trend to enlarging American homes, they were distanced from expanded specialized dining and living rooms. At times they were relegated to a separate building (especially in the South and on wealthy farms or plantations), as families sought to remove themselves from the sounds, smells, and dangers of the work. The passing of the hearth in favor of the cookstove was not always lauded; some average families mourned the loss of the congenial kitchen fireside, fearful that both the cuisine and the family were doomed.

Social Implications

The experience of contemporary hearth cooks has added to the correction of past assumptions and misconceptions; for example, the experienced home cook could indeed produce delicious complex meals on a daily basis. There was no inherent danger in long clothing—to the contrary, the natural fibers did not flame (only smolder), while skirts and sleeves provided comfort, insulating the body from the heat. There was more threat from tipped kettles and scalding.

In addition, the activity has reinforced the concept of a strong family unit: despite gender work divisions, there were clear advantages to social cooperation—the quality and quantity of family food depended on it. The large body of economically viable skills and knowledge that were specifically women's, the oral tradition of recipe and cookery transmission, the time and strength required, the daily distinctions between drudgery and creativity, and the need to juggle hearth tasks with other necessary chores are only some of the areas informing the current interpretation of social history.

If nothing else, in pinpointing individual and family behavior, it supports a strong case for individualization that surviving cooking manuscripts do not convey.

See also **Iron Cookstove, The**.

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Alice Ross

HÉDIARD, FERDINAND. Born in Loupe, a village near Chartres, Hédiard (1832–1898) became interested in the world of imported foods at a young age when he discovered at the port of Le Havre all kinds of cargo from Martinique, Haiti, Guadeloupe, and the Lesser Antilles, all part of the colonial French empire at the time. Fired with the mission of introducing the French to the food wonders he had experienced as a young boy, he opened his first store at the age of twenty-three, in 1850. In 1854, he opened a larger store, which he called "Comptoir d'épices et des Colonies," (trading post selling the products of the colonies), in effect, the first French grocery store. He imported island commodities such as rum, cacao, coffee, bananas, and other tropical fruits and made them all available to a public—including the painter Eugène Delacroix, who lived in the neighborhood—that had never experienced such a taste of the exotic.

As the French empire expanded, Hédiard's business grew. He made a big splash exhibiting the pride of his importations at the 1867 Paris World's Fair, and in 1880 he opened another store in Paris, much more fully realized than the first, at 21 place de la Madeleine, where the flagship store still stands. In 1889, he penned a book of recipes (still in print) to show off the best use of his exotic products. Over its long history, the store has drawn the notice of the rich and famous, such as the writers Alexandre Dumas, Colette, and Jean Cocteau; performing artists such as Jean Gabin, Marlene Dietrich, and Charlie Chaplin; and a loyal following of princes, maharajas, and politicians.

Upon his death, he left the business to his daughter Marie-Blanche and her husband, Max Kusel, who operated it for a time, after which a series of owners have continued the operation in expanded but somewhat changed form.

In 1920, the store's pastry chefs developed a special line of marzipan candies. In 1935, what became the store's signature gold-foil-wrapped packages were developed. The store was modernized in 1950. In 1969, to handle the growing demand worldwide for the Hédiard line, a facility near Nîmes in the Gard Valley opened for the artisanal production of jams, conserves, fruit pastes, glacéed fruits, and other products. Expansion to five additional city locations throughout Paris and three locations in the suburbs followed in the 1970s. To commemorate the 150-year anniversary, a restaurant was opened at the place de la Madeleine location. Since 2001, an Hédiard website is bringing the world to Hédiard—not bad for a company founded by a man who never left French soil.

See also **Candy and Confections**; **Chef**; **France**; **Retailing of Food**.

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HERBICIDES. Weeds have been deemed undesirable during much of human history for their negative influence on crop production, their unsightly appearance in the landscape, and in some cases their toxic properties and negative effects on human and animal health. Consequently, weed control is as old as the discovery of agriculture, eight to ten thousand years ago. Techniques for weed control have progressed from the employment of intensive human labor to complex systems involving mechanical, chemical, and biological methods. The earliest methods to eliminate weeds involved physical removal by grubbing or hoeing, followed by cultivation practices using first draft animals and then tractors. Since 1945, the use of chemical herbicides has become the predominant weed control technique in many parts of the world.

Chemicals have been suggested for weed control since antiquity. Theophrastus (372–287 B.C.E.) mentions killing trees by pouring olive oil over their roots. Cato (234–149 B.C.E.) advocated the use of amurca (the watery residue left after the oil is drained from crushed olives) for weed control. Other chemicals include sodium chloride, sulfuric acid, sodium arsenite, copper sulfate, iron sulfate, carbon bisulfate, arsenic trichloride, and petroleum oils. The first synthetic herbicide, 2-methyl-4,6-dinitrophenol (dinitro) was developed in France in 1932 for selective weed control in beans. In 1940 ammonium sulfamate was introduced for control of woody plants.

The chemical herbicide age began in 1941 when R. Pokorny first synthesized 2,4-dichlorophenoxy acetic acid (2,4-D) and reported that it had growth-regulating effects on plants. E. J. Krause of the University of Chicago later suggested that 2,4-D might be used to kill weeds, which stimulated research to test this and other newly synthesized chemicals for weed control in the field. These herbicides proved effective, and in 1945 the American Chemical Paint Company was awarded a patent for 2,4-D as a weed killer. The great potential of synthetic herbicides to control weeds and reduce human labor stimulated the birth of the herbicide chemical industry, resulting in the development of over 180 herbicides for weed control by the end of the twentieth century.

Herbicides are now primarily developed in the private sector. Chemists typically synthesize a variety of compounds, which are screened for their ability to control weeds and then modified and formulated for efficient use. Present herbicides tend to have very low mammalian toxicity because they inhibit biochemical pathways that are unique to plants.

There are a number of chemical classes of herbicides and various mechanisms by which herbicides kill plants. Herbicides generally act by inhibiting specific cellular functions, including photosynthesis, plant-specific amino acid biosynthesis, pigment formation, shoot and root growth, cell membranes, cellulose biosynthesis, lipid biosynthesis, and growth hormone activity.

Herbicides may be applied in many ways. Some herbicides are applied to the soil and absorbed by the plant root and/or shoot and move to their site of inhibition within the plant. Others are primarily applied to emerged foliage and either have an immediate contact effect on the foliage by burning or desiccation, or are translocated throughout the plant, leading to total plant death (systemics). Most soil-applied herbicides kill weed seedlings as they emerge from the soil, while foliage-applied herbicides control emerged weeds and can kill quite large plants.

Herbicide selectivity, the ability to kill weeds but not crops, can be accomplished either by directed application or through biochemical mechanisms. Placement of the herbicide to avoid contact with the crop is widely used. For example, tree crops with deep roots often do not absorb soil-applied herbicides. While it is an effective herbicide for killing most broadleaf plants (dicots), 2,4-D is ineffective on most grassy weeds (monocots). This makes it useful in monocot crops, such as grains and turf. Others selectively kill monocot grasses but not dicots, making them effective in crops such as soybean. Some crops metabolize an applied herbicide to an inactive form while the weeds cannot, so the weed is killed, but the crop is not harmed. For example, atrazine is metabolized to an inactive form by maize while weeds are killed.

In many weed and crop situations there are no good selectivity mechanisms for herbicides. With the advent of recombinant DNA technology (genetic engineering) certain crop plants, such as soybean, corn, and cotton, have been made resistant to nonselective herbicides such as glyphosate by adding genes that make the crop immune to the herbicide. This technology is expected to increase, though its rate of acceptance has been slowed by the reluctance of the food industry to utilize transgenic crops because of concerns expressed by certain consumer advocacy groups.

Modern agriculture in the United States is almost inconceivable without the use of herbicides. Herbicides reduce labor inputs for weed control and make it possible to control weeds where cultivation is infeasible. They reduce the need for mechanical cultivation that can injure crop plants and lead to soil degradation via structure loss and compaction. Herbicides allow the use of no-till crop production, which reduces the need for plowing, now considered a destructive practice. Efficient weed control improves crop growth by reducing weed competition for nutrients and water, and results in improved harvesting and crop quality.

A Source of Controversy

Despite the obvious advantages of herbicides, their use has raised concerns relating to human health and the environment. Since herbicides are toxic to plants, critics have questioned their toxicity to other organisms exposed directly or indirectly. The persistence of some herbicides in the environment has led to concerns relating to their carryover in the soil and effects on subsequent crops as well as their influences, due to drift or volatilization, on non-target plants. Furthermore, through repeated exposure to herbicides, many weeds have become resistant, which reduces the efficacy of previously effective herbicides.

Other concerns involve herbicide costs, the requirement for additional equipment for precision application, and questions relating to proper disposal of unused herbicides.

The advantages and disadvantages of herbicide use are thoroughly evaluated by the U.S. Environmental Protection Agency (EPA) prior to registration and labeling of any new compound. All new pesticides must be granted a registration, permitting their distribution, sale, and use. The EPA assesses a wide variety of potential human health and environmental effects associated with use of the product, including the particular site or crop on which it is to be used; the amount, frequency and timing of its use; and recommended storage and container disposal practices.

In evaluating a pesticide registration application, the registrant must provide data from tests done according to specific EPA guidelines conducted under recognized “Good Laboratory Practice.” Results of these tests determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish, or plants, including endangered species and non-target organisms, as well as possible contamination of surface water or groundwater from leaching, runoff, and spray drift. The potential human risks evaluated include short-term toxicity and long-term effects, such as cancer and reproductive system disorders. A pesticide will only be registered if it is determined that it can be used to perform its intended function without unreasonably adverse effects on applicators, consumers, or the environment. The EPA also must approve the specific language that appears on each pesticide label; the product can only be legally used according to label directions. The EPA continually evaluates herbicides as to their safety, and any compound that is found to cause any adverse effect is immediately removed from the market.

At the present time herbicides provide consistent, broad-spectrum, and effective weed management in an economical manner. In the future, herbicides will be required to pass even more stringent tests related to their safety. While new-generation herbicides will likely be applied at even lower doses with less environmental persistence and exceedingly low toxicity to non-target organisms, herbicides are now recognized as only one factor in efficient weed control. Weed management is an ever-evolving system that will continue to use an integrated approach, combining cultural, mechanical, chemical, and biological techniques. In this process, however, herbicides will remain an essential component for weed control to help insure a sustainable food production system that reduces unacceptable risks to the environment while producing an abundant and safe food supply.

See also **Agricultural Research**; **Contaminants, Chemical**; **Ecology and Food**; **Government Agencies**; **Pesticides**; **Safety, Food**; **Toxins, Unnatural, and Food Safety**.

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HERBS AND SPICES. The terms "herb" and "spice" describe plants or parts of plants used for medicine, cooking, and pleasure all over the world. These plants number in the thousands and come from almost every plant family known. This makes it almost impossible to generalize about their uses and properties. However, a treatment of this length could not be written without generalizations, so it is important to keep in mind that for every statement made one or more exceptions exist.

Definitions

Herbs are the green, leafy parts of plants. They are most efficacious and flavorsome when used fresh, and they are mostly grown in temperate to hot regions. Spices are derived from any part of a plant that is not a leaf: for example, cloves are flower buds, cinnamon is bark, ginger is a root, peppercorns are berries, nigella is seed, cumin is a fruit, saffron is stigmas, cardamom is pods and seeds, and asafetida is a gum. Spices are usually used in small amounts, are best used dry (the drying process often enhances the flavor), and most grow in subtropical or tropical climates. One single plant can be both an herb and a spice. Aromatic seeds like dill are a spice, while dill leaves are an herb. However, coriander and hamburg parsley roots, garlic and fennel bulbs are all regarded as herbs rather than spices.

What Do They Look Like?

Herbs and spices cover the complete range of growth habits and sizes of plants, and they can be annuals, biennials, perennials, trees, shrubs, climbers, and grasses. They grow in a wide range of conditions and habitats from the tropics to polar regions. They can be found at sea level, some even grow in the sea or in fresh water, and others grow near the tops of the highest mountains. Despite this diversity it is true that many of the better-known herbs and spices fall into distinct groups. One group contains those plants found in the Lamiaceae (mint family). They are characterized by young stems that are four-angled, simple opposite leaves, and flowers with five more or less fused petals. Glands on these plants usually contain volatile fragrant oils. Most originate in the Mediterranean or Central Asia and are used as potherbs, to make perfumes, and in the manufacture of pharmaceutical products. Well-known herbs such as basil, bergamot, calamint, hyssop, lavender, lemon balm, mint, rosemary, sage, savory, and thyme are in this family.

In the Apiaceae (carrot family) are important herbs and spices such as angelica, anise, caraway, chervil, coriander, cumin, dill, fennel, gotu kola, lovage, and parsley. These plants mostly originate from temperate regions all over the world. They are characterized by being aromatic and having hollow stems and dissected leaves arranged in spirals, often attached by a base that sheathes the stem. The usually small, five-petaled flowers appear in umbels and are followed by strongly scented fruits (often called seeds). The leaves of many of these plants are important herbs, while the fruits are widely used spices.

French tarragon is in the Asteraceae (daisy family), members of which grow mostly in temperate regions all over the world. Plants in this group usually have simple or dissected leaves arranged in spirals. Flowers are usually tiny discs grouped together in compact heads and surrounded by a ring of ray flowers with straplike petals. Other herbs in this family include burdock, chamomile, chicory, dandelion, marigolds, pyrethrum, safflower, wormwood, and yarrow. Some are important culinary herbs, while others are important medicinal herbs. The group also includes herbs used to kill and repel insects and to produce dyes.

The Lauraceae (laurel family) consists mostly of aromatic, evergreen shrubs and trees originating from warm and tropical regions of Southeast Asia and northern South America. The herbs and spices in this family include sweet bay, camphor, cassia, cinnamon, and sassafras.

Allspice, cloves, cajuput oil, eucalyptus, and myrtle are all in the Myrtaceae (myrtle family). These are trees and shrubs that grow in tropical and warm areas of the world. They bear scented leaves containing important essential oils, and many also bear edible fruit.

Some important root spices are in the Zingiberaceae (ginger family). These plants mostly grow from thickened

The formal herb garden at the Henry Doubleday Research Association's garden center, Ryton, near Coventry, England. Featured here are golden feverfew, lady's mantle, and tansy. The Ryton gardens are open to the public and offer programs on growing herbs organically. © MICHAEL BOYS/CORBIS.

aromatic rhizomes with large, upright, alternate leaves. They are mostly found in tropical and subtropical regions of the world. In this family are cardamom, Chinese keys, galangal, gingers, torch ginger, turmeric, and zedoary.

History

Archaeological evidence shows that the use of spices and herbs dates back to long before recorded history, when human ancestors first added sharp-flavored leaves to early cooking pots. Roaming hunter-gatherer groups experimented with leaves, roots, flowers, and seeds, so over time they built up a precious compendium of knowledge that was passed from one generation to the next. As civilization progressed and nomadic tribes settled in one place, herbs and spices were not just collected from the wild but were deliberately sown near dwelling places. By the beginning of the agricultural period plants were collected from the wild and grown near dwellings for food, flavor, medicine, fuel, decoration, dyes, poison, and weapons and to alter early humans' sense of reality.

The earliest written records come from ancient Egyptian, Chinese, and Indian cultures. The Ebers Papyrus that dates from 1550 B.C.E. describes some eight hundred different medicinal remedies and numerous medicinal procedures. Early Egyptians used spices and herbs in medicine, as cosmetics and perfumes, for embalming, in cooking, and to kill and repel pests.

Trade

The ancient trade in some spices was highly lucrative. Black pepper was the most lucrative of all, although cassia and cinnamon were essential ingredients in Egyptian embalmment. Taprobane (Sri Lanka) was well known to the Greeks and Romans, and trade with it is described in the Byzantine topography of Cosmas Indicopleustes. The earliest known Chinese records of the uses of plants date from 2700 B.C.E., from the herbal compiled by Emperor Chin Nong. In India the Vedic literature of about 1500–1200 B.C.E. describes many different plants used in religious ceremonies. When the Queen of Sheba visited King Solomon in the tenth century B.C.E., she offered gifts of rare and sought-after spices and herbs, probably with the hope of increasing and expanding the existing trade in these commodities.

Evidence of trading and use of herbs and spices is in the writings, among others, of the Greek physician Dioscorides and the Roman civil servant Pliny the Elder in the first century C.E. The spread of the Roman Empire also spread herbs such as rosemary, savory, garlic, and thyme into northern Europe and Britain. Romans took with them precious supplies of spices like pepper and ginger. The fall of the Roman Empire accompanied a dramatic decrease in trade until the eighth century and the spread of the Muslim Empire, when once again spices and herbs were on the move and were widely used in medicine and cooking. After the Norman conquest of Britain, spices such as ginger, cloves, mace, and pepper were once again found on the tables of wealthy Britons.

Later the ongoing search for and trade in other valuable spices, which at different times have been worth as much as gold, led to some of the great voyages of discovery. Ginger, pepper, cloves, cinnamon, galangal, mace, and nutmeg were the reasons for battles fought, fortunes made and lost, and new worlds discovered. These spices launched Europe and Britain, attempting to satiate their desires for these exotic ingredients, into the age of exploration. Christopher Columbus discovered America while searching for a new sea route to the Spice Islands. In 1498 Vasco da Gama, the Portuguese navigator, rounded the Cape of Good Hope and established a new spice route to India and beyond. Magellan eventually found the western route to the Spice Islands in the 1520s. In the following centuries the Portuguese, Dutch, and British fought wars for control of these routes and the islands where many of the spices grew.

Modern methods of preservation led to a decrease in the use of spices in many Western countries, and at the same time, with modern methods of transportation, spices became ubiquitous and relatively cheap.

Growing Herbs and Spices

In the past herbs and spices were grown in gardens and harvested for use in the home, or they were collected from the wild, in what was known as wild crafting. As the demand for herbs and spices increased, they were also grown on a small scale as agricultural crops. The growth, harvest, and processing of herbs and spices was and in many cases has remained a labor-intensive enterprise. Consequently these crops often were grown in countries where labor was cheap. In the early twenty-first century Egypt grew and exported large quantities of anise, basil,

TABLE 1

Common culinary herbs

Name*	Description	Climate, place of origin	Part used	Uses
Basil *Ocimum* species Lamiaceae	Annual, small shrub	Tropical to warm temperate, Asia and Africa	Fresh leaves, young stems	Tomato dishes, salad, stuffings, sauces, soups
Bay leaves *Laurus nobilis* Lauraceae	Perennial, medium tree	Temperate, Mediterranean	Fresh or dried leaves	Soups, stews, stir-fries, sauces, meats, desserts
Bergamot *Monarda didyma* Lamiaceae	Herbaceous perennial, medium	Temperate, North America	Fresh or dried leaves and flowers	Salads, pork, chicken, seafood, eggs, drinks, teas
Chervil *Anthriscus cerefolium* Apiaceae	Annual, small shrub	Temperate, Europe and Western Asia	Fresh leaves	Salads, stir-fries, sauces, cheese, garnishes
Chives *Allium shoeoprasum* Alliaceae	Herbaceous perennial, small clumps	Cold temperate, Yugoslavia, Siberia, Asia Minor	Fresh and dried leaves and flowers	Salads, stir-fries, sauces, cheese, breads, garnishes
Cilantro *Coriandrum sativum* Apiaceae	Annual, small shrub	Temperate, Europe	Fresh leaves, flowers, roots, dried seeds	Salads, stir-fries, soups, chicken, fish, eggs, garnishes
Curry leaf *Murraya koenigii* Rutaceae	Perennial, small tree	Tropical and subtropical, Asia	Fresh and dried leaves	Curries, pickles, chutneys, fish, vegetables, rice
Dill *Anethum graveolens* Apiaceae	Annual, tall shrub	Temperate, Southwest Asia	Fresh and dried leaves, dried seeds	Salads, stir-fries, chicken, seafood, sauces, garnishes
Fennel *Foeniculum vulgare* Apiaceae	Herbaceous perennial, tall shrub	Temperate, Mediterranean seeds	Fresh and dried leaves, fresh stem base, dried seeds	Salads, stir-fries, eggs, seafood, sauces, soups, vegetables
Garlic chives *Allum tuberosum* Alliaceae	Herbaceous perennial, small clump	Temperate, Southeast Asia	Fresh leaves flowers, buds, flower stems	Salads, stir-fries, sauces, soups, cheese, garnishes
Gotu kola *Centella asiatica* Apiaceae	Perennial, low spreading groundcover	Tropical to warm temperate, Asia and Australasia	Fresh leaves	Salads, soups, rice, garnishes
Lemongrass *Cymbopogon citratus* Poaceae	Perennial, clumping grass	Tropical to warm temperate, India and Ceylon	Fresh and dried leaves and stems	Soups, stir-fries, beef, chicken, seafood, sauces, teas
Marjoram and oregano *Origanum* species Lamiaceae	Herbaceous perennial, spreading clumps	Temperate Mediterranean to East Asia	Fresh and dried leaves	Soups, stews, sauces, cheese, breads, eggs, vegetables
Mint *Mentha* species Lamiaceae	Herbaceous perennial, spreading clumps	Temperate, Europe, Asia, Africa	Fresh and dried leaves	Salads, sauces, lamb, chicken, seafood, garnishes, drinks, teas
Parsley *Petroselinum crispum* Apiaceae	Biennial, low-growing clump	Temperate, Europe	Fresh and dried leaves	Salads, sauces, cheese, garnishes on most foods
Rosemary *Rosmarinus officinalis* Lamiaceae	Woody perennial, medium bush	Temperate, Mediterranean	Fresh and dried leaves	Stews, sauces, soups, stuffings, breads, eggs, teas
Sage *Salvia officinalis* Lamiaceae	Woody perennial, medium bush	Temperate, Mediterranean and North Africa	Fresh and dried leaves	Stews, sauces, soups, stuffings, breads, eggs, teas
Tarragon *Artemisia dracunculus* Asteraceae	Herbaceous perennial, spreading clump	Temperate, Central and Eastern Europe, Southern Russia	Fresh and dried leaves	Salads, soups, stews, chicken, seafood, eggs, vegetables
Thyme *Thymus* species Lamiaceae	Perennial, low bush or spreading clump	Temperate, Europe and Asia	Fresh and dried leaves	Stews, sauces, soups, stuffings, breads, eggs, teas
Watercress *Nasturtium officinale* Brassicaceae	Perennial, spreading clump	Temperate, Europe and Southwest Asia	Fresh leaves	Salads, soups, sauces, eggs, garnishes

*Garlic is not included here as it is discussed in the text.

Fresh nutmegs are red. The shell covering is dried and called mace. © Bob Krist/CORBIS.

caraway, dill, and fennel; China produced fennel, garlic, ginger, and cumin; India grew celery seed, fennel, and turmeric; and Croatia produced sage, savory, and rosemary, to name a few. At that time the herb and spice industry could be divided into three main categories, essential oils, medicinal crops, and culinary herbs and spices (fresh and dried).

Essential Oils

Essential oils are usually found in specialized oil cells or ducts in plants. Oils from aromatic plants are generally volatile, so they are extracted by water or steam distillation. Some volatile and most nonvolatile essential oils are obtained by solvent extraction. The aromatic, resinous product obtained from nonvolatile oils is known as an oleoresin. Oleoresins are concentrated and are widely used in the food industry. For example, pepper oleoresins are used in processed food, while turmeric oleoresin is a common natural coloring agent in food and pharmaceuticals. Essential oils are produced and processed all over the world, and France, Brazil, China, Spain, and Mexico are among the largest producers. These oils are often the by-products of another industry, and citrus oils, extracted from the skins of oranges, lemons, and limes, account for a large proportion of the essential oil industry. Pine and cedarwood oils are by-products of the timber industry. Of the herbs and spices planted specifically for oil production, anise, bergamot, citronella, lemongrass, lavender, mints, and rosemary are probably the most widely grown. Mints represent the largest essential-oil crop in the United States. Dill is also an important oil crop, used mostly in the manufacture of pickles.

Medicinal Herbs and Spices

It is particularly important that medicinal herbs and spices are grown in ideal rather than marginal conditions so the proportion of medicinal constituents is maximized. Usually the constituents of medicinal value to humans are secondary metabolites produced by plants for purposes other than growth. Advocates for organic gardening insist that conditions most closely approximating wild conditions are best for growing herbs, especially medicinal herbs, because the use of pesticides and herbicides can alter the plants' constituents, thereby altering their flavors and medicinal attributes.

Wild Herbs and Spices

Wild crafting of herbs and spices occurs all over the world. Some herbs, such as echinacea and goldenseal, have become rare in the wild because of overharvesting. Although all herbs can be cultivated, one school of thought says the best medicinal herbs are taken from the wild, so pressure on wild herb populations in all parts of the world continues. Conversely, some cultivated herbs have escaped into the wild, where they have become problem weeds. Harvesting these from the wild helps keep them under control while providing plenty of raw material for processing.

Culinary Herbs

In the past culinary herbs and spices were collected from the wild or grown in gardens among vegetables and flowers. By the twenty-first century, although the traditions of collecting flavorings from the wild and growing a few herbs in gardens continued, more people in Western countries demanded interesting and exotic flavors with their foods. This trend produced a proliferation of fresh, processed, frozen, and dried herbs and spices on supermarket shelves and a burgeoning industry to support these demands. In these Western countries the processed herb market is mostly supplied by companies that dry, process, package, and transport the produce to market. These companies are usually supplied by contract growers, often from other countries. Many herbs are dried for use as herb teas as well as for flavorings. A smaller but increasing market exists for biodynamically and organically grown herbs, both dried and fresh.

Culinary Spices

Most commercially grown herbs are produced in temperate regions, as are the seed spices, such as coriander, dill, cumin, caraway, and fennel. Most spices, however, are indigenous to and are grown commercially in subtropical and tropical regions. Each spice is usually grown in just a handful of countries and then exported all over the world. For example, the best cinnamon still comes from its native Sri Lanka; cassia come from China, Indonesia, and Vietnam; cloves come from the Moluccas, Zanzibar, and Madagascar; pepper comes from India, Indonesia, and Malaysia; and ginger comes from Jamaica, Nigeria, and India. The spice saffron is native to more temperate regions, and most of it is grown in and exported from Spain, Kashmir, Greece, and Iran.

Drying Spices

Spices are usually dried straight after harvest, either in the sun or in drying rooms. The drying ensures that essential oils and oleoresins are largely preserved intact. As some spices dry, enzymes and chemicals in the spice react to create a different flavor. For example, when peppercorns are dried in the sun, the volatile oil piperine is formed, thus giving dried peppercorns their unique flavor. Vanilla beans also only develop their flavor after months of careful, slow drying. Once dry, spices are best stored in airtight containers to preserve their volatile oils. These oils are released by the application of heat (frying, roasting, boiling) and are absorbed by the food, which takes on a new flavor. Many spices are ground after drying. But once they are ground they lose their flavor much more quickly, so it is best to use freshly ground spices when possible. Whole spices can be stored away from direct light for up to three years, ground spices only for about one year.

Fresh Herbs

The fresh herb market in Western countries saw enormous growth in the last decade of the twentieth century with an increase in the variety of herbs available for purchase. As the size of this market increased, some herbs moved from a niche product to one fully integrated with fresh market vegetables, so they are grown, harvested, packaged, transported, and marketed in the same way as vegetables. Even so, fresh herbs tend to be grown on smaller farms and are often sold in smaller specialty grocers, farmers' markets, and roadside stalls. In the supermarkets fresh herbs, often hydroponically grown in greenhouses, are sold in bunches or increasingly in pots. At the beginning of the twenty-first century the fresh herbs available for sale at the Los Angeles wholesale fruit and vegetable market included anise, arugula (rocket), basil, chives, cilantro, dill, epasote, lemongrass, marjoram, mint, oregano, parsley, rosemary, sage, sorrel, tarragon, thyme, and watercress. The variety of herbs available is increasing with demands from immigrants for herbs from their native countries and a general wish for a greater variety in herb flavors.

Everyday Ingredients

Most people eat or use herbs and spices in some form every day, in vanilla ice cream, chili and Worcestershire sauces, alcoholic drinks such as gin, in cinnamon buns and in seed breads. Herbs flavor toothpaste and cough medicines, and they are drunk as teas and added to vinegars, oils, and sauces. The scents and flavors of herbs and spices originate from the essential oils in the plant material. These oils are a complex combination of organic compounds such as alcohols, esters, and aldehydes. So the growth, harvest, and drying of herbs and spices aims to maximize the preservation of these oils and thereby the scents and flavors. This is also true of the preparation and cooking of herbs and spices. For maximum flavor herbs should be harvested at the last possible moment and chopped just before use. If this is not possible, purchased herbs should look as fresh as possible (no wilting or bruised or brown leaves) and should be stored in plastic bags in the refrigerator until needed, preferably not more than a few days. Again they should be chopped just before use.

CLASSIC HERB COMBINATIONS

Bouquet Garni

This name is given to any small bunch of fresh herbs tied together and added to sauces, stock, soups, stews, and casseroles. The herbs are removed before serving. The basic combination is one bay leaf, a sprig of parsley, and a sprig of thyme. Other herbs used in bouquet garni are lemon balm, tarragon, fennel, rosemary, sage, and oregano.

Fines Herbes

A classic French combination of equal amounts of finely chopped chervil, chives, parsley, and tarragon. This mixture is used with soups, sauces, eggs, grilled meats, and fish. Lovage and fennel are sometimes added.

Herbes de Provence

A mixture of herbs that thrive in southern France during the summer: marjoram, oregano, rosemary, savory, and thyme. Use fresh or dried on any Mediterranean-style dish, pizza, stew, kebabs, and tomato dishes.

Dried Herbs

Dried herbs should be green (not brown) and should retain a lot of flavor when crushed. They should be purchased in small amounts and used before the use-by date. Drying an herb or spice reduces the water content, and if done properly it concentrates the flavor. For this reason using only a quarter to a third of what one would use if the herb were fresh will produce the same flavor. Some herbs retain more flavor than others when dried. Basil, chives, parsley, chervil, and coriander leaves all lose some flavor components when dried, while rosemary, sage, and oregano stay much the same, just more concentrated.

Using Herbs

Many fresh herbs should only be added near the end of cooking, otherwise their flavors are lost. Herbs such as cilantro, parsley, chervil, dill, and basil should all be added in the last few minutes of cooking or should be sprinkled over a dish just before serving. Dried herbs and some of the more strongly flavored fresh herbs like rosemary, sage, and bay can be cooked for much longer. In parts of the Mediterranean and in some Asian countries, it is usual to serve a bowl of assorted fresh herbs or a salad made predominantly of herbs with the meal. This serves the twofold purpose of stimulating and revitalizing the palate and aiding digestion.

Green sauces are also popular in many cultures and can be used to add piquancy to an otherwise bland meal. These sauces are made by pounding fresh green herbs with a pestle in a mortar or a food processor. They can be as simple as a single abundant herb, a clove of garlic, and drizzle of olive oil all pounded together. They can be as complex as Italian pesto (pine nuts and basil), North African *chermoula* (coriander, mint, and parsley leaves), French sauce *verte* (parsley, tarragon, chervil, and chives leaves), and Yemeni *zhoug* (coriander and parsley leaves), all of which also require a range of spices and other ingredients. These sauces are spread on bread, spooned into pasta or rice, added to soup, used as a marinade, spread over cooked meat, or used as a dip.

Much Southeast Asian cooking, especially in Vietnam and Thailand, demands fresh rather than dried herbs to obtain their distinctive flavors. Cilantro leaves and roots, lemongrass, garlic, ginger, turmeric, and chili are used fresh in traditional dishes from these countries. In contrast, Middle Eastern dishes use mainly dried and ground ginger and turmeric.

Using Spices

Spices are an essential component of cuisines from all over the world. Spicy food is not necessarily hot. The heat in spicy food usually comes from pepper or chili. If these are not added to a spice mix, the dish will not have any heat. Nearly all spices are dried before use. They are best purchased whole and ground just before needed. If this is not possible, then one can buy ground individual spices or mixtures a little at a time and use them within twelve months. Many spices, whether used whole or ground, need to be lightly cooked before use. This enhances and in some cases changes the flavor of the spice. Whole spices can be spread over a tray and dry roasted for a few minutes in a hot oven. They can then be ground or left whole and added straight to a dish. Ground spices are best gently fried, without oil, in a frying pan for up to sixty seconds.

Mixtures

Spice mixtures, which vary from country to country, are judicious combinations of spices that give a balance of flavors, often with surprising highlights. The various tastes of spices are usually categorized into five taste groups, sweet, pungent, tangy, hot, and amalgamating. Curry, for example, is a spice mixture that involves the selective use of pungent and aromatic spices. Some of these spices, like coriander, are added to almost every mixture; others, like star anise, are only rarely added to achieve a specific flavor.

Seed spices are an important component of many different breads, where they complement the carbohydrates and contain oils that aid digestion. Poppy and sesame seeds are used on bread rolls, nigella and black sesame seeds on Turkish breads, and caraway and dill seeds in and on many European breads. This use dates from antiquity, when different seed spices were used in cakes, biscuits, and breads to improve flavor and to help digestion.

Traditional Uses

Hundreds of herbs and spices have been used in cultures all over the world for thousands of years. During this time countless traditions, myths, and rituals have evolved. The following gives just a taste of some of these.

In times past foul or nasty odors were often associated with evil, while sweet, fragrant scents indicated goodness and purity. Herbs and spices with strong or unpleasant scents were avoided, while the sweetly scented ones masked bad odors and protected against evil. Spices in particular were in demand to improve preservation and to disguise the flavor of rotten or foul-tasting food. The Romans used ginger to counteract rancidity. Ginger is also associated with the rites and passages of life. It is given to new mothers all over Asia to restore strength and vigor, while the Chinese see ginger as a warming (yang) and stimulating food, believing it calms and purifies. Closely related turmeric is used in Indian ceremonies to anoint brides, while in Thailand it is used to anoint novice monks before ordination.

Dill is an herb and a seed spice with a long history. Romans fed it to their gladiators to confer vitality, and in medieval times it was added to love potions. Some Americans know it as "meeting house seed" because at one time dill seeds were chewed to dull the pangs of hunger during long religious services. Parsley grew wild on remote Grecian hillsides, but the ancient Greeks did not usually eat it. They used it in funerals and as a symbol of death; to be "in need of parsley" meant that one was seriously ill. In early medieval England the slow and patchy germination of parsley was explained by the suggestion that, once sown, parsley went nine times to the devil and back before sprouting. Those with worries about hair loss were advised to sprinkle their heads with parsley seeds three times a year. Rosemary is another herb with connections to funerary rights. In France rosemary was customarily placed in the hands of the deceased before burial, and in England sprigs of rosemary were thrown into the open grave. Rosemary was also believed to aid memory. Greek students twined rosemary in their hair, believing the scent would stimulate memory. Tradition has it that where rosemary flourishes the women are in charge, while according to an Arabic proverb a person whose sage grows well will live forever.

The statuesque herb angelica has been used in pagan and Christian festivals for centuries. It is indigenous to cold northern Europe, and its name is derived from a legend in which an angel appears to a monk in a dream

CLASSIC SPICE COMBINATIONS

Panch Phora
1 tsp. brown mustard
1 tsp. cumin
1 tsp. fennel
1 tsp. fenugreek
1 tsp. nigella

Whole seed mixture; fry or roast to release full flavor. Add to vegetables, seafood, breads, and pulses.

Pickling Spices
3 tsp. black pepper
3 tsp. yellow mustard seed
4 dried bird's eye chilis
3 tsp. allspice berries
3 tsp. dill seed
1 tsp. mace blades
1 crumbled cinnamon stick
2 crumbled bay leaves
2 tsp. cloves
4 tsp. ground ginger

Whole seed mixture, used to make pickles, chutneys, and spiced vinegar. Can be wrapped in muslin and removed before bottling.

Garam Masala
2 tsp. black peppercorns
1 cinnamon stick
1 tsp. cloves
2 tsp. cardamom seeds
2 tsp. cumin seeds

Grind the spices. Many different forms of this recipe exist, but they generally revolve around the same spices. Optional extras include bay leaves, coriander seeds, mace, and nutmeg. Use with fish, poultry, other meats, most vegetables, rice, pulses, and eggs.

Mixed Spices
1 cinnamon stick
1 tsp. allspice berries
1 tsp. whole cloves
2 tsp. grated nutmeg
2 tsp. ground ginger

Grind the whole spices. A traditional English mixture. Use in desserts, pies, cakes, and biscuits.

Basic Curry
10 tsp. coriander seed
5 tsp. cumin seed
1 tsp. brown mustard seed
5 whole bird's-eye chili
1 tsp. fenugreek seed
1 tsp. whole peppercorns
2 tsp. ground turmeric

Roast the whole spices, grind and mix all the spices together. Hundreds of different curries exist with varying combinations of the above spices. Other spices that can be used in curry mixes are fennel, cinnamon, cloves, cardamom, ginger, and curry leaves.

Mexican Chili Powder
5 tsp. chili powder
3 tsp. ground cumin seed
2 tsp. sweet paprika

Use to flavor chili con carne and other bean and minced beef recipes.

Quatre Épices
5 tsp. ground black pepper
2 tsp. ground cloves
2 tsp. ground ginger
2 tsp. ground nutmeg

A French spice mixture. Use in preserved meats like salami, with game meats, and with slow-cooked beef and chicken dishes.

Chinese Five-Spice Powder
1 tsp. black peppercorns
1 tsp. ground cassia
1 tsp. cloves
3 tsp. fennel seed
5 whole star anise

Grind the whole spices. Use with stir-fried vegetables and as a marinade for seafood, chicken, pork, and duck.

and tells him this plant can cure the plague. It was also believed that angelica protected a person carrying it against witches and their spells. Other sweet herbs such as lavender and rosemary sweetened washing water to scent clothes and, strewed around rooms, repelled insects and masked unpleasant smells.

Herbs and Spices in the Twenty-first Century

Modern medicine led to a decrease in the use of herbal medicines in Western countries in the twentieth century. Nevertheless herbal remedies remain widely used in many poorer parts of the world, and herbal remedies have begun to regain popularity in the West. Many old uses

TABLE 2

20 common culinary spices

Name*	Description	Place of origin, climate	Part used	Quality and taste	Uses
Allspice *Pimenta dioica* Myrtaceae	Perennial, tall evergreen tree	Tropical, America and West Indies whole and ground	Dried and cured unripe berries	Pungent, clovelike	Sweets and cakes, pickles, preserved meats, curries
Caraway *Carum carvi* Apiaceae	Biennial, medium clump	Temperate, Europe and West Asia	Dried seeds, fresh leaves and roots mixes	Pungent, earthy with anise and orange	Breads, cheeses, pork, sausages, apples, cabbage, pastes, spice
Cardamom *Elettaria cardamomum* Zingiberaceae	Perennial, medium clump	Tropical, India	Dried pods and seeds, fresh leaves	Pungent, warm, camphorous	Fruits, cakes, biscuits, custards, curries, rice
Cassia *Cinnamomum aromaticum* Lauraceae	Perennial, tall evergreen tree	Tropical, Burma	Dried bark, whole and ground	Sweet, strong, slightly bitter	Pastries, cakes, biscuits, curries, spice blends
Chili *Capsicum* species Solanaceae	Short-lived perennial, perennial, small bushes to small trees	Tropical, America	Fresh and dried fruits and seeds	Hot, fruity	Spice blends, curries, pastes, sauces, sambals, pickles, dips
Cinnamon *Cinnamomum zeylanicum* Lauraceae	Perennial, medium evergreen tree	Tropical, Southern India and Sri Lanka	Dried bark, whole and ground	Sweet, mild, warm, woody	Stewed fruits, rice, curries, spice blends, sweet dishes, cakes, breads
Cloves *Syzygium aromaticum* Myrtaceae	Perennial, medium evergreen tree	Tropical, Moluccas	Dried flower buds	Pungent, camphorous, spicy, slightly peppery	Curries, spice blends, spiced wines, stewed fruits, custards, pickles, meats
Coriander *Coriandrum sativum* Apiaceae	Annual, small shrub	Temperate, Europe	Dried seeds, whole and ground	Amalgamating, citrus and sage	Cakes, pies, biscuits, fruits, curries, spice blends, pickles, sauces
Cumin *Cuminum cyminum* Apiaceae	Annual, small shrub	Temperate, Mediterranean	Dried seeds, whole and ground	Pungent, earthy sweet flavor	Curries, spice blends, rice, fish, lamb, breads, pickles, vegetables
Fennel *Foeniculum vulgare* Apiaceae	Herbaceous perennial, tall shrub	Temperate, Mediterranean	Dried seeds, whole and ground	Amalgamating, sweet anise	Salads, soups, spice blends, pastas, breads, sausages
Fenugreek *Trigonella foenum-graecum* Fabaceae	Annual, small, slender and Asia	Temperate, Southern Europe	Dried seeds, whole or dried leaves from seeds	Pungent, spicy and bitter	Vegetable and fish curries, spice blends, sprouts grown
Ginger *Zingiber officinale* Zingiberaceae	Perennial, spreading clump	Tropical, Asia	Fresh and dried, whole and ground roots	Pungent, spicy, sweet, warm to hot	Biscuits, cakes, fish, meats, vegetables, curries
Juniper *Juniperus communis* Cupressaceae	Perennial, shrubs to medium trees	Temperate, Europe and Asia	Dried berries	Pungent, savory, spicy, pine	Game meats, duck, pork, chicken, soups, stews
Nigella *Nigella sativa* Ranunculaceae	Annual, medium, erect	Temperate, Southwest Asia	Seeds	Pungent, black, bitter, slightly metallic tasting	Breads, spice blends, potatoes, curries
Nutmeg and Mace *Myristica fragrans* Myristicaceae	Perennial, evergreen medium tree	Tropical, Indonesia	Nutmeg-seeds, Mace-placental seed coverings, dried, whole or ground	Nutmeg-sweet, warm, aromatic Mace-pungent, spicy, sweet	Nutmeg-root vegetables, custards, cakes, biscuits Mace-seafood, meat sauces
Pepper *Piper nigrum* Piperaceae	Perennial, climber	Tropical, Southern India and Sri Lanka	Dried or pickled fruits	Hot, pungent, fragrant	Most savory foods
Saffron *Crocus sativus* Iridaceae	Perennial, small, bulbous	Temperate, probably Greece	Dried stigmas woody, fragrant	Pungent, earthy,	Rice, seafood, chicken, cakes
Star anise *Illicium verum* Illiaceae	Perennial, evergreen, small tree	Warm temperate to tropical, China and Vietnam	Dried fruits woody, aniseed	Pungent, spicy,	Vegetables, fruits, strong seafood, cured meats, sweet dishes
Turmeric *Curcuma longa* Zingiberaceae	Perennial, leafy clump	Tropical, India	Fresh and dried, whole and ground roots	Amalgamating, spicy, bitter	Spice blends, curries, fish, stir-fries, rice
Vanilla *Vanilla planifolia* Orchidaceae	Perennial, climbing orchid	Tropical, Florida, West Indies, Central and South America	Cured seed capsules	Sweet, fragrant	Desserts, cakes, biscuits, ice creams, sugar, chicken

*Mustard is not included here as it is discussed in the text.

of herbs have been confirmed by scientists, while new uses are being found. For example, Taxol is extracted from yew trees to treat some cancers.

See also **Ethnobotany**; **Myth and Legend, Food in**; **Sensation and the Senses**.

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Penny Woodward

HERDING. Domestication of animals for food began about 10,000 years ago in the Near East, in the western part of the Fertile Crescent. This coincided with a period of climatic warming following the last retreat of the Pleistocene glaciation in Europe and Asia. Livestock provided a more regular supply of food that tended to mitigate, but not entirely eliminate, the seasonal patterns of resource availability that faced the hunter and gatherer. The Neolithic pattern of keeping animals for food followed shortly after the earliest domestication of plants in the same area of the Near East. Since that time other grazing and browsing animals were domesticated and their origins have been found at different sites around the globe. Table 1 lists major domestic species with earliest dates and places of domestication. All of these species can provide food in the form of meat, organs, marrow, blood, milk, or fat, although some function as draught, pack, or riding animals, and provide wool, hides, skins, hooves, and dung. When the earliest animals were domesticated, they were reserved for slaughter and their meat was used for food. Today, the livestock species listed in Table 1 constitute more than 3,000 breeds or domestic subspecies and provide a variety of foods and materials.

About 6,000 to 7,000 years ago, domestic animals began to be used for milking, wool production, and other purposes in addition to meat in what Andrew Sherratt (1981) has called the "secondary products revolution." Milk production or dairying may have been practiced more than 7,000 years ago in the Near East since there is evidence for milking cattle and ovicaprids (sheep/goats) in Neolithic Europe that dates back to 6,000 years ago. A significant problem in the cultural development of dairying was the biological evolution of tolerance to milk sugar—lactose—through production of the digestive enzyme—lactase—beyond infancy by children and adults. Almost certainly the ability to utilize lactose by breaking down this disaccharide sugar into its digestible monosaccharides occurred by natural selection. The picture of adult lactose tolerance is a complex one of relationships among genetics, digestive physiology, and digestive enzyme adaptation. However, this is one of the best examples that we have of culture change (pastoralism to dairying) actually producing biological change (in genetics of populations) through natural selection.

Animal domestication and herding spread from centers in Eurasia to Europe, South and East Asia, and Africa. The pig was dispersed from Southeast Asia to New Guinea by least 3,000 years ago, and then later to the Pacific Islands. Much later, following Columbus's discovery, European domesticated animals were transported to the New World. In the indigenous New World, the Andean llama and alpaca were the only animals herded throughout North and South America.

Traditions of agro-pastoralism arose in moist areas or areas capable of irrigation: in marginal, semiarid, or arid lands, transhumant (seasonal migrations) and nomadic herding predominated. David Harris (1996) noted

Table 1

Earliest Domestication of Major Livestock Species

Dates are in approximate years before the present

Common Name	Species	Date	Place	Reference
Goats	*Capra* sp.	10,000	Near East (SW Asia)	1
Sheep	*Ovis* sp.	9,000	Near East	1
Pigs	*Sus* sp.	9,000	Near East, China	2
Cattle	*Bos* sp.	8,000	Near East, India	3
Horses	*Equus caballus*	6,000	Eurasian steppes	4
Water Buffalo	*Babalus babalis*	6,000	China	5
Camelids	*Llama* sp.	6,000	Central Andes	6
Donkeys	*Equus asinus*	5,000	NE Africa	4
Camels	*Camelus* sp.	5,000	Arabia (dromedary) Central Asia (bactrian)	7
Yak	*Bos grunniens*	>2,000	Tibetan Plateau	8
Reindeer	*Rangifer tarandus*	<2,000	Northern Eurasia	9

References: [1]Legge (1996), [2]Clutton-Brock (1979), [3]Clutton-Brock (1989), [4]Clutton-Brock (1992), [5]Olsen (1993), [6]Novoa and Wheeler (1984), [7]Köhler-Rollefson (1996), [8]Olsen (1990), [9]Aikio (1989).

Herding yaks in the Do Tarap Valley of Nepal. © CRAIG LOVELL/CORBIS.

that the early Near East Neolithic (about 8,000 years ago) a "package" of foods that included cereals, pulses, goats, and sheep was particularly effective in providing a diet that contributed to population growth and expansion, and the spread of new subsistence practices.

Today, non-Western herding practices range from nomadic pastoralism in Africa, the Near East, and Asia to agro-pastoralism in the Mediterranean, Near East, Africa, and Asia. Diets are highly variable: some populations consume large amounts of animal products, whereas others trade animal products for cereals and sugar, and still others use animal products only to supplement a largely vegetarian diet. Since the earliest period of domestication, livestock have always contributed foods that are high in energy, balanced in nutrients, and both high and balanced in amino acids and the quality of protein. The cultural selection for a balanced diet became crucial to human health when the predominance of cereal and root crops in intensive agriculture contributed to dramatic population increases.

Several examples of pastoral diets can be drawn from Africa. There is considerable variation in food intake, where animal products constituted between 80 percent (Turkana) and 21 percent (Fulani and Baggara) of dietary intakes as a proportion of caloric intake. Moreover, in all these dairying populations milk is said to be a staple food. Other sources of human dietary variation are: (1) animal productivity, (2) seasonal changes, (3) the mix of animal species, breeds, and herd composition, (4) the patterns of animal use, and (5) trade practices. Animal productivity depends on the breeds of livestock, the forage productivity of the environment, and the patterns of herd management—such as ranching, sedentary, transhumant, or nomadic (Little et al. 1999). Well-fed stock will be larger and have more muscle mass and greater body fat deposits. Seasonal changes in semiarid ecosystems lead to loss of body fat and muscle mass in livestock, reduced milk production in lactating females, and lower fat content of milk (Galvin and Little 1999). Different livestock species, breeds, and age/sex groups show variable food productivity; for example, dairy herds will have high proportions of females and high reproductive rates (population increase). Patterns of livestock use vary from largely food production (meat, milk, blood), to use of animals for traction, packing, or riding. In the case of Andean camelids, llamas are principally pack animals, while alpacas provide wool and meat. Trade of animal products for cultivated foods can substantially enrich diets. The concept of "verticality" in highland pastoral peoples entails exchanging of animal products for cultivated food from lowland populations. This is practiced by Indian Bakkarwal sheep and goat herders and by Peruvian Quechua llama and alpaca herders. Pastoralists depending principally on livestock products for food often will have very high protein intakes but low energy (calorie) intakes. Conversely, pastoralists who trade some of their animal products for cereal foods are likely to have adequate protein and higher energy intakes.

Herding of livestock is practiced today on all continents from tropical grasslands to Arctic tundra. More than 75 percent of world meat production in grassland-based ecosystems is from North America, South Amer-

PRIONS AND MAD COW DISEASE

Prion diseases are produced by infectious agents that are proteins. These prion proteins resist inactivation by normal procedures because they do not have a normal nucleic acid genetic makeup. Prion diseases are often referred to as transmissible spongiform encephalopathies (TSE) because of the damage caused to the brain. The two livestock prion diseases that are known today are scrapie in sheep and bovine spongiform encephalopathy (mad cow disease) in cattle. Mad cow disease is transmissible to humans, and another human prion disease, kuru, was probably originally transmitted to humans through a modified form of scrapie via another prion disease called Creutzfeldt-Jacob disease. Mad cow disease is an example of a domestic zoonosis, that is, a disease that is transmitted from a domestic animal to humans. Two other domestic zoonoses that can be transmitted from livestock to humans are brucellosis or ungulent fever (present in goats, sheep, cattle, and pigs) and anthrax (present largely in cattle).

DEFORESTATION AND LIVESTOCK GRAZING

Deforestation dates back in antiquity to the first rise of cities in the Near East about 5,000 years ago. Yet 2,000 years ago, in Roman times, 90 percent of Europe was still forested. Today, there are many causes of deforestation—living space for an increasing human population, agriculture, charcoal production, use of wood for fuel, commercial logging, and others. However, deforestation for herding of livestock, especially cattle, is one of the least productive uses for land. Increasing demands for beef and increasing numbers of fast-food chains internationally have contributed to the growth of cattle ranches in North and South America. It is estimated that more than 10 million hectares (24.7 million acres) of tropical forest are lost each year, and of these losses, about 10 percent or one million hectares are lost to grazing lands.

ica, Western Europe, Japan, Australia, and New Zealand. Residents of these major Western livestock producing nations (especially the United States, Argentina, and Australia) consume substantial amounts of animal protein and fat calories. Such dietary practices, when combined with sedentary physical activities, have contributed to high rates of cardiovascular disease in many of these Western nations. Another liability resulting from the close contact of humans and livestock are "zoonoses," that is, diseases that originate in animal populations but are transmitted to humans. Examples are bacterial cattle diseases such as anthrax and brucellosis that are widespread around the world. Scrapie in sheep and mad cow disease are neurological degenerative diseases produced by pathogens called prions. When contracted by humans, they are almost always fatal.

Livestock productivity as food is low when compared to agricultural productivity, and requires either vast grazing lands or substantial importation and use of feed (Jordan 1993). Increasing demand for animal protein has certainly contributed to deforestation through cutting and burning of forests to maintain grasslands. And livestock manure is one of the major pollutants of bodies of water in the United States (Cincotta and Engelman, 2000). An estimate of the global livestock body mass in 1950 was about 340 million metric tons (3.4×10^{11} kg). This biomass of livestock nearly doubled to an estimated 600 million metric tons (6.0×10^{11} kg) in the year 2000 (Cincotta and Engelman, 2000). In contrast, non-Western livestock production in marginal lands that are unsuitable for agriculture (transhumant or nomadic herding) is an efficient system of animal food production that is not environmentally degrading. However, this system of keeping herds represents an exceedingly small proportion of worldwide livestock productivity.

See also **Goat**; **Mammals**; **Meat**; **Sheep**.

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Michael A. Little

HERODOTUS. Known as the "Father of History," Herodotus (c. 484–424 B.C.E.) was born on the southwest coast of Asia Minor in Halicarnassus, which was at that time a Greek-speaking city ruled by Artemisia, queen of Caria, under the overlordship of the Persian Empire. Herodotus traveled widely in that empire and in Greece. Eventually, exiled from Halicarnassus, and having spent some years in Athens (where he gave regular readings of his work), he joined the new colony of Thurii in southern Italy, where he died.

Herodotus is the author of the earliest surviving work of history and one of the masterpieces of Greek literature. It is owing to him that the word "history" came to mean what it does: he introduces his book as "the inquiries (*historiai*) of Herodotus of Halicarnassus." The usual title in English translations is *The Histories*. His purpose was to explore the interaction, peaceful and warlike, between Europe (particularly Greece) and Asia (particularly the Persian Empire). Some of his best stories are of kings, but he takes just as much interest in the adventures of differently privileged people—physicians, athletes, merchants, priests, and cooks.

Book 2 of Herodotus's *Histories* focuses on Egypt (then subject to Persia) and North Africa. Books 1 and 3 include much information on Babylonia, Lydia, and other Persian provinces. Book 4 includes a survey of the peoples of Scythia (the Russian steppes).

One of the means by which Herodotus characterizes peoples is through their food behavior. His descriptions of the Egyptians, Persians, and other highly civilized peoples among whom he had lived are far more nuanced than those of "barbarian" peoples, most of whom he knew only by hearsay. The underlying message to his audience is different in the two cases. He was rightly impressed by the long history of civilization in Egypt and Babylonia and by the efficiency of the Persians: he seems to encourage the reflection that the lifestyle of these peoples is logical in its own terms, sometimes more logical than that of the Greeks, and may have been instrumental in their successes. Barbarian tribes, by contrast, are shown as making stranger and stranger food choices as they recede farther and farther towards the edge of the world, from agriculturalists to pastoral nomads to cannibals.

A structural anthropologist before the term was invented, Herodotus is not one to waste a promising structure. He asserts, and it is likely enough, that if the Persians took a decision while drunk, they made a rule to reconsider it when sober. Few authors between Herodotus and Lévi-Strauss would have dared to add, as Herodotus does, that if the Persians took a decision while sober, they made a rule to reconsider it when they were drunk (*Histories*, book 1, section 133).

Herodotus is preeminent as a historian of the conflict of cultures. Throughout his work, food behavior is often the focus for sensitive and striking portrayals of culture clash. When Persian ambassadors visited the king of Macedonia, their stupidity in demanding the company of women at dinner, in conflict with local custom, was justly rewarded: the "women" who entered the dining hall were young men in disguise, armed with daggers, and the ambassadors were never heard of again (*Histories*, book 5, sections 18–20).

See also **Africa: North Africa**; **Greece, Ancient**.

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Andrew Dalby

HIGH-TECHNOLOGY FARMING. During the twentieth century, farming changed more than at any time since it began. Crop and animal production in the United States went from a labor intensive to a capital-intensive operation. What caused these changes?

Crop Production

The revolutions in crop production started with the mechanical revolution that began with the plow, the planter, and the reaper, and the shift from horsepower to tractor power. The mechanical revolution started after the turn of the twentieth century with the replacement of the horse with modern tractors, combines, and cotton pickers. Since that time, machinery design has kept pace with the increased tractor power.

The second revolution in crop production began with the introduction of hybrid corn in the 1930s. Since then, average U.S. corn yields have increased from 25 bushels in 1930 to more than 140 bushels per acre today. Corn hybrids, along with other practices, greatly enhanced growing conditions so the genetic potential of the hybrid is expressed during most years. The plant breeding revolution has had similar impact on yield of other crops like rice, wheat, and soybean.

The third revolution in crop production came with the increased availability of fertilizers, particularly nitrogen fertilizer. The fertility revolution gained momentum

Hydroponic farming is demonstrated with cultures of lettuce at Disney's Epcot Center, Orlando, Florida. © JOSEPH SOHM; CHROMOSOHM, INC./CORBIS.

when munitions plants built during World War II were converted into factories for making nitrogen fertilizer. The ready availability of nitrogen fertilizer, along with better understanding of fertility through soil testing, improved fertilizer application and crop growth. Other nutrients like limestone, phosphorus, and potassium helped achieve the genetic potential of the crop. Fertilizer applications are still improving through variable rate applications as part of precision agriculture. Virtually every American farmer uses fertilizer to increase crop yields.

The fourth revolution is in the use of herbicides, insecticides, and fungicides to control weeds, insects and diseases that reduce crop growth. This revolution began in the 1950s. Modern weed control practices enable farmers to plant crops much earlier. Now corn and other crops grow during more favorable moisture and temperature conditions without competition from weeds for light, water, and nutrients.

The fifth revolution in crop production is the biotechnology revolution. It did not influence crop production until about 1995. Present benefits include better quality seed such as canola, insect resistant seed such as bollworm resistant cotton and corn borer resistant corn, seed with herbicide resistance such as soybeans, cotton, and corn. Many other changes are imminent. Use of seeds with herbicide, insect and disease resistance impact favorably on the environment because they replace less environmentally friendly chemicals. The revolution in biotechnology promises to increase quantity and quality of the foods we eat.

The sixth revolution in crop production is the new availability of computers, software, and satellites. This technology enables what is often referred to as precision agriculture (PA). Precision agriculture technology enables advances from a data-poor to a data-rich environment. Previously, yields were measured by fields; now it is possible to measure yield continuously. The Internet affects farmers' business practices just as it does other types of business.

Livestock Production

The farm livestock sector has changed dramatically in the past fifty years. Farms have gone from mixed crop and livestock operations to specialized livestock enterprises. Economic factors—the comparative cost of land, labor, capital, and environmental regulations—have brought about these changes. The cost of labor and land per animal fell dramatically while capital investment and environmental costs increased. Farms with small herds and flocks yielded to large specialized farms with large animal concentrations.

Before 1950, farms had many different crops, including hay and pasture, as well as various types of animals: cattle, hogs, and chickens. In the twenty-first century, there are large specialized farms: dairies, beef feedlots, hog operations, and chicken and turkey houses.

Such operations use small land areas or are housed entirely inside buildings. Many animal units can be managed with small amounts of labor. The result is animal farms where all the best health controls are available and applied to keep herds and flocks healthy.

Computer technology has increased the amount and way data is collected. Dairies know the daily and annual milk output for every cow in the herd; hog farmers know the weight gain and feed conversion efficiency of every sire used in their breeding operation; cattle feedlot managers know the weight gain and the carcass quality of every animal; and poultry producers know the feed-to-meat ratio of their broilers and the egg production of each laying hen.

The ease of obtaining data by computer and the ready availability of well designed equipment and buildings has decreased labor and enabled increases in size of animal operations. Increases in the economic efficiency of producing meat and eggs have reduced the cost of products at the grocery store. While many small animal operations exist, most production is from larger operations. Biotechnology's promise for animal agriculture is comparable for crop production and will lead to many new products.

Animals such as cattle, sheep, and goats still graze land too rolling, too dry, or otherwise not suited for crop production. Such cow-calf and sheep operations harvest the biomass that would otherwise be uneconomical to harvest and supply feedlots with animals. Land well suited for crop production—flat, with adequate rainfall or available irrigation—has reduced animal grazing during the past twenty to fifty years.

Summary

Crop and animal agriculture has changed more in the past century than it has since farming began many millennia ago. Modern-day crop production practices, often called precision agriculture (PA), benefited from all earlier revolutions in crop production. Precision agriculture technology developed because of ubiquitous and inexpensive computational power, software (GIS), and satellite location systems (GPS). Precision agriculture equipment enables variable-rate fertilizer, herbicide, plant population, and yield assessment. Wide adoption of PA equipment will occur as it becomes economical. Technology has moved crop production from a high labor and low capital intensive to a low labor and high capital intensive industry. Typical Midwest Corn Belt farms have gone from less than 160 acres to more than 500 acres. The labor necessary to produce a bushel of corn decreased from more than thirty minutes in 1930 to a fraction of a minute in 2002. Availability of high powered well designed equipment; well-adapted hybrids and varieties; precise weed, insect, and disease control; improved plant and animal genetics; and improved animal health have all contributed to the revolution in plant production we have discussed. Biotechnology and computer revolutions enable us to manage large operations and design crops and animals that will be more nutritious in the future. Consumers are the major beneficiary of these developments since food purchases now requires less than 10 percent of average income.

See also **Agriculture, Origins of**; **Agriculture since the Industrial Revolution**; **Agronomy**; **Crop Improvement; Food Production, History of**; **Food Supply and the Global Food Market**; **Food Supply, Food Shortages**; **Green Revolution**; **Herbicides**; **Horticulture**; **Livestock Production**; **Pesticides**.

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E. C. A. Runge

HINDU FESTIVALS.

India is a land of bewildering diversity, a unique and colorful mosaic of people of various faiths. There is a festival for every reason and for every season. Many festivals celebrate various harvests, commemorate great historical figures and events, or express devotion to the deities. Every celebration centers around the rituals of prayer and seeking of blessings, and involves the decoration of homes, wearing of new clothes, music, dancing, and feasting. Festivals are an expression of the spirit of celebration. They are observed with enthusiasm and gaiety and are occasions when the greater family and friends come together. They also present women with an opportunity to socialize. Many of these festivals are associated with special foods.

Among the most important Hindu festivals are Makar Sankranti, Shivratri, Holi, Onam, Ganesh Chaturthi, Dussehra, and Diwali. They are celebrated throughout the country in various forms.

Makar Sankranti

Also referred to as Lohri in the North and as Pongal in parts of the South, Makar Sankranti is a celebration of the "ascent" of the sun to the North. The festival marks the coldest day of the winter (14 January), after which the biting cold begins to taper off. In the North, the festival is marked by the lighting of bonfires, into which sweets, rice, and popcorn are thrown as offerings. In the South, prayers are offered to the sun god, because without the sun, there would be no harvest. During the festival, the most commonly eaten foods are sesame seeds and jaggery sweets, rice cooked with milk, jaggery (called *pongal*), and sugar drops. Jaggery is a dark crude sugar made from palms.

Shivratri

Shivrati literally means the night of Shiva. It is celebrated in February and March. Devotees of Shiva abstain from eating food throughout the day and only break their fast the following morning after a night of worship. The offerings of food to the deity comprise "cooling" foods, because Shiva was said to be hot-tempered. These include milk, water, honey, and the leaves of the wood apple tree (*aegle marmelos*), which are said to be cooling. Another food popular at this festival is *thandai*, a drink made with milk, almonds, and hemp seed. Hemp seed is said to have been dear to Shiva and is thus imbibed as part of the festivities.

Holi

Celebrated essentially in northern India, this boisterous festival heralds the onset of spring (in mid-March). It is a festival of color, and people smear each other with colored powder and spray each other with colored water. Singing and dancing add to the gaiety of the occasion. It is variously associated with Krishna (as is evident in the particularly extensive celebrations at Vrindavan and Mathura, the two places associated with Krishna) and Shiva. Legend has it that the celebration of Holi is actually a recreation of the marriage procession of Shiva. The delicacies eaten during this festival include *malpua* (fresh bread soaked in a sugar syrup), *puranpoli* (unleavened wheat bread stuffed with lentils and jaggery and baked on a griddle), and *gujjiyas* (flour patties stuffed with milk solids, sugar, almonds, and raisins and then deep-fried).

Onam

Onam, the harvest festival, is traditionally celebrated in Kerala (in August–September). The harvest has been reaped and the granaries are full; therefore it is time to rejoice.

Ganesh Chaturthi

Celebrated essentially in Maharashtra, this festival celebrates the birthday of Ganesha, the elephant-headed god who is the son of Shiva and Parvati. Ganesha is the remover of all obstacles and difficulties; he is the one who will grant success in all human endeavors. Therefore, no new venture is started without first praying to Ganesha. His image is installed in individual homes for a period of hours or days leading up to the festival, at which point those same images are displayed in a procession with much singing and dancing, and then immersed in running water. Ganesha's favorite food *modak* (a wheat flour pastry stuffed with coconut and jaggery and baked on a griddle) is offered to the deity and served throughout the festival's duration.

Women worshipping the sun god during the Chhat Puja Festival held on the banks of the Hooghly River in Calcutta. Devotees arrive at sunset and spend the night in prayer. The women shown here are sending offerings into the river. © REUTERS NEW MEDIA INC./CORBIS.

Dussehra

Celebrated in October, Dussehra commemorates the victory of good over evil, and culminates in the burning in effigy of Ravana and the triumph of Rama. It is celebrated in various ways throughout the country, often with much music and dancing, and lasts for ten days. During this time, there are public performances of the Ramlila (the story of the Hindu epic, the Ramayana). On the day of Dussehra, new accounts are opened, and new ventures started.

Diwali

Celebrated twenty-one days after Dussehra, this festival commemorates Rama's return to his hometown, Ayodhya, after having been in exile for fourteen years. While Dussehra celebrates Rama's victory over Ravana, Diwali celebrates his return. Thousands of oil lamps are lit to welcome him home, making it a night of enchantment. Homes are decorated, and sweets are exchanged between family and friends. Fireworks and festivities are part of the celebrations. On this day, the goddess of wealth, Lakshmi, is worshipped.

See also **Fasting and Abstinence: Hinduism and Buddhism**; **Feasts, Festivals, and Fasts**; **Festivals of Food**; **Hinduism**; **India**; **Religion and Food**; **Weddings**.

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Thangam Philip

HINDUISM. Hinduism is a religion, a philosophy, and a way of life. It guides people along paths that will ultimately lead to the individual soul (Atman) becoming one with the Universal Consciousness.

The religion recognizes that everyone is different and has a unique intellectual and spiritual outlook. Therefore, it allows people to develop and grow at their own pace by making different spiritual paths available to them. It allows various schools of thought under its broad principles. It also allows for freedom of worship so that individuals may be guided by their own spiritual experiences. This freedom of worship permits individuals to worship in any place, be it a church, mosque, or *gurudwara*. The tolerance shown by this religion to other faiths is unmatched. Hinduism has never been imposed on anyone, whether on a subjugated people through wars, or by offering spiritual or economic benefits to the poor.

The strength of Hinduism lies in its adaptability to the infinite diversity of human nature. It has a highly spiritual and abstract side suited to the philosopher, a practical and concrete side suited to the worldly individual, an aesthetic and ceremonial side suited to the person of poetic feeling and imagination, and a quiescent and contemplative side suited to the lover of peace and seclusion.

Hinduism is also unique in that it has adapted itself to include numerous ideals and precepts of other religions, such as those of Jainism and Buddhism. For instance, among many communities, offerings of rice and ghee (or clarified butter) took the place of animal sacrifice—a compromise with Vedic ritualism. Many of the early Aryans had been meat eaters, but under the influence of Buddhist and Jain ideas, numerous groups of Brahmins and non-Brahmins became vegetarian.

Another feature unique to Hinduism is its belief that liberation or deliverance (*moksha*) can be achieved in this life itself: one does not have to wait for a heaven after death.

Hindu Beliefs as Reflected in Food

Rebirth or reincarnation. The Hindus believe that one must go through several births and rebirths before attaining liberation. The hardships of the current world are a result of the actions of a previous life that have to be atoned for in the present life.

Karma. The law of karma (or action) also supports the above theory. It suggests that every action has a similar or related reaction. Although it is not possible to change one's past life, it is possible for one to shape the future and to pave the way for a better life in rebirth through the actions of the present.

Dharma. Dharma refers to duties that have to be performed at different stages of one's life. These must be completed without a thought of possible rewards or benefits and should also be accomplished to the best of one's ability. They are responsible for the prevailing social order in the world. There are four stages of Dharma:

- Student or Brahmachari—This first phase involves living and studying with a guru.
- Householder or Grihastha—This next phase starts with marriage.
- Retirees or Vanaprastha—The third phase occurs when the duties of child rearing and work are over.
- Sanyasi—This is the final phase when all worldly desires are renounced and the individual spends all of his or her time in meditation.

Hindu Scriptures

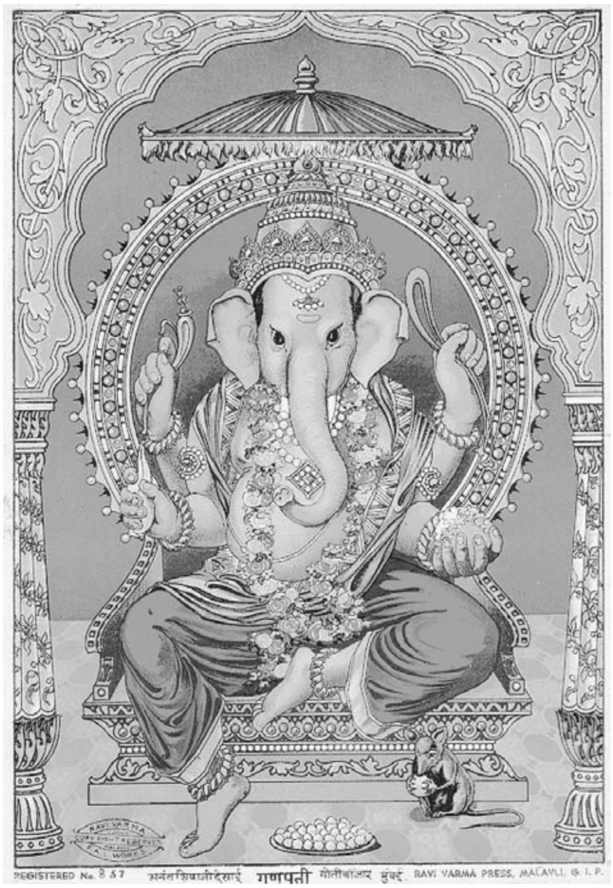
Hinduism is based on the Eternal Truth as it has been explicitly defined in the scriptures:

1. The Srutis come from the Vedas, of divine origin and unchangeable. They encapsulate the greatest truths.
2. The Smritis, referred to as the Dharma Shashtras, are of human composition. They govern the daily conduct of people, including the actions of the individual, the community, and the nation, and may change over time.
3. The epics are those stories or fables in which the philosophy of the Vedas is told. The most important epics are the Ramayana and the Mahabharata.
4. The Puranas are the Hindu scriptures that convey the truths of the Vedas and the Dharma Shashtras in the form of tales. These stories form the basis of religious education for the common man.
5. The Agamas record the doctrine for the worship of different deities, including Shiva, Vishnu, and Shakti.
6. The Darshanas encompass the six schools of Hindu philosophy; they guide scholars.

Hindu Gods and Goddesses

Hinduism has many gods and goddesses, some of whom were worshipped by early peoples who later came into contact with this faith. The aim of Hinduism is not the worship of any one of these deities, but rather the means with which the individual soul or Atman will become one with the Brahman, or the Universal Soul. Among the most commonly worshipped gods are:

- Nirguna Brahman—The Universal Soul who transcends time and space and is formless.



Popular print of Ganesa, the Hindu god of wisdom and prudence. He is usually depicted as a man with an elephant's head. The print dates from circa 1930. ROUGHWOOD COLLECTION.

- Saguna Brahman—The concept of Ichwara, the Great God, with a form upon which the individual mind may fixate during prayer and meditation.
- The Trinity—As personified by the three attributes of Ichwara, including their feminine dimensions: creation (Brahman), preservation (Vishnu), and destruction (Shiva).

Attaining *Moksha*

There are essentially three paths to attain oneness with the Universal Consciousness:

1. Bhakti yoga (the path of devotion)—The vast majority of people choose this path of single-minded devotion to a favorite god.
2. Karma yoga (the path of action)—Those who choose this path believe in the dictum "work is worship." No job is too menial or too low for this devotée, as all work is a means of realizing God.
3. Jnana yoga (the path of knowledge)—This is perhaps the most difficult of the three paths and therefore chosen by very few, usually scholars. Knowledge of the Vedas, Upanishads, and Bhagavad Gita is essential.

See also **Buddhism**; **Fasting and Abstinence: Hinduism and Buddhism**; **Festivals of Food**; **Hindu Festivals**; **India**; **Religion and Food**; **Weddings**.

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Thangam Philip

HIPPOCRATES. Hippocrates (460–377 B.C.E.), a disciple of Democritus, was a Greek physician who is now considered the father of Western medicine. Born on the Greek island of Cos, he was associated with the cult of Asclepius, the Greek god of healing whose staff entwined with a serpent became the symbol of medicine. In the seventh century B.C.E, Asclepius, aided by his two daughters, Hygeia and Panacea, superseded Apollo as the greatest of the healing gods, and temples in his name were built to heal the sick. According to legend, the centaur Chiron taught Asclepius pharmaceutical knowledge about drug plants.

Hippocrates, considered the originator of a Greek school of healing, was the first to clearly expound the concept that diseases had natural rather than supernatural causes. Various works attributed to him and to his school are contained in the Hippocratic Collection, which includes The Hippocratic Oath, Aphorisms, and various medical works. He was an expert in diagnosis, predicting the course of disease. Based on the color and pallor of the ill person, disease was considered to be an imbalance of the four "humors"—blood, phlegm, yellow bile, and black bile—a concept that was to affect medicine for the next two thousand years. This concept persists in the following terms that describe distinctive temperaments: sanguine (warm and ardent), phlegmatic (sluggish, apathetic), and bilious (ill humored). Healing emphasis was placed on purges, attempts to purify the body from the illness produced by excesses or imbalance of humors. Hippocrates particularly noted the influence of food and diet on health, recommending moderation.

In the work *On Ancient Medicine*, Hippocrates notes differences in individual responses to food. He comments on the fact that some can eat cheese to satiety while others do not bear it well, a diagnosis of what we would now call lactose intolerance. The use of drugs was also an area of study: between two hundred and four hundred herbs were mentioned by the school of Hippocrates.

See also **Greece, Ancient; Health and Disease; Medicine; Pythagoras.**

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HOLIDAYS. Holidays are "holy days," when people interrupt the profane, mundane round of production and celebrate with the preparation and eating of special foods and meals. The two basic forms of holidays are a festival (from Latin *festum* for 'feast'), when people break their normal weekly, monthly, or annual routine to celebrate together, and a vacation (in the sense of leaving their homes and workplaces empty), when an often longer disruption may be accompanied by dislocation, as people change residences or travel.

Festivals

Traditionally, festivals have enjoyed an explicitly religious interpretation, so that the Sabbath of Jews, Christians, and Muslims is a God-ordained day of rest. Many holidays have been associated with seasonal change, and the New Year is celebrated in many calendars, notably the Chinese, with brilliant feasts. Other festivals have been national, ordered by governments to honor founding events and heroes, such as Bastille Day (14 July) in France. Further holidays might commemorate children, an emperor's birthday, the achievements of war veterans or the working class. Australians take legislated days off for horse races.

Festival foods often feature in cookery books, such as the multivolume *Foods and the World* series of Time-Life (1968–1971). Conversely, festival foods are often described in surveys of holidays around the world, such as *Holidays and Festivals* (1999). Traditionally, women have worked together for several days on elaborate preparations, such as finely decorated confectionery and pastries, which have been keenly anticipated each year and have long remained poignant reminders of local, ethnic, and religious affiliations.

Eating and drinking might become especially abundant at harvest festivals and the breaking of a fast, as when Carnival concludes the Christian Lent and at the end of Ramadan, the ninth month of the Muslim year. Particular foods might be featured, such as the lamb and unleavened bread of the Jewish Passover. The Hindu festival of lights, Divali, celebrates the longest night of the year (which falls in October or November in the Western calendar) with gifts of sweets, which vary immensely across the subcontinent. The Scottish *haggis*, which is a boiled sheep's stomach stuffed with mutton offal and oats, is a triumph of symbolic grandeur if not culinary, typical of midwinter and so featuring at *hogmanay* (New Year's Eve) and again on Burns Night (25 January), which commemorates the birthday of poet Robert Burns, who praised the *haggis* as the "great chieftain o' the puddin'-race."

Thanksgiving (the last Thursday in November) is a national American feast on which families dine on turkey and traditional accompaniments. The warmer weather of Independence Day (4 July) encourages parades and more casual, outdoor eating, especially barbecued chicken and perhaps an apple pie or red, white, and blue cake. Particular foods tend not to be associated with newer holidays, and yet the community mindedness of Martin Luther King's Day (the third Monday in January) might be reflected in sharing minority cuisines and decorating paper bags for food deliveries to the needy.

Vacations

Monarchs frequently took their court on an extended voyage through the countryside from palace to palace. Other leisured classes have long avoided either extreme of temperature by "summering" or "wintering" at an alternate house or resort. With the expansion of rail and road networks and the democratization of the annual break, more people took vacations. They could grow up knowing life on the farm from childhood holidays spent with cousins, could visit distant relatives when several national holidays coincide (such as Christmas–New Year's and the Japanese "Golden Week"), and could experience the products of hotel, restaurant, and other kitchens, sometimes in foreign countries, where everything might be closed for an unexpected holiday of pageantry and feasting.

The Effect of Globalization on Holidays

Whether in premodern China, ancient Rome, medieval Europe, or modern industrial societies, the proportion of holidays has remained remarkably constant—approximately one day in three. However, with globalization, and more continuous production and consumption, fewer collective breaks are observed. The seasonal emphasis is giving way to consumer weekends, a few national days, plus individual annual leave. Religious feasts are losing out to sport and entertainment, gift-giving breaks such as Christmas are commercially exploited, and vacations are serviced by organized leisure and tourism industries.

The innocent "holiday mood," which has been relished not just by the holidaymakers but novelists and screenwriters, is in danger of being lost. Holidays provide scenic locations, laid-back atmospheres, and breaks in everyday routines for the unexpected to happen. A gem of the French cinema, Jean Renoir's *Une partie de campagne* (often translated as A Day in the Country, 1936/46), centers around a Parisian family picnic at a country inn, during which two men invite the mother and betrothed daughter to go boating. In *Le Rayon vert* (The Green Ray or Summer, 1986), director Eric Rohmer shifts his listless heroine to various French holiday destinations, and she memorably justifies her vegetarianism over an outdoor lunch. Hollywood has often taken teenagers on summer holidays for lessons in growing up, their chosen meal typically milkshakes and hamburgers.

The association between holidays and foods may be lessening, yet it persists in many ways, and understanding the genesis of holidays assists in continuing to reinvent them.

Explaining Holidays

The Russian author Mikhail Bakhtin in *Rabelais and His World* (1968) analyzed the carnivalesque, the inversions when aristocrats and servants change places, when scatological humor temporarily undermines the dominant ideology, and when eating reappears as a "grotesque" reality. More conventionally, such boisterous breaks as Mardi Gras are often said to "release" pent-up energy that might otherwise be destructive.

Other social scientists have viewed holy days as "sacred" moments that give shape to otherwise "profane" time. Developing this approach from Émile Durkheim, anthropologist Edmund Leach asks in "Two Essays concerning the Symbolic Representation of Time" (1961) why people dress up in "false noses" or, more precisely, adopt three types of behavior: increased formality (such as an English Sunday), masquerade (New Year's Eve revelry), and role reversal (Mardi Gras). He then argues that such activities generate and reinforce sacred time (so that "transgressive" and "sacred" accounts are not so different). Such holidays contribute to social cohesion, not only reinforcing a common interpretation of the world, but also facilitating a rhythmic pattern of activities and so the "ordering of time."

Food is then usually regarded as "symbolic" of sacred time. Yet the inverse often makes better sense because holidays are grounded in cycles of food production. The interruption in "profane" routine by joy, revelry, or contemplation generates the holy. A harvest festival is an obvious case, when an intense burst of consumption follows a busy period of gathering and preserving, and when people are no doubt so profoundly thankful that they bring these crops before the gods.

Likewise, lamb might "represent" Easter, but while offering first fruits might come to "symbolize" spring, before that, the rejoicing at their arrival generates the concept of spring. The word "Easter" comes from the old English *easter* or *eastre*, a festival of spring, and its lambs, eggs, and rabbits are more than mere "symbols" of spring; they are spring. The Jewish festival of Passover derives from the Hebrew's nomadic origins, when the new growth would have supported extended gatherings, celebrated by sacrificing some of the newly increased flock. Since Jesus had been put to death around the time of Passover, Christians adopted the symbolism of Jesus as a sacrificial lamb.

The trappings of Christmas belong to the phalanx of "pagan" midwinter festivals; the merrymaking and exchange of presents join the ancient Roman festival of Saturnalia and other cheering anticipations of cornucopia. With no certain tradition as to the date of Jesus' birth, Emperor Constantine chose the winter solstice, possibly to "compete" with the other festival, as often stated, but more likely to place Jesus' birthday appropriately at the beginning of the year.

Not only the seasonal festivals but also the weekly are based on the food supply. In different cultures, weeks have comprised three, four, five, six, seven, ten, or other number of days. With few exceptions, these have been organized around the market cycle. A strict periodicity must be maintained for both the circuit of sellers and the attendance of buyers. The Christian world took the seven-day week from the Jews, who had adopted it from the Babylonians.

Marking out the market week and seasonal year, festivals dramatize the cycles of food production and consumption upon which our survival depends. The feasts become time-keeping devices, proto-calendars. For, in another inversion of a common assumption, holy days were not the products of formal calendars, but their antecedents. Festivals originally had ecological dates, because they related closely to winter scarcity, bud-burst, arrival of flocks of birds or schools of fish, the weakening of the monsoon, and other natural cues. With precise astronomical observations, central authorities then created rational calendars and so, eventually, more "exact" festivals.

Upholding Holidays

Commercialism has boosted Christmas, Mother's Day, Father's Day, and others. Among ancient holidays that have gained new life, Valentine's Day encourages couples to dine out, and Japanese women to give chocolates. The food and drink industries have introduced a range of festivals, not the least the return of weekend farmers' markets, and annual food and wine fairs replete with tastings and grand banquets.

The mobility of global populations might have made many holidays anachronistic in that traditional meals are out of season; for example, Christmas turkey and plum pudding are absurd in the middle of the hottest days, as happens in the Southern Hemisphere. Yet people adapt, and many Australians enjoy the heavy fare during their winter, on 25 June or 25 July (for some reason, seven months out seems to be preferred). People invent their own rituals to surround a global television event, such as the annual telecast of the Academy Awards.

The individualization of holidays encourages new approaches. The registration of precise dates of birth has helped make this an important anniversary; many people ask for their birthday off from work, and even attach an appropriately seasonal food or meal. Married couples, probably having conducted much of their courtship over dinner, having founded their new household at a wedding breakfast, and then having gone on a honeymoon, celebrate wedding anniversaries at a romantic dinner at a restaurant or weekend retreat. Perhaps they celebrate other milestones, such as the departure of children from the "nest." People take other rites of passage seriously, such as reaching adulthood at the age of eighteen or twenty-one.

Influential American and British cookery writers discovered the joys of traditional European cuisines on sojourns after World War II. Many others now make an annual gastronomic tour, steered by the "stars" in restaurant guidebooks. Food and wine-producing areas have become tourist attractions. Enthusiasts take cooking lessons in Tuscan villas.

More modestly, a holiday is a chance to catch up with household chores, for a city worker to spend time in the kitchen, or for everyone to go on a picnic. People shift to a beach or mountain house to get away from the clamor of newspapers, television, and junk mail, and go fishing or hunting. Stressed workers still need time to read, to chat over coffee, to walk along the beach, to linger over meals, to philosophize into the night. Even more fundamentally, human beings need to keep in touch with the seasons. Given the range of the world's climates, clinging to the best local products is a force for difference.

See also **Buddhism; Christianity; Christmas; Day of the Dead; Easter; Epiphany; Fasting and Abstinence; Feasts, Festivals, and Fasts; Hindu Festivals; Hinduism; Islam; Judaism; Passover; Shrove Tuesday; Thanksgiving; Wedding Cake; Weddings.**

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HOLLAND. *See* **Low Countries.**

HOME ECONOMICS. From its beginnings, the profession of home economics, also called family and consumer sciences, closely paralleled the general development of education for women. Home economics developed out of political, economic, and technical conditions in the last half of the nineteenth century. Before then, formal training for women was virtually nonexistent. What did exist was the realization that obligations of the home extended beyond its walls. The discipline was begun by men and women, including Ellen H. Richards, Wilbur O. Atwater, Edward L. Youmans, and Isabel Bevier, who aimed to develop a profession that understood the obligations of and opportunities for women. They wanted to use scientific principles and processes to enhance management of households, and they wanted to make home and family effective parts of the world's social fabric.

Family and consumer sciences or home economics, as taught and practiced in the United States and abroad, has a broad and comprehensive focus. A plethora of names, including domestic science, living science, home science, home science education, human ecology, human sciences, practical life studies, household technology, science of living, family and household education, family and nutritional studies, and nutrition and consumer studies, also have been used to describe the discipline, whose purpose is to meet specific and general needs of individuals and families. Although the names were numerous, a single widely accepted definition was adopted at the 1902 Lake Placid Conference on Home Economics, one of ten such conferences held annually from 1899 to 1908 devoted to the study of laws, conditions, principles, and ideas concerned with a person's immediate physical environment, his or her nature as a social being, and the interrelationships therein.

Founding Home Economics

Publications, such as Catharine Beecher's *A Treatise on Domestic Economy* (1841), and legislation, including the Morrill Act (1862), probably provided the impetus for the Lake Placid conferences. The Morrill Act devoted federal lands to support the development of colleges of agriculture and mechanical arts. This helped shape the field of home economics because women subsequently were admitted to these land-grant colleges, as they were called, and to some private institutions, such as Oberlin College in Ohio.

The first home economics class in an institution of higher learning was offered at Iowa State College in 1871 and was called "domestic economy." Kansas Agricultural College began its domestic economy curriculum two years later, and Illinois Industrial University followed a year after that. These and the others that followed helped women apply theories in arts and sciences to everyday living. As they studied domestic economy along with some classical curricula and as theirs became an academic discipline, educational opportunities for women expanded.

Concurrently the interest in adult education courses expanded. Prior to the last quarter of the nineteenth century, women's work was mostly needlecraft, sewing, and cooking; the work was done at home; and women received little formal educational training for these tasks. Some classes in cookery existed, such as those at the Boston Cooking School begun by Maria Parloa, and Mothers Clubs and Reading Circles developed. In time, all of these organizations had major impacts on communities. Mothers Clubs and Reading Circles became Parent Teacher Associations, and the Society of the Study of Child Nature became the Child Study Association.

Ellen Richards influenced the field of home economics and all of women's work. Considered the founder of the profession of home economics, she became in 1873 the first woman to earn a bachelor of science degree at the Massachusetts Institute of Technology (after earning an A.B. from Vassar in 1870). She published *The Chemistry of Cooking and Cleaning* and a manual for housekeepers, both in 1881. Some years later she worked on an exhibit in Chicago for the World's Columbian Exhibition (1890) based on her nutrition experiments. This exhibit was influential in establishing the first school lunch program in 1894.

Academic and adult education courses as well as increased immigration, industrialization, and urbanization added impetus for the development of this discipline, initiated at the first Lake Placid Conference on Home Economics in 1899. Three years later the conference founded a national organization, the American Association of Home Economics (AHEA), which actually began its work in 1909. The goals of AHEA were to improve living conditions in homes, institutional households, and communities. Conference participants selected subject matter that stressed family applications and developed academic requirements in cultural, technical, and vocational venues. These originally included the areas of food, clothing, shelter, and institutional management and shortly thereafter expanded to include child development, personal and family relationships, consumer education, home management, and housing.

Participants at the Lake Placid conferences designed the discipline's educational requirements in natural and social sciences and the arts and humanities for elementary and secondary schools and institutions of higher education. They also developed ways to access funding to implement these goals, including advocating passage of the Smith-Lever Act of 1914 and the Smith-Hughes Act of 1917. These two acts established, respectively, the Cooperative Extension Bureau and education in home economics at precollege and college levels. These efforts developed ties between institutions of higher education and teacher preparation.

World War I created demands for professionals trained in institutional management and dietetics, natural situations for home economists. After the war, additional demands arose in public health, community feeding, school lunch supervision, consumer protection, and related areas. These demands expanded the discipline's activities well beyond cooking and sewing. During the depression of the 1930s, home economists were further called upon for advice in managing family needs. These newer roles required that institutions of higher education develop and emphasize research and divide their educational offerings into narrower specialties.

These circumstances, along with a 1930 AHEA report, changed training for professionals. The training kept physiological, psychological, economic, social, and political perspectives; increased emphasis on sociology, economics, and philosophy; and decreased required courses in education, science, and home economics. This shifted the emphasis from home-related skills to those needed in away-from-home situations. Additional changes during and after World War II expanded preparation and broadened professionals' areas of service.

The AHEA suggested ways to strengthen family life, expanding offerings and reducing skills courses for the five largest areas of the profession, that is, home economics education; child development and family relations; textiles, clothing, and fashion merchandising; general home economics; and food, nutrition, and dietetics. Building on the basic disciplines, the AHEA promoted more research relating to nutrition, child development, consumer economics, and home management to increase the discipline's impact on families, homes, consumers, legislation, and technology, and on all types of households and related institutions.

Late Twentieth-Century Developments

No other discipline integrates so many applied and theoretical areas of education or reaches out as far as home economics. Many conferences, committees, and research efforts have kept the AHEA and its constituents current. In the 1960s efforts were expended toward accreditation of all undergraduate programs, achieved in 1967. The eleventh Lake Placid Conference met in 1973 to revitalize values and to develop future directions to broaden home and family life into an ecosystem conceptualization, emphasizing interdependence of people in rapidly changing environments. In the 1980s the organization focused on certification of professionals, which began in 1986.

Reaching out to meet the demands on professionals, AHEA was instrumental in organizing a professional summit to build consensus among five related organizations, including the AHEA, the home economics division of the American Vocational Association, the Association of Administrators of Home Economics, the National Association of Extension Home Economists, and the National Council of Administrators of Home Economics. At a conference in Scottsdale, Arizona, in 1993 these organizations opted to change the discipline's name from home economics to family and consumer sciences (FCS), for which the memberships favorably voted the following year. In 1997 national standards for middle and high schools were developed and adopted for FCS education, focusing on content, process, and competencies.

Positioning itself for the twenty-first century, the profession developed additional ways to empower individuals and families to take charge of their lives, to maximize their potential, and to function independently and interdependently. To further these means of empowerment, FCS and related professionals work together to create opportunities and options for their diverse constituencies, and they have made strides to increase minority membership and leadership. In addition, they have set standards for integration and application of knowledge among all peoples and constituencies. FCS professionals, with the help of others who share the same goals, have moved women's work toward the center of higher education. They have impacted society and continue to work so all professionals can see efforts in the home and the community increased and gender marginalization reduced.

The national organization, renamed the American Association of Family and Consumer Sciences (AAFCS; renaming effective 1994), promotes improvements in individual and family life. Its efforts effect changes in areas such as food, nutrition, textiles, clothing, family relationships, child development, family resource management, design, housing, and consumer studies. Using its unique, integrated approach, it strengthens and empowers individuals, families, and communities, enhancing the quality of life. The profession strives for positive change in the multifaceted environments and ecosystems in which people live, work, and otherwise partake of life.

See also **Extension Services; Nutritionists; Professionalization; School Meals; Women and Food.**

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HOMELESSNESS. No nation is without its homeless. In the United States alone, between 280,000 and 600,000 men, women, and children are homeless each night, according to differing estimates. They are without permanent lodging because of poverty, lack of affordable housing, low wages, substance abuse, mental illness, or domestic violence. In many other countries, however, civil unrest, war, and famines bring about homelessness. At the beginning of the twenty-first century, there were more than eleven million homeless worldwide.

Paramount among the problems facing the homeless are poor nutrition and hunger. They can be life-threatening, especially among refugees. Protein-energy malnutrition is a major contributory cause of death among newly displaced refugees. International relief organizations and the United Nations set up refugee camps and make the distribution of nutritionally adequate food rations a high priority. The homeless in the United States often do not experience such extreme food deprivations. However, many are often chronically undernourished. Compared to other groups at risk for hunger, the homeless are at greatest risk, being ten times more likely to go without food for a day compared to the poor. Few are able to obtain three meals a day, and many go at least one day a month without any food. Scant research indicates that many have caloric intakes far below recommended levels and may have inadequate intakes of calcium, folacin, iron, magnesium, or zinc. Their low-calorie diets, which tend to be high in fat, cholesterol, and sodium and inadequate in essential nutrients, may further compromise the already poor health status of the homeless.

While many rely on homeless shelters, especially in winter months, a large number find refuge in cars, abandoned buildings, on grates, in parks, or, other outdoor places. Most have been without a fixed and regular nighttime residence for more than one year. Lacking a stable home environment and cooking and storage facilities exacerbates their inability to obtain an adequate, varied, and healthy diet. While it is not uncommon to see a homeless person panhandling or scavenging for food through trash cans, most depend on soup kitchens and shelters for the major portion of their daily nourishment. Soup kitchens and shelters typically serve one meal a day on-site, although some shelters permit their residents to prepare and cook their own meals. Those who are substance abusers or have mental health problems are more likely to resort to obtaining food from trash cans or begging, compared to those without these health conditions.

Participation in the Food Stamp Program, the government's largest antihunger program, is unusually low among the homeless. While homeless advocates speculate that most of the homeless are eligible, they argue that barriers such as documentation of identity or administrative burdens prevent many from participating. The difficulty of making effective use of food stamp benefits without adequate cooking and storage facilities is also a barrier. While the Food Stamp Program does permit states to contract with restaurants to serve meals at concessional prices to the homeless, such authorizations are uncommon among states.

See also **Body Composition**; **Caloric Intake**; **Class, Social**; **Food Banks**; **Food Pantries**; **Food Politics: United States**; **Food Stamps**; **Food Supply, Food Shortages**; **Hunger, Physiology of**; **Poverty**; **Soup Kitchens**.

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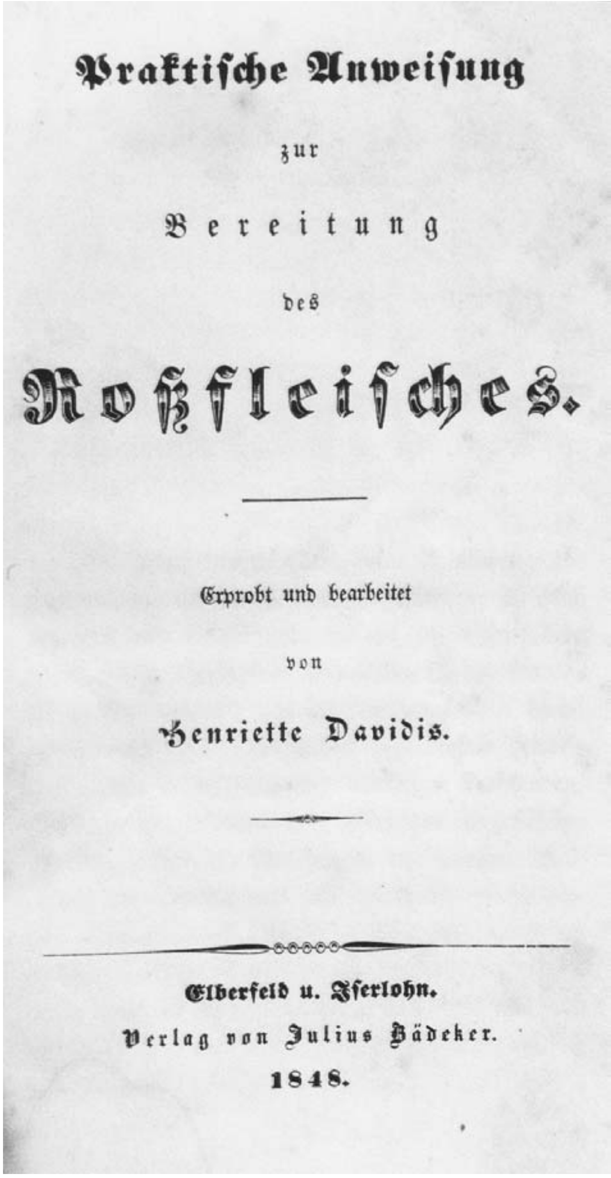
HORS D'OEUVRES. *See* Dinner; Meal.



Praktiſche Anweiſung
zur
Bereitung
des
Roßfleiſches.

Erprobt und bearbeitet
von
Henriette Davidis.

Elberfeld u. Iſerlohn.
Verlag von Julius Bädeker.
1848.

Title page of the first cookbook to deal with the preparation and cooking of horse meat. It was written by Henriette Davidis, one of the most popular cookbook authors of nineteenth-century Germany. The book was issued during a period of widespread famine and political upheaval. COURTESY OF HANS WEISS. ROUGHWOOD COLLECTION.

HORSE.

For the last five thousand years, the horse has of been of greater human interest for its strength than as a source of meat. The domestication of the horse is considered to have taken place in the present-day Ukraine in the fourth millennium B.C.E., and the practice spread from there. Prior to that, wild horses had been caught for food and seem to have been eaten by most peoples that adopted them during the first three thousand years of their domestication, though other, work-oriented kinds of use were more important.

The people of ancient Greece and Rome despised horse eating, although it was still practiced among the Germanic peoples and Asian nomads at that time. The Asian nomads also made a common use of mare's milk and "koumiss"; in fact, fermented mare's milk has been an important foodstuff in the steppes of Central Asia and is still a common drink there, and is also known in Scandinavia and the former Soviet Republics. Boeuf tartar is believed to originate from Asian Nomads, who preferred horsemeat to beef and therefore many think that this dish was originally made from horsemeat. Horsemeat is still an important food in Mongolia and Japan. The Japanese like to use it in their famous teriyaki. Horses are bred for food in many places in Asia, as in Mongolia, Central Asia, and Japan.

The dietary restrictions of Jews, Muslims, and most Hindus do not allow horsemeat in the diet. The practice of sacrificing horses and in some cases consuming their meat has been widespread in Europe and South Asia from the beginning of their domestication. It was part of pagan Germanic ceremonies and its importance in pagan religion is probably the reason why it was despised by Christians. Horsemeat is the only foodstuff that Christianity has abolished from the diet for religious reasons. Canon law forbade the eating of horses, and most of the Christian societies in Europe adopted that ban. This ban was for the most part abolished in first half of the nineteenth century in the Christian countries of Europe. Now horsemeat is eaten in most of the European countries, and in France, Belgium, Italy, Switzerland, and Iceland horses are bred for food production, although horse has not yet become a considerable part of the diet in any of these countries. The French and Flemish consume the most horsemeat in Europe, but the highest rate of consumption has amounted to only about five percent of that of beef. In the last decades of twentieth century the consumption of horsemeat dropped. One reason was that meat was cheaper when it was a byproduct of raising horses for uses that machines have mostly taken over now. Another reason is the increased opposition to eating horsemeat by animal rights activists. Activists in the United Kingdom have fought against eating horsemeat for decades, and in America the campaign against horse slaughtering for food is also prominent. Some American Indians are traditionally horse eaters, but the average consumption in the United States is low, although horsemeat is readily available. French immigrants make up a considerable part of the horse eaters. In many places in the Americas, as in the United States (the leading producer of horsemeat), Argentina, and Canada, horses are bred for their meat but it is mostly exported.

Horsemeat is darker red than beef and venison. Raw horsemeat is also more fibrous, and if kept for a while, it becomes rapidly black in color. It is more than 50 percent lower in fat and energy than beef, but of comparable nutritional value. After slaughter, foals and horses up to about two years old are usually chopped and prepared in ways similar to cattle and served as various kinds of steaks and goulashes, although special recipes for horsemeat are rare in the cookbooks of the Western world. The meat is easy to digest and the taste generally falls somewhere between beef and venison but a bit sweeter than either. Meat of older horses is commonly salted, smoked, or made into sausages. It can be very difficult to distinguish foal meat and beef, if it is spiced the right way. Hence in many places measures have been taken to prevent selling of horsemeat as beef. Older horses tend to be fatter, and horsefat is yellowish in color and not considered good in taste. The horsefat gets quickly rancid if not properly conserved, and horsemeat deteriorates more rapidly than beef. The fat, when melted, becomes oillike, and has been used for bread baking in northern Europe.

See also **Asia, Central**; **Cattle**; **China**; **Dairy Products**; **Goat**; **Japan**; **Mammals**; **Meat**; **Pig**; **Taboos**.

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Hallgerđur Gísladóttir

HORTICULTURE. Horticulture, literally garden culture, is a part of crop agriculture that also includes agronomy and forestry. By tradition, horticulture deals with garden crops such as fruits, nuts, vegetables, culinary herbs and spices, beverage crops, and medicinals, as well as ornamental plants. Agronomy is involved with grains, pasture grasses and forages, oilseeds, fiber crops, and industrial crops such as sugarcane, while forestry is involved with trees grown for timber and fiber as well as the incidental wildlife. The edible horticultural crops are used entirely as human food and are often utilized in the living state and thus highly perishable. In contrast, edible agronomic crops are often utilized in the nonliving state, are highly processed, are often used for animal feed, and usually contain a high percentage of dry matter. The precise distinction between horticultural and agronomic crops is traditional. In general, horticultural crops are intensively cultivated and warrant a large input of capital, labor, and technology per unit area of land, but in modern agriculture, horticultural crops may be extensively grown while many agronomic crops are now intensively cultivated. Many crops are claimed by more than one discipline. Horticulture is practiced in large agricultural operations, in small farm enterprises, and in home gardens.

Horticultural Arts

Horticulture is associated with a number of intensive practices that collectively make up the horticultural arts. These include various propagation techniques incorporating special plant structures such as bulbs, corms, or runners; the use of layers or cuttings; budding and grafting; and micropropagation involving tissue culture. Cultural practices include soil preparation, direct planting or transplanting; fertilization; weed, disease, and pest control; training and pruning; the use of controlled environments such as greenhouses or plastic tunnels; applications of chemical growth regulators; various harvest and handling methods; and various postharvest treatments to extend shelf life. Other practices associated with horticulture are breeding and genetic techniques for crop improvement, marketing methods, and food processing. Ornamental horticulture, not considered here, includes added practices associated with landscape architecture and the floral arts. While horticulture is an ancient art with many of its practices empirically derived, present-day horticultural arts are intimately associated with science, so that modern horticultural science is one of the most advanced parts of agriculture. Recently some horticultural growers have attempted to reduce or even eliminate reliance on inorganic fertilizers and pesticides through the incorporation of ecologically based practices (integrated crop management).

CROP PROPAGATION

Horticultural crops are multiplied sexually (seed propagation) or asexually (clonal or vegetative propagation). Many vegetables and herbaceous (soft-stemmed) ornamentals are seed-propagated (beans, tomato, petunia). However, some seed is produced by nonsexual means (apomixis—bluegrass, many citrus, mango), and plants produced by this type of seed are considered vegetatively or clonally propagated. Clonal propagation occurs naturally in many horticultural crops through special vegetative structures such as the tubers of potato, the runners of strawberry, the cloves (corms) of garlic, or the bulbs of tulip. Clonal propagation can be achieved by cuttings, where pieces of the plant regenerate missing parts. Thus, shoot cuttings regenerate roots (grape), root cuttings regenerate shoots (sweet potato), and leaf cuttings regenerate shoots and roots (African violet). Most fruit crops are propagated using grafting techniques where plants are physically joined together, in which the combination of parts achieves physical union through tissue regeneration to grow as a single plant. The part of the combination that provides the root is called the stock; the added piece is called the scion. When the scion consists of a single bud only, the process is referred to as budding. A modern form of vegetatative propagation is called micropropagation and involves tissue culture—the aseptic growth of cells, tissues, or organs in artificial media.

This technique permits very rapid propagation and is widely used for many foliage plants. It is commonly used to produce disease-free stock of strawberry, which are later propagated in the field by runners.

Horticultural Food Crops

Horticultural food crops include an enormous array of species that are grouped in various ways.

Fruits. Fruits of woody perennial plants have long been prized for sources of refreshment, for their delightful flavors and aromas, and as nourishing foods. Fruit crops can be defined as temperate, subtropical, and tropical depending on their temperature requirements. Temperate fruits are deciduous (drop their leaves in the cold period) and undergo dormancy requiring a certain amount of low temperatures (chilling period) before growth is resumed in the spring. Subtropical fruits require a very short chilling period. Tropical fruits are usually evergreen and are extremely cold-sensitive. Within these groupings fruit crops are usually grouped by taxonomic affinity. The temperate fruits include the pome fruits (apple, pear, quince, medlar), stone fruits (apricot, cherry, peach and its smooth-skin variant the nectarine, and plum), vine fruits (grape and kiwifruit), and small or bush fruits (strawberry; blueberry, cranberry, and lingonberry; brambles such as blackberry, raspberry, and various hybrids; currants and gooseberries). The subtropical fruits include citrus (citron, grapefruit, the tropical pomelo, sweet orange, lemon, lime, mandarins, and various hybrids such as the tangor or tangelo); and fruits associated with Mediterranean climates (avocado, cactus pear, carob, fig, loquat, persimmon, pomegranate). There are hundreds of tropical fruits, of which the most important are banana and plantain, mango, papaya, and pineapple, but there are hundreds of others with regional interest, including acerola, akee, carambola, cherimoya, durian, guava, litchi, mangosteen, passion fruit, rambutan, sapodilla, and soursop.

Nuts. The important tree nuts that enter into international trade include almonds, Brazil nuts, cashews, chestnuts, hazelnuts, macadamias, pistachios, pecans and hickories, and walnuts.

Beverage crops. Beverage crops include the subtropical crops—coffee, tea, and maté—and the tropical cacao used for cocoa and the confection chocolate.

Vegetables. Vegetables are typically herbaceous (soft-stemmed) plants in which various parts are used as food, including roots, tubers, leaves, fruit, or seed. There are various groupings based on the part consumed and taxonomic affinity. Vegetables include the root crops (beet, carrot, cassava, celeriac, dasheen, horseradish, parsnip, potato, salsify, turnip, radish, rutabaga, and sweet potato, as well as some little-known Andean tubers such as oca, mashua or anu, and ulluco, and root crops such as arracacha, maca, and yacon); bulb or corm crops including the pungent alliums (chive, garlic, leek, onion, shallots,

PLANT DOMESTICATION

The greatest advances in horticulture, the selection and domestication of our useful crops, were made in prehistory by farmers unknown and unsung. The basic techniques of horticulture were well established by ancient cultures in antiquity (5000 to 1500 years ago). In fact, a complete record of horticulture practices is illustrated in the tomb artwork of ancient Egypt. The horticultural technology of antiquity includes basic propagation techniques (seed handling, grafting, use of cuttings); planting and cultivation (plowing, seed bed preparation, weeding), irrigation technology involving water storage, lifting, and channeling; storage technology such as granaries; fertilization and crop rotation; plant selection; basic food technology (fermentation technology in bread- and winemaking, drying, and pickling), and even the beginning of protected culture (the Romans had a primitive greenhouse using mica for cucumber forcing).

and chive); salad or leafy crops (arugula or rocket, celery, chicory, cress, endive, lettuce, parsley); cole crops or crucifers (cabbage, cauliflower, broccoli, brussels sprouts, kohlrabi, Chinese cabbage, and various Asian types such as bok choy); potherbs or greens (chard, collards, dandelion, celeriac, kale, mustard, orach, spinach, New Zealand spinach); solanaceous fruits (eggplant, sweet and hot peppers, tomato and husk tomato), cucurbits, also known as melon or vine crops (chayote, cucumber, muskmelon, pumpkin, squash, watermelon); legumes or pulse crops in which the seed is consumed (adzuki bean, broad bean, chickpea, common bean, cowpea, lima bean, mung bean, rice beans, tepary bean, urdbean, garden pea, and pigeon pea). Some vegetables are perennial (artichoke, asparagus, Jerusalem artichoke, rhubarb, sea kale). Some agronomic crops are consumed as a vegetable in various stages, and these types are included as horticultural crops. Examples include sweet corn (the immature ears of a sweet type of maize), immature vegetable soybean or edamame, and the young leaves of amaranth.

Culinary herbs and spices. Aromatic plants used for culinary purposes are called herbs when they are temperate species and spices when they are tropical. Examples include allspice, anise, basil, capsicums, caraway, cardamom, cinnamon, chervil, clove, coriander, cumin, dill, fennel, funugreek, garlic, ginger, laurel, marjoram, mint, mustard, nutmeg and mace, onion, organum, parsley, pepper, poppy seed, rosemary, saffron, sage, savory, sesame, star anise, tarragon, thyme, and turmeric.

Horticultural Societies

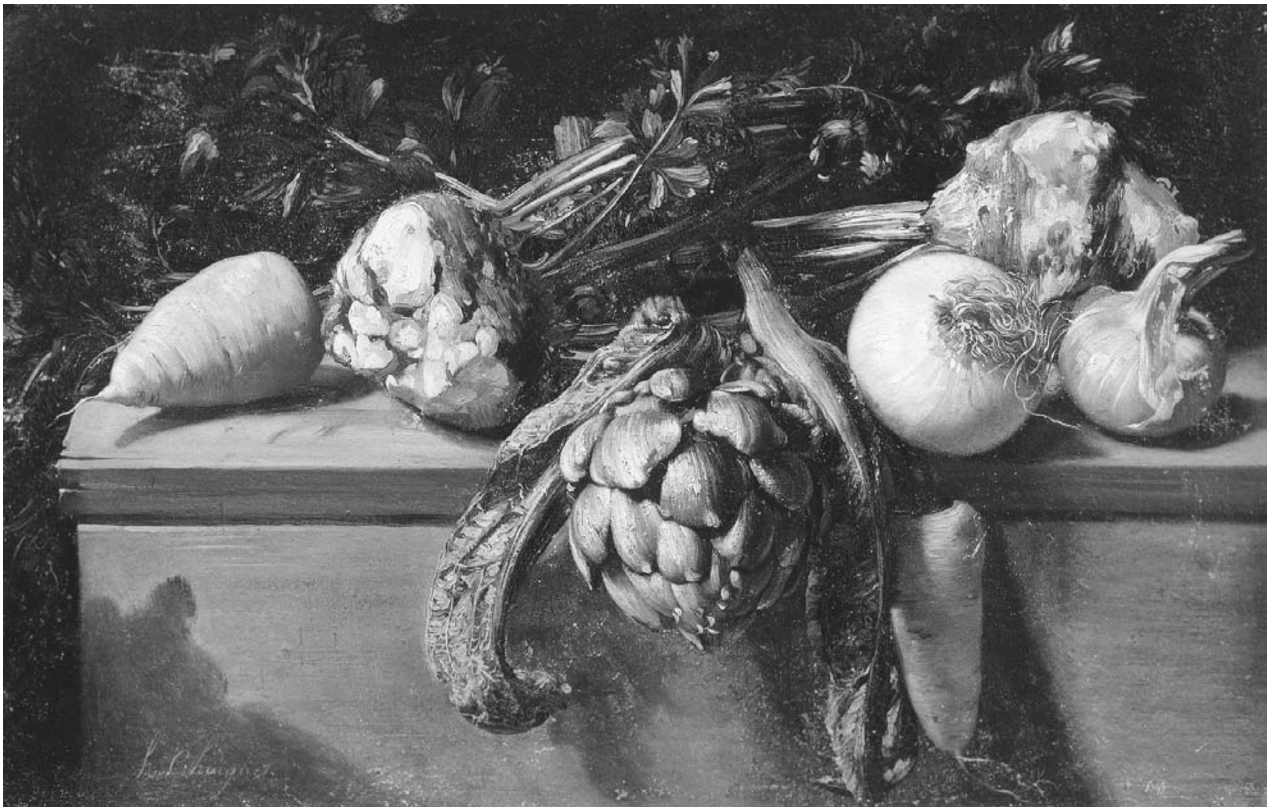
The field of horticulture has a great many organizations and societies devoted to all phases of horticulture, including amateurs and fanciers, growers and handlers, researchers, and academics. There are plant societies devoted to individual or groups of crops, trade organizations devoted to the production and marketing of individual horticultural crops, and scientific societies devoted to scientific research. In the United States, the principal society devoted to the science of horticulture is the American Society for Horticultural Science (founded 1903) with offices in Alexandria, Virginia. The society publishes three scholarly journals as well as books, and conducts annual meetings. Examples of other scientific societies in the United States include the American Pomological Society, devoted to fruits and nuts, and the American Potato Society. Growers of horticultural crops are also organized in state societies. Many countries have a national scientific society devoted to horticulture. The International Society for Horticultural Science located in Leuven, Belgium, sponsors international horticultural congresses every four years.

Horticultural Education

Horticulture is a recognized part of the curricula in agriculture worldwide. In the United States many land grant universities have horticulture departments devoted to undergraduate education leading to the B.S. degree. Most of these departments provide advanced training leading to the M.S. and Ph.D. degree. However, since the 1990s

THE MORRILL ACTS

The land-grant universities trace their origins to the Morrill Act signed by Abraham Lincoln in 1862, a famous piece of legislation sponsored by Justin Smith Morrill of Massachusetts. Monies from the sale of public lands (30,000 acres for each of its Senate and House members) were to be used as a trust fund to endow a college where practical education in agriculture and engineering would be emphasized. The Agricultural Experiment Stations associated with the land-grant colleges trace to legislation (Hatch Act of 1887) sponsored by William H. Hatch of Missouri. In 1890, the Second Morrill Act was passed and provided direct annual appropriations and forbade racial discrimination in admission to colleges receiving the funds. States were allowed to escape this provision if separate institutions were maintained and a number of the “1890 colleges” in various states open to African Americans became known as “black colleges.”



The bounties of horticulture are celebrated in this still-life painting by French artist Hippolyte Chaignet. Collection of the Musée des Beaux-Arts. © ARCHIVO ICONOGRAFICO, S. A./CORBIS.

there has been a trend for horticulture and agronomy departments to combine into either a Crop Science or Plant Science department. A number of schools give two-year programs leading to associate degrees.

See also **Agriculture since the Industrial Revolution**; **Agriculture, Origins of**; **Aquaculture**; **Climate and Food**; **Extension Services**; **Farmers' Markets**; **Gardening and Kitchen Gardens**; **Genetic Engineering**; **Greenhouse Horticulture**; **High-Technology Farming**; **Organic Agriculture**; **Organic Farming and Gardening**; **Organic Food**; **Prehistoric Societies: Food Producers**; **Sustainable Agriculture**.

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Jules Janick

HOUSEHOLD. Definitions of what constitutes a household have always been dynamic and dependent on political, historical, and cultural factors. Prior to the nineteenth century, typical households were large and agriculturally self-sustaining, with most family members contributing to homestead productivity. The industrial revolution in Europe and the United States brought about changes in household and family structure that influenced fertility patterns and household size, including changes in gender roles and definitions of modernity.

The contemporary American household continues to change in composition and size. Married couples comprised 78 percent of households in 1950, but this percentage dropped dramatically over the next forty years to a low of 53 percent in 1998. The average size of the American household has also decreased in recent years. Over half of American households (57 percent) now consist of only one or two people, compared to an average of 3.1 persons in 1970 (USDS, 2001).

Other nations have also experienced rapid shifts in household size and composition. In their 2000/2001 General Household Survey, the National Statistics Office of Britain reported a doubling and tripling, respectively, of one-person and two-person households between 1971 and 2000. The percentage of married-couple households with dependent children dropped from 31 percent of all households in 1979 to 21 percent in 2000 (Walker et al., 2001).

The basic definition of "household" given by the U.S. Census is "all the persons who occupy a housing unit." The only qualification is that there can be no more than eight persons not related to the head of the household; the unit then becomes "group quarters" (USCB, 1999). Another governmental definition of household, determined by the Food and Nutrition Service (FNS) division of the U.S. Department of Agriculture, is "individuals who live in a residential unit and purchase and prepare food together." This definition plays an important role in the Food Stamp Program, as the household is the basic unit on which benefits are granted. According to Food Stamp Program policy, people who share a housing unit but do not prepare and purchase food together are not considered a household. Thus, food is a crucial component of the Food Stamp Program's definition, even if not of that of the U.S. Census.

Food also plays a role in how other countries define a household. In the view of the Swiss Household Panel, one criterion that defines a household is whether household members share a meal at least once every week. Anthropologists and others often define a household in terms of food preparation and consumption: all individuals who consume food from one hearth belong to a household. Central to this is the idea of "commensality," or food sharing, and anthropologists have often documented the key role of food in the formation and maintenance of social relations both within the household and beyond. Nutritionists and economists have often used the household as a primary unit of analysis. While the household appears to be a "natural unit" for studies of food consumption and nutrition, this conceptualization poses a problem in many parts of Africa and Asia where households are polygamous or where "extended family" households are common.

Anthropologists are increasingly engaged in the examination of household dynamics, focusing on social interactions, marital-sexual power relations, and work or food allocation. Recent research has shown that household composition and size can play a considerable role in dietary intake and distribution. In some settings or cultures, particularly where food resources are insecure, gender or age discrimination may result in unequal food distribution among some household members.

Many cultures also assign significantly different positions and/or status levels to males and females. The types of high-social-value foods vary between cultures, but depending on the kind of food, its restriction could have significant nutritional implications for one gender or the other. Some cultural groups, such as the Chagga of Tanzania, have distinct food prescriptions and proscriptions for men and women. Males are proscribed against eating green vegetables, so females in households are ultimately the only members consuming these foods. Other societies may prohibit women from receiving foods considered to be of high social value, such as meat or animal products, particularly during pregnancy or lactation. However, these cultural norms of proscription or prohibition do not always reflect behavioral adherence. Women denied meat may be at higher risk for protein and iron deficiencies. In rural Nepal, unequal food distribution and cultural beliefs were shown to influence inadequate micronutrient intakes by women, and plate-sharing within households was protective among children for mild xerophthalmia, a clinical deficiency of vitamin A. Cultural beliefs, then, can influence both positive and negative nutrition and health outcomes.

To investigate nutrition and health status within and across households, it is important to understand the complex interrelationships of the overall environment. This is the strength of a biocultural approach that situates individuals and households within specific cultural and social settings.

See also **Anthropology and Food; Division of Labor; Food Stamps; Gender and Food; Malnutrition; Nutritional Anthropology; Places of Consumption; Population and Demographics; Time.**

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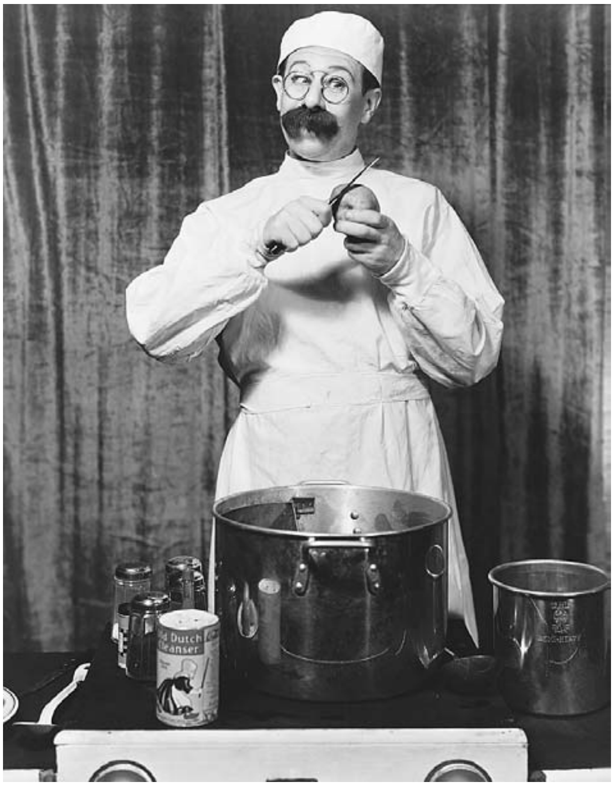
Margaret E. Bentley
Erin Fields

HUMOR, FOOD IN. Humor and laughter are unique to humans and separate them from other animals. While all social and cultural aspects of human existence are subject to humor, food and sex are the most widespread topics because they are the fundamental biological bases of human existence. Food habits and sexual practices show considerable cross-cultural variations. People in different cultures have definite views not only of the foods they eat but also of what constitutes a potential food. Ethnocentrism reigns supreme in matters of food and food habits.

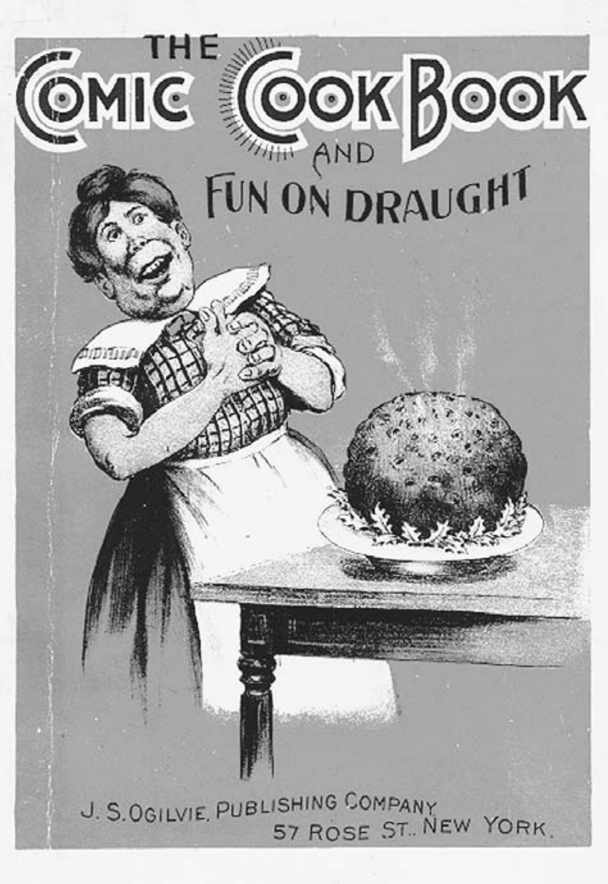


Food is a handy weapon for humor on the stage. Actor Bert Lahr is seen here cooking (with a pinch of Old Dutch Cleanser) on stage during a performance of *George White's Scandals* at the New Amsterdam Theatre in New York. © JOHN SPRINGER COLLECTION/CORBIS.

Humor in individual societies targets food and eating habits while humor at the universal level focuses on cross-cultural differences in food habits, food values, and ideologies. No single comprehensive, cross-cultural treatment of food-related humor exists, although there is an extensive literature on the foods and food habits of people in specific societies. This essay discusses the humor of food, primarily in the United States.

Forms, Techniques, and Topics of Food-Related Humor

Verbal and nonverbal humor is primarily based on incongruity and takes various forms: jokes, puns, riddles, funny stories, parodies, ludicrous definitions, malapropisms, one-liners, caricatures, cartoons, pranks, and practical jokes. Cartoons and caricature generally use visual humor while pranks and practical jokes exploit social situations. However, almost all types of humor depend on language. The techniques used in humor are exaggeration, ludicrous imitation, reversal and contrariness, and



Food has always been an easy target for humor. This spoof on cookery and dining manners was sold at New York newsstands as a Christmas joke book in 1890. It contains several chapters on various branches of cookery, including recipes. ROUGHWOOD COLLECTION.

trivializing everyday life events. Topics include genuine and fictional recipes; fast-food and other restaurants; chefs and fast-food cooks; butchers, housewives, waiters, and customers; cooking processes; eating habits of various ethnic groups; food ingredients; and eating utensils.

Jokes

Jokes are the most popular type of food humor. Jokes take many forms and include other types of humor. They include riddles, one-liners, word play, ethnic jokes, and so on. A major characteristic of jokes is the surprise punch line. Over the last fifty years, many collections of all types of jokes have been published. The introduction of the Internet has helped disseminate thousands of jokes all over the world. There exist Internet "The A-Z Jokes Collections" and new jokes are added daily.

Jokes either exaggerate or overturn common cultural practices, and target cultural roles and professions related to cooking and eating, making them incongruous. Jokes focus on the contradictions between cultural perceptions of ideal recipes, appropriate food habits, and roles, on the one hand, and social reality on the other. Among jokes relating to food professions, those relating to waiters are especially popular, and the question-answer format is most common. Generally, waiters provide the punch line by their culturally inappropriate and incongruous answers to customers' complaints.

Pranks and Practical Jokes

Pranks and practical jokes are an important aspect of all informal and formal social interactions. Generally, individuals, but occasionally groups, are the butt of these jokes, especially at parties, weddings, and other similar social gatherings. The aim is to surprise and embarrass the chosen target, and this is accomplished through unexpected actions such as a pie in the face, removal of some clothing thereby revealing "private" body parts, pouring water or liquor on a person or a group of people, or throwing smelly foods at the victim(s). Some pranks are so well established in the United States that the victims expect them, thereby canceling the element of surprise. A popular ritual in the United States is a "roast," a banquet in honor of a celebrity who is subjected to humorous tongue-in-cheek jibes and insults by friends. The target is figuratively roasted until he or she is totally embarrassed, to the amusement of the participants.

Cartoons

Cartoons are a very widespread and popular form of humor. In the United States, daily newspapers are full of cartoon strips, many of which focus on food. The two best known are "Blondie" and "Beetle Bailey." Blondie's husband Dagwood is famous for his appetite and huge sandwiches. The waiter and the cook at the diner where Dagwood eats his lunch are also humorous characters. The catering business started by Blondie has led to several hilarious episodes. While "Sarge" in the Beetle Bailey cartoon strip is known for his gluttony, the army cook is notorious for his awful cooking, and his food is disliked and made fun of by the soldiers. The "Far Side" cartoon series by Gary Larson has had several food-related cartoons, especially episodes which depict anthropologists being boiled in the cauldron by wild tribes. Jack Ziegler's cartoon collection "Hamburger Madness" demonstrates the zany aspects of fast food. The cartoons on the front and back covers portray the ubiquity of hamburger in the world.

Caricatures and Parodies

Caricature and parody involve creatively ludicrous imitations of aspects of food, emphasizing the contrast between its serious and trivial aspects. Humorous cookbooks (to be discussed below) caricature diners, chefs, utensils, gadgets, and cooking itself. While caricature emphasizes the visual attributes of its subject, parody focuses on language and style. It is the incongruity between the

HOT DOGS AND NEGATIVE STEREOTYPES

Americans have always had a strong negative reaction to members of some Asian societies who eat dog meat. This has much to do with the American cultural belief that one does not eat pet animals. Yet one of the most popular fast foods in the United States is named the "hot dog." How did this come about? Why do Americans call the food in question by this name when they intensely dislike the idea of eating dogs? And why is this name readily accepted? One could say, after all, "what's in a name?" But we all believe that names are important. People have a general belief in the magical ability of words. Even many Americans who do not believe in the power of words want to know when they visit a physician what they are suffering from, and they are satisfied only when the physician actually names their illness. Hence the puzzle and the irony of the name "hot dog." It is true that hot dogs do not contain dog meat. But it is interesting to contemplate how the name originated and how it became widespread. Hot dogs are also known as frankfurters and wieners. They are a type of sausage. J. J. Schnebel (at "hot dog" in "Who Cooked that up?" http://members.cox.net/ starview/) provides a brief history of this food from the time of the ancient Greeks through the Middle Ages to modern America. The names "frankfurter" and "wiener" are derived from the names of the two European cities, in which sausages were manufactured and were a popular food item: Frankfurt in Germany and Vienna (Wien) in Austria. This food was also called "dachshund sausage" because of the similarity of its shape to the German dog used in hunting badgers; thus the word is a combination of two German words, *hund* meaning hound and *dachs* meaning badger. The name continued to be used by German immigrants who began to sell these sausages in New York City in the 1860s. These sausages gradually became popular as fast foods to be served at picnics, and to be consumed for a quick lunch on the street, in restaurants, and at baseball games.

Schnebel credits the sports cartoonist Thomas Dorgan of the *New York Journal* for inventing the name "hot dog." Dorgan wanted draw a cartoon of a "barking" sausage steaming in its roll—which was until then known as dachshund sausage—being eaten at baseball games in New York. He did not know the spelling of the word "dachshund" so instead he used "hot dog" and the name caught on.

The joke below titled "Americans Eating Dogs" illustrates how ethnic stereotypes are mutual, with an added twist emphasizing the similarity of a hot dog to the male organ of procreation in humans and many other animals.

Two foreign nuns have just arrived in the United States by boat and one says to the other, "I hear that the people of this country actually eat dogs."

"Odd," her companion replies, "but if we shall live in America, we might as well do as the Americans do."

Nodding emphatically, the Mother Superior points to a hot dog vendor and they both walk toward the cart.

"Two dogs, please," says one.

The vendor is only too pleased to oblige and wraps both hot dogs in foil and hands them over the counter. Excited, the nuns hurry over to a bench and begin to unwrap their "dogs."

The Mother Superior is first to open hers. She begins to blush and then, staring at it for a moment, leans over to the other nun and whispers cautiously, "What part did you get?"

serious and trivial that is amusing. Asian cultures that emphasize food rituals are often subjected to such parodies. Television has occasionally emphasized caricature in regularly featured cooking shows. In the United States there is now a twenty-four-hour channel devoted to cooking shows, some of which tend to lean toward caricature.

Sitcoms have their share of the humor of cooking, involving episodes where inept men and woman take a stab at cooking and end up in total chaos. Fun is also made of exaggerated rituals connected with selling and buying ready-made food. The episodes of the "Soup Nazi" in the popular sitcom *Seinfeld* are worth noting here. Customers have to stand in line, politely ask for the kind of soup they want, pay the right change, and move to the side in a drill-like fashion. The cook and proprietor named the "Soup Nazi" by the main four characters in the show can, and does, refuse his soup to anyone who does not obey this ritualistic etiquette or displeases him in any way. Yet, people line up outside his joint to taste his soup. The *Seinfeld* episodes devoted to this theme and involving the four major characters are hilarious.

Well-known food dishes and their names are subject to parody that works both ways. Known foods and recipes, and other food-related events, actions, states, and so forth are manipulated to sound like famous book or movie titles and these, in turn, are altered to remind the readers of famous recipes, as illustrated in *To Grill a Mockingbird And Other Tasty Titles*, concocted and illustrated by Ruth Young and Mitchell Rose. A few examples from it are "The World According to Carp," which is described

Waiter Jokes

Among all food jokes, the most popular seem to be those making fun of waiters. Such jokes portray waiters as rude and not interested in the orders and complaints of the customer; in other words, waiters are not seen as true professionals. However, these jokes also focus on the presumed ability of waiters to answer any customer complaints with witty and unexpected one-upmanship, thereby creating an incongruous situation. The preferred format of waiter jokes is question and answer. The following are a few examples.

1. Customer: Waiter, there is a dead spider in my soup!
   Waiter: Yes, Sir, they can't stand the boiling water!
2. Customer: Waiter, waiter, there is a fly in my soup!
   Waiter: Not so loud, Sir, everyone will want one!
3. Customer: There is a small slug in my salad !
   Waiter: Sorry, Sir, I'll get you a bigger one!
4. Question: Why do waiters prefer elephants to flies?
   Answer: Have you ever heard anyone complaining of an elephant in their soup?
5. Customer: Waiter, waiter, there is a spider in my soup!
   Send for the manager!
   Waiter: It's no good, Sir, he's frightened of them too.

as "Smash nationwide bestseller by a writer's writer! Meet T. S. (Terribly Salable) Carp, porpoiseful young novelist, and discover the best love story New England has produced since "Ethan Fromage"; "Lady Chatterley's Liver"; "Moby Duck"; and "The Soufflé Also Rises." The illustrations accompanying each tasty title are exaggerated and amusing.

Imaginary food recipes focusing on the personality traits of famous people are favorite areas of food humor. This kind of humor is difficult to categorize, although it probably comes under the heading of parody. *Freud's Own Cookbook* by James Hillman and Charles Boer (1984) and *Jean-Paul Sartre's Cooking Diary* (author unknown) are two such examples. The first describes such dishes as "Slips of the Tongue in Madeira Sauce" (p. 48)," "Erogenous Scones" (p. 75), and "Incredible Oedipal Pie" (p. 76), that are reminiscent of concepts developed by Freud and his friends and colleagues. The Sartre book consists of philosophical musing about cooking and recipes.

One-Liners, Puns, Riddles, and Word Play

These closely related and occasionally overlapping genres of humor are devoted to comments about commonsense rules of eating, dieting, low-calorie foods, overeating, obesity, food fads, and favorite, and addictive, foods of individuals and groups. Incongruity is the result of such techniques as reversal, exaggeration, and double meaning. Note the following: "Eating should never make you sad, unless it is a mourning meal"; "Visibly upset from the whole ordeal, the grape juice started to whine"; "I used to work at the sugar packaging factory. Then my position was dissolved"; "The upper crust of society is composed of a lot of crumbs held together by dough"; "If you eat something, but no one else sees you eat it, it has no calories."

Consumption humor is contrary to the commonsense constraints concerning what to eat and how much. Everyone has particular food addictions and many believe in the dictum of living to eat rather than eating to live! Humor focuses on such shortcomings. Note these one-liners: "If we are what we eat, then I am easy, fast, and cheap"; "A balanced diet is a cookie in each hand"; "No one thinks of any 'rules' associated with the when, where, and how chocolate should be eaten." We have the riddle: "Q.: Why is there no such organization as Chocaholics Anonymous? A: Because no one wants to quit eating chocolate."

Humor associating food with various aspects of human anatomy and sexual activities is widespread and popular. For example: "Q: What did one strawberry say to the other strawberry? A: If we hadn't been found in the same bed together we wouldn't be in this jam!" Note "The Life Story of An Egg": "So you think your life is bad, then just think how bad the life of an egg is. . . . You only get laid once. You only get eaten once. It takes four minutes to get hard and two minutes to get soft. You have to share a box with eleven other guys. And the only chick that ever sat on your face was your mother!"

Dictionaries of food items and related terms with creatively outrageous or absurd meanings are another type of humor, as illustrated by *A Cook's Dictionary* by Henry Beard and Roy McKie. They "bring new meaning to matters of taste." The very definition of the word "cooking" on the cover page is given as "1.n. the art of using appliances and utensils to convert ingredients and seasonings into excuses and apologies." A "chef" is defined as "any cook who swears in French," while "health food" is defined as "any food whose flavor is indistinguishable from that of the package in which it is sold." This dictionary also includes cartoon-style humorous sketches of food-related activities.

See also: **Feasts, Festivals, and Fasts**; **Folklore, Food in**; **Sex and Food**; **Table Talk**.

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Mahadev Apte

HUNGARY. *See* **Central Europe.**

HUNGER, PHYSIOLOGY OF.

Hunger is the set of internal experiences that lead a human or animal to seek food. Appetite describes the preferences that surround the selection of food that is found. For many people, hunger is a set of feelings often focused on the stomach. It may be associated with contractions of the stomach or intestine, and described as "emptiness." Indeed, many of the early ideas about hunger and its opposite, satiety, were described in terms of stomach contractions or stomach distension. Increased physiological understanding has yielded the information that the stomach and intestine are only one part of the system experienced as hunger.

A drive to eat food can be produced by damage to selected parts of the brain, usually located in the hypothalamus near the pituitary. When this area is damaged, animals and humans become voracious eaters and become obese. This indicates that there are sections of the brain that can inhibit food intake that, when destroyed, fail to do this. Alternatively, there are other regions of the brain (lateral hypothalamus) where damage in either humans or animals produces reduced food intake and wasting.

The connections between what happens in the body and how the brain recognizes it have advanced by leaps and bounds since the 1970s. One of the first discoveries was that many of the same messages or signals that are found in the stomach and intestine are also found in the brain. These so-called gut-brain messages can serve to stimulate or inhibit feeding. As a general rule, the ones produced and released in the body tend to inhibit feeding. Thus cholecystokinin, a hormone that causes the gallbladder to contract, also inhibits food intake. This peptide works both in the body and when put into the brain. Another gut-brain hormone is ghrelin. In contrast to cholecystokinin, ghrelin stimulates food intake whether injected into the body or into the brain. The fat cells are another source of important signals for hunger. The most important of these sources is a hormone called leptin. When this hormone is absent in either humans or animals, massive obesity results. When this hormone is given back, hunger immediately subsides, indicating the important role that this hormone plays in the control of hunger. The amount of leptin released from fat cells increases as the total body fat increases. It thus serves as a circulating marker for the level of fatness. Once in the circulation, leptin acts on the brain. Through a lock-and-key mechanism, leptin changes the formation of four other hormones in the brain that regulate eating. When leptin is high, the release of two peptides (neuropeptide Y and agouti-related peptide) in the brain is reduced and two other hormones (cocaine-amphetamine regulated transcript and proopiomelanocortin) are released. Acting in concert, this combination of hormones reduces feeding and relieves the sensations of hunger. Conversely, when leptin is low, the opposite situation occurs, and hunger develops along with the search for food.

Insulin is a second major hormone in the body that signals hunger. In diabetic patients who take insulin and tightly control their blood sugars, mild degrees of obesity frequently develop. Similarly, some of the drugs for treating obesity (sulfonylureas and peroxisome proferator-activated receptor-γ agonists) produce weight gains. One likely way this happens is through reducing blood glucose that in turn signals the need for food.

The role of circulating glucose in the initiation of hunger has been advanced considerably. Beginning with studies in animals, it was found that a small drop of about 10 percent in glucose preceded the onset of many but not all meals. When this drop in glucose was prevented, the animal did not eat at the expected time. That is, hunger had been prevented by manipulating glucose. The glucose-stimulated hunger can be provoked by giving a drug that mimics the key nerve (vagus) that supplies the pancreas to release insulin. Studies in human beings also found that a small drop in glucose preceded many meals. It has been long known that there were lock-and-key systems in the brain responding to glucose or its deficiency. The experiments described above suggest that the brain signals a small release of insulin that leads to a transient decrease in glucose, which in the "primed" animal produces an internal feeling of hunger.

These many signals for feeding can increase the intake of all available foods, or they can signal intake of certain foods. We know that when we have eaten our fill of turkey at Thanksgiving, there is still room for pumpkin pie or ice cream. The loss of hunger for one food after it is eaten is known as sensory specific satiety, that is, the overall drive to eat can be regulated in parts. This is consistent with the finding that some of the signals described earlier stimulate one type of food intake or another, but not necessarily all. Thus, some signals are known that will specifically reduce the intake of fat and others, carbohydrate.

Obesity results from changes in leptin or damage to the brain. From studies on the control of feeding, it is known that at least two monamine neurotransmitters (norepinephrine and serotonin) in the brain play a particularly important role. These neurotransmitters have been the subject of considerable interest, since most of the medications used to treat obesity influence hunger through changing levels of one or both of these neurotransmitters. As more is learned about the control of hunger, a steady source of new targets is available that can be used to develop future medications for the treatment of obesity.

See also **Acceptance and Rejection; Anorexia, Bulimia; Appetite; Eating: Anatomy and Physiology of Eating; Obesity; Sensation and the Senses.**

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HUNGER STRIKES. The hunger strike is a type of political resistance notable for deploying deliberate self-starvation to protest alleged injustice and abuses of power. Food plays a central and paradoxical role in these acts by virtue of its conspicuous literal absence, yet compelling figurative presence. Hereby, the substantive rejection of material food comprises the main tactical strategy of hunger strikes, while the evocative symbolisms of food and food denial inscribe the moral messages conveyed by proactive martyrdom for a cause.

History and Political Agendas

Although the origins of hunger striking are obscure and its venerable history sketchy, it is known from diverse cultures and varying historical epochs dating back to antiquity. Hunger strikes were described in the lore of ancient India, and were well-established practices in medieval Celtic societies. In the early decades of the twentieth century, British suffragettes deployed hunger strikes to gain women's right to vote; and in the closing decades, hunger-striking Chinese students in Tiananmen Square petitioned for democratic reforms, and Tibetan monks staged public fasts outside the United Nations to spotlight their struggles for self-determination. The hunger strikes of Mahatma Gandhi in British-occupied India, Andrei Sakharov in the Soviet Union, Nelson Mandela in apartheid South Africa, and Bobby Sands of the Irish Republican Army, made these individuals renowned in their respective days. In modern times starvation rebellions have been geographically widespread and have championed numerous political causes, ranging from wholesale indictments of totalitarian power to more localized claims for citizens' entitlements within late capitalist democracies.

Instances from the 1980s and 1990s include Chinese women seeking asylum in the United States on the grounds that the one-child policy (and consequent forced abortions) are a form of political persecution, Iranian refugees resisting deportation from France, Kurdish fasters in Turkish jails petitioning to be accorded political-prisoner status, Israeli physicians on hunger strike for better wages, and American activists lobbying to abolish homelessness. Hunger strikes have been directed against nuclear proliferation, unjust imprisonment, immigration policies, and military actions; and they have been undertaken to champion political sovereignty, environmental protection, education reform, animal welfare, and the rights of workers, farmers, and minorities.

Common Characteristics

As their mode of operation, all hunger strikes share in common the principles of nonviolence, a claim to martyrdom for a cause, and an appeal to a universalized ethics that aims to indict by shaming the opponent. Modern applications are further framed by their appropriation of democratic and human rights discourses, and by their potential to capitalize on the vast and rapid circulation of sensational spectacles in a global media network.

In general the issues that incite hunger strikes have either been failed by, or fall outside the purview of, official legislation. By necessity, then, these strategies are designed to circumvent conventional systems of jurisprudence. Nonetheless, in dramatizing an interrogation via a tacit appeal to a public "jury," the hunger strike is structurally analogous to courtroom trials, such that it can be said to function as a kind of "meta-juridical trial." This trial is launched when the hunger-striking protagonist declares self-starvation, and thereby extends his quest for justice in the vulnerability of existence. Such deliberate martyrdom puts the body in an escalating "state of emergency" that graphically tests the resolve of the activist while simultaneously attesting to the depth of commitment. Taking oneself hostage to endorse a political agenda in effect constitutes the initial accusation, or "prosecutorial gesture," whereby the characteristically private act of not eating paradoxically transforms into a public indictment of an (allegedly) unjust system and its overseers. Under conventional trials, language—in the form of law codes and legal arguments—is the established tool of power and order. Yet, in the meta-juridical trials set in motion by hunger strikes, the authority of language is symbolically displaced, to be superseded by food as an alternative medium of communication. In other words, food provides a symbolic vocabulary in the political resistance movement that makes starvation (nonfood) a weapon of social reform.

Food as Symbol

The meaning-making enterprise of hunger strikes strategically exploits the complex and contradictory significance of food, which has been ambivalently endowed with both positive and negative associations in numerous cultures throughout history. Complementary to its role as vital nourishment, food characteristically betokens hospitality and charity, commands an exalted status at major life events, and is a special marker of ideology and identity. Food's beneficence is encoded in language: for example, "com-pan-ionship" in English means "the sharing of bread," thereby etymologically connecting friendship to a fundamental staple of Western cuisine. In its constructive essence, then, food is a preeminent material catalyst of human sociality and a signifier of shared community. Given its multifaceted centrality in human relations, the repudiation of food by hunger strikers can be read as an analogical rejection of community. In the manner that putrid food is inedible and can provide no nutritional sustenance, an unjust society is deemed uninhabitable and can offer no political-moral integrity. This leads to the self-exile of the faster, voluntarily removed from the (allegedly) corrupt circle of sociality.

The refusal of food engenders moralistic messages. For, despite its widely celebrated virtues, it is the intentional abstinence from food that has long been considered a ritual of purification in many religious traditions. Moreover, such self-disciplining still sends ethical (as well as aesthetic) messages in contemporary popular culture. According to Judeo-Christian teachings, the transgression of eating the forbidden fruit launched humankind's original fall from paradise; and gluttony was considered foremost among the seven deadly medieval sins. Abstinence from food provided one escape from these beastly temptations of the flesh, and accorded a path to greater spirituality that placed fasters outside the inherently violent food chain of consumption. It is upon this pious path of nonconsumption that hunger strikers embark, seeking some claim to moral righteousness by virtue of their excess asceticism. The faster's refusal to incorporate food asserts the individual body as sacrosanct and autonomous, and (through the symbolic substitution of food for community) safeguards the boundaries of the self against infiltration by a demoralized system. Importantly, in the striker's brief moment in the public limelight, self-starvation functions as an emphatic character sketch that stages a contest of willpower and suffering in order to prove dedication. By association, these performances strive to pair the political faster with the moral connotations that underlie willingness to sacrifice oneself for one's beliefs.

By ransoming the body as the battleground of resistance, the hunger strike seeks to redefine political issues as existential matters, and replace abstract rules with an impending crisis of life or death. Whether its diplomacy is better characterized as "nonviolent penetration of the heart" (to quote Gandhi) or as "political blackmail" (to cite his opponent, Viceroy Linlithgow), the act is one of keen, if nonetheless desperate, negotiation. Hereby, the violence fasters inflict on their own bodies (which are literally consumed by starvation) symbolically parallels the violence they contend power has inflicted on them (which "consumes" their moral integrity). The striker's purposeful hunger for food thus makes concrete an unfulfilled hunger for justice that can only be satisfied by a reformation of the political-moral order.

Communal Bond

In the iconoclastic logic of the goal-oriented fast, such reformation begins with the private suffering of the martyr put forth as a call to collective action. Just as trespasses of justice are deemed to be public concerns, the individual in need (and in pain) is deemed to be a matter of collective accountability. The individual's need for food invokes a primary interrelationship, based on food sharing as an archetype of caretaking. Insofar as premeditated self-starvation delves into the corporeal conditions of existence, it attempts to forge the commonality of hunger (an experience, to some degree, familiar to all) into an elementary, alimentary bond between striker and spectator. This bond is offered as the foundation for a code of ethics that seeks to mobilize righteousness from mutual responsibility for one another's physical and moral well-being. To ignore a cry for justice (and/or food) is tantamount to a shameful rejection of human mutual dependency.

Hence, in mirroring the violence of power and challenging its humanity, political martyrs endeavor to shame the (proclaimed) perpetrators of injustice. Reliant on its audience, the hunger performance summons civil witnesses to participate in this shaming and speak out against abuses of power. Through this unconventional diplomacy, hunger strikers appoint themselves scapegoats who map the ethical trespasses of an errant society onto their sacrificial bodies (a move which provocatively advertises sociopolitical inequities as undeniably bodily concerns). Here, food symbolism—with its mercurial nature—reemerges. For the messages underlying these political rituals of transformation are consonant with the healing and nurturing significance of food, which, when blessed and shared (witness consumption of the scapegoat, the totem, the transubstantiated bread of communion) can be sustaining, as can society, when purged of corruption. An end to the political fast, and the striker's consequent return to the community of food sharing, symbolizes redemption of the collective moral good.

See also **Consumer Protests**; **Food as a Weapon of War**; **Symbol, Food as**.

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HUNTING AND GATHERING. Hunting and gathering, or more generally stated as foraging, can be defined as a mode of subsistence in which all food is obtained from wild resources without any reliance on domesticated plants or animals. This has been the dominant means of subsistence for 99.5 percent of the 2.5 million years of human existence. It was only in the last ten thousand years or so that people began to domesticate and produce food in some areas, while in other areas hunting and gathering continued up until the nineteenth and twentieth centuries. Within this time period and throughout the many different geographical regions that people inhabited, there has been tremendous variation in food consumption. We will examine some of the major geographical, cultural, and temporal trends within this great diversity, as well as some common misconceptions.

Among the most prevalent misconceptions are the following:

1. People relying on wild foods had to work constantly in order to obtain enough to eat, and thus had no time to develop the arts of civilized life. In reality, quantification of time use among contemporary hunter-gatherers living in comparatively harsh environments has demonstrated that even these foragers spend only two to five hours a day in obtaining food, leaving far more time for leisure than "civilized" people have.
2. Hunter-gatherers are frequently on the brink of starvation and are generally malnourished. In contrast to this view, recent studies have shown that most hunter-gatherers experience infrequent famines and are generally better nourished than neighboring or comparable agriculturalists due in part to the wider variety of foods that hunter-gatherers usually obtain and the lack of reliance on the narrow range of starch-rich plants that tend to typify agricultural and horticultural societies.
3. Hunting was the predominant source of food for hunter-gatherers. In fact, except for Arctic and Subarctic areas, plant foods were the most abundant and reliable foods and provided most of the daily fares (see Lee and DeVore 1986, Hayden, 1981). Surprisingly, hunters in most hunter-gatherer societies only manage to kill a few large game animals (over 10 kg) per year (Hawkes et al., p. 687).
4. Meat has a higher caloric value than vegetable foods. In fact, they are often of equal value (Eaton et al., p. 80).
5. Meat was always hunted. However, large proportions of the meat obtained even among contemporary hunter-gatherers is scavenged from kills of other animals.
6. Meat was the major goal of hunting. In reality, fat is much more important (Hayden, 1981; Speth and Spielmann).

One example is seen among the Australian Aborigines, who, after bringing down a kangaroo, cut open the abdominal cavity of the animal in order to determine the fat content. If there is insufficient fat on the animal, it is not eaten but left in the bush. Similar behavior is recorded in James Woodburn's film *The Hadza* (1966). There are also a number of accounts of hunter-gatherers who were starving despite the fact that they were eating large amounts of very lean meat. This is sometimes referred to as "rabbit starvation" in North America since it historically involved the reliance on lean rabbits by hunter-gatherers. Fat was critically important among hunter-gatherers for proper metabolism, for obtaining essential fatty acids, and for adequate calories to maintain body temperatures during cold periods.

While animals may not have been the major staple of most hunter-gatherer diets, ethnographically they were universally highly valued far above other types of foods. Successful hunting of animals conferred great status on individuals (Hawkes et al.), and hunting was almost universally carried out by men, while women and children gathered plants and small animals such as lizards, mice, or frogs.

Evolutionary Trends

The origin of hunting is hotly debated. Wooden spears have been recovered from deposits over 400,000 years old, and reasonable arguments have been advanced for hunting going back to the Lower Paleolithic, some two million years or more ago. Other scholars argue that there was a prolonged period encompassing the Lower Paleolithic and perhaps the Middle Paleolithic, when people (proto-people) relied primarily on scavenged rather than hunted meat. There is little evidence for the use of plant foods from these early periods, but they undoubtedly played important roles in the overall subsistence diet.

Up until twenty thousand years ago or so, we must assume that all food was either eaten raw or was roasted on open fires (the initial use of fire is also disputed, but seems definitely to be in place by 400,000 years ago). Until the end of the Paleolithic, there is no evidence of boiling containers or the heating of rocks to boil liquids. Ethnographically, there appears to have been no hunter-gatherers that made any alcoholic beverages either.

It is only around twenty thousand years ago that fire-cracked rocks begin to appear and were probably used in boiling foods such as vegetables and the first bone soups (for extracting the bone fats). Some five to ten thousand years later, the first evidence for the systematic exploitation of a wide range of new food types appears. This includes the first evidence for grass seed use (grinders), systematic fishing (net sinkers, fishhooks, leisters, and fish remains), and semi-toxic nuts like acorns. The expansion of food resources used together with the new technological inventions that made this possible is sometimes referred to as the "Mesolithic" technology or exploitation pattern. It is this pattern that persisted in most areas of the world where hunter-gatherers survived until contemporary times.

Choice of Foods

The choice of which plant, fish, insect, bird, and animal species were to be used for food was initially constrained by the regional environments that groups lived in and by the relative abundances at different trophic levels. In the Arctic, there are simply not many plant foods available for most of the year; in deserts, there are no fish; in each environment, the nature of the plants and animals will differ somewhat, but there will always be fewer (and more dangerous) carnivores than herbivores and more plants than herbivores. It is not possible or meaningful to catalog all such variations; however, it is possible to understand hunter-gatherer choices of foods in other ways using general trends or categories.

Although there is some variation between cultures in terms of what is considered to taste good, taste is frequently an important factor in determining which species are preferred to eat. Very strong-tasting flesh tends to be avoided (e.g., crows, mutton birds, mountain sheep [at least in the Northwest of North America]). Very fibrous or woody plants are less desirable than those with more fleshy tubers or fruits. There are also many plants that are mildly toxic or produce undesirable effects when eaten in varying amounts.

The nomadic Dayak peoples of Borneo hunt with blowpipes and preserve many features of a primitive lifestyle based on hunting and gathering. © CHARLES AND JOSETTE LENARS/CORBIS.

Transcending these considerations, it has often been observed that species that are rich in fats, oils, starches, or sugars are avidly sought by hunter-gatherers. This appears to be due to the fact that high caloric foods are relatively rare in the wild. Wild animals are very lean during most of the year, averaging only about 4 percent fat versus the 29 percent fat content that is typical for domesticated animals (Eaton et al., p. 80). Bears are often favorite foods because they store large amounts of fat for winter hibernation; beavers are favored for the same reason. In southeastern Australia, streams were modified and canals constructed in order to capture large numbers of migrating, oil-rich eels. Elsewhere, in eastern Australia, large gatherings of people occurred in order to harvest bushel loads of oil-rich moths in their mountain mating locations. In central Australia, witchity grubs were relished for the same reason, although only a few could be obtained at a time. Honey is another insect product greatly sought after by hunter-gatherers. Starch-rich tubers, nuts, and grains were also eagerly sought. In contrast to the more vegetarian agriculturalists of later times, salt does not appear to have been a major concern for most foragers, probably because of the natural salt content in the meat that they consumed.

There were also foods sought for more special dietary purposes. While berries might not provide many calories, they were often rich in vitamins necessary for good health. Keene has shown that the need for hides, vitamin C, and calcium were major nutritional bottlenecks among some groups of hunter-gatherers and that these considerations determined which animals and how many were hunted.

Some animals and plants were also avoided due to totemic or other cultural taboos. These might vary from individual to individual and from group to group. Some groups ate their domesticated dogs, others did not; the Tasmanians ate fish in their early prehistory, but avoided fish completely in their later prehistory. It is often difficult to discern any logic or pattern to these kinds of food prohibitions.

Finally, some scholars have tried to use optimal foraging theory to model hunter-gatherers' food choices. Winterhalder and Smith explain this theory, which postulates that resources that provide the best returns for the time and effort invested in their procurement and processing should be the most intensively used, and that all resources can be ranked relative to each other in these terms. The initial applications of this theory used caloric returns as the measure of theoretical desirability. Researchers attempted to calculate travel time, harvesting time, processing time, and caloric returns. The results did not fit the model expectations very well, but perhaps given all of the other factors that influence food choices (listed above), this may not be too surprising. In addition, risk factors probably play important roles. Food species that can be reliably obtained on a day-to-day basis may be preferred over foods that can only be obtained more sporadically, even if the reliable foods require more time and energy to obtain on average. Thus, plant foods, shellfish, and abundant small animals like lizards are sometimes the mainstays of hunter-gatherer diets while scarcer, more mobile types of food such as large game animals are eaten more episocially.

Of all the lower ranked food types requiring more effort, grass seeds constitute something of a special case. O'Connell and Hawkes observe that grass seeds are particularly inefficient sources of food in Australia, although many groups used them. It is therefore difficult to understand why they were used, and especially to understand why they only began to be used in the last fifteen thousand years or so of hunter-gatherer evolution. There are no seed grinding tools in the world archaeological record up to that time. Certainly, grass seeds contain starches, oils, and protein in desirable proportions. It is primarily the collection and processing costs that seem to have made this type of food unattractive, although some wild stands of wheat in the Near East can be harvested at the rate of one kg per hour as shown by experiments using Mesolithic type technology. One might expect the use of seeds for food to occur first in these more productive types of environments; however, it is curious that the Tasmanians never used grass seeds despite the occurrence of large seeded species similar to those in the Near East, whereas a number of Australian groups used several smaller seeded species. Various researchers have suggested that grass seeds may have begun to be used due to population pressures, or due to advances in processing and collecting technologies, or due to the emergence of prestige feasts, a topic to be pursued below.

The Effect of Food on Culture

The nature of food resources used by hunter-gatherers has many ramifications for understanding their cultures. For most simple hunter-gatherers, or "foragers," wild food resources are scarce, fluctuating, and susceptible to overexploitation. Thus, population densities are very low (usually only supporting one person for every ten to one hundred square kilometers); group sizes are small (twenty to fifty people); the groups are nomadic (moving every few weeks to new resource areas); little if any food is stored; sharing food with others in the group is the normal (often obligatory) practice; intergroup alliances are formed to access refuges in times of famine; feasting is limited to sharing meat and fat from large desirable game animals; private ownership of resources and most other items is absent or rudimentary; borrowing is rampant; societies are comparatively egalitarian; and competitive or aggrandizing behavior is not tolerated (Hayden, 1993). This was probably the nature of most hunter-gather groups during most of the Paleolithic. In contemporary terms, the Hadza of East Africa and the Central Australian hunter-gatherers exemplify this type of adaptation.

Toward the end of the Paleolithic, and increasingly during the Mesolithic, there is evidence of dramatic changes in some of the richer environments of the world, especially along the richer riparian habitats and migration routes (whether terrestrial or marine). In the richest habitats, "complex" hunter-gatherers emerged. Population densities rose dramatically, groups became semi-sedentary or fully sedentary, storage of foods became important, new technologies appeared for obtaining and processing new species in massive quantities (especially fish, nuts, and seeds), large plant roasting pits occur for the first time (up to eight meters in diameter in the Northwest), prestige objects appear and testify to private ownership of wealth as well as important socioeconomic differences, sharing is more limited, and debt-structured or competitive feasting emerged for the first time in human history. Northwest Coast cultures are perhaps the best examples of complex hunter-gatherers with their massive harvesting and storage of salmon, eulachon, halibut, or other fish species; their heavy use of shellfish; and their use of sea mammal blubber for feasting.

Feasting and Domestication

Above all, as documented in Dietler and Hayden, it is the use of feasting to create debts, to obtain desirable goods and services, to craft political power, to establish close social relationships, and to transform surplus food production that is perhaps the most important turning point in the history of the use of food and in the evolution of human culture. Up until the development of surplus-based feasting, which provided sociopolitical and economic benefits, all animal species, including human beings, could only use as much food as they, or their coresidents, could eat themselves. This placed an absolute ecological limit on the utility of food. However, with the advent of feasting forms that conferred major advantages on hosts (such as better alliances, more [or more desirable] spouses, and more socioeconomic/political power), a new ecological paradigm was created without parallel in the natural world up until the emergence of complex hunter-gatherers. For the first time, as much surplus foods could be used (and transformed into other desirable items or relationships) as could be produced. This created an open-ended, positive-feedback relationship between resource production and practical benefits. The more that could be produced, the greater the sociopolitical and economic advantages that could be obtained; and the greater the sociopolitical or economic advantages, the more food could be produced; and so on. It is, above all, the establishment of this kind of positive feedback relationship through feasting that has most likely created the geometrically increasing rate of population, technological complexity, and political complexity that has characterized the past fifteen thousand years.

The establishment of feasts based on surplus production, and the host's desire to impress guests or make them beholden to him, may well have been among the factors responsible for the development of food production and the domestication of plants and animals some ten to twelve thousand years ago. Katz and Voigt have suggested, for instance, that cereal grains may have been domesticated primarily as a means of producing alcoholic beverages such as beer. In fact, there are no alcoholic beverages recorded for simple foragers, but it is possible that alcohol first began to be produced in the context of complex hunter-gatherer prestige feasting as among the Gunditjmara hunter-gatherers of southeastern Australia. On the Northwest (Pacific) Coast, there were certainly potlatches that featured starches (clover roots) and intoxicants (tobacco) as central parts of the feasts.

There are many other theories that purport to account for the development of domesticated animals and plants, such as climatic changes and population pressures. In support of the feasting and surplus model of domestication, it can be noted that among complex hunter-gatherers such as the Ainu of Japan, bear cubs were captured in the wild and raised for a year by wealthy families specifically for consumption at special prestige feasts. Moreover, domestic animals in traditional societies appear to be eaten exclusively in the context of feasts. Similarly, starchy clover roots and cinquefoil roots were tended and grown in Northwest Coast societies for use in feasting. In all these feasting contexts, the most prestigeous foods are those with high lipid, starch, or sugar contents (fish oil, blubber, bear meat, deer fat, seeds, clover roots). These are the foods that were given to the most prestigeous guests. These are the foods for which extra efforts were expended in order to produce. Rather than being forced by population pressures and famine to use foods that required great effort to produce, it may have been the importance of impressing guests at feasts that accounts for the extra efforts used to procure and prepare such low ranked but highly desirable foods as grass seeds, clover roots, and bear meat. This is especially true in complex hunter-gatherer societies where other more highly ranked foods are plentiful (e.g., in the Mesolithic/Epipaleolithic archaeological cultures of the Near East, and in the ethnographic Japanese and Northwest Coast cultures). The highly desirable foods used to impress important guests in complex hunter-gatherer feasts exhibit the same characteristics as those that were eventually domesticated and that we find in supermarkets today. The fruits are the largest, most succulent available; the vegetables are the least fibrous and highest in starches or oils; the meats have the highest fat contents. There is a world of difference between the use of foods by simple foragers and complex hunter-gatherers, and we are far more similar in our use of foods to complex hunter-gatherers than we are to the use of foods by simple foragers, even though the vast majority (99 percent) of our physical, mental, and emotional evolution occurred in the context of simple foraging.

See also **Agriculture, Origins of; Anthropology and Food; Evolution; Game; Mammals; Prehistoric Societies: Food Foragers**.

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Brian Hayden

HYPERTENSION. *See* **Health and Disease; Salt; Sodium.**

I

IBERIAN PENINSULA.

This entry comprises three subentries:
Overview
Portugal
Spain

OVERVIEW

The Iberian Peninsula, in southwestern Europe, is occupied by Spain and Portugal. It is separated from the main continent by the Pyrenees and surrounded by the Atlantic Ocean to the northwest and west and the Mediterranean to the south and east.

The characteristics and features of Iberian cuisine cannot be understood without reference to the culinary influence of the Romans, Arabs, Jews, and Christians, and the dietary exchange that followed the conquest of America and colonialism in Africa and the Far East. However, Rome did not conquer the Basque country, and the Arabic heritage never reached the northwestern fringe of the Peninsula.

When former Muslim areas came under Christian rule, Muslims were forced to adopt Christianity. The expulsion of these so-called Moriscos from the Peninsula in the seventeenth century was the end of Moorish culinary system in Iberian lands. However, some Moorish elements are still discernible in Peninsular cuisine, particularly in regions where Moors or Moriscos remained for a longer time. These regions are Alentejo, Algarve, Andalusia, Aragón, Extremadura, Murcia, and Valencia.

Contact between Moors and Christians

Moorish foodways influenced the cuisine of Christian upper classes during the Umayyad caliphate and Taifas' periods (tenth to twelfth centuries), during which Al-Andalus (the Iberian Muslim kingdoms) served as a cultural model. Secondly, there was a certain amount of cultural contact between Moors and Christians during long peaceful periods of time in frontier lands. Moorish culinary influence was also the product of years of interaction between Moorish and Christian communities in cities in which, after the Christian conquest, Muslims were confined to ghettos. Another point of contact between Muslim and Christian culture was through the kingdom of Granada, the last Muslim territory in the Peninsula, conquered in 1492.

The Morisco rebellion in the kingdom of Granada (1568–1570), the relocation of the Granadan Moriscos around the kingdom of Castile, and their resistance to integration into Christian society despite the pressures of the Inquisition produced in Christians an aversion toward Moorish foodways. This aversion did not stop the culinary exchange, and, in fact, the influence of Christian culture and foodways on Moorish cuisine led to the disappearance of certain Moorish culinary practices. Often there was a substitution, addition, or different combination of ingredients and dietary practices. The outcome was a cuisine that contained some Moorish components but had different flavors, smells, colors, and textures.

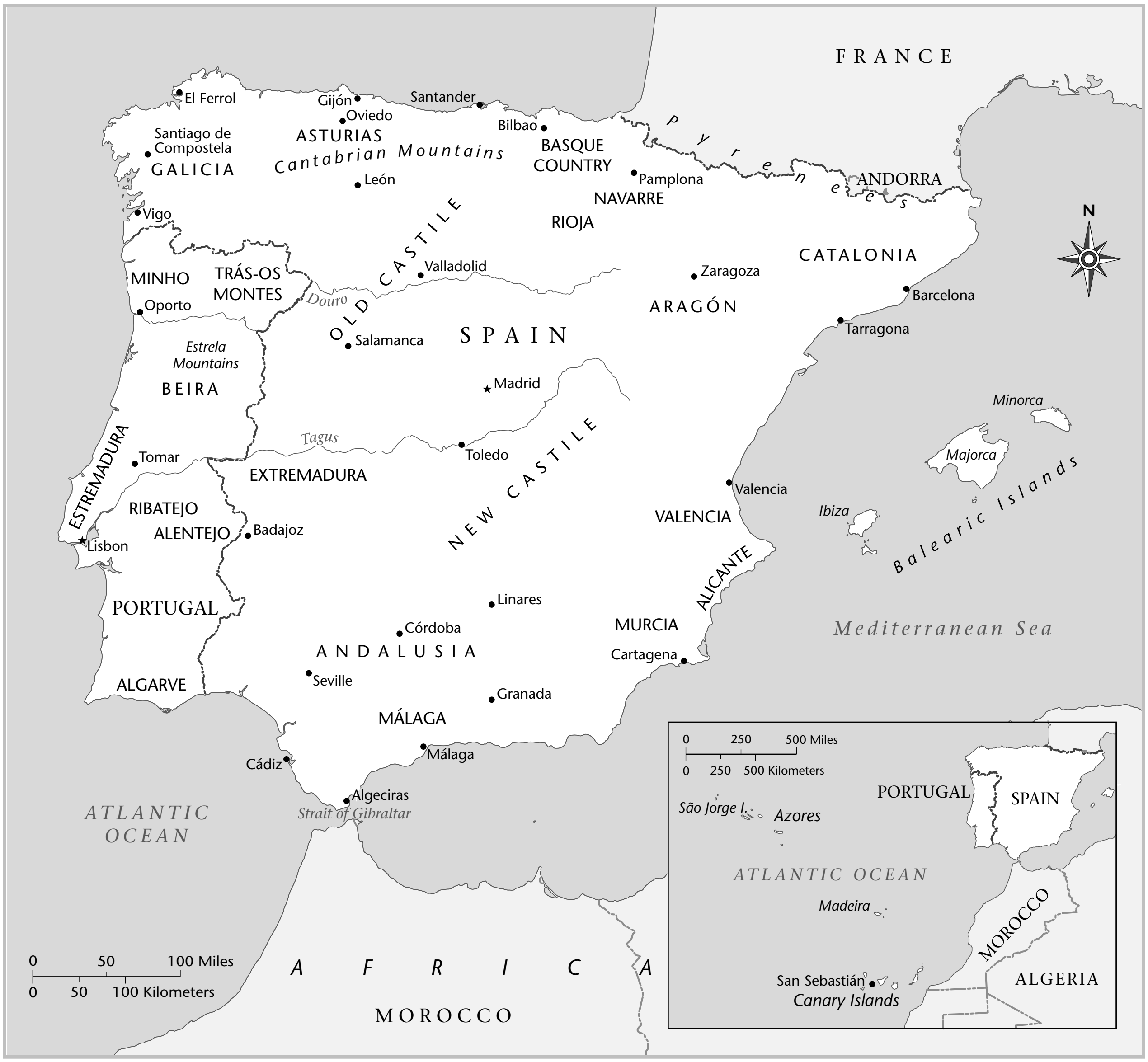
Moorish Culinary Contributions

Expiración García in *La Alimentación* (Food), Lucie Bolens in *La cuisine andalouse* (Andalusian cuisine), and Manuela Marín in *Cuisine d'Orient* (Eastern cuisine) have described Al-Andalus cuisine. However, contemporary Iberian cuisine has only a few elements of this Al-Andalus cuisine. In the Iberian Peninsula, these culinary features are marked by the prevalence or use of certain ingredients, dishes, methods of cooking, or ways of eating that were once typical of Al Andalus but devoid of any religious meaning. These features having a Moorish heritage are the following:

Communal sharing from the same dish. Examples of such shared dishes are paella, *migas* (fried breadcrumbs or semolina), and *gachas* and *papas* (porridges). This practice of sharing is no longer as prevalent as it once was.

Predominance of yellow, green, and white colors. Yellow is common in most rice dishes, in fish stews with rice or noodles, and in some chickpea stews. White is typical of some sweet rice puddings (*arroz con leche* and *arroz dolce*), some porridges, and some soups such as *ajo blanco* (a white garlic soup), the original gazpacho, *gazpachuelo* (a fish and egg soup), and various almond soups. Green is the dominant color of some Portuguese dishes prepared with coriander, although the *sopa verde* (green soup) cannot be included in this category.

Use of saffron, cumin, and coriander. Coriander is rarely found in traditional Spanish cuisine but is very popular in Portugal, especially in dishes from Alentejo; some food


FRANCE
El Ferrol
Gijón
Santander
Oviedo
Bilbao
Santiago de Compostela
ASTURIAS
Cantabrian Mountains
BASQUE COUNTRY
GALICIA
León
Pamplona
NAVARRE
Pyrenees
ANDORRA
Vigo
OLD CASTILE
RIOJA
N
MINHO
TRÁS-OS MONTES
Valladolid
Zaragoza
CATALONIA
Oporto
Douro
ARAGÓN
Barcelona
Salamanca
SPAIN
Tarragona
Estrela Mountains
BEIRA
Madrid
Minorca
Tagus
NEW CASTILE
Majorca
ESTREMADURA
Tomar
Toledo
EXTREMADURA
Valencia
Balearic Islands
RIBATEJO
Ibiza
ALENTEJO
Badajoz
VALENCIA
Lisbon
ALICANTE
Linares
PORTUGAL
Córdoba
MURCIA
Mediterranean Sea
ANDALUSIA
Cartagena
Seville
Granada
ALGARVE
MÁLAGA
Málaga
Cádiz
Algeciras
Strait of Gibraltar
ATLANTIC OCEAN
0 50 100 Miles
0 50 100 Kilometers
AFRICA
MOROCCO
0 250 500 Miles
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PORTUGAL
SPAIN
São Jorge I.
Azores
ATLANTIC OCEAN
Madeira
MOROCCO
San Sebastián
Canary Islands
ALGERIA

writers relate this use to African influences. Saffron is used both to color and to flavor rice dishes, legume stews, and meat casseroles. Cumin seasons some legume stews, sausages, and dishes of meat or fish.

Spiced stews made from chickpeas, lentils, and fresh or dried broad beans. Examples of such legume and bean stews include *potaje de garbanzos*, *potaje de lentejas*, *fava rica*, and *favas con coentro*. The consumption of broad beans, however, has diminished during the last sixty years. Bulgur, or cracked wheat, is still included in some dishes from the Alpujarras region in Andalusia.

Savory or sweet porridges, made from different grain flours. These porridges, such as *gachas* and *papas*, were also the basis of Roman cuisine.

Dishes made with breadcrumbs or slices of bread. Breadcrumbs or torn-up slices of bread are used for thickening and giving texture to many varieties of gazpacho and other kinds of soups (*açorda*, *sopa de ajo*, *ensopados*, and *sopas secas*). Breadcrumbs are also the main ingredient in *migas*, a traditional and popular dish. There are some factors that relate the recipe for *migas*, in its Andalusian version, to the recipe for couscous. The first element is the way in which *migas* are cooked. A sort of steam cooking is produced through the sauteeing and continuous stirring of the semolina or the crumbs (these are previously soaked and drained) and gives a golden and granulated appearance to the dish. *Migas*, similarly to couscous, serve as the base for a wide range of other ingredients such as fresh fruit, fried vegetables, fried or roasted fish or sausages, and even sweets. Finally, *migas*, like couscous, are eaten from the pan in which they were prepared; the pan is placed on the table, and the whole family eats from it.

A Link Between *Migas* and Couscous

Southern Spain's *Migas,* a dish of sautéed breadcrumbs or semolina, are a derivative of couscous, a staple dish of steamed semolina. The following is an excerpt from *A Recipe from an Anonymous Andalusian Cookbook of the Thirteenth Century,* translated by Charles Perry:

> I have seen a couscous made with crumbs of the finest white bread—for this one you take crumbs and rub with the palm on the platter, as one rubs the soup, and let the bread be neither cold nor very hot; put it in a pierced pot and when its steam has left, throw it on the platter and rub with fat or moisten with the broth of the meat prepared for it.

Spiced fritters and desserts. Various doughnutlike fritters (*buñuelos*, *boladinhos*, *roscos*, *filhós*, *pestiños*) and desserts (*alcorza*, *alfeñique*, *alajú*, nougat, and marzipan) are made by combining honey or sugar, egg yolks, cinnamon, and sometimes ground almonds.

Other popular foods and dishes. Flatbreads, either baked (*pão estentido*) or fried (*pão de sertã*, *torta*), stuffed eggs, stuffed eggplants, vermicelli stew, spiced meatballs, shish kebabs (*pinchos morunos*, *espetada*), and quince paste are current Iberian foods also mentioned in Arab cookbooks.

See also **Africa: North Africa**; **Couscous**; **France**; **Islam**; **Italy**.

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Teresa de Castro

Portugal

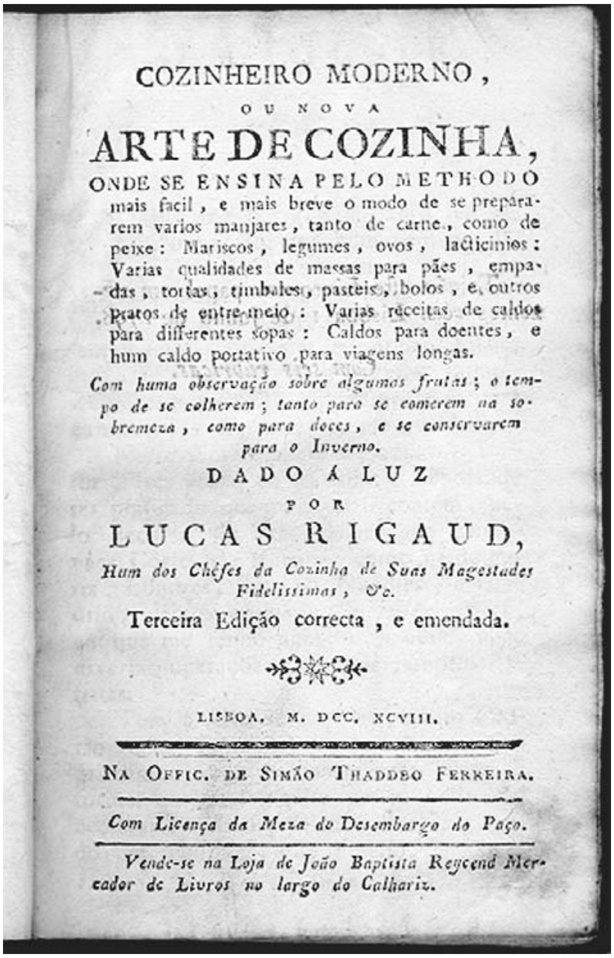
Although smaller than the state of Indiana, Portugal was the seat of a great European empire, and its trading network has marked its culture and cuisine. Even before nationhood, Portugal was successively invaded by Celts, Phoenicians, Greeks, Romans, Visigoths, Swabians, and Moors, and was influenced by these cultures. The birth of the Portuguese nation dates back to 1139, when Afonso Henriques took the title king of Portugal, after a major victory against the Moors, although the south remained under Moorish rule until 1250. Spain and Portugal signed the 1494 Treaty of Tordesillas, under papal auspices, dividing the New Worlds between them. The Spanish claimed the Americas, while the Portuguese acquired Brazil and the Spice Route, from Africa to Timor. Portugal's last trading colony, Macao, established in 1557, peacefully reverted to Chinese control at the end of 1999. Portuguese traders brought back to Europe a treasure of spices such as cardamom, pepper, ginger, curry, saffron, and paprika, as well as other exotic foods, such as rice and tea from Asia, coffee and long pepper from Africa, peppers, tomatoes, potatoes, tropical fruits, and peanuts from Brazil. All ingredients form part of Portuguese cuisine today. As Jean Anderson notes in *The Food of Portugal*, the ingenious combination of Old and New World foods differentiates Portuguese cooking from Spanish (p. 10).

Regions

Portugal faces the Atlantic, whereas Spain, except for Galicia, identifies itself as Mediterranean. In the north, Minho province is a green garden of small plots and vineyards. Inland, Tràs-os-Montes is a land of stark mountain ranges and hills with a severe climate. The Douro River, rising in Spain, flows to Oporto, through steep-terraced vineyards. The three Beira provinces form the Portuguese heartland, with the highest mountains. The center of the empire, Lisbon's Estremadura province received much wealth from the colonies, as is evident in its varied cuisine. The gentle plains of Ribatejo along the banks of the Tagus provide pastureland. Alentejo, meaning "beyond the Tagus," is a vast expanse of cork oak, olive trees, and wheat fields along the Spanish border. The Moorish occupiers remained longest in southernmost Algarve, leaving their influences on the architecture, customs, and food. Portugal's only remaining overseas territories are the Atlantic archipelagos: Madeira and the Azores.

Portuguese Eating Habits

Although young people tend to favor international fast foods, the rest of the Portuguese still prefer slow cuisine and fresh fish and vegetables. Portuguese families are increasingly dependent on hypermarkets—giant supermarkets that function like compact department stores—springing up everywhere, but the weekly farmers' markets are still very popular. Portuguese households begin the day with a continental breakfast of coffee and milk with bread and butter, honey, or jam. The main meal takes place at lunch, with an appetizer (*acepipes*) like fresh cheese or codfish balls, one course—generally meat and vegetables—and dessert. Country loaves, more refined rolls, or cornbread appear with every meal. A lighter supper can start with soup, one course of perhaps fish, and fruit. There is usually a midmorning break for coffee and a roll, and children take a midafternoon snack of sandwiches and milk. Most elegant teahouses, where ladies of



COZINHEIRO MODERNO,
OU NOVA
ARTE DE COZINHA,
ONDE SE ENSINA PELO METHODO
mais facil, e mais breve o modo de se prepararem
varios manjares, tanto de carne, como de
peixe: Mariscos, legumes, ovos, lacticinios:
Varias qualidades de massas para pães, empadas,
tortas, timbales, pasteis, bolos, e outros
pratos de entre-meio: Varias receitas de caldos
para differentes sopas: Caldos para doentes, e
hum caldo portativo para viagens longas.

*Com huma observação sobre algumas frutas; o tempo
de se colherem; tanto para se comerem na sobremeza,
como para doces, e se conservarem
para o Inverno.*

DADO Á LUZ
POR
LUCAS RIGAUD,
*Hum dos Chéfes da Cozinha de Suas Magestades
Fidelissimas, &c.*
Terceira Edição correcta, e emendada.

LISBOA. M. DCC. XCVIII.

NA OFFIC. DE SIMÃO THADDEO FERREIRA.

Com Licença da Meza do Desembargo do Paço.

Vende-se na Loja de João Baptista Reycend Mercador de Livros no largo do Calhariz.

Title page of the 1798 Portuguese edition of *The Modern Cook or New Art of Cookery,* written by Lucas Rigaud. This cookbook was popular in Spain and Portugal during the eighteenth century. ROUGHWOOD COLLECTION.

leisure used to indulge in rich egg and sugar cakes, have closed with changing work habits, but pastry shops serve the seventeenth-century convent sweets.

Meal times. Typically, Portuguese meal hours are closer to those of the French than the Spanish: They do not share their Iberian neighbors' midafternoon repasts and siestas or midnight suppers, except on Christmas and New Year's Eve. Lunchtime is 1:00 P.M., and many workplaces still close from 1:00 to 3:00 P.M. The traditional dinner hour is 8:00 P.M.

Weekly cycle. Traditional dishes like *caldeirada* (fish or shellfish stew) and *cozido á portugesa* (boiled meat and vegetables) are served in homes on weekends to allow for more time for food preparation. Portuguese families also like to eat out on weekends. Many popular restaurants offer generous half-portions, but even so, prices have soared faster than wages, and the average family is going out less.

Seasonal Cycle

With its temperate Gulf Stream climate, coastal Portugal does not suffer the extreme temperatures of inland Iberia. It rarely freezes, and fresh fruits and vegetables are available year round, although they vary with the seasons. Even sardines come in seasons, fatter and juicier from June through October. At year's end there is the *matança* or the killing of the pig, and the smoking of lean meat and stuffing sausages to last through the winter. Basically the Portuguese eat the same substantial meals all year. Inland, however, where summer temperatures can hover over 100°F (37°C), lighter wines are served and occasionally *gaspacho*, a cold tomato and cucumber soup, similar to its Spanish cousin *gazpacho.* There are also *escabeches*, cold marinated meats, for scalding summer days.

Feasts and special occasions. Religious feasts, with special foods, are still important in this Roman Catholic country. Christmas Eve supper usually features the national favorite *bacalhau cozido* or boiled dried codfish, with cabbage, potatoes, and hard-boiled eggs, smothered in garlic and olive oil. (Portuguese fishermen have been sailing to Newfoundland for cod since the fifteenth century, salting and drying it at sea. But in response to European fishing restrictions imposed in the 1990s, Portugal imports cod from Norway, which is more expensive.) On Christmas Day, the main course features roast turkey, and for dessert there is *rabanadas*, slices of bread dipped in eggs, honey, red wine, sugar, and cinnamon, and fried.

At Easter, lamb or young goat is marinated overnight in white wine, roasted, and served with baked potatoes. Lamb soup uses the lamb's heart, liver, lungs, tripe, blood, and plenty of stale bread. A popular Easter dessert is cottage cheese tarts.

Every region has a saint's festival with special foods. Lisboners pay homage to Saint Anthony with a costume parade, block parties, grilled sardines, and red wine. Oporto celebrates St. John with fireworks, street dancing, cabbage soup, and red wine. The Templar city of Tomar honors the Holy Spirit, with the Festival of Crowns, a cortege of girls, wearing tall crowns of fresh loaves of bread and paper flowers, accompanied by merrymaking and a panoply of sweets like almond cheese cakes and pumpkin tarts.

Other festive occasions include birthdays, weddings, baptisms, and first communions. These used to call for elaborate banquets, but in the early twenty-first century the menu is simpler: traditional dishes like tripe, hake filets, roast lamb, baked rice, and egg and sugar tarts.

Regional Foods and Wines

As communications have improved in this compact country, more regional dishes have acquired national status. *Cozido á portugesa*, the hearty Portuguese boiled dinner, with chicken, spareribs, sausages, and vegetables originates from Estremadura but is found everywhere. Other national favorites include green soup with shredded cab-

Port Wine

Originally port was a dry red table wine and came from the Upper Douro Valley some 2,000 years ago. Then in 1820, exceptionally warm weather produced unusually sweet grapes and the full, rich dessert wine that the English adored. To satisfy eager English customers, port wine producers added brandy, which stopped the fermentation early and preserved the high sugar level of the grapes, raising the alcohol level to about 20 percent. The process of producing port is now mechanized. The new wine is no longer transported in *rabelos,* flat-bottomed sailboats, but trucked to the port wine lodges, at Gaia across from Oporto. There it is blended and stored to mature.

The French now consume more port than the British, Pasquale Iocca of the Portuguese Trade Commission emphasizes in the *Food of Portugal* (Anderson, 2001). He points out that the British still favor vintage port ten to fifty years old, whereas the French prefer tawny port aged three to five years in casks.

bage and potatoes from the Minho, fish or shellfish stew found all along the coast, baked dried codfish (the fish is first soaked in liquid before cooking) with onions and potatoes originally from Oporto, and *açordas*, or creamy dry bread soups from Alentejo. The national sauce of crushed tomatoes, green peppers, and onions is the universal condiment. The "national" dessert is *arroz-doce*—rice pudding.

While Port and Madeira dessert wines have gained worldwide recognition, Portuguese table wines are beginning to attract more attention. There are some fifty officially demarcated wine-growing regions. The best reds come from the Alentejo, although those from Beira are better known. Increasingly popular is the effervescent white *vinho verde* or new wine, from the Minho. Excellent natural and carbonated mineral waters come from Beira and Tràs-os-Montes.

Between the Minho and Douro food culture. Minho province, blessed by rivers, fertile farmland, trellised vineyards, and a fruitful sea, is home to an exceptionally varied cuisine. From the Minho and Lima Rivers come salmon trout and lamprey. Atlantic specialties include sardines grilled on pine needles, octopus stew, and shad vinaigrette. Pork is the dominant meat, with delicacies like pork cubes marinated in *vinho verde*.

Oporto's unlikely favorite food is tripe. In fact, the native people are known as *tripeiros* or tripe-eaters because in the fourteenth century they donated all their meat to feed the navy in its defense of Lisbon against Juan I of Castile. The *Portuenses* were left with the innards, which they learned to use in many innovative ways.

Estremadura food culture. Naturally the richest, most cosmopolitan cuisine is found in the capital, reflecting the diverse population, who settled here from all over Portugal. Lisbon's specialties range from stuffed crab and lobster *açorda* to rice and turnip greens or codfish hash. Then there is café beefsteak, with cream sauce and french fries, which made its debut in popular cafés and is now a regular in many homes. Over the past decade, immigrants from the former colonies of Angola, Goa, and Macao

Madeira

It was the visionary Prince Henry who first brought Malvasia grapes from Crete in the fifteenth century to Madeira as the basis for the island's important wine industry. The special intense quality of Madeira wines comes mainly from the basaltic soil and mild climate. Like port, Madeira is fortified with brandy to ensure its quality during shipping, but it acquired its distinctive, slightly scorched flavor by chance. Sometime in the seventeenth century, a case of Madeira was forgotten in the hold of a ship when it reached its destination in the New World. The wine returned to Madeira considerably enriched after its lengthy sea voyage twice through the steamy tropics. Subsequently, Madeira merchants began to send their wines on long tours to enhance the sweetness and aging. Then they found they could get the same results by a process of steaming the wine at home.

Queen Catherine of Bragança, the Portuguese wife of King Charles II of England, was indirectly responsible for the popularity of Madeira wines in colonial America, according to Pasquale Iocca of the Portuguese Trade Commission. In the *Food of Portugal* he points out that because of Queen Catherine's influence, Madeiras were the only European wines exempted from the 1665 export ban and shipped duty-free to the English colonies. The signing of the Declaration of Independence was celebrated with glasses of Madeira, and George and Martha Washington used to drink a pint of Madeira every evening with dinner.

Madeira exports virtually halted after the island's vineyards were devastated by disease in 1852. Several English companies that were involved in producing and shipping Madeira helped to reconstitute the vineyards. By 1900, Madeiras were back better than ever, but Americans had meanwhile switched to sherry.

Couve tronchuda is a variety of Portuguese open-headed cabbage dating from ancient times. It is still a traditional ingredient in Portuguese cookery and serves as the main ingredient in this cabbage and sausage soup. © Becky Luigart-Stayner/CORBIS.

have established new ethnic restaurants in Lisbon, which are certain to influence future eating habits.

Alentejo food culture. Portugal's least developed region, the Alentejo has produced the most imaginative dishes. Frugal housewives have ingeniously used the staple ingredients bread, olive oil, and garlic to produce outstanding dishes. *Açorda á alentejana* is a creamy bread puree with coriander and poached eggs. Another dry soup is *migas*, crumbled bread and olive oil, cooked with cubes of beef, pork, and bacon. The most astonishing combination is pork and clams, with pork loin marinated in chili sauce—the flavors meld together beautifully.

Food culture of Madeira and the Azores. In 1425, Portuguese navigators discovered uninhabited, forested islands, some 350 miles off the Moroccan coast, which they called Madeira (wood in Portuguese). Realizing the islands' importance as a stopover for transatlantic shipping, Prince Henry, in the fifteenth century, sent over settlers, mostly from the Minho, to plant sugar cane and vineyards. Despite the distance, Madeira's cuisine is very Portuguese, enhanced with other influences. Fresh tuna steaks and scabbard fish are marinated in garlic and olive oil and fried, but served with fried cornmeal and even corn-on-the-cob. The local *cozido* includes the usual pork and vegetables, but also sweet potatoes, green pumpkin, and couscous. Madeira's fruit salad, however, is strictly local and includes papaya and passion fruit.

The nine Azores have the closest ties to the United States. In the old days, whaling crews from the Azores sailed to New England and California, many settling there with their families, who still visit the islands in summertime. Commercial whaling has stopped, but many Açoreanos live by fishing, and fish is an important part of the diet. Fish soup Azores style includes the local catch: haddock, porgy, grouper, mackerel, swordfish, eel, and squid or octopus. Dairy farming and cheese making are also important activities, and the fragrant, moist cheese from São Jorge Island is a bestseller on the mainland.

Food culture of other regions. In the wild, hilly Trás-os-Montes, the pig is "king" and fed with table scraps. In the past, the prevalence of pork caused problems for the many Jewish converts. Maria de Lourdes Modesto recounts in *Traditional Portuguese Cooking* how the "new Christians" invented *alheiras*, a delicious, porkless sausage based on partridge, to escape detection by the Inquisition's spies (p. 47). *Alheiras* are still popular, but sometimes include pork.

Mountain folk of Upper Beira are masters with leftovers. After roasting a baby goat that is basted with white wine, the head is boiled for broth, the backbone and the

FURNAS

One of the most traditional dishes of the Azores is *cozido de lagoa das furnas* (boiled dinner from Furnas Lake). This lake on São Miguel Island is a volcanic crater, and the beach contains numerous *caldeiras* or small caverns spewing sulfur. Chunks of beef, pork, and chicken, sausages, bacon, turnips, carrots, potatoes, and red peppers, covered with cabbage leaves, are put into an aluminum pan, with the lid tightly shut. The pan is placed in a cloth bag, with a long string, and let down into a *caldeira,* then covered with a wood board and volcanic sand. The *cozido* takes about five hours to cook in the steaming ground—the ultimate in Slow Food.

heart, liver, and lungs stewed, and the cutlets are fried and always served with boiled potatoes. Beira also produces Portugal's creamiest cheese, made from long-horned sheep that feed on wild herbs in a demarcated zone of the Estrela Mountains.

The Ribatejo, with its alluvial plains, is famous for its dark full-bodied red wines and substantive dishes like stone soup made from pig's ear, *chouriço* (a spicy sausage), ham, and red kidney beans.

Algarve's clean beaches, sun, mild sea, and air temperatures have made it Portugal's primary tourist resort, and this situation has threatened it with a loss of identity. By avoiding international establishments, it is still possible to find original Algarve seafood dishes, like octopus with rice, tuna steaks in onion sauce, or squid stuffed with ham and *chouriço.*

See also **Cheese**; **Crustaceans and Shellfish**; **Feasts, Festivals, and Fasts**; **Fish**; **Meat, Salted**; **Mollusks**; **Sausage**; **Slow Food**; **Vegetables**; **Wine**.

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Marvine Howe

SPAIN

Spain, situated on the westernmost peninsula of Europe and opening to the Atlantic Ocean on the northwest, historically has been oriented toward the Mediterranean both in its climate and in the temperament of its people. First settled by Celts, then invaded by Phoenicians, Greeks, and finally the Romans, who consolidated the peninsula into one province, ancient Spain became one of the most important agricultural regions of the Roman Empire. Following the Romans came the Goths, then Nordic invaders, and finally the Arabs, so that during the Middle Ages the country fragmented into many small kingdoms. Those former kingdoms roughly correspond to the provinces and regional cultures comprising modern Spain. Each of the invading peoples added its own identity to the rich mixture known as Spanish cuisine.

The Main Cultural Regions

Galicia, which has Celtic roots, is in the far northwest of Spain, and to the east are Asturias and the Basque country, whose culture and language predate Roman Spain. To the east of Asturias are Navarre and Catalonia, two important kingdoms during the Middle Ages that established Spain as a major maritime power in the Mediterranean. Along the western border with Portugal is Extremadura, and in the Spanish heartland to the east are Old and New Castile. Along the Mediterranean coast in the South, opposite Africa, are Andalusia and the Comunidades of Valencia and Murcia, all with distinctive regional cookeries and internationally known wines. The Arabic influence was strong in these regions and lingered in many aspects of the culture, perhaps best typified by the great Moorish palace of the Alhambra in Granada. Of course many islands are part of Spain, among them the Balearic Islands of Minorca, Majorca, and Ibiza and the Canary Islands off the Atlantic coast of Africa. No matter how Spanish culture is studied, it is obvious that this huge diversity rather than any one element of it defines the cuisine of modern Spain.

Added to this diversity is the climate. In the northern coastal area the weather is generally cool, even rainy, whereas in the central and southern parts of the country the climate is hot and dry like other parts of the Mediterranean. Thus even in its kitchen gardens and agriculture, the country exhibits a great diversity. In addition several gastronomic riches of the New World, including the tomato, the potato, the capsicum pepper, cacao, and vanilla, reached Europe via the Spanish Empire.

The Characteristics of Spanish Eating Habits

Not until the late twentieth century did a "national" Spanish characteristic for the times and places of food

Traditional olive oil storage jar. Spain, seventeenth century. Gray earthenware. The design is based on the ancient Roman *dolium.* The exterior of the jar was sealed with pitch (still extant), then sunken into the floor of the cellar. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

consumption emerge. Previously the family determined such patterns locally, but new family structures and work customs shifted the patterns dramatically. The typical pattern became two main meals (midday dinner and supper), a light breakfast, and two optional meals (tapas and *merienda*). Breakfast, the first meal, generally corresponds to the European continental breakfast, consisting of a quickly eaten, fortifying menu based on pastries, small breads, coffee, milk, butter, and marmalade, and it is essentially of French origin. Alternatively something totally Spanish, such as *churros* and *porras* (fritters) can be substituted.

Main meals. The most typical feature of the meal schedule is the tendency for Spaniards to delay the timing as much as possible. When midday dinner is adjusted to the work schedule, it usually takes place at around 2:00 P.M. On the other hand, when festivities or vacations allow more flexibility, Spaniards tend to postpone it until 4:00 in the afternoon for relaxation or friendly reunions or because of the earlier consumption of tapas. The most significant feature of the Spanish midday dinner is to prolong it as late into the day as possible with the help of desserts, liqueurs, and coffee. Its only rival activity is the siesta or midday nap. This dinner involves a major consumption of food. After the Spanish Civil War (1936–1939) families began to eat at the table three main dishes plus appetizers, cheeses, and dessert. Subsequently this pattern devolved into two main dishes and dessert.

The traditional Spanish supper usually takes place around 10:00 P.M., also in the home. It is characterized by its pretension of being light, although it consists again of two main dishes and dessert. Vegetables and fish are often preferred to assure that it is less heavy than the midday meal.

Meals between meals. Spaniards, being of a relaxed, Mediterranean temperament, have created a minimeal between breakfast and midday dinner. This meal, called an appetizer elsewhere in the world, is referred to in Spain by the verb *tapeo* (to eat tapas). Drinks and food are of equal importance to eating tapas. It is also popular among Spaniards to not eat the tapas in one establishment but rather to stroll through various eateries throughout the course of the morning.

A classical tapa can be eaten with a toothpick, in small pots or bowls with a fork, or on top of a piece of bread. All of these variations have their own descriptive nomenclatures based on appearance: *pinchos*, *cazuelitas*, and *montados.* Drinks of low alcoholic content, such as beer and wine, are always drunk with the tapas. In the South wines such as Jerez, Fino, and Mazanilla are served. Usually the higher the alcoholic content of the beverage served, the smaller the quantity of food consumed until, at the far extreme, tapas simply become dried fruits and olives.

Merienda. *Merienda* is the meal between the midday meal and supper. Generally it is a meal for socializing during afternoon visits or during a game of cards, or for children and the elderly who require extra nourishment between fixed meals. The drink most representative of the Spanish merienda is chocolate. Spanish-style chocolate is characterized by its thickness, although it is traditional to drink it in small cups called jícaras accompanied by absorbent cookies that can be dipped into the chocolate.

Another *merienda*, easy to eat during journeys, is the *bocadillo.* This is the equivalent of the sandwich, but it is prepared with a whole loaf of Spanish bread. During times of food shortages, *bocadillos* have been filled with sliced quince or a little grated chocolate. The more classical *bocadillos* are made of *serrano* ham and *manchego* cheese.

The *bocadillo* has undergone a gradual evolution. It is used as a quick meal suitable for any hour of the day since all of the basic types of nutrients can be put into the loaf, such as chorizo (a spicy pork sausage), *calamares a la romana* (squid fried in butter), sardines, or *tortilla a la española* (Spanish omelet). For excursions to the countryside something special is created, *bocadillo* filled with breaded filet of beef.

The weekly meal cycle. The Spanish housewife generally makes a clear distinction between the everyday meal and the festive meal, especially on Sundays. Traditionally it was possible for working husbands and schoolchildren to eat in their own homes every day, and only manual laborers were obliged to eat at work. Housewives created a varied menu by distributing dishes representative of each day of the week—for example, Monday macaroni, Tuesday lentils, Wednesday stew, Thursday broiled fish, Friday porridge, Saturday salads, and Sunday paella. Depending on the economic means of the family, beef could be a choice, especially for Sundays. This custom continues in the "dish of the day" on restaurant menus.

The Seasonal Cycle

In spite of the geographical diversity of Spain, a shared seasonal climatic variation is common to all parts of the country. Thus, except for the colder regions, summer tends to be hot throughout Spain, which defines the character of summer meals. The foods of the warm season favor easy preparation and light, refreshing ingredients, such as salads and gazpachos. The basic ingredients of a typical salad are lettuce and tomatoes, and the simple salad dressing—olive oil, wine vinegar, and salt—is prepared at the beginning of the meal by the guests themselves. This custom has continued in public restaurants. When the server places the cruet stand on the table, it is a sign that one of the dishes will include lettuce.

The "king" of all the first course dishes is gazpacho, one of the great contributions of Spanish cooking to hot weather cuisine. It is similar to a cold tomato soup, but in gazpacho all the ingredients, ripe tomatoes, cucumbers, green sweet peppers, garlic, olive oil, salt, and vinegar, are raw and are liquefied. Cold water is added to thin the soup. At restaurants it is served with garnishes, consisting of the same ingredients cut into small pieces, and small bits of bread.

In Spain the cold season is associated with the consumption of legumes. Lentils are part of a tasty repertoire of everyday meals, but when Spaniards want to feel satisfied, they think of garbanzo stew. When they want to feel extremely full, they think of the *fabada asturiana*. The *fabada* is a thick stew of white beans and pork products from the region of Asturias on the coast of northern Spain.

The Festive Cycle

The celebrations that have influenced Spanish gastronomy the most are the religious feasts, notably Christmas, a time when major excess prevails. The traditional feast days are Christmas Eve dinner on 24 December, Christmas Day dinner on 25 December, New Year's supper on 1 January, Three Kings supper (Epiphany Eve) on 5 January, Epiphany breakfast on 6 January, and Epiphany dinner on 6 January.

During the Middle Ages, Christmas Eve dinner followed a vigil, and from this period a light dish called *sopa de almendras* (almond soup) survived as a nostalgic relic. Only after midnight mass, or *misa de gallo*, could the great gastronomic excesses begin. Eventually this became the preeminent family dinner. The traditional dishes have continued, although they have evolved over time. Earlier the meal consisted of savoy or red cabbage and fish, usually red porgy, but grilled leg of lamb has become the porgy's competitor.

Certain Spanish confections, such as *turrones*, *marzapán*, and *polvorones*, convey a nostalgic dimension to Christmas, since they are only consumed at this time. The Christmas meal is family oriented, and turkey is the main dish. New Year's festivities tend to lose their family orientation, since New Year's Eve is a supper prelude to a party outside the home. Consequently it is light and easy to prepare, generally a cold meal of various seafoods, especially prawns. The cheapest and most common prawns are baptized with plenty of Catalan Cava (Spanish champagne).

Three Kings' supper on Epiphany Eve is a magical night for children, since they wait for gifts from the Three Kings of the East. The breakfast on Epiphany morning would not be of major importance were it not for the fact that the Magi have brought a *roscón*, a large, round, braided bread flavored with orange-flower water and decorated with crystal sugar, chopped almonds, and dried fruits. Spaniards give each other *roscones de Reyes* until every house has a great accumulation of them.

Lent is a period of recovery, forty days of penitence preceding the celebrations of the death and resurrection of Jesus. The traditional vigils and fasts during these forty days have developed many variations over time, yet the vigil dishes and the dishes of nourishment for days of fasting are a form of nostalgia or remembrance. The representative dish of a vigil is a *potaje* consisting mainly of garbanzos, dried codfish, spinach or cabbage, hard-boiled eggs, and a touch of cumin. During Lenten fasting one characteristic sweet, called *torrija*, is consumed. It is made with sliced bread soaked in milk and sugar, dipped in an egg batter, fried in olive oil, and drowned in wine, orange juice, or honey.

In addition to these great religious observances, each region of Spain has its own patron saint, who is celebrated with some characteristic meal. The confections made in the saint's honor add a special note to the extraordinary fare of the celebration and have given rise to numerous types of *rosquillas*, *panecillos*, and *bollos* ornamented with saintly symbols. Remarkably bakers invent new recipes for modern festivities, so many traditional observances are revitalized on a daily basis.

The Regional Cookeries of Spain

Because Spain has varied regional identities and diverse agricultural districts, regional cooking has acquired a special meaning. Besides the different languages and dialects, regionalism is thoroughly manifested in highly varied gastronomic traditions. In spite of this localization, many dishes have become popular over the entire country.

Local inns and taverns have a commercial interest in exposing consumers to dishes representative of the region. These can be identified by their last names, such as *a la gallega*, *a la asturiana*, *a la riojana*, *a la catalana*, *a la valenciana*, *a la murciana*, *a la andaluza*, just to mention a few specialties. Obviously these dishes are not always accurately prepared outside their regional settings, but they do allude to distinct culinary styles. Each regional capital has centers, called Casas Regionales, representing the cultures of other regions. These centers normally include restaurants that serve food typical of the regions they represent. All of Spain's regional cookeries are accompanied by an enormous diversity of wines that gradually have become certified by their nominations of origin, including sparkling Catalans, red Riojanos with a *ribera del Duero* body, and full-flavored Andalusians, plus a series of local liqueurs, the outstanding one being Anis.

Basque cookery. The importance of Basque cookery rests on the great Basque love for gastronomy and on the high quality of the natural products from that region, of which fish is the most important. In Basque country the clubs called Sociedad Gastronomica are exclusively for men. Whatever food they prepare themselves, they must also eat. The purpose of this society is to conserve traditional Basque cookery, but the members also are mindful of creative new cooking techniques. Out of this region great chefs, including those from the Basque part of France, given its close proximity, have emerged with innovative talents. In any city of Spain a restaurant run by a Basque chef will be well known for the high quality of its cookery.

Of the fish caught along the Basque coasts, the most notable is hake, which is also one of the most expensive. However, its closest relative, weakfish, is generally less expensive and equally tasteful. The best dark-fleshed fish also come from these waters, such as bonito and tuna. Basque sardines and anchovies have earned international popularity, and an industry has developed around preserving sardines and salted anchovies in oil.

Among the dishes most representative of Basque cookery, hake in green sauce stands out, as does *marmitako*, a stew composed of chopped bonito and potatoes with olive oil. The Basque secret of preparing codfish *al pil-pil* is the peculiar pan-shaking movement that must occur at the correct moment of cooking to emulsify the sauce. The typical wine from this region is *txacolí*, a young wine of low alcoholic content.

Castilian cookery. The central part of Spain is an extensive region known historically as the two Castiles. It is an area characterized by plateaus and a continental climate, cold winters and hot, dry summers. The area is rich in cereal products and herds of wool-producing animals, both sheep and goats. During the cold season residents consume legumes, most commonly garbanzos and lentils. Castilian-style garbanzos have given their name to the famous dish *el cocido madrileño.* Grain products hold an important place among the region's numerous shepherds, who make a light meal—by frying flour or pieces of bread in olive oil, garlic, ground red pepper, and bacon—called *migas de pastor.*

From Castile comes the best quality Spanish lamb, which when grilled attains a level of specialty by virtue of its utter simplicity. This area of Spain is also famous for its traditional method of grilling lamb and suckling pig. The cold, dry winters are traditionally the time for pork butchering, resulting in the famous chorizo sausage. This region also produces the famous *manchego* sheep's milk cheese, which gets its aromatic flavor from the wild herbs growing in the pastures where the sheep graze.

The cookery of Valencia. This style of Spanish cookery is famous for its clever use of rice. It has been said that the region's cooks are capable of producing 365 rice recipes, one for each day of the year. The two most famous rice recipes from this region are *paella valenciana* and *paella alicantina.*

Spanish rice is cooked with a precise proportion of grain to water so, at the end of the cooking process, the grains are perfectly fluffy, with no stickiness from excess water. The *bomba* variety of rice is ideal for paella, since it absorbs the stock surrounding it, producing the best texture.

The classic *paella valenciana* is composed of elements from the kitchen garden, chicken, rabbit, vegetables, and snails. *Paella alicantina* is essentially composed of seafood. It is visually attractive, presented at the table with shellfish, lobsters, shrimp, and prawns arranged radiating from the center. In both types of *paella*, saffron is essential to give the rice a yellow color and a distinctive flavor.

Andalusian cookery. Andalusia is one of the world's major producers of olive oil, and it has a bountiful seacoast and hot Mediterranean weather. These characteristics have given the regional cuisine its primary features, the refreshing gazpachos, the fried fish, and a style of cookery generally easy to prepare and accompanied by richly flavored wines. Andalusian fish fries are especially famous, and the best cured ham comes from this region.

The high quality of the region's ham is due to the fact that the *cerdo ibérico* (Iberian pig) breed is raised mostly in this region. The pigs' special diet in the pasture and a unique curing process contribute to the fine flavor of these hams, which are classified as *serrano* (plain cured) and *bellota* (acorn ham). *Bellota* comes from Iberian pigs fed on acorns, which achieves a flavor somewhat on the sweet side. This ham is of such prestige that it has been called Spanish "caviar."

Other regions. In addition to the culinary regions already mentioned, Galicia includes the best seafood, Ri-

PAELLA VALENCIANA

The paella is the pan used to cook this legendary dish, and valenciana refers to Valencia, the region of Spain on the shores of the Mediterranean where it originated. It is typically cooked outdoors in the countryside on a dry wood fire. The paella must be set at a suitable height to be surrounded by the flames during the first part of the cooking, and the fire must be kept burning at the correct strength.

Generally a good paella depends not so much on the quality of the ingredients as on combining all the components in the correct proportions. The five basic elements—oil, water, rice, heat, and cooking receptacle—need to be balanced with an almost mathematical precision. The experience and personal touch of whoever is in charge of the cooking are also of utmost importance.

The preparation of a paella in the countryside is a ritualistic festive occasion, which can sometimes turn into a gastronomic debate! The relaxed, lighthearted atmosphere is punctuated with jokes and comments on the progress of the food.

The experience culminates when the paella is deemed ready, removed from the fire, and carried to the table.

Ingredients:
$6\frac{1}{2}$ oz. (200 gr) fresh or dried large lima (butter) beans, or *fava* (broad) beans, soaked overnight
$4\frac{1}{2}$ cups (2 qt. / 2 l) water
$\frac{2}{3}$ cup (5 fl. oz. / 155 ml) olive oil
$1\frac{1}{2}$ lb. (750 gr) chicken, in chunks
1 lb. (500 gr) rabbit or lean pork, in chunks
8 oz. (250 gr) green beans, trimmed and halved
1 tomato ($3\frac{1}{2}$ oz. / 100 gr) peeled and finely chopped
1 teaspoon paprika
salt
12 small land snails or 1 sprig rosemary
2 pinches saffron
$2\frac{1}{2}$ cups (13 oz. / 410 gr) medium grain rice.

Put the lima beans on to boil in 2 cups (16 fl oz. / 500 ml) of water.

Heat the oil in an 18-in. (45-cm) paella (shallow metal pan) and fry the chicken and rabbit chunks, turning to ensure even cooking. Add the green beans and fry gently. Keeping the heat low, add the tomato, then the paprika, immediately followed by the rest of the water.

Add the lima beans with the cooking water. Add salt and bring quickly to a boil, then turn down the heat and continue cooking until the meat is cooked (45–60 minutes).

Add the snails or rosemary. Check the seasoning and add the saffron. Turn up the heat and add the rice, spreading it out as evenly as possible. Cook quickly for the first 10 minutes then turn down the heat gradually for another 8–10 minutes.

Taste the rice to check if it is done. The grains should be soft but still quite firm inside. Remove from the heat and allow to rest 5 minutes before serving. Serves 4.

Lourdes March

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oja produces the highest quality Spanish wines, Catalan cookery is notable, and many subregions are incorporated within the larger provinces. The cookery of Galicia in particular benefits from the rugged coastline, ideal for nurturing quality seafood. Furthermore, its inland prairies produce beef and veal famous throughout the country. The delicious empanadas of medieval origin are made with the products of both land and sea.

The cookeries of Navarre and of the Rioja region enjoy the benefit of being in areas with special microclimates, and they are privileged with many bays and river valleys, where rich soils produce appealing vegetables. These vegetables are the ingredients in excellent stews that have encouraged mammoth feasts.

Catalan cooks, in their desires to rescue local traditions and to blend them with an innovative curiosity, compete with the Basques for first place in the Spanish kitchen. Their emphasis on grills and wood-burning fires is most likely of Roman heritage. As in Roman times clay tiles are used in cooking mushrooms, vegetables, fish, and meats. Catalan sauces or *picadas* are made by pounding mixtures of aromatic ingredients, such as garlic, dried fruits, tomatoes, herbs, olive oil, salt, and even cookies to give them a surprisingly sweet flavor. The weight of tradition is also reflected in Catalonia's varied ornamental confectionery.

Other regional foods, of no less importance, include the Murcian, with its fish chowders and the cookery of the Balearic archipelago, probably the most ancient style of cooking in Spain. Extremadura on the Portuguese border and the Canary Islands possess culinary riches inherited from Spain's age of discovery. From their cities came the curious voyagers who inaugurated Spain's expansion into a world empire, the true beginning of globalization.

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Alicia Ríos

Translated from the Spanish by
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ICE CREAM. Ice cream, or iced cream as it was originally called, was once narrowly defined as a luxury dessert made of cream, sugar, and sometimes fruit congealed over ice. The techniques for making water ices and sorbets probably led to experimentation with cream and milk in Italy during the Renaissance although no recipes survive. On the other hand, there is clear literary evidence that this experimentation underwent considerable refinement in France during the seventeenth century, and that it was the French court of Louis XIV that first served ice creams at banquets. The use of snow and ice to cool wines was known to the Romans, and sorbets were well known to the Persians and Byzantine Greeks. It does not take a large leap in technology to go from sorbets to frozen creams, yet it was the use of sweet cream from cow's milk that originally made true ice cream possible. In fact, it is the rich milk from certain breeds of cattle that further defines the texture and flavor of this product.

Early Techniques

The original technique for making ice cream was relatively simple, although it was predicated on a good supply of ice or well-packed snow. A large pewter basin was filled with coarsely broken ice, over which the confectioner scattered salt. Salt lowers the melting temperature of the ice and thus induces evaporation. Another smaller pewter basin was set into the salted ice. This basin contained the cream, sugar (usually in the form of syrup), and flavoring—lemon being by far the most popular ice cream flavor until the 1850s. The small basin was then turned by hand and the cream mixture stirred gently until it congealed due to the cooling action of evaporation. Otherwise, it was still-frozen, then beaten once firm. This method is found in numerous recipes surviving from the latter half of the sixteenth century, as well as in quite a few eighteenth-century printed cookbooks, including the *Receipts of Mary Eales* and Hannah Glasse's *Compleat Confectioner.*

The cookbook of Mary Eales, which appeared in 1718, is considered the first to feature an ice cream recipe printed in English, and it varies in technique from the basin method just described. Eales placed her cream in pails in an ice chest and still-froze them, a method developed by professional French confectioners and similar in shape to the crank-turned freezers of the nineteenth century. The appearance of ice cream in domestic cookbooks of the period may be taken as evidence that ice cream had moved from strictly palace fare of earlier times to the tables of the literate well-to-do. This is confirmed in America by a 1744 reference to ice cream on the dessert table of Governor Blandon of Maryland—a thing to be marveled at and noted diligently in a dinner guest's diary. The governor's ice cream was served with fresh strawberries, a foreshadowing of the ubiquitous strawberry and ice cream festivals that today have become such an integral part of the American cultural scene. As for Governor Blandon, it goes without saying that many wealthy colonial Americans owned icehouses, which made such luxuries possible.

Implicit in the operation of making ice cream was the use of metal that transfers the cold temperature of the ice as quickly as possible to the cream. Pewter was the preferred metal of most ice cream makers down to the end of the nineteenth century, when it was replaced by other alloys. The reasons for replacing pewter were several: it pitted easily and it was soft. Complex molds made of pewter would eventually warp or bend, especially around the area of the hinges, which would lead to leaks and imperfectly shaped molded ices. Most important, pewter reacted chemically with acids in ice creams, thus forming toxic lead salts. This realization did not occur to confectioners until the chemistry of food became better understood; thus, it is highly probable that toxins in ice cream contributed to some of the maladies suffered by consumers in the past. This was certainly the case prior to pasteurization because freezing cream or milk does not kill microbes or prevent enzyme breakdown. However, none of these modern concerns affected the historical popularity of ice cream in Europe or America. It would probably be more accurate to say that ice cream became such a rage that its negative effects on the body were rarely mentioned even in medical literature. The loudest critics of ice cream bemoaned the costliness, for ice cream was indeed an expensive indulgence until the invention of the commercial ice cream maker in the late 1840s.

If French confectioners brought ice cream to the attention of the world by serving it at the French court, these same confectioners also codified the art of making ice cream so that, by the middle of the eighteenth century, numerous books could be consulted on ice cream making from A to Z. While the basin method was generally a technique employed in household confectionery, professionals made ice creams in ice chests and experimented with various substances to enhance freezing, including alum and saltpeter. The French also coined the term *fromage glacé* for true iced cream and introduced such unusual flavorings as cinnamon, chocolate, bergamot, and orange flower petals. The French in addition developed the concept of serving ice cream in tiny glasses, normally arranged on glass salvers. These standing displays, sometimes stacked very high, are depicted in quite a few confectionery books and necessitated the invention of tiny pointed spoons for eating the creams.

As ice creams became more fashionable, the formulas for making them also became more and more complex. This was especially true for ice creams that were molded because they required a firmer body than the old hand-whipped sorts. Cutting cream with milk and the addition of eggs, all of which was gently cooked until thick, became one of the signature methods used by French confectioners. Modern American ice cream producers generally call such cooked egg-thickened ice creams "French," as in French vanilla ice cream, although in the nineteenth century Sarah Rorer in Philadelphia and Agnes Marshall in London categorized them emphatically as Neapolitan. In fact, cooking the milk or cream was practiced by more than just French confectioners, and in America at least it was associated primarily with Italians. Neapolitan ice cream was also a specific flavor combination: three distinct layers, one green (pistachio), one white (vanilla), and one orange (orange flavor) in imitation when sliced of the Italian national flag.

Puss-in-boots ice cream mold. New York, circa 1881. Pewter alloy (cleaned). Like period gingerbread molds, themes for ice cream molds were derived from popular culture. In this case, the mold design is based on an 1881 Christmas trade card (next page). ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

The Popularity of Ice Cream

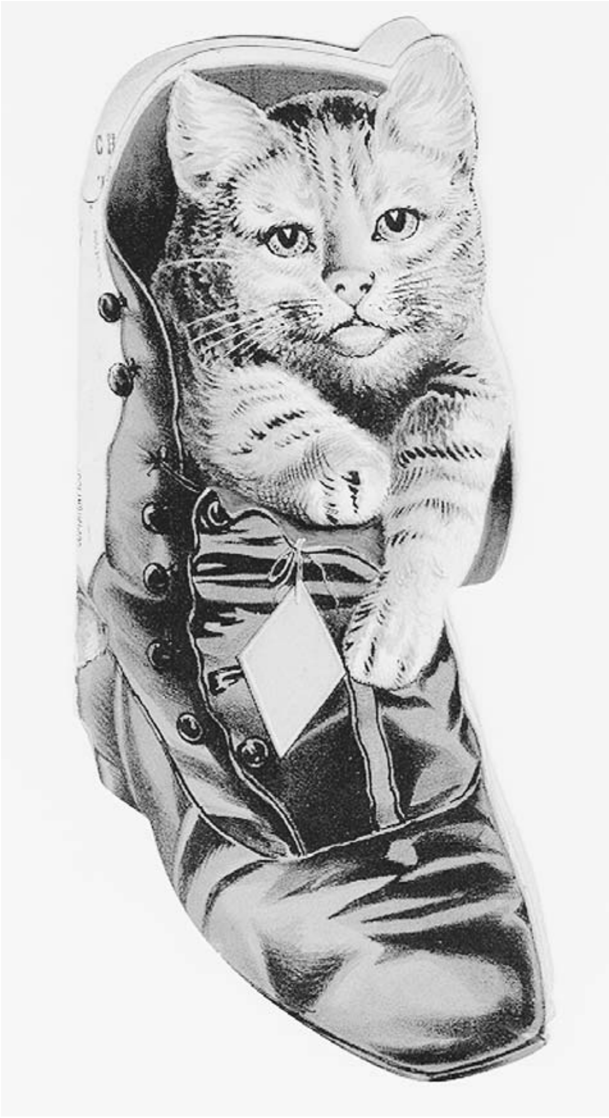
The French Revolution did much to spread the popularity of ice cream, especially in England and America, where refugee confectioners set up business. Some of the most active French confectioners settled in New York and Philadelphia, and their advertisements for ice creams are common in American newspapers from the 1790s into the 1820s. It was also during this period that ice cream gardens developed. They featured a confectionery shop where a variety of sweet foods were prepared, where wines and lemonades were served, and even elaborately planted flower gardens and, on occasion, musical entertainment. Since the best cream was seasonal—May and June being the optimal months—the ice cream gardens also offered cooked food to such an extent that many of them resembled outdoor restaurants. The cookery, however, was light, and for the most part appealed to women and children, since they could not enter oyster houses or taverns unless accompanied by a male. Ice cream gardens became safe havens where even teenage girls could socialize (or flirt) with budding admirers. Furthermore, ice cream gardens were off-limits to African Americans; thus in cities like Philadelphia, a number of black cooks established their own counterparts. Once commercial ice cream became less expensive, the ice cream garden was replicated by churches as a fundraising event under the name of an ice cream social.

The most famous ice cream in nineteenth-century America came from Philadelphia owing to the proximity of fine dairies, rich pasturage on which to feed the cows, and no small amount of local ingenuity. While several French confectioners established a penchant for rich ice creams during the 1790s, especially the demand for finely molded *fromages glacés* at supper parties and balls, it was the Parkinson family who put Philadelphia ice cream on the map.

George Parkinson and his wife Eleanor created a confectionery business that made Philadelphia vanilla ice cream a synonym for the city's haute cuisine. Their son James opened a restaurant in the early 1840s with an ice cream garden in the back—situated in the center of an elaborately pruned collection of roses. Parkinson's sales bills, advertisements, and surviving menus offer a rich selection of ice creams and ice cream sculptures. When Swedish singer Jenny Lind visited Philadelphia in 1850, Parkinson sent to her hotel room an ice cream harp complete with an ice cream nightingale perched on top (the singer was nicknamed the "Swedish Nightingale," hence the allusion). The ice cream was served on a huge silver platter together with a Bohemian glass ice cream service, molded jellies, and "iris-colored" cakes. Parkinson's showmanship did not go unrewarded. The story of the ice cream and Lind's response made national headlines. Parkinson's ice cream flamboyances and another important local development in the history of ice cream probably worked together to establish this food as a national dish. Ice cream is certainly viewed today as an American food, but its transformation would never have happened without Eber C. Seaman.

The Impact of the Crank-Turned Ice Cream Machine

Seaman was a New Jersey Quaker who invented a crank-turned ice cream machine, which he patented in 1848. His invention was first tested in the ice cream saloon of Mrs. E. A. Harbach, a Philadelphia confectioner also famous for her candies. Until the invention of Seaman's device, ice cream had to be made in small batches by



Chromolithograph folding trade card issued for Christmas 1881 by the Philadelphia dry goods store Sharpless & Sons. ROUGHWOOD COLLECTION.

hand. Seaman's crank-turned machine allowed one person to turn out many large batches of ice cream in a matter of hours. This brought down the unit cost of ice cream so that, within a short period of time, it became little more than a street commodity. Seaman's invention is what allowed the American love affair with ice cream to blossom. His large commercial machine was soon miniaturized so that anyone with a supply of ice could make their own ice cream by the quart or gallon. Thus, the hand-turned ice cream machine became a common household utensil by the 1880s, and numerous pamphlet-sized cookbooks were sold to go with them, all including detailed directions for ice cream recipes. One of the most popular brands of ice cream machine was the White Mountain, which gained many testimonials from leading cooks of the day.

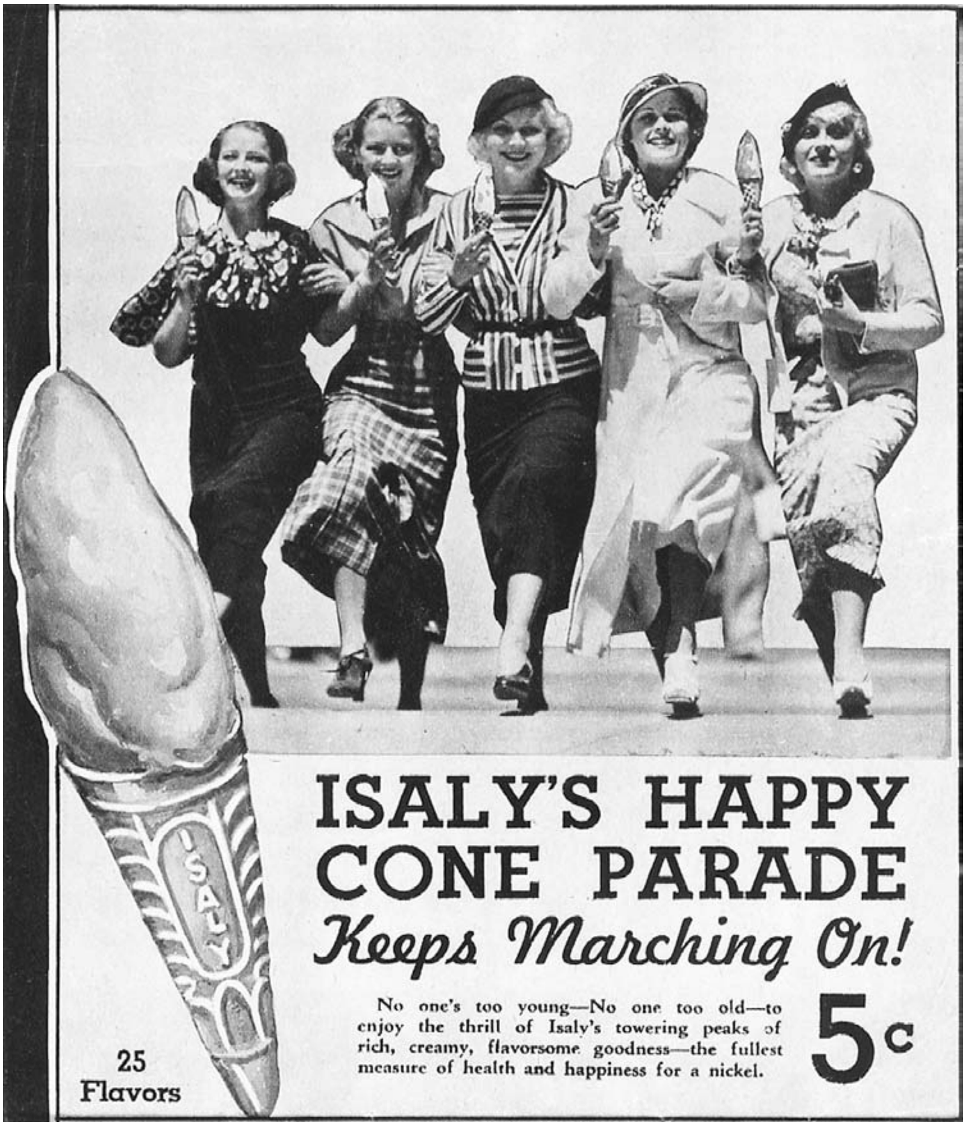
Sarah Tyson Rorer of Philadelphia was a champion of such ice cream pamphleteering, primarily in her role of product endorsement. Rorer's New England counterpart was Mary J. Lincoln of the Boston Cooking School, whose magazines are today a gold mine of period ice cream recipes and illustrations, especially of the odd ways in which the creams were styled for presentation. One wonders whether her ice cream in the shape of a beef tongue realistically colored would have appealed to all sensibilities. On the other side of the Atlantic, Agnes B. Marshall of London not only offered her own patented ice cream freezer, a rich selection of elaborate ice cream molds, but also Marshall's patent ice cave for transporting ice creams to picnics, and two technical books on the subject: *The Book of Ices* (1894) and *Fancy Ices* (1922). Her domination of the late Victorian world of ice cream outshines the likes of either Rorer or Lincoln, and her cookery books are now considered classics of their genre. While Marshall is now part of history, her popularization of iced soufflés and especially of iced puddings has been long-lasting, especially in British cookery.

The future of ice cream, however, was not prophesized in the books of Marshall, but by Rorer. She broke down ice creams into these pragmatic categories: Philadelphia ice cream (using cream only), Neapolitan ice creams (frozen custards employing eggs), and ice creams from condensed milk or a product called evaporated cream. She also included in her 1913 cookbook a recipe for an "Alaska Bake" that was ice cream baked under a thick coating of meringue. In the last two examples, she was somewhat forward-looking in that baked Alaska became popular by the 1920s, and the shift away from natural ingredients to all sorts of artificial additives was already beginning to overtake commercial ice cream production in the early 1900s.

The first step in this evolution was the introduction of condensed milk by Gail Borden in 1856. Commercial thickeners appeared during the 1870s in the form of powders, such as powdered egg yolks, then various gelatin products, both animal- and plant-based. Finally, in 1899 the French introduced homogenizers that largely served as cream substitutes. This led to ice cream powders.

Espoused Health Benefits

Home ice cream making was always fraught with uncertainties, especially the achievement of good texture. Ice cream powder was introduced as a fail-safe remedy with health benefits thrown in for good measure. As one 1908 Jell-O cookbook claimed, "the healthfulness of good ice cream is beyond question. In many cases of illness the patients crave ice cream, and doctors and nurses tell us that it is usually good for them." This reasoning harks back to the Italian sorbets of the eighteenth century, which were often administered to patients suffering from high temperature. But those ices were primarily water



No one's too young—No one too old—to enjoy the thrill of Isaly's towering peaks of rich, creamy, flavorsome goodness—the fullest measure of health and happiness for a nickel.

Advertisement from circa 1935 showing the "Happy Cone," which later became known as the Skyscraper. Its tall, phallic shape was made possible by a specially patented scoop. COURTESY OF JUNE V. ISALY AND BRIAN BUTKO.

and sweetened fruit juice, which the body metabolizes differently from dairy-based products.

The health slant was doubtless an attempt to adjust to the Pure Foods Act of 1906 because this same point is echoed across the board in most confectionery advertising of the period. After the United States acquired Cuba, the per capita consumption of sugar soared. Sugar began to permeate all aspects of the American diet, and this trend has not stopped. Yet, as an antidote to demon rum, the fountains of sugar at the ice cream parlor ("parlor" denotes respectability) or local drugstore became the morally correct culinary altar for Methodists, Baptists, and other dry denominations. It was in that blue law milieu that the ice cream sundae was born at Two Rivers, Michigan, in 1881. The sundae transformed plain ice cream into a rapture of chocolate syrup, chopped nuts, and candy tidbits known as nonpareils.

Ice Cream as a Part of Street Culture

Meanwhile, in cities where large communities of Italians settled, the hokey-pokey man became a fixture of popular street culture. He was an ice cream vendor and moving sandwich stand par excellence, with a small pushcart and a variety of Neapolitan flavors—Naples being the presumed origin of all the ice creamers in that line of work. The hokey-pokey man sold ice creams in paper cups and in paper cones so that customers could walk and eat at the same time. They also sold ice cream called penny licks. These were little glasses that contained a penny's worth of ice cream, a marketing gimmick aimed primarily at children. When the ice cream was eaten, the glass was given back to the vendor, who then washed it and refilled it for the next customer. The hokey-pokey man gave rise to a flavor of ice cream in cities like New York and London. In Philadelphia, his name attached itself to a hokey sandwich made with an antipasto salad of cold meats and lettuce now known as the hoagie.

The Ice-Cream Cone

The inventor of the ice-cream cone is not known, although claims abound. There is ample evidence that the concept existed in several forms long before the debut of the cone at the St. Louis World's Fair in 1904. The benefit of the cone was that the ice cream container could be eaten, yet if one is to accept the research of Brian Butko (2001), there was considerable resistance to the idea when it first attracted public attention. Hygiene was one reason, sticky fingers another. The public perception of ice cream was that it should be clean, like milk itself, a food that was both basic and culturally defining. The ice cream parlor and the drugstore soda fountain probably did more to help the ice cream cone gain acceptability in the long run, but it was the carefully wrapped ice cream snacks of the 1920s that eventually captured the market.

That ice cream should assume its hallowed place beside the drug counter during Prohibition may seem at first glance the most remarkable of fates, but it was the original idea that ice cream was both safe and healthy that allowed it to invade the domain of the local apothecary. Temperance instilled Americans with a love of drugs as a substitute for luxury: patent medicines were mostly alcohol, and the tempering qualities of ice cream were not known to cause a Fourth of July picnic to degenerate into debauchery. Perhaps this is one reason why American ice cream evolved into yet another branch of frozen snacks during the 1920s. Perhaps it was also due to a shift in lifestyles and altruistic spin-offs geared toward Hollywood and a need to provide movie theaters with frozen finger foods. Whatever the reason, one of the most important additions to the ice cream story arrived in the form of ice cream "novelties," to use a term then current.

Ice Cream Novelties

This included such portable snack foods as the ice-cream sandwich, the popsicle, and the Klondike, which is today the most popular of all ice cream products of this type. Most of these foods were born about the same time. Eskimo Pies were first marketed in 1921. Good Humor's ice cream "suckers" initially appeared in Youngstown, Ohio, in 1922. And in response to the success of Eskimo Pies, Isaly's of Pittsburgh created the Klondike, its polar bear logo curiously similar to the polar bear used by Marshall in her famous book of ices. Isaly's went on to become a household name in the Midwest, and their popular skyscraper cones left no doubt that even ice cream could assume phallic meanings.

Ice Cream in the Twenty-First Century

Ice cream has now come full circle. Most of it is extremely cheap and for this reason it has lost its sexiness. Low-fat dieticians have decried it as the frozen grease that clogs our veins. Ice cream has become for many the moral opposite of granola or a raw carrot. However, people gorge on ice cream that they feel is safer, which has not only lost its cream, but instead is made entirely of nondairy products, euphemisms for ingredients that never passed through a cow. It might be far more healthful to eat real ice cream in moderation and enjoy a long walk afterwards. This seems to be the rallying cry of the Slow Food Movement and other present-day culinary groups dedicated to revitalizing ice cream, and to restoring its flavor and cultural significance.

See also **Additives; Dairy Products; Icon Foods; Sherbet and Sorbet; Slow Food; Snacks.**

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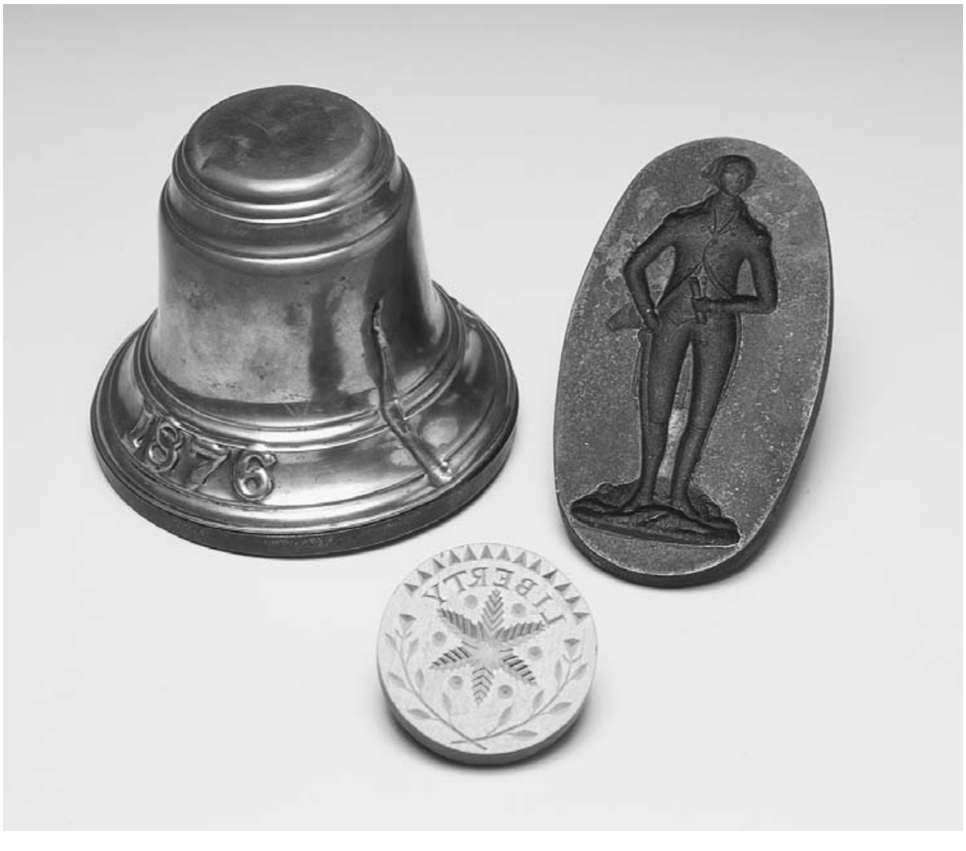
William Woys Weaver

ICON FOODS. The term "icon" was first used during the Middle Ages as a religious word suggesting images, figures, signs, or objects representing sacred elements. They were fabricated items meant to recreate or suggest something or someone consecrated or divine. Icons themselves are pictures, signs, or resemblances of seemingly more significant things or people. They are slightly different from symbols or indexes in that they have meanings of their own; however, they develop elaborate meanings when used in reference to something more significant. Icons, tangible signs of something larger, are displayed as pictures, objects, and even food, whereas indexes and symbols have meaning only in relationship to another object. It is through the icon that people gain access and learn about the object. Icons are signs that stand for or define something else (Parmentier, 1994; Peirce, 1931).

In the twenty-first century the term "icon" often implies an object representing something else, but even this definition has evolved. Within popular culture, icons are not necessarily just representative of something else but also may be something that receives an extraordinary amount of attention, praise, and idolization. "Iconic" can also mean formulaic or repetitive, as is seen in logos and other illustrative representations. And icons themselves change meanings over time.

The word "icon" today has largely lost its religious and spiritual attachment. Rather, icons are used in secular settings. Examples of icons are found throughout popular culture in movies, books, stories, clothing, music, celebrities, and food. Specific icon foods, when consumed or even just imagined, immediately suggest links to specific places, culturally bound groups, or communities.



Icon foods are always fair game for parody, and, conversely, many icons are also themes for food. The Eiffel Tower, Leaning Tower of Pisa, and the Statue of Liberty have often been reproduced in ice cream or candy. Here we have the Liberty Bell (1876 copper mold complete with faux crack) sold under the guise of walnut ice cream at the U. S. Centennial. To the right is a George Washington cast iron cookie print (for Washington's Birthday), which reappears as a patriotic motif on the preserve jar in "Preserves" (Volume 3, page 153), and a "Liberty" cookie mold for a New England Fourth of July picnic. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

They are used within a cultural context, exploring how specific foods mirror express groups of people, as opposed to the original religious meanings and connotations of the term "icon." Icon foods and their images also have different meanings for different groups of people, whether grouped by nationality, ethnicity, religious affiliation, or ideological beliefs.

Personal Identity, Group Identity, National Identity

Icon foods help define individual, group, and national identity. The difficulty here is determining whether inside members of a group deem the food iconic or outsiders consider it representative of the group.

Specific foods or food practices may serve as icons for individual people's beliefs or values, as seen in the example of vegetarianism. Corporate identity may also be defined by food icons, as in crediting producers on restaurant menus or the use of fast-food logos. Ethnic groups are often defined by specific foods, considered quintessential to their cultures. National, regional, racial, religious, and ethnic identities are often dictated by specific icon foods. Sometimes these foods are selected by the group itself, as with the state-created Israeli cuisine; southern American grits; Louisiana "crawfish"; Maryland blue crab; Maine lobster; Florida orange juice; Massachusetts cranberries; Vermont maple syrup; Texas chili; New York bagels; Alsatian *choucroute garnie;* French croissants, cassoulet, and ratatouille; Japanese sushi, Scottish haggis; German wursts; Austrian Sacher torte; and Antiguan pepper pot. Sometimes outsiders choose foods they judge iconic for groups they are not members of, often with negative references.

Iconic Food Logos and People

Throughout the world, but predominantly in the United States, food logos for famous food companies represent the whole of American culture and the values of capitalism and enterprise. Around the world America is synonymous with McDonald's. The commonly recognized McDonald's "golden arches" are a representation of modern corporate worship. Other large-scale food company logos are known worldwide also. It is not the foods themselves that suggest the country but in these cases the food businesses that symbolize entire nations. For example, Heineken, Fosters Lager, and Guinness Stout are all brands of beer, but each conjures up specific images of its home country and people, Holland, Australia, and Ireland, respectively. Similarly food clip art emphasizes the visual aspects of food over its taste. It is not the actual food but the image of the food or of the food company and what that image represents. For example, Ronald McDonald is an icon, but he is not a food, a restaurant, or even a person.

The famous Andy Warhol Campbell's soup artwork is an example of a pedestrian food product elevated to iconic proportions. The labels and branding of many other established and popular packaged food products, including Heinz ketchup, Tabasco sauce, Yoo-Hoo chocolate drink, and Oreo cookies, are iconic. In these examples, iconic seems to mean "has been that way for a long time." It is recognizable. People may also serve as food or culinary icons, symbolizing the highest levels of culinary prowess (Julia Child, George-Auguste Escoffier, and Marie Antoine Carême) or representing food values (Alice Waters) or food commercialism (Emeril Lagasse).

See also **Metaphor, Food as**; **Religion and Food**; **United States**.

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Jennifer Berg

IMMUNE SYSTEM REGULATION AND NUTRIENTS.

Chicken soup, herbal tea, and vitamin C pills take on special meaning in cold and flu season. But beyond their possible role in treatment and comfort, nutrients are essential and fundamental parts of immune system function. To understand nutrient-immune interactions, it is helpful to understand how the body's immune system functions in general.

The human immune system has evolved to the state where it cannot only maintain continual vigilance against new challenges, but can "learn" from past challenges and "remember" more efficient means of resolving those challenges if they are ever encountered again. The numerous cooperative mechanisms by which the immune system addresses (but does not "remember") novel challenges are collectively termed "innate immunity." These mechanisms include proteins that can bind to or neutralize a wide variety of foreign particles, and cells that can phagocitize foreign particles to remove them from the body. In the process of neutralizing and removing foreign particles, other cells within the immune system (mainly dendritic cells) transport samples of the foreign particles (antigens) to specialized tissues and organs (spleen, lymph nodes, Peyer's patches) where naive cells (T cells and B cells) not previously exposed to foreign particles can adapt their surface molecules (through gene recombination) in order to increase the efficiency with which later encounters with the foreign particle can be resolved. These adapted cells and associated specialized proteins (immunoglobulins—proteins that function as antibodies) provide immunological memory of past encounters and form what is termed "acquired immunity."

The body's ability to resolve infections can be likened to the running of a race. The infectious agent must elude detection by the immune system until it can proliferate and establish itself within the body. The earlier the body can detect this infection (by maintaining a critical concentration of innate immune system cells and proteins throughout the body) and the faster the body can produce new protective cells and proteins, the better the chance of winning the race. The key steps in this process—efficient communication and rapid biosynthesis—are constrained by the availability of raw material, and in the body, raw material means nutrients. In this light, well-established nutritional principles can also be regarded as immunological paradigms.

Biosynthesis: Building New Cells and Proteins

The immune system is continually producing a remarkable number of new cells and proteins to provide a broad repertoire of potential immune responses and maintain functional concentrations in the periphery. An average adult has nearly six pounds of bone marrow, which produces about one trillion white blood cells per day, accounting for 8 percent or more of the total protein synthesis in the body. About 60 percent of bone-marrow biosynthesis is devoted to producing neutrophils (innate immune system phagocytes), amounting to about 100 billion cells a day, which then survive only one to two days in circulation. Studies in laboratory rats indicate that in the acquired immune system, cell turnover is ten times higher in the thymus than in the liver. Of the millions of naive T cells and B cells produced in the thymus and bone marrow every day, only about 3 to 5 percent of T cells and 10 to 20 percent of B cells pass positive and negative selection steps to reach the periphery and enter the "race" that was described.

As for proteins, more than two-thirds of the IgA (an acquired immune system protein useful in protecting mucosal surfaces—eyes, mouth, etc.) produced by the body every day (more than three grams per day for a 155-pound person) is secreted onto the body's mucosal surfaces for short-term disposal. Immunoglobulins also account for a significant fraction of total blood protein (second only to albumin) and must be replenished continually at a rate of about six grams of immunoglobulins per day for a 155-pound person. Clearly, maintaining the immune system is a demanding process for the human body.

On the cellular level, upon activation, a lymphocyte doubles the amount of intracellular energy (ATP—that is, adenosine triphosphate) committed to protein synthesis (up to 20 percent of total cell energy use), while nucleotide synthesis begins consuming about 10 percent of the cell's energy. This ATP is ultimately derived from dietary macronutrients (protein, carbohydrate, or fat) through metabolic steps that require thiamin, riboflavin, biotin, pantothenic acid, and niacin. When ATP supply is limited, protein and nucleotide syntheses are the first cellular processes to suffer. The building of proteins and nucleotides from amino acids also requires folate, vitamin B_6, and vitamin B_{12} as the essential cofactors. Enzymes that build immunologically active proteins and cells also rely on diet-derived transitional metal atoms (iron, zinc, copper, etc.) for stability and to serve as functional centers. For example, ribonucleotide reductase is a rate-limiting enzyme in nucleotide synthesis, but the only way to maintain the loosely bound iron atom in its functional center is with adequate dietary iron intake. When deprived of multiple nutrients during malnutrition, these immunological processes are clearly compromised as exemplified by reduced thymus mass, lower IgA secretion, and poor proliferation of immune cells in vitro.

Signaling and Gene Regulation

The ability to expand or direct an immune response depends on communication between and within cells. In the innate immune system, various cells can produce signaling molecules (eicosanoids, chemokines, etc.) that attract phagocytes to the site of a challenge (inflammation) while alerting the rest of the immune system. In the acquired immune system, the adaptation of immune cells can be directed toward more efficacious products by signals between cells (cytokines, receptor interaction, etc.) and inside of cells (intracellular signaling molecules, nuclear binding factors, etc.).

Perhaps the clearest relationship between essential nutrients and immune system signaling is the transformation of dietary essential fatty acids into eicosanoids. Certain kinds of fat, which synthesize polyunsaturated fatty acids, are essential to life. These fatty acids are classified as omega-3 or omega-6 fatty acids based on their chemical structure. These fatty acids are used by the body to manufacture eicosanoids (prostaglandins, thromboxanes, and leukotrienes) that regulate inflammation and other body functions. At a molecular level, the distinction between dietary intake of omega-3 versus omega-6 fats is functionally important since eicosanoids derived from omega-3 fats do not produce as much inflammation as omega-6 fats.

An area of immunological research that has rapidly expanded in recent years is the discovery and characterization of proteins that carry signals between the cell surface and nucleus as well as where these proteins bind within various genes. Both vitamin A and vitamin D regulate gene expression by binding to specific gene sequences including, for example, the genes that regulate production of the antiviral protein interferon-gamma. A deficiency of either of these vitamins can impair immune function. Pharmacological doses of vitamin D have been investigated for their therapeutic potential in autoimmune disorders.

Immune system cells also initiate intracellular signals in response to oxidation. Oxidative stress induces expression of intracellular proteins (AP-1 and NF-kB), which leads to increased production of pro-inflammatory signaling molecules (such as cytokines and chemokines) and their receptors. Vitamin E, vitamin C, and other antioxidants can reduce NF-kB expression, which may contribute to their wide variety of effects on the immune system. Intracellular oxidation state also may alter acquired immune responses, but further research is needed to determine if dietary antioxidants can modify oxidation-sensitive genes and proteins.

Life-Cycle Stages

Different stages of the life cycle have unique nutritional demands and are characterized by unique immunological functionality. Both young children and the elderly have clear age-related immune function deficiencies. In addition, many children in the United States do not meet their daily requirements for several immunologically relevant nutrients, including vitamin E, iron, zinc, and vitamin B_6. The elderly may also have difficulty meeting their requirements for vitamin B_{12}, zinc, vitamin E, iron, vitamin D, and vitamin B_6 as a result of physiological changes due to aging or to inadequate dietary intakes. Pregnant and lactating women are remarkable because they produce acquired immune system products for the sole apparent purpose of export to the infant. Likewise, pregnant and lactating women frequently do not meet their nutritional demands for folate, vitamin B_6, iron, and zinc. Few studies have examined the interaction between nutrients and life-cycle–dependent immune outcomes in otherwise healthy people, but the available data indicate that these interactions have immunological impact—for example, vitamin E among the elderly and iron among postpartum women. Given the susceptibility of these populations to infectious disease, a better understanding of nutrient-immune life-cycle interactions is needed to promote optimal immune status through adequate nutrition.

Nonnutritive Food Components and the Immune Response

For immunologists, developing more efficacious vaccines and certain anticancer agents is a process of improving immune system performance. As nutritional paradigms have shifted from preventing deficiency to promoting optimal health, nutrition scientists have also sought to improve immune system performance. Many in vivo studies have examined more or less purified food components like phytochemicals (polyphenols), herbs, and carotenoids. Such studies frequently use classic immunological tests—cell proliferation, blood lymphocyte counts, skin hypersensitivity responses, etc.—but the results of these tests should be interpreted with caution. For example, a food component that increases cell proliferation may be beneficial if it is the protective cells that proliferate more readily. Conversely, increased cell proliferation would be harmful if autoreactive T-cell or B-cell clones were expanded or inflammatory responses were boosted inappropriately. Although these measures are useful for preliminary identification of nutrient-immune interactions, additional studies using efficacy-related immune measures (infectious disease risk, vaccine titers, etc.) are needed before such phenomena can be termed beneficial.

Summary

To maintain immunological competence, the immune system must quickly alert the body to foreign challenges and rapidly manufacture the cells and proteins needed to stop exponentially dividing infectious organisms. It is apparent that some essential nutrients are signaling molecules. Others can be rate-limiting factors in cell division and protein synthesis. The brevity of this review has prohibited the exploration of many other important nutritional immunology topics: nutrient interactions with infectious agents, treatment of autoimmune disorders, cancer biology, and metabolic functions of nutrients unrelated to biosynthesis or signal transduction. Clearly, the most venerable nutritional paradigms of growth and development are important for shaping the magnitude and character of immune responses.

See also **Fats**; **Gene Expression, Nutrient Regulation of**; **Iron**; **Nutrients**; **Vitamins: Overview**; **Vitamins: Water-Soluble and Fat-Soluble Vitamins**.

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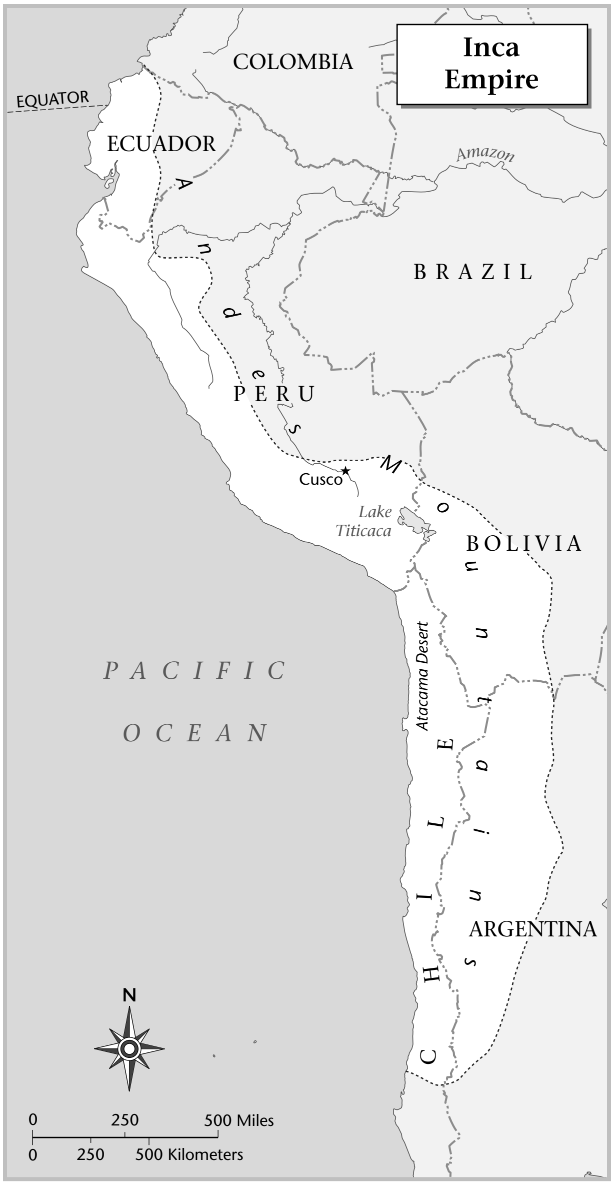
J. Paul Zimmer

INCA EMPIRE. The imperial Inca state was built upon thousands of years of cultural history and diverse elaborate statecraft of the Andean region of western South America, beginning in the thirteenth century C.E. Though the empire was short-lived (it was conquered by Spain in the sixteenth century), the Inca of the Cuzco valley brought together hundreds of groups, including speakers of many mutually exclusive languages from the dry western South American coasts to the verdant Amazonian foothills, from warm and moist valleys of modern Columbia to the dry Atacama Desert of Chile and the dry mountains of northwestern Argentina. They conquered this territory in less than sixty years. Among their many tools for statecraft were food production, storage, and feasting. When they conquered they divided the lands for the state, for the sun (the focus of their religion), and for local use. In this way the conquered people had to work all of the land, though most of the produce was for the Inca rulers; produce was taken to and stored in highly regularized storage buildings called *qolqa* placed at administrative centers (*tambo*) throughout the empire. Food had great cultural value and carried the histories of the consumers in every meal. The recipe and type of plant variety used identified a person's background, much as clothing did. The Inca encouraged these differences, to keep account of the groups that they codified in a hierarchical record-keeping organization, with the local leaders reporting to Inca administrators.

All social events were marked with food and gift exchanges. These feasting activities occurred at the conquest of new peoples, but also at the renewal of group allegiances and all religious ceremonies. John Rowe notes that the value of crops was so great that at the start of planting season, between September and November, when the rains began, the Sapa Inca (king) himself would join the religious assembly to make the first hole in the ground for maize (corn) planting in a sacred field of the religious authorities. While men had to make the holes in the ground, women had to place the seed in the earth. Singing accompanied this activity, recounting major military victories. After this planting was begun, beer was provided to all workers. The crops were tended throughout the rainy season, to keep animals from eating them, until harvest, which began around May when the rains tapered off. In the highlands, harvest was accompanied by large cooked meals, primarily of potatoes, in the fields, to repay helpers.

When the Inca arrived on the borders of a group they wanted to conquer, they would send emissaries ahead to ask if the group wanted to join the Inca state or would rather fight. If the group chose to join and not fight, a date would be set for a ceremony. On that date, the Inca military leaders would arrive in the territory bearing gifts of fine clothing, elaborate imperial ceramics, and jewelry, for the new local leaders to take on the emblems of the Inca state. If the local leaders accepted these gifts and their takeover, there would be a feast of beer and meat. These events focused on specific dishes, ceramics, and cuisine. Tamara Bray reports that there were three highly standardized receptacles to present food at these state occasions; a jar or *arybaloid*, a plate, and a cup or *keru*. The jar was to serve liquid, always a fermented beer called *chicha* in Quechua, the Inca language. This vessel shape is the oldest ceramic shape in the Andes. This beverage could be made out of many plant items, the strongest being the fruit from a leguminous tree of the warm valleys and coasts, *Schinus molle*, called *molle*. *Chicha* could also be made from quinoa (*Chenopodium quinoa*), an annual grain that grows in the high mountains, but the most common and of highest value was *chicha* from maize (*Zea mays*). (In fact, it is clear that the Inca made maize the state crop and focused much of their conquests on the warmer intermontane valleys



Ancient terraced fields at Mora, Peru. By terracing fields into the sides of steep mountains, the Inca were able to increase their food production many times over. © CHRIS RAINIER/CORBIS.

and coasts.) This beer would be consumed in highly decorated tumbler-shaped cups made of ceramic or wood. This vessel probably became an important item used in ritual consumption in the earlier Middle Horizon states. The plate was an innovation for dry food presentation in the Andes. This would be how the dried camelid meat (*charqui*), boiled potatoes (*papa)*, or toasted corn kernels (*kamcha*) would have been presented. Outside of the imperial Inca feasts such dried foods would have been presented on nicely woven cloth, as is still done in the countryside in the early twenty-first century. The Inca controlled hunting of large game, primarily two kinds of deer (*loyco* and *taroka*) and guanaco, for their pleasure, making these species a less common foodstuff than in earlier times.

Most of the populace typically ate something quite different. There were two main meals a day. The first was a thick soup eaten out of bowls in the midmorning after early tending of herds. It was made of potatoes, quinoa, or maize in the highlands, depending on the elevation of the farmer, and of lima beans or maize on the coast. The highland evening meal at dusk was consumed after a day in the fields and usually was solid food consisting of beans or boiled potatoes with a spicy sauce of chili peppers and wild herbs, eaten out of a common cooking jar with wooden spoons or on woven cloth. Meat was sometimes included, but it was usually only reserved for feast days. This would often be llamas or alpacas (camelids) in the higher areas, or guinea pigs (*cuyes*), and less often wild ducks, rabbits, and other small animals caught in the fields. Along the coast, fish, shellfish, and also seaweed would have been a common soup base as well as an addition to the evening meal, again spiced with chili peppers and wild herbs.

See also **Beer: From Late Egyptian Times to the Nineteenth Century**; **Central America**; **Maize**; **Mexico**; **Mexico and Central America, Pre-Columbian**; **South America**.

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Christine A. Hastorf

INDIA.

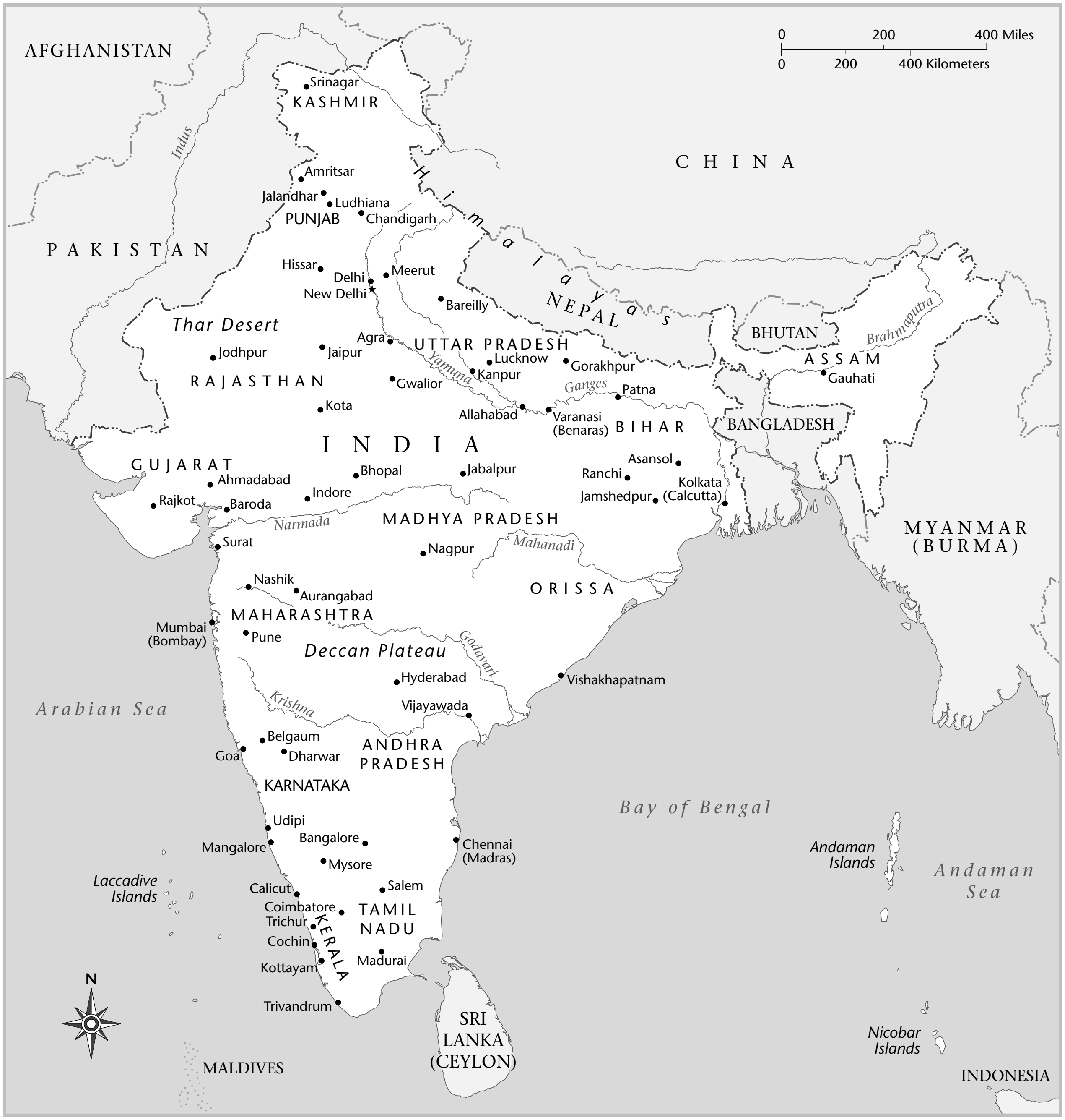
This entry contains three subentries:
Moghul India
Northern India
Southern India

MOGHUL INDIA

Indian cuisine reached its zenith in the royal kitchens of the kings, nawabs, and maharajas —the one-time rulers of India's princely states who patronized art and culture, and enjoyed a lavish lifestyle. Among the varied cuisines that were native to India or borrowed from other world cultures and amalgamated within the Indian milieu, the one that stands at the forefront is "Moghlai cuisine," named for the era of the Grand Moghuls during which time it developed and became immensely popular. So rich and grand was this cuisine that it left a lasting impact on and influenced other equally grand cuisines—the Awadhi cuisine of Lucknow and of the Rampur royal family in North India and the Hyderabadi cuisine within the state of Nizam in the Deccan region.

In spite of multiple invasions—by the Aryans in 200 B.C.E., the Greeks led by Alexander the Great in 326 B.C.E., the Moghuls in the sixteenth century, the British in the eighteenth and nineteenth centuries, and the more limited incursions of the Mongols, Huns, Arabs, Turks, Afghans, Portuguese, and Dutch in between—India still managed to establish and maintain its own unique cuisine, with that of the Moghuls being a major influence.

Muslim incursions into India began as early as 712 C.E. However, their presence only began to be felt around 1000 C.E., starting with the raids of Mahmud Ghaznavi. The first Muslim kingdom was declared in India in the twelfth century with the establishment of the "Delhi sultanate," although it was not until 1526 that Babur the Mughal, a descendant of Tamerlane and Genghis Khan, successfully invaded the Punjab and proclaimed himself emperor of India. Humayun, Akbar, Je-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Delhi
Meerut
New Delhi
Bareilly
NEPAL
Thar Desert
Agra
UTTAR PRADESH
BHUTAN
Brahmaputra
Jodhpur
Jaipur
Lucknow
Gorakhpur
ASSAM
Yamuna
Kanpur
Gauhati
RAJASTHAN
Gwalior
Ganges
Patna
Kota
Allahabad
Varanasi (Benaras)
BIHAR
BANGLADESH
INDIA
Asansol
GUJARAT
Bhopal
Jabalpur
Ranchi
Ahmadabad
Kolkata (Calcutta)
Indore
Jamshedpur
Rajkot
Baroda
Narmada
MADHYA PRADESH
MYANMAR (BURMA)
Surat
Mahanadi
Nagpur
Nashik
Aurangabad
ORISSA
MAHARASHTRA
Mumbai (Bombay)
Pune
Godavari
Deccan Plateau
Hyderabad
Vishakhapatnam
Arabian Sea
Krishna
Vijayawada
Belgaum
ANDHRA PRADESH
Goa
Dharwar
KARNATAKA
Bay of Bengal
Udipi
Bangalore
Chennai (Madras)
Mangalore
Andaman Islands
Mysore
Andaman Sea
Laccadive Islands
Calicut
Salem
Coimbatore
TAMIL NADU
Trichur
KERALA
Cochin
Madurai
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SRI LANKA (CEYLON)
Nicobar Islands
MALDIVES
INDONESIA

hangir, Shah Jehan, and Aurangzeb, with whose death in 1707 C.E. the empire effectively came to a close, followed Babur as emperor.

During Babur's rule, a Moghul era with unparelleled power flourished. Architectural projects involving the construction of great cities, palaces, mosques, and monuments were executed in North India. This time period also marked the genesis of a "cuisine" later designated as Moghuls' cuisine in India. While cherishing their cuisine, Babur and his successors, soon titled Grand Moghuls, inadvertently enhanced many facets of Indian life. They introduced a unique grandeur and style to an otherwise austere Indian hospitality.

Moghul cuisine is classified as the richest and most lavish cuisine of North India. It revolves around lamb preparations for which it is famous. Prepared with cream, luscious fruits, and almonds, and served with rich *pulaos* (preparations of rice), the gamut of lamb preparations can be described in one sentence: "A really superb North Indian cook can produce a different lamb dish for every day of the year." History, tradition, and religion have encouraged North Indian cooks to experiment with lamb dishes. Because of their Muslim backgrounds, Moghul kitchens could not use pork. The use of beef was also actively discouraged in a predominantly Hindu country. And, neither geography nor habit permitted the ready inclusion of fish or seafood in the diet. Although Moghlai cuisine came to include some excellent chicken dishes, they never compared in quality or scope with the supreme Moghlai culinary achievement, the inspired cooking of lamb. It was mandatory that the animal be slaughtered by cutting the jugular vein with a sharpened knife and while uttering the name of Allah. The meat produced from this type of slaughter, that is, by bleeding the animal to death, was called *halal* meat.

To the somewhat austere Hindu dining ambience, the Muslims brought a refined and courtly etiquette of both group and individual dining, and of sharing food and fellowship. Food items indigenous to India were enriched with nuts, raisins, spices, and ghee (clarified butter). These included meat and rice dishes (*pulaos*), dressed meats (kebabs), stuffed items (*samosas*), desserts (*halwa* and stewed fruit), and sweetened drinks (*falooda* and sherbet). New dishes enriched the cuisine of the land, like those made of wheat finely ground with meat (*halim* and *harisa*), the frozen *kulfi*, a rich ice cream of milk solids, or the *jalebi* (a sweet made from gram flour, which is deep-fried and sweetened in sugar syrup). The Muslims influenced both the style and substance of Indian food.

Moghlai cuisine consists generally of *sharbat i labgir* (a very sweet sherbet), *naan e tanuk* (light bread), *naan e tanuri* (chapatis cooked in tandoors), *samosas* (whole wheat pastry stuffed with meat, onion, etc.), mutton, the flesh of birds such as quail and sparrow, *halwa*, and *sabuni sakar* (a mixture of almonds, honey, and sesame oil). Wine was also customarily served. After the meal, it was customary to serve betel leaf to refresh the palate and to aid digestion.

Vast table settings and spreads were commonplace. However, most eating was done by hand, although spoons and knives were used for serving and carving. The hospitality of the elite Moghuls was legendary. It was often the case that a nobleman's entire staff would be fed their main midday meal at his home. This would comprise *naan* (bread baked in a tandoor), goat meat, chicken *biryani*, a cup of wine, sherbet, and betel leaf. Frequently, the nobles ate their meals together and the unconsumed food would be distributed to beggars.

During the reign of Akbar, there were three classes of cooked dishes. The first, called *safiyana*, was consumed on Akbar's days of abstinence. No meat was eaten on these days, and the dishes were either rice- or wheat-based. The rice-based dishes included *zard birinj* (saffron rice), *khuska* (boiled rice), *khichri* (a dry preparation of rice and lentils cooked together), and *sheer birinj* (rice cooked with milk and sweetened). The wheat-based dishes included *chichi* (essentially the gluten of wheat isolated by washing and then seasoned). Also included in the meal were lentils, *palak saag* (spinach), *halwa* (a generic name for a dessert made by cooking one ingredient like carrots with milk solids and clarified butter, and then sweetening it with sugar), and sherbets. Both meat and rice cooked together, or meat and wheat prepared together, constituted the next set of dishes. Those with rice included *pulaos*, *biryanis*, *shulla* (a spicy mix of rice, lentils, and meat), and *shurba* (a thick soup). Those with wheat included *halim* and *harisa* (both are made by pounding wheat and meat together with spices), and *kashk* and *qutab* (both prepared with meat and wheat with different spices). The third class of cooked dishes were those in which meat was cooked with *ghee* (clarified butter), spices, curd, eggs, and so forth, to yield dishes such as *yakhni* (a mutton preparation), kebabs, *dopiyaza* (literally, "twice onions," once at the start of cooking in ground form and then later sliced and fried), *mussaman* (a mélange of minced meat, onions, herbs, and spices used as a stuffing), *dumpukh* (meat or vegetable dry-cooked in a heavy-bottomed, tightly sealed pan on a slow fire), *qaliya* (a meat dish cooked with a vegetable, in which the gravy is thick and saucelike), and *malghuba* (a spicy meat dish).

Variations of bread served were either thick, made from wheat flour and baked in an oven, or thin, made from unleavened dough and baked on iron plates using a dough of either wheat or *khushka* (boiled rice). The Persian Muslims preferred leavened bread baked in an underground oven. The *paratha* (whole wheat bread, layered with fat and baked on a griddle) was an adaptation of the deep-fried *pooris* (whole wheat dough, rolled out and deep-fried). The more affluent Muslims ate *baqar khani* (leavened bread enriched with clarified butter), whereas *shirmal* (a sweet baked bun-type bread) was even more upscale than *baqar khani*.

Raw materials came from various places: rice from Bharaij, Gwalior, Rajori, and Nimlah; *ghee* from Hissar; ducks, water fowl, and certain vegetables from Kashmir; and fruits from across the northwestern borders as well as from all over the country. Babur's personal fascination with Indian fruits was evident in his description of them, his names for the fruits sometimes making a technical comment on their variety: the citrus phylum-orange, lime, citron, *santhra* and *galgal* (both are species of orange), *jambiri lime* (rough lemon), *amritphal* (perhaps the mandarin orange), and *amal bid* (a citrus fruit).

A favorite breakfast for common Muslims was *naan* accompanied by *kheema* (minced meat) or kebabs. Rice and onions, and rice-based desserts, such as *phirni* (rice flour cooked with milk and sweetened), *sheer birinj* (rice and milk cooked together and then sweetened) blended with milk and sugar, *halwas*, and dried fruits were other delicacies. The Muslims also adopted the Hindu habit of chewing betel leaves stuffed with areca nuts and spices after a meal.

Eminent citizens who lived in grandeur relished serving opulent preparations, which could number as many as fifty types at a time. Most of the preparations served were those inspired by the Persians and Iranians, and included such dishes as *khormas* (meat, chicken, or fish with a sauce of creamy consistency), kebabs, *rotis* (unleavened bread), and *pulaos.* The marriage of the Persian Princess Noor Jehan to Indian Prince Jehangir also contributed to the import of many delicacies to India and this had its own profound effect on Moghul cuisine.

The art of retaining the rudimentary character of a food preparation while incorporating multiple seasonings was mastered by Indian chefs. A classic illustration is the preparation of Moghlai *biryani*. This dish is also a model for the fusion characteristic of cooking from a bygone era. Two odd or incompatible ingredients—rice and lamb—were not only marinated, but also married with spices, curds, saffron, an aromatic mixture of spices, and garnished with *varq* (silver leaves).

Although there is room for modification or different styles in *biryani*, its basic formula is as steadfast as that of another speciality, kebabs. Through the multiple processing of lamb, which was minced, steamed, skewered, broiled, cubed, or sliced, Moghul chefs demonstrated great dexterity in the preparation of this dish. The two most popular dishes in the kebab family were *shammi* kebab (a combination of minced lamb, nuts, and chickpeas, stuffed with chopped onions and green chilies) and *nargisi* kebab (a hard-boiled egg covered with a preparation of minced lamb, onions, spices, and herbs, and then deep-fried).

Chefs were trained to present their food as impressively as possible. Some even went as far as preparing *khichri* (a rice and lentil preparation) with almonds and pistachio nuts, which were cut to resemble grains of rice and lentils. This was all done for visual effect. Colors also played a major role in food presentation. Various permutations and combinations were used to make the appearance of the dish as attractive as the taste.

The Moghuls introduced rich, milk-based sweets in India. Tiny bits of bread coated with sugar and ghee were prepared for the ceremonies of *Fatiha* (prayers offered to one's ancestors) and *Niyaz* (prayers offered to the Prophet). *Malida* (a sweet made with broken bread, sugar, and ghee, although the bread is often replaced with semolina) was another sweet dish. Gradually, milk, which had been thickened by boiling it down, replaced flour in the preparation of sweets. The Moghuls were also fond of candies and conserves. During their reign, *murabbas* (sweetened preserves) and *achars* (pickles) were developed and commonly used. *Halwa*, a sweet item, would be made with a variety of ingredients, from which it would take its name. For instance, if made from carrots, it would be called "carrot" *halwa*, if made from lentils, it would be called "lentil" *halwa*, and so on. *Halwa* is said to be of Arab origin. The most popular *halwa*s with the Muslims were *sohan* (a sticky wheat confection), *papri* (a crispy sweet confection made with wheat and sugar), *habshi* (made with wheat, reduced milk, and sugar), and *dudhia* (made with bottle gourd, reduced milk, and sugar). *Barfi* (a dry, white, soft sweet like a milk cake) originated in Persia (*baraf* means snow in the Persian language). *Balu shahi* (a sweet, glazed wheat patty), *khurme* (a date-shaped sweet), *nuktiyan* (a sweet dish made of wheat and sugar shaped as small beads), *gulab jamun* (croquettes made of milk solids, deep-fried until golden brown, and then soaked in sugar syrup), and *dar behisht* (a sweet dish of rice flour and thickened milk) were all developed during this era. *Jalebis* originated in Arabia, where they are called *zalabia* (a gram flour batter, piped out in circles in hot oil, deep-fried until crisp, and then soaked in sugar syrup).

Food that was served at feasts at home or transported to another setting was called *tora*. This comprised a *pulao* (a rice-based dish); *muzafar* (a sweet, rich rice dish flavored with saffron); *mutanjan* (meat, sugar, and rice with spices); *shirmal* (a sweet baked bun-type bread)*; safaida* (a simple sweet rice dish); fried aubergine; *shir birinj* (a rich sweet rice dish boiled in milk); *qaurma* (a meat curry)*; arvi* (a fried vegetable with meat); *shammi kababs* (croquettes of meat and lentils); and *murabba* (sweetened preserves), *achar*, pickles, and chutney.

Regional environments influenced dietary rituals in India. Meat or any type of flesh is forbidden after a funeral. No food is cooked in the house of mourning for forty days after the death. Women who are seven months pregnant receive vegetables, dried fruit, and cake on their laps. After an engagement ceremony, dates and sugar are distributed to the family of the groom-to-be. At the wedding, the bride and her kinswomen eat from the same plate, a practice that would be unthinkable in the Hindu world. Islamic festivals such as *Bakrid*, *Id*, and *Moharram* are celebrated all over India. The foods consumed by the community have a strong Islamic influence. *Maleeda* (broken bread, sugar, and ghee) is a common ritual offering.

The Moghul emperors relished the practice of eating *paan* (betel leaf). Two betel leaves formed one *bira*: One leaf was stuffed with *supari* (betel nut) and *kattha* (*Acacia catechu*, heartwood extract), and the other leaf would have *chuna* (lime). Sometimes, the betel leaves contained *kapur* (camphor) and musk. When chewed, this sweetened the breath and reddened the lips. *Paan*s were bestowed as a mark of royal favor on courtiers. By the end of the seventeenth century, a *paandaan* (a container for betel leaves and other ingredients) was given as a royal present to ambassadors and nobles.

The Moghul emperors favored water from the Ganges River. People with the highest integrity oversaw the transportation and distribution of water, from the source to its points of consumption. The water was tasted before consumption as a precautionary measure against poisoning. The use of wine was neither prescribed nor forbidden in the Mughal fraternity.

Devout Muslims celebrate three main festivals, each of which is replete with its own food requirements:

- *Ramadan* is observed as a time of fasting and austerity. During this period, Muslims fast from sunrise to sunset, breaking their fast only with the setting sun. The month culminates in the festival of *'Id al-fitr*, where alms are distributed. Traditionally, *sheer qurma* (a sweet dish of milk, vermicelli, nuts, and dried fruits) is made on this day and offered to family and guests. *Haleem* and *harees*a are other dishes that are commonly eaten at this celebration as they are very nutritious.
- *Id uz zuha*, or *Bakrid*, commemorates the sacrifice of Ishak by prophet Ibrahim in the name of God. However, God instructs Ibrahim to sacrifice a ram instead. On this day, Muslims sacrifice lambs, goats, rams, and cows and feast on ritual *pulaos*, *biryanis*, curries, and roasts. These are then sent to family and friends not in attendance.
- *Muharram* is observed in honor of the saint Hussain, who fell in battle against Yazid, the tyrant ruler of Arabia. Meat is strictly avoided on this day. *Khubooli* (a simple austere dish of rice and chickpea lentils), yogurt and rice, and *zarda* (a sweet dish made with rice) are prepared and offered in prayers.

See also **Asia, Central**; **Hindu Festivals**; **Hinduism**; **Islam**; **Middle East**; **Ramadan**; **Religion and Food**; **Zoroastrianism**.

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Thangam Philip

NORTHERN INDIA

India is a vast country. Its geography and climate vary tremendously, from the landlocked mountains and the fertile Indo Gangetic plains in the North, to the arid Deccan plateau and the coastal regions of the South. It is these differences that have given India a rich and varied tradition of food.

India is made up of people from several faiths, and the gulfs between them are substantial, including dietary customs and prohibitions. Thus, the Hindus and Sikhs will not eat beef; the orthodox Hindus and Jains avoid onion and garlic, considered "passion-inducing"; the Parsis, who came to India in the seventh century from Persia, gave up eating beef as a gesture of thanks to the Hindu ruler who gave them asylum; and the Muslims and Jews abstain from pork but relish beef, the meat of sheep, and chicken.

Although India is associated strongly with the concept of vegetarianism, which came into being with the advent of the faiths of Buddhism and Jainism in the sixth century B.C.E., the majority of people in India are, however, nonvegetarian. In Punjab, chicken, lamb, and goat meat are relished, and in Kashmir, the Kashmiri pundits are known for their love of meat and famous *wazwan*s (feasts), where up to thirty nonvegetarian courses may be served. Nonetheless, in most Indian families where meat is consumed, this occurs no more than one day a week, usually on a Sunday afternoon. For many other families, meat is consumed only three or four times a year, usually at weddings. In many middle-class families in the North, it is common to find women who do not partake of meat, fish, or eggs, while the men in the family do. The consumption of meat in these areas is sometimes associated with masculinity.

Outside Influences

India is a melting pot of people of all religions and races, its diversity resulting from countless invasions and migrations, including those of Alexander the Great (356–323 B.C.E.). Invaders came in search of wealth and soon discovered India's spices.

The food of North India was greatly influenced by the Persians, who entered India in the eleventh century. From the thirteenth to sixteenth centuries, Mongolian conquerors brought with them Afghan and Persian cuisine, the rich and fragrant foods of their regions. This marked the start of luxurious eating. Pilafs and *biryanis* (meat-based pilafs), garnishes of *varak* (sheets of pounded silver), spicy *kormas* (braised meat in creamy sauces), *koftas* (grilled, spicy meatballs), and *kababs* graced the tables of the emperors and intermingled Hindu and Muslim cuisines: the meat dishes of the Middle East combined with the spicy gravies that were indigenous to India. And, Muslim *naans* (bread cooked in a tandoor) and *chapatis* (bread cooked on a griddle) were consumed side by side with the more traditional *pooris* (bread made from whole wheat flour and fried in oil) and *bhathuras* (bread made from white flour and yeast and then deep-fried in oil). The idea of ending a meal with a confection also originated in the Middle East. Most of these were made of almonds, rice, wheat flour, or coconut, sweetened with sugar, and scented with rose water.

More recently, Indian cuisine has been influenced by the British, particularly in certain sections of society, such as the army and among educated, urban professionals. They institutionalized the use of white bread, as well as sandwiches, toast, and tea drinking.

Sushruta Samhita

The *Sushruta Samhita* is an ancient Ayurvedic text, dating back to 600 B.C.E. This traditional healing practice originated almost five thousand years ago, and its theory influenced Greek and Chinese medicine. According to Ayurvedic theory, the human body is made up of five elements: air *(vayu*), water (*jala*), fire (*agni*), earth (*prithvi*), and space (*akash*). These combine to form the constitution of the body. Any imbalance in this constitution produces disease, and Ayurveda aims to correct such imbalances by the use of suitable counter-substances.

Food plays an important role in countering the imbalances. There are six basic tastes, which are made up of two elements each: sweet (earth and water), sour (fire and earth), salty (fire and water), bitter (space and air), and astringent (earth and air).

As these elements also form the constitution of the body, the choice of food should be such that it reduces the predominant elements within the body, so that a balance exists between them. When the elements are in equilibrium, one will enjoy good health. However, what may be beneficial for one person might not suit another. Diets therefore vary from person to person, depending on age, sex, climate, and other variables.

The *Sushruta Samhita* suggests that foods be varied in taste according to the season: spring (pungent), summer (sweet and cold), monsoons (salty and sour), autumn (sweet), and winter (pungent and oily). The use of correct foods in different seasons will presumably prevent the onset of disease.

Seasonality of Cuisines

The well-defined seasons of India bring with them a series of particular fruits and vegetables. Thus, menus and diets vary considerably year round—from lush berries in the early days of summer to ripe watermelons available during the later hot weeks of the same season. Certain seasons are associated with specific foods, according to the *Sushruta Samhita*, an ancient medical text, written around 600 B.C.E. It recommends pungent foods in spring, sweet and cold in summer, salty and sour during the rains, sweet in autumn, and greasy and hot in winter.

In Kashmir, where the winters are cold, the staple diet of meat, fish, and rice is supplemented with vegetables that have been sun-dried during the summer months. Seasonality also extends to herbs and spices. During the cold months of winter, "heat-generating" spices like cinnamon, cardamom, cloves, black pepper, and chilies are used in cooking to keep the body warm. Mace is considered taboo in summer, whereas poppy seeds are regarded as cooling during the summer months.

Foods of the Northern Region: Kashmir, Punjab, Uttar Pradeshi, and Rajasthan

Traditionally, Indian food is served as a complete meal in one course. It is composed of several vegetables, a *dal* (a purée of lentils), and a central starch, which is the main source of calories. Yogurt, relishes, and chutneys are served on the side. In the North, the starch is unleavened bread, such as *chapati* (a flat griddle bread). People in the North tend to eat more wheat and maize, which are easily available and made into bread.

Pulses high in protein, carbohydrates, and fiber have always played an important part in the diet of Indians. For vegetarians, pulses provide essential proteins.

The most commonly eaten meats are chicken, mutton, and fish. A rice-based sweet usually signifies the end of a meal. Savory and sweet snacks are very popular, but do not correspond to specific meals or dishes. Northern India has a great tradition of "snacking."

Alcohol is not consumed along with food, but iced water or *lassi* (a yogurt-based drink) usually accompanies the meal. Aperitifs like *kanji* (made from fermented carrots and mustard seeds), *aam panna* (raw mango juice), *jaljeera* (made from tamarind juice and cumin seeds), and *nimbupani* (fresh lime juice) are the favored drinks in the North.

North Indians place great emphasis on the use of milk and milk products in their cuisine. This is particularly true of the Punjabis, who use a great deal of ghee

Snacking in India

Indians love to snack and have a penchant for light, spicy foods. This has given rise to a whole new cuisine called *chaats,* a generic name for several salty snacks that originated in Delhi. They leave a spicy, lingering taste in the mouth and are usually eaten during mid-morning or at teatime.

Chaats come in a wide variety of savory tidbits, spiced mainly with *ajwain* (bishop's weed). They are consumed with two chutneys: the fresh and tangy mint chutney and a tamarind-based chutney called *sonth.* Most chutney preparations are vegetarian and have potatoes and/or lentils as the base. Almost all have some fried components. *Chaat* tends to be bought rather than made at home, and is eaten at roadside stalls, where it is served in bowls made out of leaves.

The Tandoor and Tandoori Cuisine

Tandoors are clay ovens that are air-dried, embedded in sand or earth, and fired with either wood or charcoal at the bottom. The heat generated is distributed up the sides of the oven. The average temperature within a tandoor ranges between 1,112 to 1,472°F (600 to 800°C). Some tandoors can withstand extreme heat, up to 2,552°F (1,400°C).

Tandoors are most commonly used in Punjab. It is a versatile piece of equipment and can be used to cook meats, kebabs, breads, and *dal* (lentil purée) with equal ease. Over recent years, there have been variations in the types of tandoors available: from gas-operated models to electric ones. However, in the final analysis, the flavor from the original charcoal-fired tandoor is unsurpassable. Tradition holds that a tandoor in regular use improves the flavor of anything cooked in it, because the heated clay releases a mellow fragrance that permeates the food. In the case of meats, the final taste is a result of the smoke that emanates from the marinade which has dripped on the hot charcoal.

Tandoors are used to cook a variety of meats and breads. The prerequisite for cooking meats in the tandoor is that they must be marinated. The popularity enjoyed by Indian cuisine around the world can be attributed, in large measure, to the tandoor, because it uses very little oil or fat for cooking and the foods thus cooked are moderately spiced.

Prior to use, the tandoor has to be seasoned. This is done by rubbing the inside walls of the tandoor with a paste of spinach or any other green, leafy vegetable. After this has dried, a mixture of mustard oil, buttermilk, jaggery, and salt is applied over the paste. The tandoor is then heated by lighting a small fire at the base, so that the temperature rises gradually. If the temperature rises too fast, the internal walls will crack and it will not be possible to control the temperature. Once heated, the mixture will peel off, and it has to be reapplied three or four times to properly season the tandoor. Finally, the inside walls need to be sprinkled with brine and allowed to dry.

(clarified butter), white butter, *paneer* (homemade cottage cheese), and cream in their cooking. For those who cannot afford or tolerate ghee, the preferred oils are mustard and peanut.

Tandoori cuisine has its origins in the northwest frontier province, now in Pakistan. The cuisine gets its name from the tandoor (the oven in which the food is prepared) and has contributed to the growing popularization of Punjabi cuisine throughout the world. In many cases, tandoori cuisine is synonymous with Indian cuisine.

Northern Indian Cuisine by State

Kashmir. Kashmiri cuisine is a unique blend of Indian, Iranian, and Afghani cuisines. It is essentially meat-based and centered on a main course of rice. Unlike the Brahmins in other parts of the country, the Kashmiri Brahmins are nonvegetarian.

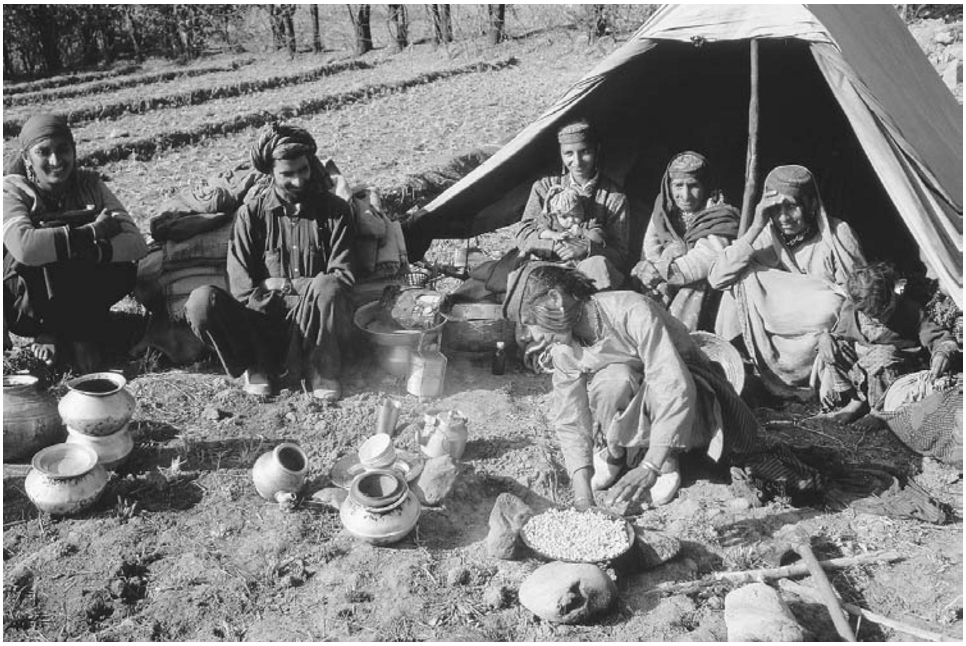
The abundance of dried fruit and nuts (walnuts, dates, and apricots) in the region has inspired their use in desserts, curries, and snacks. Sauces for curries are made from dairy-rich products.

A local spinachlike green called *haak* is popular in the summer months, as are lotus roots, which are used as a meat substitute. Fresh vegetables are abundant in the summer, including a prized variety of mushrooms called *guhchi*, used only for special occasions. Fresh fish is favored in the summer, while smoked meat, dried fish, and sun-dried vegetables are used in the winter.

Kashmir is also known for a very special green tea called *kahwa*, flavored with saffron, cardamom, and almonds and served from a samovar, a large metal kettle, which originated in the Russian steppes.

Punjab. Punjabi cuisine is simple, substantial, and robust, reflecting the extremes in climate and the industrious nature of its people. It forms a distinctive part of the culture. Everyday meals are centered on bread; there are a great variety of flat breads. *Parathas* (breads that are plain or stuffed with shredded, seasonal vegetables, seasoned with herbs and spices, and baked on a hot griddle) are favored for breakfast, served with a dollop of homemade butter.

Main meals throughout the year would comprise one *dal*, at least one seasonal vegetable, *chapatis* or *parathas*, and yogurt. *Lassi* (a yogurt shake) accompanies the midday meal, and pickles are served on the side. Some of the more popular dishes include a variety of locally grown legumes and *dal*s, cooked whole or split, *saag* (spinach), *mutter paneer* (homemade cottage cheese cooked with peas), and *baingan bhartha* (smoked eggplant cooked with tomato). Punjabis are fond of nonvegetarian food like tandoori chicken, chicken curry, and meat *koftas* (meatballs in gravy). Sweets are welcomed; carrot *halva* (grated carrots cooked with milk solids and clarified butter and garnished with almonds) served hot is a favorite in winter, while chilled *kheer* (rice pudding) is popular during the summer. *Makki ki roti* (corn bread) and *sarson ka saag* (mustard greens) served with white butter is another well-liked winter dish. Rice, which is prepared only for special occasions, is rarely served plain. It is made with cumin or fried onions or, in winter, jaggery. Punjabis prefer aromatic basmati rice, especially at banquets and large social gatherings.



Bakarwal gypsy family preparing chapatis over a camp fire at Sonamarg, India. The Bakarwal gypsies are a nomadic group who travel between the Jammu lowlands of India and the mountains of Afghanistan. © LINDSAY HEBBERD/CORBIS.

Dhabhas are roadside eateries, commonly found on the highways in North India, particularly in Punjab. They were formerly frequented by truck drivers, criss-crossing the vast subcontinent in search of a hot, home-cooked meal. Today, *dhabhas* have sprung up not only on the highways, but also in urban areas as well, and are frequented by a cross section of society. They typically have a limited menu of one *dal*, one vegetable, and one meat dish served with a variety of breads. The menu varies daily and the food cooked is always fresh because refrigeration is lacking.

Uttar Pradesh. This state is best categorized by the cities of Benaras (Varanasi), which is traditionally Hindu in character, and Lucknow, which is traditionally Muslim in character.

Varanasi is one of India's holiest cities, bisected by the Ganges River, the waters of which are said to wash away a lifetime of sins. Many Hindus use the water from the Ganges for cooking and for sacred ceremonies. Breakfast in Varanasi consists of *pooris* (whole wheat bread that puffs up when deep-fried) or *kachoris* (whole wheat bread stuffed with split peas or fenugreek greens and deep-fried), eaten with *aloo bhaji* (potatoes spiced with ginger, cumin, and dried mango powder) or *aloo koda* (a combination of potatoes and pumpkin). Meals tend to be vegetarian and stick to the following formula: one *dal*, one or two seasonal vegetables, *chapatis* or some other form of traditional bread, yogurt, with side dishes of pickles and relish. People in this region are very fond of sweets, and a variety are available year round. These include *malai gujiyas* (sheets of reduced milk, folded over mounds of sweetened nuts), *lal peras* (deep red, caramelized sweetmeats), and *malpuas* (sweetened pancakes).

In Lucknow, a typical breakfast consists of *parathas* (whole wheat bread plain or stuffed with shredded vegetables and baked on a griddle) or *kulcha* (flat sour dough bread), eaten with spicy fried liver and *andey ki bhujia* (scrambled eggs cooked with chopped onions, tomatoes, green coriander, and green chilies).

The average middle-class family will eat a *salaan* (meat gravy with a seasonal vegetable), a vegetable *bhujia* (a dry preparation of vegetables), boiled rice, and *dal* for dinner. The upper-middle-class family will supplement this with a kebab or another meat dish and *kheer* (a creamy, chilled rice pudding). Occasionally, a *korma* (meat curry) replaces the *salaan*, and a *biryani* or *pulao* replaces the more ordinary boiled rice. For those with a sweet tooth, the typical summer sweet is a *guramba* (unripe mangoes cooked with sugar and semolina), and during the winter, *rasawal* (rice cooked with sugarcane juice). Family dinners tend to be very elaborate. Lucknow is also well known for its kebabs, particularly the *kakori kebab*, which is made by pounding meat and fat until it becomes a paste. To this poppy seeds, cloves, and other ground spices are added, and the pounding continues until the meat turns almost gluey. This mixture is then wrapped around skewers and grilled over live charcoal.

Rajasthan. Rajasthani cuisine has been influenced by the availability of food resources in the desert state and by the warlike lifestyle of the Maharajas. The food had to be cooked in such a way that it would last for several days when the men went off to war. The scarcity of water gave rise to a cuisine that is cooked with very little or no water. This is especially true of the desert belt, where milk, buttermilk, or ghee is often substituted for water.

The princely families of Rajasthan were obsessed with *shikar* (hunting) and enjoyed game. Their meat delicacies are incomparable. During the hunts, meats, including poultry, game, and fish, are marinated, skewered, and grilled over live fires to make *soola kebabs*. Within the ancient palaces, the recipes were a closely guarded secret. Game is cooked in several ways. Rabbit, deer, and boar are prized, and what is not consumed is pickled for later use.

At the other end of the spectrum are the Marwaris, who are strict vegetarians and will not even use garlic and onion in their cuisine. Dried lentils and beans from indigenous plants are the staples of a Rajasthani diet, as wheat and rice do not grow in the desert. *Bajra* (millet) and *makki* (maize) are used for making various kinds of bread. The Marwaris use a lot of pulses and gram flour in their cuisine as vegetables are scarce in the desert climate. *Moong dal khilni* (a dry preparation of lentils, tossed in a mixture of spices), *moong godi ki subzi* (grape-sized dumplings of green gram, which has been ground to a paste and sun-dried), and *gatte ki subzi* (rolls of gram flour, steamed and cooked in buttermilk sauce) are delicacies in this region. Other innovations include the use of mango powder as a substitute for tomatoes, and asafoetida, to enhance taste in the absence of garlic and onions. Sweets are also very popular.

Feasting and Fasting

A proverb in North India says "after a fast, a feasting; and after a feasting, a fast." Festivals in India always revolve around food: either through feasting, fasting, or feeding someone. They are numerous, and celebrate harvests and the prevalence of good over evil in stories related to gods and goddesses. Food is an important part of any celebratory event. No festival or celebration is complete without sweets, which are said to ward off evil spirits. In North India, some of the popular festivals are Lohri, Holi, Janmashtami, and Diwali.

Lohri (the winter solstice) is a festival connected to the solar year. It is also celebrated as a harvest festival in many parts of the country. *Til laddus* (a sweet made from sesame seeds) is distributed among family and friends and eaten throughout North India. *Til* is considered auspicious and "heating," an important attribute given the cold weather prevalent at that time of year. Another traditional preparation on this day is *khichari* (a preparation of rice and lentils cooked together).

Holi is the festival of color that celebrates the end of winter and the coming of warm weather. The crops have been cut, threshed, stored, or sold. People of all ages celebrate by throwing color on each other. The festival is also celebrated with special sweets. In the North, families and friends share *gujiyas* made with *khoya* and nut stuffing (wheat pastry with a stuffing of milk solids and nuts) and sugar *batashas* (sugar flakes). *Thandai*, a chilled, milk-based drink flavored with almonds, cardamom, rose petals, and whole pepper, is synonymous with Holi and is routinely served to all celebrants or guests.

Janmashtami is associated with Krishna. The food prepared on this day is prepared from milk and curds, much beloved by him. A part of the festivities includes filling a large earthen pot with milk, curds, butter, honey, and fruit and suspending this pot from a height of between twenty and forty feet. Sporting young men and boys form human pyramids to bring the pot down and to claim its prized contents. Many families fast on this day, but one meal is allowed. This meal includes fruit, sweets, nuts, and curds.

Diwali, the festival of lights, commemorates the victory of good over evil. It is also the day when Lakshmi, the consort of Vishnu and the goddess of prosperity, is worshiped. Lakshmi and Vishnu are said to dwell in the celestial *Kheer Sagar* (the ocean of milk). This is the origin of the word *kheer*, a popular confection of milk and rice that is prepared on almost all festive occasions as an auspicious offering to placate the gods, after which it is served to the priests and guests. The preparation of *kheer* is a must on Diwali.

Diwali signifies the onset of winter. The harvest is over, and it is time for a change in diet that is more appropriate to the winter season. On this auspicious day, unleavened bread, which is traditionally baked, is fried, perhaps to symbolically display prosperity with the extravagant use of fat. This may also be because during the winter months, the body requires more calories to combat the cold, and richer foods become easier to digest. The affluent eat dried fruits, nuts, and sweetmeats, while others gorge themselves on *kheel khilone* (puffed rice and candied sugar figurines). There is a great emphasis on sweets, with gifts of sweets exchanged between family, friends, and business associates.

The most elaborate festival has to be Wazwan, a Kashmiri feast, that was introduced to India about five hundred years ago from Central Asia. It is a blend of the culinary styles of the Mughals and Persians who were Muslim on the one hand, and the Kashmiri pundits who are Hindu Brahmins on the other hand. As many as forty courses may be served during Wazwan, with at least twelve and up to thirty courses being nonvegetarian.

There are numerous fasts in India. Each day of the week is dedicated to one of the many Hindu deities. Those with particularly strong religious sentiments fast on the day dedicated to their favorite deity. For example, those who believe in Hanuman will fast on a Tuesday. These fasts require that only one meal, without cereal and salt, be eaten throughout the day, although fruit, nuts, sweets, curds, and liquids are allowed. Muslims in

KASHMIRI WAZWAN

A Wazwan is a Kashmiri feast held to celebrate any occasion. It is a formal affair, and the number of people invited to attend could exceed one thousand, depending on the occasion and the social status of the host.

The Wazwan is a blend of cuisines of the Kashmiri Pundits, Mughals, and Persians. The concept of the Wazwan is more than five hundred years old and has its roots in Central Asia. The central starch for the meal is rice and there are several meat preparations. The Wazwan often includes up to forty courses, of which at least twelve and as many as thirty may be meat-based.

Traditional cooks called Wazas prepare the elaborate meal. Being a Waza is hereditary; it is passed from father to son. Four senior Wazas are required along with twelve assistants to prepare the feast for one thousand guests. If the Wazwan is a dinner, they start cooking at sunrise and continue preparing food until sunset. For a lunch, the Wazas arrive the previous evening and cook through the night.

The planning of the feast can take days and the cooking many hours. It begins early in the morning and continues throughout the day, with a whole retinue of people including butchers and assistants working to prepare the meal. There are no shortcuts in the preparation of food. The sheep are slaughtered using the *halal* method (bleeding the animal) on the day of the feast. Different cuts of meat are used for different preparations: ribs for *tubbak maz* (ribs simmered with black cardamom, turmeric, and salt, and fried in clarified butter); marrow bones, neck, and rump as well as the breast for *rogan josh* (meat curry simmered in yogurt with red kashmiri chilies and saffron); various cuts of meat for *seekh kebabs* (minced meat ground with spices and grilled on skewers); and meat from the backbone and tail for *aab ghosht* (meat cooked in a milky sauce). All the fat trimmed from the meat is saved for the preparation of *gushtaba* and *rishta kebabs.* These are prepared by pounding the meat and fat separately to a paste. To every kilogram of meat, 250 grams of fat are added, and the pounding continues with the addition of black cardamom and other spices. These are then formed into smooth round kebabs (a quarter pound for each *gushtaba* and half that size for each *rishta kebab*) and simmered in huge cauldrons with yogurt, whole spices, and salt.

The vessels used for cooking are like the large, flat copper platters used to serve the food; many of them have a traditional *chinar* (maple) leaf design on them. The guests sit on the floor around the plates: four guests to each plate. The Wazas serve the food: In addition to all the meat preparations, there is also *haak* (a green, leafy vegetablelike spinach), tomato *paneer* (cream cheese cooked with tomatoes), various chutneys like green chili and walnut, as well as plain yogurt. *Gushtaba* marks the end of the meal. The sweets generally served include *sooji ka halwa* (a semolina sweet cooked with clarified butter) and *phirni* (a rice flour and milk dessert). Finally, hot cups of *kahwa* (green kashmiri tea flavored with saffron and cardamom and garnished with sliced almonds) are poured from samovars to aid in the digestion of the feast.

India observe Ramadan and fast for the entire month, rising at 4 A.M. to eat a small meal and breaking their fast at sundown with a full meal, including meat. This fast does not permit the consumption of food or drink throughout the daylight hours.

Another rigorous Hindu fast is *karwa chauth*. Punjabi women observe this fast for the welfare of their husbands. They wake up before sunrise and eat *sargi* (food that has been given to them by their mothers-in-law). This includes one pasta item, fruit, sweets, and *matthis* (fried savory made from flour). Throughout the day, they are not permitted to eat or drink anything until moonrise. Then, after prayers, a full meal is allowed.

Religious Significance of Food

Rice. Rice has an important place in Hindu religious ceremonies. During weddings, it is thrown into the fire because it is the symbol of fertility. When the Hindu bride leaves her maternal home for the last time, she throws fistfuls of rice over her head, signifying the riches of her childhood home. Similarly, when she enters the home of her husband for the first time, she knocks over pots of rice that line the entrance to the house. The extent to which the grains spill across the floor denotes the prosperity the bride will bring to her new family.

Rice is also a traditional dish in the daily menu offerings at the temple. Legend has it that an ancient king dreamed Lord Jagannath had asked him to introduce boiled rice in the menu at the temple. The monks, unwilling to partake of the plain food, even when the king told them of his dream, decided to feed it to a dumb monk first to see if he regained his powers of speech before accepting the rice as temple food. According to legend, not only did the monk retrieve his powers of speech, he also recited all the verses from the Vedas.

Mango. Mango leaves and fruit also have religious connotations. It is said that mango is the favored fruit of Ganesha, the deity who can remove any obstacles. All those who wish to have their desires fulfilled string a garland of mango leaves on their front doors.

Ghee. Because it is considered pure, ghee has great religious significance. It is used in all Hindu ceremonies, burned in every temple lamp, and used during cremation.

Kara Prasad. Associated with the Sikh community of Punjab, an offering (or *prasad*) of wheat flour, clarified butter, and sugar in equal amounts is made to the gods symbolizing universal brotherhood. During its preparation, hymns are sung in the food's praise. The *prasad* is made and served by devotees at the *Gurudwara* (a Sikh place of worship); it seeks to break down barriers of caste.

See also **Asia, Central**; **Buddhism**; **Civilization and Food**; **Hindu Festivals**; **Hinduism**; **Islam**; **Religion and Food**; **Rice**; **Weddings**.

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Thangam Philip

SOUTHERN INDIA

Southern India has been exposed to a variety of enriching influences through the years, including a number from Southeast Asia and Africa. Coconut and banana derive from Southeast Asia, betel leaf, areca nut, sago palm, and certain yams from Africa. Although the six tastes enjoined by Vedic practice are still more or less observed during a meal in most parts of India, the actual order in which the items are eaten differs from region to region. Broadly speaking, the South has a common order, and the arrangement of food items on a banana leaf used for eating is similar in Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala.

Andhra Pradesh

The food from Andhra Pradesh is renowned for its sharp and pungent flavor. As in most southern states, the *dosa* (fermented rice flour and lentil pancake) is common everywhere. However, the favorite remains *pesarattu*, a rice pancake with a filling of semolina and onions, cooked together. This is served with *sambar* (a spicy lentil preparation) and a variety of chutneys. Rice is a staple food in the region. No meal in Andhra is complete without the famous Andhra pickles that come in several varieties. *Rasam*, a spicy lentil soup, is common to the entire southern region, but interestingly, mulligatawny soup derives its name from the Telugu *mulligatanni* or black pepper water.

Hyderabadi food is distinct, having been influenced by renowned Moghlai cuisine. The kitchens of the Nizams combined the Muslim influence of the Moghlai court with a predominantly Hindu subculture to create a cuisine that is the ultimate in fine dining.

Hyderabadi cuisine includes *biriyani* (rice layered with mutton and cooked), *haleem* (wheat pounded with mutton), *baghare baigan* (roasted eggplant), and tomato *kut* (a tomato chutney). The repertoire is rich and vast, both in vegetarian and nonvegetarian fare. What also distinguishes Hyderabadi food is its sourness, clearly a Telugu influence. Souring enhances the taste of the food and is considered good for the heart and for digestion. The various souring agents used in Indian foods primarily reduce spoilage by microorganisms and also counteract the pungency resulting from the use of red or green chilies. The favorite souring agents are lemon and tamarind, although dishes like the *khormas* (meat curries with a creamy consistency) are soured with yogurt, and some dishes of Western origin, such as lamb chops, are soured with vinegar. Green mango when in season is a favorite souring agent for meat dishes and dals. Another favorite is *narangi*, a sour citrus fruit, which is used to flavor various dishes. The tomato too is often used to sour a dish rather than as a vegetable. In Southern and Western India, *ambada* (roselle leaves), a kind of spinach with a distinct sour taste, is another great favorite. Fresh or dried prawns, chicken, or meat cooked with *ambada* can be quite delicious, as is common dal soured with *ambada*. Sour berries called *karonda* (*Carissa caranda*) and sour fruits such as *kamrak* (star fruit or carambola) are also used to sour meat dishes.

Hyderabadi food can, in addition, be hot and spicy, another Telugu influence. Specialties include several dishes that are picklelike in flavor: *chatni gosht* (chutney meat), *achar gosht* (pickle-meat curry), *achar ke aloo* (pickle-potato dish), and *mirchi ka salan* (picklelike dish of green peppers and special herbs).

Chili peppers are used in Hyderabadi cooking in several ways—they can be chopped, ground into paste, slit, and deseeded, or an entire chili can be inserted in the dish. Certain red chili powders, especially those that come from the coastal Andhra region, have a flaming red color and a hot taste.

The procedure of seasoning, or *baghar*, is used in Hyderabad to great effect in order to infuse a dramatic nuance of taste into a dish. In *baghar*, food is seasoned by a process of dropping chilies, herbs, and spices into hot oil and then pouring that concoction over a dish while it is still sizzling. There are also exotic methods of seasoning that are quite unique to Hyderabad. In a lentil curry called *thikri ki dal*, a piece of freshly fired earthen pot is broken, heated until red hot, and added to the dish so that the rich aromatic flavor of the earth is captured. Similarly, in a dish called *kabab kheema* (minced kebab), a piece of red-hot coal is deposited in the center of the cooking pan and covered immediately so that the kebab absorbs the smoke and flavor of the burning coal.

Certain spices that are hardly used in North Indian cuisines are rather commonly used in Hyderabad, quite obviously due to Muslim-Moghlai influence. These are *shah jeera* (black cumin), *khus khus* (poppy seeds), *magaz* (seeds of muskmelon and watermelon), and *kabab chini* (cassia buds). Another spice used very often in Hyderabad, a South Indian legacy, is *til* (sesame seeds), which is scarcely used in the North.

A magical mix of various herbs and spices called *bhojwar masala* is indeed a Hyderabad offering to Indian cuisine. It is used in dishes like *baghara baigan* (seasoned eggplant), *mirchi ka salan* (green chili curry), and *mahi gosht* (a meat dish), and contains a mixture of coriander seeds, sesame seeds, cumin seeds, bay leaf, groundnut, dried coconut, and a lichen with an exotic aroma curiously called *pathar ka phool* (stoneflower). Another mix of herbs and spices from Hyderabad and much more exotic is *potli ka masala*, thus named because herbs and spices are tied in a *potli*, a sack of muslin cloth, and placed in the cooking dish. *Potli ka masala* is used mostly in *nehari*, a broth of pig's feet and goat's tongue, and *chakna*, a tavern dish of meat and organs. This mixture of spices is very different in taste and is literally an orchestra of fragrances. It includes sandalwood powder, dried vetiver roots, dried rose petals, bay leaves, coriander seeds, black cardamom, cassia buds, *pathar ka phool*, *gehunwala* (a kind of grain), *pan ki jadi* or *kulanjan* (a lesser variety of galingale), and *kapur kachri* (*Hedylium spicatum*).

Sugar is an important agricultural product from southern India, where it has been grown for several thousand years. This shows workers processing sugar in the open air. © ENZO & PAOLO RAGAZZINI/CORBIS.

Hyderabadi cuisine is more nonvegetarian than vegetarian, but the repertoire of Hyderabadi vegetarian fare is also complex and indicative of a high level of cooking skill. Hyderabadi prefer rice to bread, although *phulka* and *paratha* are also eaten. An earthy Maharashtrian bread made from an Indian millet called *jawari ki roti* is very popular. Nonetheless, rice is overwhelmingly preferred. It is said that nearly forty varieties of *biryani* are made in Hyderabad, including *pulao*. In Hyderabad a delicious mixed-vegetable *biryani* called *tahiri* is often served. It is said that throwing a handful of it on the ground in a spray will test the quality of a cooked *biryani*. If each grain of rice falls separately from the other and the grains do not stick together, then the *biryani* has made the grade.

Hyderabad is also a curry paradise. Broadly speaking, Hyderabadi curries come in five to six forms. One is *shorva* (or *shorba*), a thin, soupy curry with dumplings of meat and a vegetable, which could be potato, okra, some of the gourds, or colocasia, and soured with tamarind and

MIRCH KA SAALAN (WHOLE GREEN CHILIES IN A MASALA GRAVY)

Mirch ka saalan is among the better-known Hyderabadi dishes. Since it keeps well for several days, the Hyderabadi often carry it with them on long road or rail journeys.

Preparation time	40 minutes
Cooking time	25 minutes
Serves	6–8 persons

Ingredients

Green chilies, large	8–9 ounces, slit on one side
Onions	4, cut into 4–6 pieces each
Ginger	1-inch piece
Garlic	½ pod, with the skin removed
Coriander seeds	1 tablespoon
Cumin seeds	1 teaspoon
Sesame seeds	3 tablespoons
Peanuts	½ cup
Poppy seeds	1½ teaspoon
Dried coconut (*copra*)	about 1 ounce
Fenugreek seeds	¼ teaspoon
Turmeric powder	¼ teaspoon
Red chili powder	1 teaspoon
Jaggery or sugar	1 teaspoon
Tamarind	2½ ounces
Curry leaves	a few
Cooking oil	1 cup
Salt	To taste

Method

Soak tamarind in about 1 cup of warm water. Mash and sieve to obtain tamarind water. Discard seeds and other residues. Set aside

Roast the onions on a griddle until they soften and turn a pale golden brown. Then dry-roast together over medium heat the coriander seeds, sesame seeds, peanuts, cumin seeds, poppy seeds, dried coconut (*copra*), and fenugreek seeds until their shade darkens very slightly and they start emitting an aroma.

Grind together the onions, roasted spices, ginger, garlic, salt, turmeric, red chili powder, and jaggery or sugar into a fine paste. Mix with the tamarind water.

Heat oil. Add the green chilies. As soon as they acquire a few golden brown spots, remove from the pan and set aside. Add curry leaves to the oil and, after a few seconds, the ground spices. Cook for about 5–10 minutes. Then add the green chilies. Cook over medium heat, stirring occasionally. Add a little water while cooking, if desired. Cook for another few minutes until the oil rises to the surface. The dish should have a fairly thick consistency.

a bit of yogurt. It is flaming red in color and can also be quite hot in taste as it is blended with red chili powder. Then there is *khorma*, which is a meat, chicken, or fish dish with a creamy consistency as it is flavored and soured with yogurt and spiced with red chili powder. All *khormas* are yogurt-based dishes. Then there are the thicker curries called *khalias*, which again are meat dishes with a vegetable in which the gravy is thick and saucelike. There are also the *bhuna* dishes, which are not exactly dry, as the name suggests, but have very little sauce, in which the mixture of spices coats the meat. Another group of curries without a specific name are those flavored with *baghar* or seasoning. In addition, there are some other curries outside these categories, but with a texture and flavor all their own.

Indians rarely bake their foods, except perhaps in the celebrated clay oven called the tandoor. Hyderabad, however, boasts of a few unique baked dishes, not surprisingly all made of minced meat. Most of these are actually *kabab*-like or are baked *kababs*, except perhaps the savory called *tootak*, made of semolina and minced meat. Some of the baked foods are obviously imports, from Arabian countries and Iran.

The gourmets of Hyderabad have incorporated other Arab dishes into their culinary repertoire, and the most spectacular of these is perhaps *muzbi*, in which an entire goat is stuffed with *pulao*, chicken, boiled eggs, and nuts and raisins, and then cooked. There is also *marag*, a rich broth of mutton and marrow, and the famous *nehari*, another fine broth of tongue and pig's feet. The Turks introduced Hyderabadi to *shawarma*, slices of goat's meat upon a special skewer. All these dishes have been subjected to Hyderabadi interpretation, and abundant use of unique Indian spices has imparted to them their own local flavor.

Another nonvegetarian category in which Hyderabadi food offers tremendous variety and culinary excitement is minced meat. *Kheema* or minced meat has a certain versatility that allows it to be cooked in several ways. A mince dish is not supposed to be watery and therefore has very little gravy. However, it goes very well with rice or bread. Several *kababs* are made with mince, as are baked dishes and savories. Mince also lends itself well to stuffing. In a group of dishes called *dulmay*, like the Greek and Armenian *dolma*, mince is stuffed in onion, potato, capsicum (sweet and hot peppers), and even fruits like apple and guava.

As in the West, there is a certain order in the manner in which food is taken in Hyderabad. Food is eaten in courses, but not served in courses. Everything is placed on the table at the same time, but eaten in a set order. A dry dish, generically called *gazak* (or appetizer), is first consumed. It could be a *kabab*, a savory, or even fried fish. The *gazak* is followed by *khalia*, a semidry mutton curry, which is eaten with *phulka* (a thin dry chapati). Then comes the *shorva* or *khorma*, which generally contains a vegetable. Alternatively, a *biryani* might be served in place of the *shorva*. Similar order prevails in the presented food at weddings and parties, only the fare is more sumptuous and has greater variety. At parties and celebrations, at least two varieties of *gazak* and two types of *biryani* are served. A chicken dish and mutton curry are also offered to guests, along with bread. For dessert, favorites include *double ka meetha* (a bread pudding), called *shahi turka* in the North, and *khubbani ka meetha*, an apricot dessert served with fresh cream.

No introduction to Hyderbadi cuisine would be complete without a word on its pickles. Since the Indian passion is for foods sour and pungent, one predilection is pickles made of green mango, lemon, tamarind, green chili, and even sour fruits like the *kamrak* (star fruit). The pickles are all seasoned and flavored with vinegar.

The Hyderabadi *paan* (betel leaf) is well known. Making a good *paan* is a delicate process and is often an exercise in *nazakat* (elegance). The Hyderabadi prefer the South Indian leaf. It is soft and does not have the coarseness or pungency of some other leaves. Each leaf is fastidiously cleaned of all its veins in order to soften it further. Both the *katha* and *chuna* (slaked lime) are processed at home. The *katha* is also treated with rose water. At the end of a meal, a silver *paandaan* (a container for the betel leaf preparation) is brought out and the lady of the house makes the *paan* with her own hands. The *paan* is rarely given by hand. It is placed in a miniature silver tray and offered with the right hand. (Food in Indian homes is always served and eaten with the right hand. The left hand is not used for either purpose, for traditionally the practice in Hindu homes is that the right hand is used to receive and/or give.) At parties, *paans* are decorated with *chandi ka varq* (silver leaf) before being served.

Andhra cuisine is largely vegetarian, except for the coastal areas, which show a preference for seafood. Fish and prawns are curried in sesame and coconut oils, flavored with freshly ground black pepper, and then eaten with rice. For vegetarians, rice is served with *sambar* (a spicy lentil preparation) and vegetables. *Pakodas* (potatoes or onions dipped in gram flour batter and deep-fried), *vadas* (fried dumplings made from split black gram) in steaming hot sambar, or *idlis* (steamed rice dumplings) are served as snacks. The Portuguese word for grain, *grão*, was first applied in India to the Bengal gram or chickpea, and later applied generally to all pulses; thus arose the terms red gram, green gram, black gram, horsegram, etc. Gram's use is unknown outside India.

A wide variety of fruit grows in Andhra Pradesh. These include custard apples (*Anomas*), grapes, apricots, and mangoes.

Karnataka

Writings on food in Kannada date back approximately a thousand years. Rice was the premier food after the tenth century C.E. in Karnataka. Four varieties of a cooked rice-ghee combination dish flavored with garlic and salt, called *kattogara*, were prevalent. Crushed *papads* was added to yield one variation, crisp-fried *sandiges*, made of the ash gourd made for another, and various cooked greens gave rise to yet other variations. By mixing in lime, *huli* (a spicy lentil preparation), turmeric, tamarind, or the powders of roasted rice and split chickpeas, flavors could be easily changed. Cooking the rice in water in which, as a preliminary step, the leaves of *tulasi* (holy basil) were boiled resulted in "curd rice" (a traditional preparation) that would keep for several days.

A traditional Thali tray in Madras, India. Each bowl contains a small portion of a vegetarian dish. © LINDSAY HEBBERD/CORBIS.

An exceptionally large number of wheat preparations also continue to be consumed. Karnataka consumes roughly equal amounts of rice, wheat, and *ragi* (millet). The wheat foods may be roasted, baked, steamed, or fried. Roasting can take several forms. *Mucchal roti* is baked between plates, with live coal above and below, and *kivichu roti* on a *kavali* or *tava* (flat griddle plate) with a little ghee (clarified butter). Several *tava*-roasted rotis may be mounted one over the other with a pierced stick and flavored with ghee, sugar, edible camphor, and *thale (Palmyra)* flower to yield *chucchuroti.* A stack of ghee-smeared circles mounted one over the other, *savaduroti*, is baked on a griddle under cover of a cup. A cup cover above, live coals below, and a ball of dough within yield *uduru roti*, from which the blackened crust is peeled off before consumption. *Mandige* or *mandage* is a delicate baked product: when baked on a heated tile, it is called *white mandige*, and when overheated but still very soft, it is called *ushnavarta mandige*. The stuffing may be varied. Sugar and ghee yield *khanda mandige;* multilayered fillings of cooked *chana*, coconut shreds, dates, and raisins result in a *mandige* variation called *perane hurige*. Today the *mandige* of Belgaum is a very large and fine *paratha* stuffed with finely ground sugar containing cardamom powder, baked on an upturned clay pot, and folded into a moderately stiff rectangle.

True baking within a seal of wheat dough, called *kanika* in Kannada, is used to make the *bhojanadhika roti*, in which *mandige* broken up into small pieces is mixed with milk, cream, coconut milk, mango juice, and sugar, and then pressed into a ball. This is placed within a covering of wheat dough and baked under seal on a hot tile with frequent turning of the vessel. When done, the upper crust is sliced off, and ghee and sugar are poured on the *roti* before it is consumed.

Wheat dough made with sweetened milk or even cream, rolled out into circles and then deep-fried, yields *yeriappa* and *babara*. Balls of dough made with wheat flour, curds, and sweetened cream are deep-fried to produce *pavuda*. A less viscous wheat batter prepared with sweetened milk is forced through a hole made at the base of a coconut shell cup (the usual extrusion device) directly into hot ghee for ropelike *chilumuri*.

Some preparations have been frequently mentioned throughout the centuries. *Melogara* is a dish of pulses and greens, with coconut gratings, but many variations are prevalent. To make it, *mung dal* (split green gram), *avarai* (flat beans), *urad dal* (split black gram), fresh *chana* (split chickpeas), or *tuvar dal* (split red gram) are first cooked with sesame seeds, then cooked again with greens, drumsticks, grapefruit, salt, and coconut gratings, and finally mixed with ghee and tempered with asafetida (gum resin) and thick milk. Even wheat dough pieces rolled into thin strands and fried may be added to *melogara.* Vegetables used for *melogara* are pretreated. Certain leaves are first washed in lime water before cooking, other greens are washed in turmeric water, and yet others with common salt or alkaline ashes. The *surana* root is first boiled with betel leaves, or soaked in rice water and then cooked with tamarind leaves. A *melogara* of dal and beans may be sweet, sour, or spicy.

There are many kinds of relish in this cuisine. *Balaka* is now made by soaking large chilies in salt water, drying them, and then frying the chilies in oil when needed as a crisp and spicy accompaniment to food. Historically, some twenty kinds of *balaka* have been prepared using various vegetables and their peels. Deep-fried items eaten as crisp and crunchy accompaniments to a meal include *chakkali* (called *murukku* in Tamil Nadu), a circular mass of continually widening rings extruded from a thick rice-*urad* (split black gram) batter, and numerous *sandige*, irregular lumps of spiced rice-*urad* batter, sesame powder, onion, or even vegetable skins like those of the ashgourd, sun-dried first, and then deep-fried until crisp in very hot oil. Curd-based relishes with greens and raw vegetables are called by various names, such as *pacchadi*, *kacchadi*, *krasara kacchadi* (this contains milk with curds), *palidya* (one variety is called *kajja*), *thambuli* (with greens and coconut gratings), and *raita* (a commonly used condiment today). *Kosamris* are uncooked relishes made from *chana* or mungbean sprouts (green gram), which are soaked in water until they soften and swell, and then garnished with salt, mustard seeds, and fresh coriander.

In the cuisine of Karnataka, there has been a vast variety of sweet items, and they have altered little over a millennium. Sweet boiled rice, rice *payasam* (rice cooked in milk and then sweetened), rice-derived *vermicelli payasam* (vermicelli pasta cooked in milk and sweetened), mixed *rice-wheat payasam* (a mixture of rice and wheat cooked in milk and sweetened), *rice kadabu* with a sweet filling, and deep-fried delicacies of rice flour and jaggery (now called *athirasa*) are all based on rice. Wheat, especially in the form of semolina, is suitable for the preparation of sweets; from it, *kesari bhath* (sweetened rice flavored with saffron), *ghrtapura* (a fried ball), *payasam* (*kajjaya*), and *ladduge* are made. Wheat vermicelli is extruded to a fine consistency from hard wheat dough (it is then known as *pheni*) and usually eaten with sugared milk. Sweet wheat rotis stuffed with a mash of boiled *chana*, jaggery (brown palm sap sugar), and coconut constitute *purige*, *hurige*, or the later *holige*; a thinner drier form is *obattu*, and there is also the rolled-up cylindrical form called *surali holige.* Rolled-out pieces of dough are fried in various forms and then dusted with castor sugar to make *phenis* and *chirotti*; *madhunala* is a small tube of dough (of wheat, rice, and *chana* with added mashed banana) filled with sugar, sealed at both ends, and then deep-fried. *Karaji kayi* is a half-moon puff with a sweet stuffing; if only sugar constitutes the stuffing, the result is *sakkare burunde*. Pulse flours of *chana* and black gram are also used to make sweetmeats. *Boondi* grains made from them are sweetened with sugar syrup and shaped into *ladduge*, *pinda*, *moti chur*, and *manohara unde*. *Jilabi*, tasty as nectar, are made of *chana* flour. Milk is the major ingredient for sweet *payasa*, as well as *hal unde* (balls of sweetened milk solids) and *halaugu*. *Shikharini* consists of curd solids lightly spiced and sweetened.

A typical breakfast in the region includes *idli* (made by fermenting a mixture of ground rice and split black gram) and *vada* (made from split black gram), accompanied by *sambar* (a spicy lentil preparation) and a coconut chutney, lemon rice, *upitu* (a savory dish made from semolina), or *kesari bhath* (a sweet made from semolina and flavored with saffron).

Vermicelli upma (a savory dish made with vermicelli pasta) is used as a snack in-between meals. The main meals are usually rice-based. Rice is eaten with clarified butter. This is followed by rice with *rasam* (a thin lentil soup), rice with *sambar*, and rice with curds for the final course. Usually, two vegetables called *palyas* accompany the meal. These are dry-cooked vegetables with green chilies, cumin, and grated coconut. A salad called *kosamri* is also eaten with the meal.

The Kodavas, Mangaloreans, and Udipis are distinct communities within the state; each has its own specialities.

Perched on the highlands of southern Karnataka in the Kodagu district are a warlike and distinctive people with a unique cuisine. Rice is eaten boiled or as a distinctive ghee-coated product (*nai kulu*), or as a *pulao* with firm meat chunks and every grain coated evenly with a mixture of spices. Rice is also transformed in numerous ways, and each has a distinct nonvegetarian accompaniment. The *akkiroti* based on a rice dough rolled out on a wet cloth is roasted and eaten with a spicy sesame chutney, a red pumpkin (*kumbla*) curry, or with a dry and salty dish of bamboo shoot chiplets (these shoots are also pickled).

With the *pulao* goes a tasty relish of ripe wild mangoes in a curd base called *mangay pajji*. A paper-thin, soft rice pancake, *neer dosai*, is accompanied by a chicken curry, into which a lot of fresh coconut is added. The *nu puttu* of Kodagu is the strandlike *idi appam* of South India, once eaten with jaggery water, but now with any liquid curry. Steamed balls of cooked and mashed rice constitute *kadambuttu*, which is paired with a pork dish with a very thick mixture of spices, of which an essential ingredient is the sun-drawn extract of the kokum fruit, locally called *kachampuli* (*kerala kudampuli garcunia cambogia*). Its acidity serves to keep the fat on meat firm and springy. A breakfast dish, *paputtu*, is prepared from rice grits mixed with grated coconut and milk, and then steamed in metal pans. This is often eaten with either pork curry or ghee and the honey so plentifully found in Kodagu. Another breakfast dish is *thaliya puttu*, made from a batter of ground rice, fenugreek seeds, and soda bicarbonate, fermented overnight and steamed. Two fish are commonly used in this cuisine. One is the sardine, *matthi meen*, and the other the tiny whitebait (*koyle meen*), cooked and eaten bones and all. There are also two popular desserts and both are based on the banana. Well-ripened fruits are mashed with the powder of roasted rice, to which a little fenugreek is added, to make uncooked *thambuttu*, which is eaten with ghee, fresh coconut gratings, and whole-roasted sesame seeds. To make *koale puttu*, mashed banana and small wedges of mature coconut are steamed in a banana leaf packet, which is opened to give a brown slab; the mixture is then eaten either hot or cold with fresh butter. The name is derived from *koovale puttu*, originally made with the soft, weepy variety of jackfruit called *koovale*.

THE UDIPIS

The Udipi region is on the coastal stretch of Karnataka, sandwiched between Goa and Kerala. The Krishna temple in the area is famous for training young boys (from the age of ten years) to work in the kitchen. All boys start as apprentices and gradually learn the trade. Thereafter, they are free to seek employment elsewhere. This has given rise to a whole chain of "Udipi restaurants" throughout Maharashtra and Karnataka. The food served at any of these places is completely standardized, with each item having the same weight, volume, and appearance. Long before the concept of chain restaurants came about in the West, along with the accompanying standardization of foods, the ubiquitous Udipi restaurant was already making its presence felt in India!

THE MANGALOREANS

The Christian community of Mangaloreans are an integral part of Karnataka. However, their food is quite different from Hindu cuisine, being as nonvegetarian as the Hindus are vegetarian. In fact, it has several similarities with the coastal cuisine of Kerala: both make use of coconut milk and similar spices. Seafood, being readily available, is also consumed in large quantities, as is heavily spiced pork.

Tamil Nadu

Located in the South of India on its Eastern coast, Tamil Nadu has a large Hindu population. The large community of Brahmins are vegetarian, hence, the state is primarily vegetarian by nature. The main cooking method in the South is steaming. As a result of this, every single home is equipped with a variety of small and large steaming pots. The word "curry" originated in Tamil Nadu. Contrary to popular belief that a curry is a dish with a gravy, curries in Tamil Nadu are dry, spiced dishes without gravy.

Most of the south, and particularly Tamil Nadu, has a hot climate, and this has been used to prepare some of the most delicious and nutritious dishes that require fermentation. For this process, no yeast is used, as the average temperature of 25°C does the work quite effortlessly. To counteract the heat, cooling ingredients such as tamarind are employed to great effect.

Idlis, small, savory rice cakes, made slightly sour by overnight fermentation and steamed the following morning, are served as breakfast to millions in the South. The process relies almost entirely on the weather to change a batter of ground rice and split peas into a light froth, which then only requires a quick steaming to become a deliciously light, highly nutritious, and very digestible breakfast.

South Indians are serious coffee drinkers. They make strong filter coffee, but do not drink it strong, preferring to mix it with lots of hot milk. The proportions vary from house to house. Sometimes, as little as 20 percent coffee is in an individual serving, and at other times it is a neat balance of half and half. Before the coffee is poured into separate glasses or cups, there is one more ritual to be performed: that of pouring the mixture from one vessel to another at some height in order to raise a head of froth.

ACHAR KE ALOO (POTATOES IN A PICKLE SAUCE)

Preparation time	15 minutes
Cooking time	45 minutes
Serves	6–8 persons

Ingredients

Potatoes	1½–2 pounds
Onions	5, ground to a paste
Ginger paste	1½ teaspoon
Garlic paste	1½ teaspoon
Red chili powder	1½ teaspoon
Turmeric powder	1½ teaspoon
Vinegar	1/3 cup
Sugar	2 teaspoons
Salt	To taste

For tempering

Nigella seeds	1 teaspoon
Mustard seeds	½ teaspoon
Cumin seeds	1 teaspoon
Whole red chilies	8

Method

Boil the potatoes. Peel and cut into 1-inch-sized pieces

Heat oil. Fry the potatoes until they are golden. Set aside. Leave about 2/3 cup of oil and remove the rest. Next fry the onions until they are golden brown. Add the ginger and garlic paste and fry a little. Next add salt, turmeric, and chili powder, and then the fried potatoes. Add about half a cup of water and cook over low heat for approximately 5 minutes until the spices are well blended and a small amount of gravy remains. Turn off the heat. Mix sugar in vinegar and add to the dish. Transfer all to the serving dish.

Heat 2 tablespoons of oil. Add the dry whole red chilies, mustard seeds, cumin seeds, and finally the nigella seeds. When the mustard seeds begin to crackle and the red chilies darken, pour the tempering over the dish.

A *dosa* is more satisfying than a simple pancake, as it is golden red and crisp on one side, smooth and white on the other. Made from almost the same batter, both *idlis* and *dosas* are the traditional breads of the South, as nourishing and digestible (due to the fermentation process) as they are delicious. They may be eaten with butter and honey or with chutneys, or they may be stuffed with a spicy blend of potatoes and onions. All these breads are unleavened and prepared in two stages. First, each round is cooked briefly on a preheated griddle; then, the partially cooked bread is held over an open flame for a few seconds. The direct heat causes moisture in the dough to turn quickly to steam, puffing the bread while the cooking is completed. For a crisper effect, unleavened dough may be cooked completely on the griddle until well browned on both sides.

The main staple in Tamil Nadu is rice. Simple vegetarian lunches consist of three courses, each eaten with rice. A typical lunch menu would be rice and *rasam* (a highly spiced lentil soup) and a preparation made from vegetables. This is followed by more rice for the second course, with *sambar* (a preparation of lentils) and *papadams.* The last course comprises rice, yogurt, and pickles. Southern meals tend to end this way: hot, fiery courses followed by bland, soothing ones.

Vegetarian meals using the same basic theme of rice, *rasam*, *sambar*, and yogurt may in skillful hands become much more elegant and elaborate. Examples include *rasavangi*, a kind of heady *sambar* with the tiniest of eggplants (aubergines) bobbing about in it; *vendakai curry*, delightfully crisp fritters made by dipping sections of okra into a spicy chickpea flour batter and frying them; *keerai poricha kootu*, a kind of thick soupy stew of lentils, spinach, and fresh coconut; and the popular *rasavade*, made with savory *urad dal* (split black gram) doughnuts, immersed in *rasam* just long enough to soften and soak up all the liquid's tart and fiery flavor.

Chettinad

Traders, merchants, and money-lenders by profession, the Chettiyars of Chettinad have traveled the seas freely since ancient times. Their wealth is enormous, and the Chettiyars are very comfortable with and open about this. They are known to begin collecting dowries for their daughters at birth. The Chettinad region of southern India that comprises Madurai, Virudhunagar, and adjoining regions is dry and arid. The cuisine of the region reflects this and also the fact that the early Chettiyars were traders in spices. Therefore, their cuisine is spicy (fiery hot) and rich in its variety of spices, the most prominent being peppercorn and red chilies.

In Chettinad a meal is traditionally eaten off a banana leaf. Some popular preparations are *meen varuval*, fried fish; *varuval kola*, fried meatballs made with a very creamy paste of meat, cashews, poppy seeds, coconut, fennel, and fenugreek seeds; *koli kolambu*, chicken cooked in spicy tamarind water; *kari kolambu*, meat cooked with roasted coriander seed and tomatoes. There are also dishes made from mixed vegetables cooked with the second water used for washing rice (*mandi*) or *idi appams*, freshly made rice vermicelli, seasoned with mustard seeds and *urad dal* (split black gram), as well as dishes made from banana flowers, banana stems, dried mango, and assorted pickles and sweets. Fennel and roasted and powdered fenugreek are the predominant spices in Chettinad chicken, fish, and vegetable preparations.

Koli uppu varuval, a kind of peppered fried chicken, is a dish that has gained immense popularity outside the Chettinad region.

Kerala

Kerala is a bit of heaven on earth. Located as it is on the West coast of India, with a long coastline, the food of the state has been influenced greatly by its climate and geographic location. There is a wealth of seafood, and the swaying coconut palms all along the coastline have resulted in the extensive use of coconut and coconut oil in the local cuisine. Other foods locally produced and consumed include many types of bananas and jackfruit. Kerala is well known for its spices. In fact, the Greeks, Romans, Arabs, and Chinese all came to Kerala to trade. Later, Portuguese, Dutch, French, and English explorers arrived to profit from the lucrative spice trade.

Black pepper is the main spice grown in Kerala. It was used in the past as currency, to pay tributes and ransoms. Other spices that grow in the area include nutmeg, cinnamon, cardamom, cloves, ginger, and turmeric. Tamarind trees and the curry leaf tree (*Murraya koenigii*) are visible everywhere; the aromatic curry leaf has greatly influenced the cuisine of the Keralites as a result. Kerala also produces large amounts of coffee and tea, and manicured tea gardens can be seen on the hills of the region. There are three major communities residing in Kerala. Hindus, Muslims, and Syrian Christians make up the bulk of the population of the state, although there are other minority communities, including Jews.

Each community has its own distinctive cuisine. Unlike the royal families of other states such as Hyderabad and Mysore, those of both Travancore and the state of Cochin are extremely austere and spartan in their food habits and lifestyle, although they are great scholars and lovers of art. Other states were known for their opulence, both in lifestyle and cuisine, but this is lacking among the royal families of Kerala. However, during the Onam festival, all Keralites enjoy a festive meal. Nonetheless, there is no special cuisine that can be attributed to them.

The Syrian Christians. Breakfast for all Keralites, whatever their religion, is the popular *appam* (also called hoppers), a pancake, or *palappam.* These are rice flour pancakes, which have soft, thick spongy centers and lacelike, thin, crisp edges. The Syrian Christians eat *palappam* with a meat stew, whereas the Hindu community comprising the Nampoothiris and Nairs eat it with a mix of vegetables (*aviyal*).

There are two other breakfast items common to all Keralites. The first is *idiappam* (cooked rice noodles or string hoppers), eaten with sweetened coconut milk or with a meat or chicken curry. The second is *puttu* (made of coarsely ground rice flour and coconut shreds, which are alternately layered in a bamboo tube, and steamed by affixing the bamboo tube to the mouth of a vessel containing boiling water). Being rather dry, *puttu* is commonly eaten with bananas or with a spicy dry chickpea curry.

Kuzhal appam is a fried crisp curled up like a tube; it is typically Syrian Christian. There are two other *appams* popular with this group, and both are sweet. *Acchappam* is a deep-fried rose cookie made of rice, the name derived from the frame (*acchu*) needed to make it. *Naiappam*, called *athirasam* in Tamil Nadu, is a deep-fried, chewy, dark doughnut fashioned from toddy (fresh or fermented palm sap), fermented rice, and jaggery.

Another rice-coconut combination uses fried rice and is called *avilose*, a Syrian Christian speciality. It can be molded into an *unda* (ball) with coconut palm treacle. *Churuttu* (which literally means cigar) is also rice-based; it has a crisp, translucent outer case, filled with *avilose* and coconut palm treacle. *Khumbilappam*, eaten by all Keralites, consists of a mash of ripe jackfruit, roasted rice flour, and jaggery, folded in the form of a triangle in a cassia leaf and steamed. During jackfruit season, a preserve called *chakka varattiyathu* is made with jackfruit, jaggery, and cardamom. This preserve is served continuously throughout jackfruit season.

Syrian Christians in Kerala eat beef, and *eracchi olarthiyuthu* (fried meat) is a daily food item, which is also served during weddings. It is a dry dish of cubed beef boiled with spices and pieces of coconut and then sautéed in oil. *Kappa kari*, pieces of tapioca cooked with ground coconut and tempered with oil, is another favorite dish among this community. Most curries, including meat, always have a lot of coconut milk.

In Kottayam and Trichur, both sea and river fish distinguish local fare. In Kottayam, the fish is cooked using a sour fruit rind (*Garcinia cambogia*), locally called *kudampuli. Meen vevichathu*, fish in a fiery red chili sauce, has a characteristic sour and smoky flavor, resulting from the *kudampuli.*

In Trichur, tender mango is the souring agent used along with coconut milk. *Meen pattichadhu* includes very small fishlike oil sardines, or even prawns with coconut gratings. A hot favorite with the laity and priests alike is *mappas*, a mildly spiced chicken curry with a thin coconut gravy.

A special sweet traditionally served at weddings is *thayirum pazham pani*, coconut palm treacle, which is poured on ripe bananas, mashed together, and then eaten with curd and rice.

The Muslims. The Muslims of Kerala are called *moplahs*; they are direct decendants of Arab traders who married local Kerala women. Although the Kerala freely use rice, coconut, and jaggery, an Arab influence may be clearly observed in their *biriyanis* and a ground wheat-and-meat porridge, called *aleesa*, elsewhere referred to as *harisa*.

The Muslim kind of roti is the distinctive *podi patthiri*, a flat thin rice chapati made from a boiled mash of rice, baked on a *tava* (flat griddle plate), and dipped in coconut milk. *Aripatthiri* is a thicker version of this made from parboiled rice and flattened out on a cloth or banana leaf to prevent it from sticking. *Naipatthiri* is a deep-fried *puri* of raw rice powder with some coconut, fried to a golden brown. All these *patthiris* are eaten at breakfast with a mutton curry. Steamed *puttus*, eaten with small bananas, are also commonly consumed as the morning repast. A wedding-eve feast may include *nai choru*, rice fried lightly in ghee with onions, cloves, cinnamon, and cardamom to taste, and finally boiled to a finish. A wedding dinner generally includes a *biriyani* of mutton, chicken, fish, or prawns that is finished by arranging the separately prepared flesh and the cooked rice in layers and then baking them with live coals above and below. Several flavored soups are made from both rice and wheat, with added coconut or coconut milk, and spices. A whole-wheat porridge with minced mutton cooked in coconut milk is called *kiskiya*. A distinctive and unusual sweet is *mutta mala* (egg garlands), chainlike strings of egg yolk cooked in sugar syrup but later removed from it. *Mutta mala* is frequently served with a snowlike pudding called *pinnanthappam* made from the separated egg whites that have been whisked up with the remaining sugar syrup, steamed, and then cut into diamond shapes. This dish is indicative of the Portuguese influence in the area.

The Hindus. There are three main communities within the Hindu group, each with its own distinct cuisine: the Thiyas, Nairs, and Nampoorthiris.

The Thiyas are a community that formerly tapped palm sap, but have now entered many other professions. *Appam* and stew are typical breakfast fare, the stew being varied: fish in coconut sauce with tiny pieces of mango, mutton in coconut milk, or simply a sugared thick coconut milk. A specialty bread is *naipatthal*, in the shape of a starfish. The curd of favor is *pacchadi* (a dish made of beaten curd with cooked vegetable marrow and coconut ground with mustard seeds, and then tempered again with mustard seeds and oil). A popular dessert is *prathaman*, split green gram boiled in coconut milk and flavored with palm jaggery, cardamom, and ginger powder, and laced with fried cashews, raisins, and coconut chips.

The *Nairs* were the original warrior class of Kerala, whose cooking skills later led to their employment as professional chefs to nonvegetarian families all over the South. Breakfast typically consists of *palappam* or bamboo-steamed *puttu*, eaten with sweetened milk and tiny bananas. Certain vegetable specialities, although eaten by all Keralites, have special Nair associations. *Aviyal* is a mixture of green bananas, drumsticks, various beans, and green cashews (distinct to Nair cuisine), cooked with ground coconut and a little sour curd, and then topped with some coconut oil. *Kalan* is similar, but uses green bananas alone, with a gravy of yogurt, ground coconut, cumin, and green chilies. *Olan* is a dish of white pumpkin and dried beans cooked in coconut milk; fresh coconut oil is poured on top of it after the cooking pot is removed from the fire. A Nair wedding feast will generally include several types of *pacchadis*, pickles, chips, and *payasams* based on milk, coconut milk, rice, dal, and fried vermicelli. No meat is served at a wedding, although it is part of the typical diet. Such domestic meat and chicken dishes, although spiced, use a great deal of fresh coconut and coconut milk for tempering. A yogurt dish containing small pieces of ash gourd or raw mango cooked with coconut, curds, and chili paste is called *pulisseri*. A sweet mango chutneylike dish called *puli inju* (fried sliced ginger in a tamarind chili jaggery sauce) is served daily.

The *Nampoothiris* are the Brahmins of Kerala who probably first arrived there around the third century B.C.E. They are strict vegetarians who favor the *idli*, *dosai*, and *puttu* for breakfast with a coconut or curd accompaniment, and eat their rice with *kootu* (a preparation of mixed vegetables), *kalan*, and *olan*. The use of garlic in cooking is avoided. Other vegetable preparations consumed include *thoran*, which is usually made from runner beans, sliced fine and then steamed and tossed with grated coconut, ground turmeric, cumin, and green chilies and tempered with oil. Other bean varieties such as field beans, sword beans, green bananas, amaranthus, cabbage, and peas can all be made into *thoran* and eaten with rice. *Aviyal* and *erusseri*, a pumpkin curry, are also included in the Nampoothiri menu.

All Keralites eat yellow banana chips fried in coconut oil and lightly salted. The *payasam* of Kerala is made with rice and milk, but *prathamans* use milk, dried fruit, and dal or paper-thin shreds of a rice roll, which are then precooked and added to the sweetened milk to yield *palada prathaman*. Memorial services held once a year for ancestors routinely include *chatha pulisseri* in their menu. This is a sour buttermilk preparation with pepper, salt, and coconut paste that is thickened through boiling.

See also **Curry; Hinduism; Islam; Rice.**

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OTHER RESOURCES

Additional information on specific cuisines available at http://www.diwalimela.com

http://www.bawarchi.com

http://www.indiacultureonline.com

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Thangam Philip

INDONESIA. *See* **Southeast Asia.**

INDUSTRIALIZATION. *See* **Agriculture since the Industrial Revolution; Packaging and Canning.**

INDUS VALLEY. The food on which the diverse peoples of ancient India lived is a subject that has received some attention since archaeologists can recover bones, teeth, and carbonized seeds from their excavations. The period covered in this entry has come to be called the Indus Age (Possehl, 1999), that period in Pakistan and northwestern India which stretches from the beginnings of farming and herding around 7000 B.C.E. through the Early Iron Age to about 500 B.C.E. This period encompasses the Indus Civilization (2500–1900 B.C.E.), the Indian subcontinent's first period of urbanization (Fig. 1).

It was centered on the Indus Valley and the Punjab, but there were important settlements in southern Baluchistan, Gujarat, northern Rajasthan, Haryana, and western Uttar Pradesh (Fig. 2).

From the point of view of soil, water, and climate, these are regions suitable for the growing of wheat and barley and the raising of cattle, sheep, and goats on a significant scale. This is the constellation of plants and animals on which the earliest farmers and herders thrived, from the Mediterranean Sea to the lands of the Indus civilization.

A glimpse at an early period of farming and herding in this region is available from the site of Mehrgarh, on the Kachi plain of the Indus Valley. Around 7000 B.C.E., the inhabitants of this village lived mostly on domesticated, naked six-row barley, along with two other varieties of domesticated barley. Einkorn, emmer, and hard wheat were present in smaller amounts. The noncereals include the Indian jujube, a cherry-sized fruit; grapes; and dates. Sugar would have come from honey.

The use of domesticated rice by the peoples of the Indus civilization is not fully documented. However, by the second millennium B.C.E., it was the staple food grain at the site of Pirak, near Mehrgarh on the Kachi plain.

The animal economy of early Mehrgarh was dominated by twelve species of what can be termed "wild big game": gazelle, swamp deer, nilgai, blackbuck, onager,

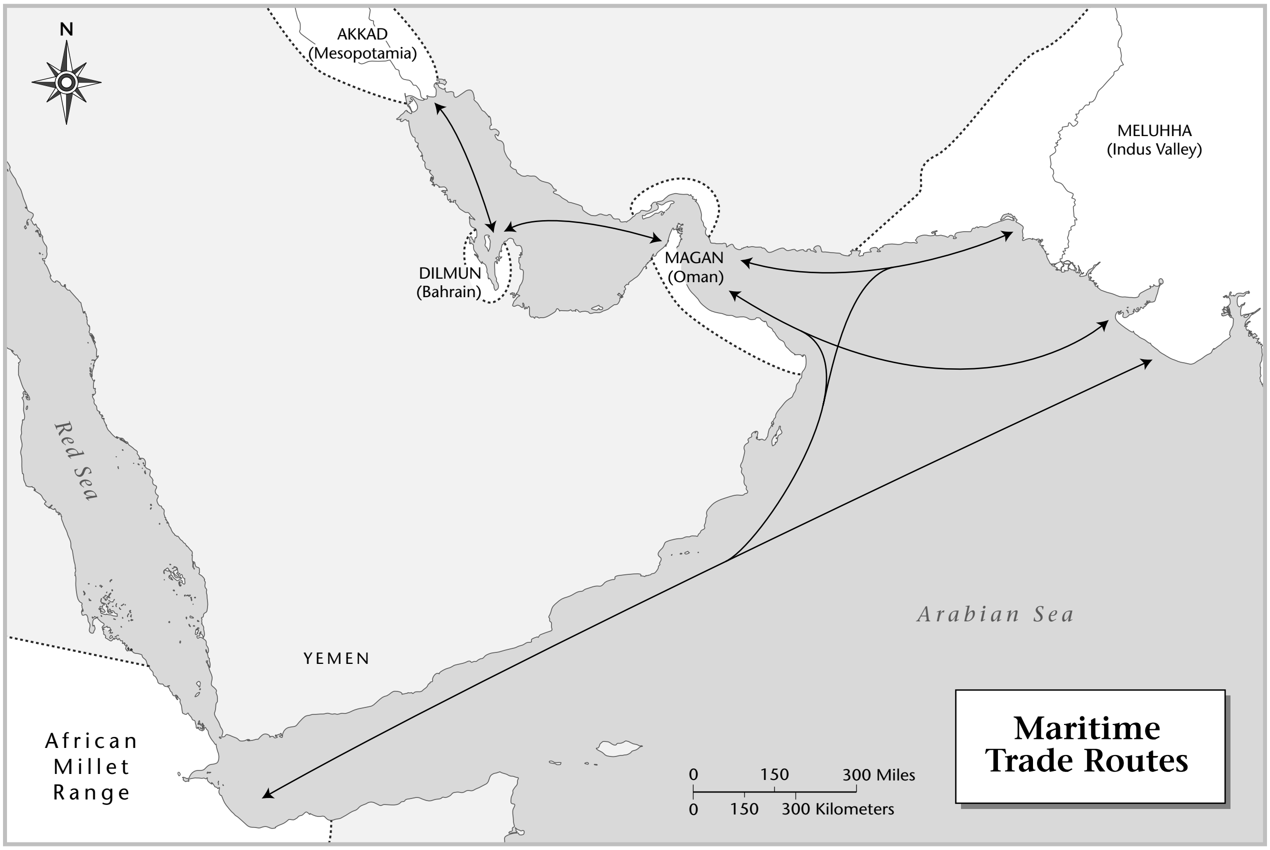
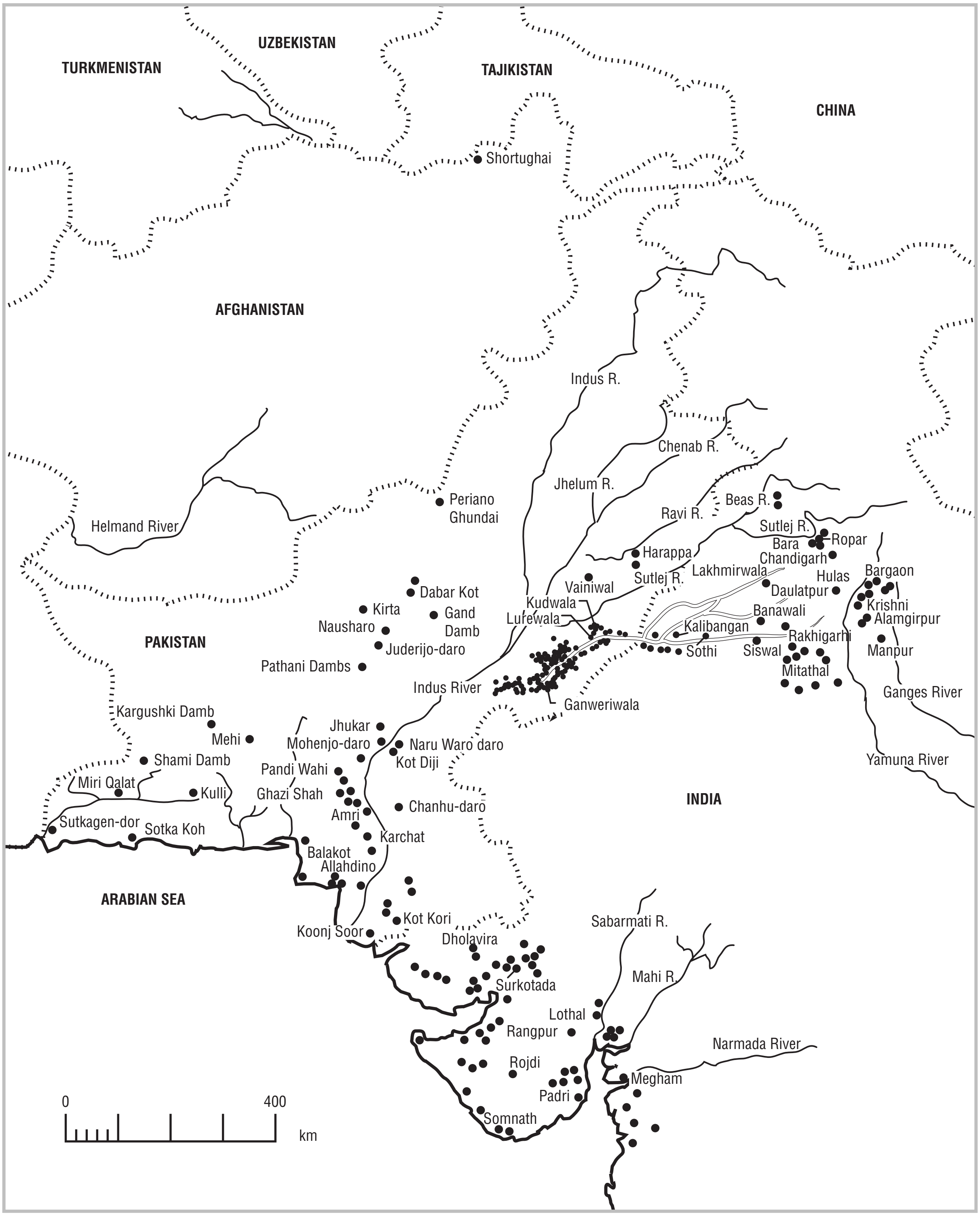


FIGURE 1


UZBEKISTAN
TURKMENISTAN
TAJIKISTAN
CHINA
Shortughai
AFGHANISTAN
Indus R.
Chenab R.
Jhelum R.
Periano Ghundai
Helmand River
Ravi R.
Beas R.
Sutlej R.
Bara
Ropar
Chandigarh
Harappa
Sutlej R.
Lakhmirwala
Hulas
Bargaon
Vainiwal
Daulatpur
Dabar Kot
Kudwala
Krishni
Kirta
Gand Damb
Lurewala
Banawali
Alamgirpur
Nausharo
Kalibangan
PAKISTAN
Rakhigarhi
Juderijo-daro
Siswal
Sothi
Manpur
Pathani Dambs
Mitathal
Indus River
Ganges River
Ganweriwala
Kargushki Damb
Jhukar
Mehi
Mohenjo-daro
Naru Waro daro
Shami Damb
Kot Diji
Yamuna River
Pandi Wahi
Miri Qalat
Kulli
Ghazi Shah
INDIA
Chanhu-daro
Amri
Sutkagen-dor
Sotka Koh
Karchat
Balakot
Allahdino
ARABIAN SEA
Kot Kori
Koonj Soor
Sabarmati R.
Dholavira
Surkotada
Mahi R.
Lothal
Rangpur
Narmada River
Rojdi
Megham
Padri
0
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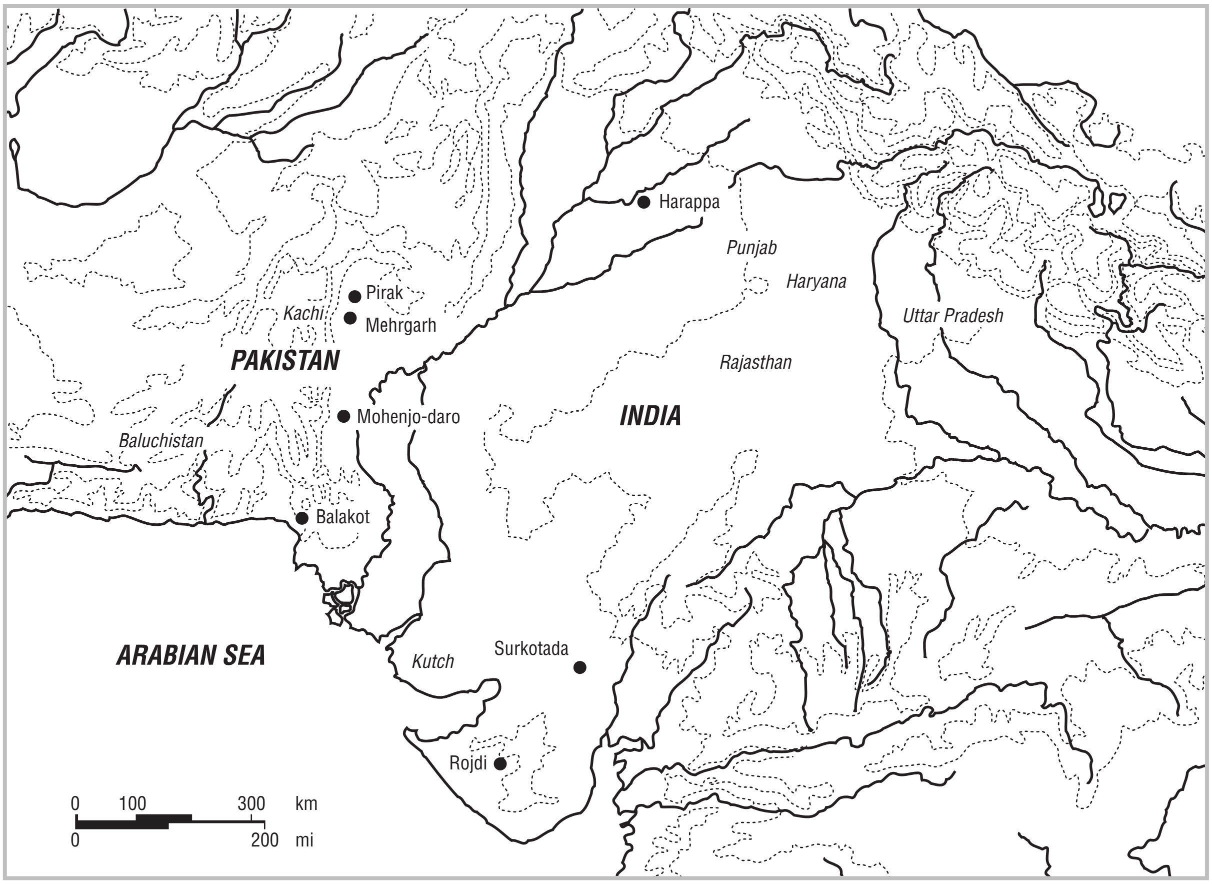
km
Somnath

spotted deer, water buffalo, sheep, goat, cattle, pig, and elephant. These are animals that would have lived on the Kachi plain itself and the hills that surround it. The virtual absence of fish and bird remains suggests that the swampy environments near Mehrgarh were little exploited, but no screening was undertaken at the Mehrgarh site, and the recovery of fish and bird bone was therefore somewhat compromised.

FIGURE 2



Meadow has noted the following concerning the subsistence economy of early Mehrgarh:

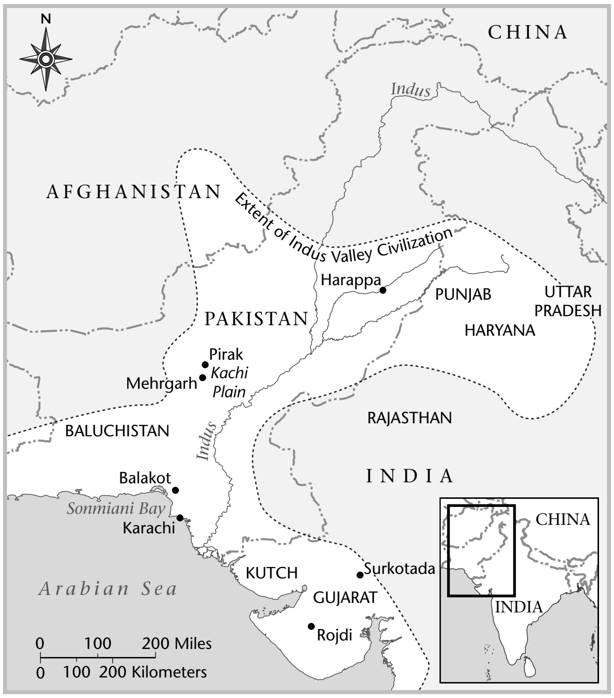
1. Goats were kept from the time of the first occupation of the site.
2. Cattle and sheep are likely to have been domesticated from local wild stock during Periods I and II (c. 7000–5000 B.C.E.).
3. Size diminution in goats was largely complete by late Period I, in cattle by Period II, and in sheep perhaps not until Period III.
4. The development of animal keeping by the ancient inhabitants of Mehrgarh took place in the context of cereal crop cultivation, the building of substantial mud brick structures, and the existence of social differentiation and long distance trade networks as attested by the presence of marine shells, lapis lazuli, and turquoise in even the earliest graves (p. 311).

From this evidence one can see that the development of food production and the domestication of the plants and animals appears to have been a local phenomenon, not one that came to the subcontinent by diffusion from the west.

Crops and Herds: Hunters, Gatherers, and Fishermen

From about 5000 B.C.E. the peoples of the Indus Valley and surrounding regions lived on a variety of food resources, both domesticated and wild. The base of the diet would have been the two cereals: barley first, and wheat second. They also cultivated various peas, beans and other pulses and exploited dates. Cotton seeds may have been present in Period II at Mehrgarh. One generally thinks of cotton as a fiber crop, but cotton oil is an important and nutritious commodity. Sesame was also domesticated in the Indus region, almost certainly for its oil. Most of these crops are grown in the winter season. For many millennia winter was the principal agricultural growing season in the subcontinent.

Extensive archaeology and archaeobotanical work in Gujarat, the southeastern "domain" of the Indus civilization, has produced evidence for the breadth of food resources used by the Indus peoples. A pot filled with seeds was recovered from the site of Surkotada. A number of seeds belonged to cultigens like Italian foxtail millet, green foxtail, and finger millet. The foxtail millet and finger millet were also found at the Sorath Harappan site of Rojdi (Weber, p. 119).



The chicken seems to have been first domesticated in China, but a case can be made that this was separately accomplished in the Indus region, where it is descended from the Indian Red Jungle Fowl, a beautifully colored bird. The male is a glossy deep orange-red, with long, yellowish neck feathers. The tail is shiny metallic black with long, arching sickle-shaped feathers. The underparts of the wild bird are blackish brown. This magnificent creature shares little in common with the almost pathetic white broiler stock now raised around the world. The wild chickens were eaten, and the eggs were probably a part of the diet.

Sedentary, village-based agriculture was complemented by herding, hunting and the gathering of additional plants. This served to expand and broaden the food base. We know from extensive analysis of animal remains that the peoples of the Indus civilization were cattle keepers on a grand scale. They also kept domesticated sheep and goats, as well as water buffalo. These animals were the source of a host of products from food to traction and of valuable materials such as fiber, leather, sinew, bone, and horn. Milk and milk products would have been very important to the Indus peoples. It is interesting to note that the subcontinent has never been a place where cheeses were prepared, but butter, *ghee* (clarified butter), and various forms of yogurt are widely known and may have their beginnings in the period being discussed here. The pig seems to have stayed wild, but it was hunted along with the animals listed above as "big game" that were not domesticated. Pigs and elephants were the source of ivory for the Indus peoples.

The aforementioned pot from Surkotada also produced large numbers of seeds from wild grass and sedges and other wild plants. This, and parallel evidence from Rojdi, informs us that gathering of wild plant material was an important part of the subsistence strategy, at least in some places. The Indian jujube was then, and is today, another food product gathered from wild trees.

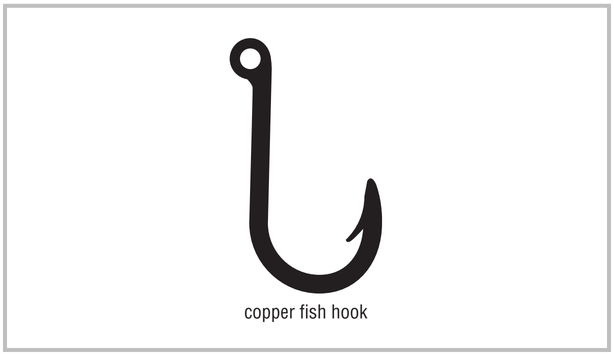
Evidence for the use of fish and shellfish is spotty and not robust in the Indus region prior to the Indus civilization. After about 2500 B.C.E., however, the use of these maritime and riverine resources increased markedly. It is clear, for example, that fish contributed significantly to the diet of the Harappan inhabitants of Balakot, just to the west of Karachi near Sonmiani Bay on the coast of the Arabian Sea. They were eating a grunt, a fish that inhabits lagoons and sea areas with sandy bottoms and is taken today by fishermen who use gill nets in Sonmiani Bay. The peoples of the Indus civilization were great fish lovers. The Indus River teems with various species that were caught and eaten. The Harappans made very nice copper or bronze fishhooks, with an eye to take the line (Fig. 3).

Large fish vertebrae have been found at some Kutch Harappan sites. Salted and/or dried fish were traded over large distances during the Mature Harappan, as documented by the presence of a marine species at the Indus civilization city of Harappa.

The peoples of the Indus civilization ate considerable quantities of shellfish and turned the shells into beautiful artifacts: bangles, beads, ladles, figurines, rings, and inlay. The gastropods included five "shank" type shells and three bivalves, or clamlike animals. At Balakot one species of "shank" and the grunt seem to have dominated the diet of the Harappans.

We do know that these protohistoric peoples ate plenty of meat, including beef. Whether any of them were vegetarians has not been determined. Some of them could have been, but the widespread modern Indian tradition of vegetarianism, and the special respect that Hindus have for cattle, came later. Modern Indian vegetarianism has many bases, but key to it historically is the philosophical concept of *ahimsa* (noninjury), which is a part of the In-

FIGURE 3


copper fish hook

dian intellectual achievement of the second half of the first millennium B.C.E.

Dietary Innovation with African Millets

The food grains of the early Indus Age were winter grasses, barley, and wheat. These do well in the northwestern region of the subcontinent where there is enough winter rain and snow to sustain them. But the main period of rainfall for the subcontinent as a whole is the summer monsoon, which lasts from June to November. This is the hot season, and the winter grasses, as well as the other winter crops that the peoples of the Indus Age used, were not well adapted to it. It turns out that the subcontinent does not have any large-seeded summer-season cereals that could be domesticated, so there was something of an environmental bind for the expansion of agriculture outside the northwestern region with its winter rainfall.

This environmental bind was broken to a large extent when three millets from Africa became available to the farmers of ancient India. These plants were sorghum, pearl millet, and finger millet, all of which evolved in a belt across Africa just below the southern margin of the Sahara desert. Evidence for maritime trade between the Indus civilization and Mesopotamia comes to us from cuneiform texts and artifacts recovered from archaeological excavations. The texts speak of Mesopotamian venture capitalists who mounted maritime trading expeditions to three lands: Dilmun, Magan, and Meluhha, identified in order as Bahrain Island, Oman, and the Indus civilization (Possehl 1997: 133–137). They brought large quantities of copper back to Mesopotamia. Sailors of the Indus civilization reached Oman and the Arabian Gulf, since quantities of common Indus pottery have been found there along with other Indus artifacts.

The presence of the African millets in archaeological sites dating from 2400 to 2000 B.C.E. in Yemen, Oman, and the subcontinent implies that one leg of this maritime trade extended to the mouth of the Red Sea, where Indus sailors, probably short on food supplies, acquired local grains (the millets) for the trip home. These are the large-seeded summer cereals on which an entire subsistence system can be based. They begin to appear in the archaeological record of the Indus civilization about 2400 B.C.E.—first finger millet, then pearl millet, and finally sorghum at the end of the third millennium.

The resulting modification to the subcontinent's subsistence pattern was slow and complex. The process was certainly not linear, with millets replacing other crops, and the massive acceptance of farming by hunter-gatherers. But over time these three African millets have made a massive contribution to the Indian economy because they were so well adapted to the summer monsoon wet season. Some measure of this success can be seen in modern statistics on cereal production in India. The three African millets are all in the list of the six most productive cereals, as seen in Table 1.

TABLE 1

Production of the top six cereals in India

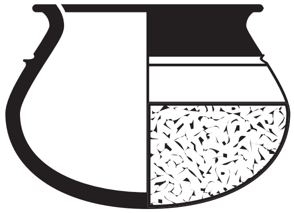
Grain	Amount in thousands of tons
Rice	70,667
Wheat	53,995
Sorghum	10,518
Corn	8,332
Pearl Millet	7,787
Finger Millet	2,379
All cereals	156,550

SOURCE: Government of India. *Indian Agriculture in Brief.* 23rd ed. Delhi: Ministry of Agriculture, 1990.

Ceramics and Food

Archaeologists have identified a few pottery shapes that can be associated with food and cooking in specific enough ways that they are interesting to talk about. There is a cooking pot, today called a *handi* in most north Indian languages (Fig. 4).

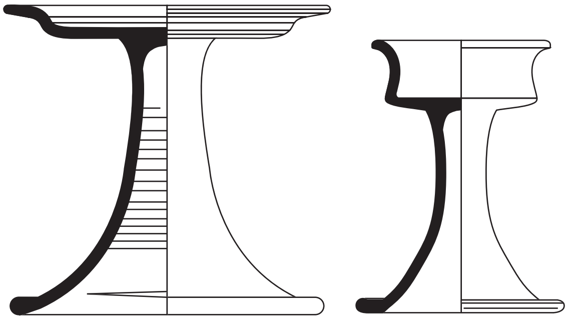
FIGURE 4



A handi

Shards from the bottoms of these pots are often fire-blackened, and they were sometimes protected against thermal shock with a coating of clay placed on the bottom after the pot was fired. The dish- or bowl-on-stand (Fig. 5). looks like a raised plate, just the sort of thing

FIGURE 5

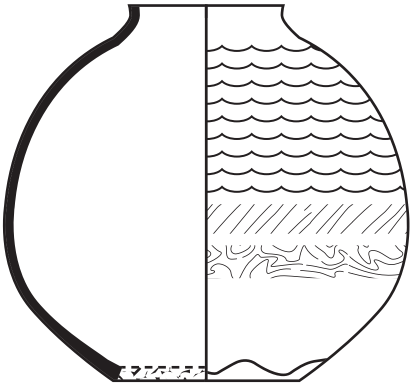


dish-on-stand

bowl-on-stand

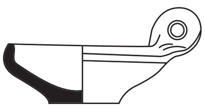
that a person who ate sitting on the floor would use to raise his or her dinner closer to the mouth. There are lots of globular pots, often with surface treatments that significantly increase the surface area of the pot. One of these ceramic types is called "wet ware" (Fig. 6), which was made by applying a viscous slurry of very fine clay over the body of a formed pot. The resulting pattern is both a decoration and functional since the many ridges increase the surface area of the pot, allowing for maximum evaporation, which kept the water in them cool. There are also small teacups (Fig. 7) with perforated handles, which look much like their modern counterparts, and probably functioned in much the same way, as well as copper-bronze frying pans (Fig. 8).

Figure 6



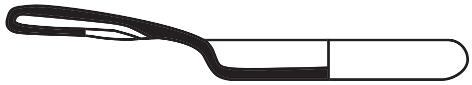
A wet ware water pot

Figure 7



tea cup

Figure 8



copper-bronze frying pan

Food and Eating in Ancient India

Based on what is known one can imagine an eating scene in a home during the Indus civilization. People seem to have eaten while sitting on the floor, which was probably covered with a rug or a mat. They were served their food in a dish or bowl on a stand. The meal could have included flat, unleavened bread of barely or wheat flour, ground at home between stones. This would have been accompanied by meat: chicken, goat, sheep, water buffalo, or even beef. At times the flesh of wild ungulates would have been available. Fish and shellfish would have broadened this portion of the diet. Various peas and pulses would have added a vegetable component to the meals; and chicken eggs may have been included. A fruit component to the meal, possibly a dessert, would have come from honey, dates, grapes and the jujube. Milk from cows, buffalo, sheep and goats would have been available, and could have added great diversity of taste to the ancient diet. Cool liquids would have come from spherical pots, like those in wet ware, and been consumed in ceramic tableware, possibly even the little tea cups. Although butter was probably prepared, since it goes rancid so quickly in hot climates, the more stable clarified form, known as *ghee* in contemporary India, was also prepared. Other oils, for cooking and consumption, would have come from sesame and cotton seeds.

Cooking would have included roasting, boiling, and baking, as suggested by the *handi*-shaped pots, and frying, as documented by the copper-bronze frying pans. By 1500 B.C.E. the *tandoor*, a clay oven, is documented. This implies that this distinctive cuisine of modern India and Pakistan has a 3,500-year history.

There would have been almost no refrigeration, so many foods would have been eaten fresh, and seasonal availability would have had an important impact on the diet. But some forms of preservation were probably known. Food grains can be stored for years if kept dry. Clarified butter keeps for months. Dried and/or salted meat and fish are implied by the presence of maritime fish at Harappa, five hundred miles from the sea.

There is much to be learned on this topic of food in protohistoric times in South Asia. But there is an outline, and that will surely be filled out over time.

See also **Butter**; **Cereal Grains**; **India**.

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Gregory L. Possehl

INFANT FORMULA. *See* **Baby Food; Lactation; Milk, Human.**

INSPECTION. Among the many systems that assure food safety, inspection is one of the most critical and difficult. As the global trade of food increased over time, veterinary experts of the Organization International des Epizooties (OIE) addressed the scientific challenge of confining animal diseases, which are the origin of most food-borne pathogens. In 1951 the spread of plant pests through trade became the concern of the International Plant Protection Committee (IPPC) of the Food and Agriculture Organization (FAO). As a result, the World Health Organization (WHO) and FAO organized a set of international standards, the Codex Alimentarius, which describes preferred methods of food production to minimize contaminants and toxicants to keep them below acceptable tolerance levels, with recommendations from the OIE and IPPC. In the early twenty-first century, the Sanitary and Phytosanitary Agreement (SPS) was the system that governed how inspection standards may be used in the fair trade of foods. This agreement was established by members of the 1994 Uruguay Round of the General Agreement on Tariffs and Trade (GATT). Together, Codex and SPS work to improve the quality of traded foods, limit the movement of crop pests and animal diseases, and mediate fair trade.

In the United States, inspection is performed by several different agencies, such as the Department of Agriculture, the Food and Drug Administration, the National Oceanographic and Aeronautic Administration, and the U.S. Customs Service. The following laws empower these agencies to perform inspections: the Federal Meat Inspection Act (1906), the Seafood Inspection Act (1934), and the Federal Food, Drug, and Cosmetic Act (1938) (Table 1). While the U.S. Department of Agriculture (USDA) cannot demand that a plant be closed, and while product recalls are voluntary, the withdrawal of all inspectors effectively means a plant can no longer ship its products since inspection is mandatory. The Food and Drug Administration (FDA) has authority to inspect food production facilities overseas, reject foods from entry into the United States, and even pull defective products off of store shelves.

TABLE 1

U.S. food inspection system

Food	Agency/office	Target
Meat, poultry, and processed egg products	USDA Food Safety and Inspection Service (FSIS)	Pathogens, filth, drug residues
Imported plants and pests, live animals	USDA Animal and Plant Health Inspection Service (APHIS)	Crop diseases
Fresh plant foods and eggs, processed foods, seafood, and dairy	FDA Office of Regulatory Affairs (ORA)	Pathogens, toxins, filth, pesticides, additives

U.S. Customs authorities assist in processing food imports at 150 ports of entry. In 2000, the FDA's limited resources allowed direct physical inspection of only 1 percent of imports. Still the system manages to catch problems (logging in over eight million lines of import detentions annually). In one season the reasons given for rejection of imports included: filth (32 percent); microbial pathogens and molds (17 percent); low-acid canned foods (12.5 percent); defective or misleading labeling (10 percent); pesticides and heavy metals (11.5 percent); decomposition (7.5 percent); and food additives (6.5 percent).

If an inspector suspects that products are unsafe, items can be detained automatically (especially if a number of previous shipments have been defective). An agency usually has a month to test the product and make a decision on its admissibility, but the importer may apply for early release after five days if the product is perishable. Permanently detained food must be remanufactured to acceptable standards, destroyed, or removed from the country within a certain period of time (three months in the United States).

In other countries inspection of imports may be a local, national, or regional endeavor. The Canadian Food Inspection Agency (CFIA) is the inspection authority in that country. In Central America, the Organismo Internacional Regional de Sanidad Agropecuaria, or International Regional Organization for Plant and Animal Sanitation (OIRSA), is the agency responsible for testing imports and assuring their safety.

Issues that arise from inspection are of two main types: political and scientific. First, if the reason for detention of an inspected food item is not transparent and scientifically valid, the importing country may be accused of erecting a trade barrier. Second, adequate sampling and testing are technically difficult. Traditionally, meat and poultry were inspected through organoleptic or sensory evaluation (smell, sight, touch), which worked for detection of gross filth, decomposition, and molds, but not for detection of microbial pathogens. Agents have begun to perform microbiological tests on meat and poultry, but such tests must be rapid, accurate, and relatively inexpensive to be useful. Perishable foods that are detained too long may not be fit for consumption by the time test results are available. Tests for many pathogens are still in development; agents often test for common pathogens like salmonella and *E. coli*, which serve as biomarkers for the existence of other pathogens in a food sample.

Even when an excellent testing procedure is available, sampling poses a problem, especially in the case of solid or semi-solid foods. Contamination may be isolated in one part of a carcass, a head of lettuce, or a production run of some other food. Sampling the entire product would eliminate the worry that a pathogen was missed, but there would be no product left to eat. Thus an elaborate science of statistical testing has evolved to ascertain with reasonable probability whether a product is contaminated based on a certain number of samples of a certain size. Still, there is no guarantee that the product is safe or that subsequent abuse will not render it unsafe.

To streamline the inspection process, many countries require government-validated export certificates to verify whether a product contains what the label says it does and that it has been approved for safety and offered for consumption in the country that produces it. Making certification an internationally harmonious process is the focus of the Codex Committee for Food Import and Export Inspection and Certification Systems.

See also **Codex Alimentarius; FAO (Food and Agriculture Organization); Food Safety; Food Trade Associations; Government Agencies; International Agencies**.

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Robin Yeaton Woo

INTAKE.

Intake is an umbrella term that refers to the act of taking something in. The term "intake" is often used in relation to food and drink, to describe how and how much is ingested. It also relates to behavior, since mental processing is involved in the action of eating and drinking. That is, physical and social stimuli are involved in feeding and drinking behaviors in terms of controlling the movements of gathering and ingesting materials; internal stimuli such as metabolism and circulating substrates also play a role. Intake of food and drink interests natural and social sciences as it is a vital behavior to sustain life that is also shaped by culture and society.

Behavioral Organization of Intake

The behavioral organization of intake involves perception of the sensory characteristics of food and drink. Physical and chemical properties of food and drink that can be sensed by the eater provide information about their nature. Orosensory attributes (that is, those relating to both taste and the other senses) can be detected by sight and sound, smell, irritance, taste, and touch. Food and drink can be appealing based on their orosensory properties. And the first mouthfuls of food can send substrates around the body within minutes.

Intake can be adjusted according to nutritional needs when orosensory characteristics are associated with the postingestive (metabolic) effects of food and drink. Orosensory characteristics can thus become cues that predict postingestional effects specific to foods and drinks. These cues can be unlearned (innate, sweet taste) or learned (acquired, bitter taste). While sweet stimuli mean energy, perhaps from carbohydrate, bitter stimuli are a cue to alkaloid toxins. From an evolutionary standpoint, it has been hypothesized that the liking for sweetness ensured animals' survival. In animals and humans, learning plays an important role in food intake. The acquisition of a taste for nutrients and an aversion for toxic substance are also vital. Behavioral and physiological analysis of the learning of pre- and postingestive control of intake was developed by French physiologist Jacques Le Magnen. His original contributions include findings on conditioned sensory aversions, carbohydrate-conditioned sensory preferences, and control of meal size.

Social and Cultural Organization of Intake

Intake is also organized according to food availability. In terms of the latter, we see the great contrast between industrialized countries where food is available in abundance and Third World countries where hunger afflicts poor people due to food scarcity. Our ancestors' intake was mainly dependent on plant food gathering, hunting, and fishing. Later on, domestication of food and animals and the development of food preservation enabled human societies to improve food availability. However, in parts of the world not well suited for cultivation, pastoralists still acquire their food from their herds of domesticated animals. Herding allows them to transform nonedible plant matter into animal products.

Intake is also determined by the culture of human groups. Learned cultural knowledge affects food choices. Socially transmitted knowledge about food includes norms, religious, or cult values, as well as myths, superstitions, taboos, and fads. The intake of certain kinds of plant and animal foods can be culturally prohibited. For example, cattle are killed for meat in many parts of the world, while traditional Hindus forbid killing cattle for meat because of their use in agriculture. Dogs serve as pets and companions in American culture while serving as food in other cultures, illustrating how intake is motivated by symbolic values of the food rather than its survival value. However, sociocultural influences do not act alone and interact with the individual's biology to determine intake.

Control of Intake

Investigations concerned with the control of intake have used various peripheral and central approaches. This has led to theories of the mechanisms controlling intake, such as the glucostatic (transient change of blood glucose), the lipostatic (fat metabolism and body fat stores), the thermostatic (thermic effect of food), and the aminostatic (essential amino acid) hypotheses. Although intake was shown to be facilitated or inhibited by a variety of substrates, the behavioral mechanisms remain to be identified. Neural bases of food intake have evolved from the those prevalent in the 1950s, focusing on appetite and satiety brain centers located in the hypothalamus, to the current hypothesis that macronutrient intake is controlled by precise synaptic pathways. Food intake might indeed be guided by macronutrient selection. However, experiments that involve presenting laboratory animals with two or more diets differing in their nutrient content in an attempt to understand brain mechanisms that control intake involves the inclusion of confounding factors. Indeed, many drugs that affect central nervous system neurotransmitters and peptides also act on sensory pathways. Therefore, unless the confounding sensory attributes of food have been excluded, one cannot conclude that the subsequent food intake is controlled by the macronutrients. This principle was applied by examining studies using sensorily contrasting forms of various macronutrients, and only brain serotonin was found to affect carbohydrate intake while the effects of catecholamines and opiates on macronutrients were not substantiated.

Intake is also motivated by factors external to the food or the drink itself. Age, sex, physiological state, nutritional state, emotions, stress, number of people present, peer groups, food trends, social pressures (body image), as well as beliefs related to food safety (for example, food beliefs related to mad cow disease, genetically modified foods, pesticide-free or organic food) are known to influence intake. Other external factors that affect intake include food availability, food cost, as well as environmental factors (season, temperature, and so forth). In addition, animal and human studies have revealed that food and macronutrient intake is related to circadian rhythms, and that food intake is concentrated during the period of main activity (for example, during the day) and is related to predictable rhythms of macronutrient selection.

Expressing Intake

Intake of food and drink is often estimated by dietary measurement of daily intake of energy (kilocalorie [kcal], kilojoules [kJ]) and nutrients (carbohydrate, protein, lipid, vitamins, and minerals. Units such as the gram (g), milligram (mg), microgram (μg), International Unit (IU), and so forth are used, as well as established human nutrition methodologies such as food diary, food recalls, food frequency questionnaires, and so on. Intakes are then qualified as adequate or inadequate based on nutritional recommendations. Nutritional research methods need to be improved by assessing cognitive perception and control of eating.

Facilitated intake and its inhibition are expressed in various ways. Among terms used to describe facilitated intake or events surrounding it are appetite, hunger, palatability, motivation to eat, and (sensory) preference. If intake is inhibited, terms such as satiety, satiation, appetite inhibition, or even satiety disinhibition are used. These terms are often used to interpret sets of quantitative data such as amount eaten during the day, meal size, ingestion rate, or numbers calculated from scales rating the hunger state. Although these measurements do not assess cognitive processes controlling intake, their direction is translated into words describing behaviors. The experimental design is therefore crucial to identify causal processes involved in intake; for example, unchanged quantitative intake while rate of intake is reduced could be interpreted as decreased pleasure while sensory preference remains unaffected.

Implications

Insufficient intake results in chronic malnutrition and periodic massive starvation. Related health problems are numerous, and include the impact of the permanent effect of energy–protein deficiency on brain development (in early childhood), parasitic diseases, and high rates of infant mortality. Controlling population growth and a better allocation of resources were proposed as solutions to world hunger. The problem of hunger could also be alleviated by technology transfer in which new technologies and crop variety could improve food production.

Disordered intake can lead to health problems such as obesity, cardiovascular disease, diabetes, alcoholism, as well as disordered eating in athletes and the eating disorders of restrictive eaters, anorexics, and bulimics. Interestingly, these health problems often arise in countries where food is abundant. Intake of specific macronutrients has been linked to diseases, for example, intake of carbohydrates has been linked to diabetes, and fat intake has been linked to heart disease, as well as to some cancers. Therefore, a better understanding of how intake is controlled could provide precious tools enabling one to intervene effectively or even prevent the development of nutrition-related pathologies.

See also **Acceptance and Rejection**; **Appetite**; **Assessment of Nutritional Status**; **Eating: Anatomy and Physiology of Eating**; **Health and Disease**; **Malnutrition**; **Metabolic Imprinting and Programming**; **Sensation and the Senses**.

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Louise Thibault

INTERNATIONAL AGENCIES. The second half of the twentieth century witnessed the growth of a type of social institution that plays an important role in food and nutrition policies and programs throughout the world. These institutions, which are commonly referred to as "international agencies," are usually constituted as suborganizations within larger sociopolitical organizational structures. One set of such institutions are the "multilaterals," which include many governments, particularly the agencies of the United Nations (UN), or those of the European Union. A second set of agencies, often referred to as "bilaterals," are the aid organizations established by national governments in the industrialized world, including those of the European states, the United States, and Canada, as well as Australia and Japan. A third type, with activities that closely parallel those of the UN and governmental agencies, includes nongovernmental organizations (NGOs) or private voluntary organizations (PVOs). These may be religious or "faith-based" agencies that are administratively connected to religious organizations or are closely affiliated with such organizations, or they may be independent groups, such as the Helen Keller Foundation or Save the Children. Many of these NGOs receive funds from bilateral and multilateral agencies.

Agencies of the United Nations

The establishment of the various agencies in the UN system began with the founding of the UN in 1945. During the following half-century, new agencies were added as needs were redefined and expanded. The current body of UN agencies whose work involves food and/or nutrition are the Asian Development Bank (ADB), Food and Agriculture Organization (FAO), International Atomic Energy Agency (IAEA), International Fund for Agricultural Development (IFAD), International Labor Organization (ILO), Joint United Nations Programme on HIV/AIDS (UNAIDS), United Nations Development Programme (UNDP), United Nations Educational, Scientific, and Cultural Organization (UNESCO), United Nations Population Fund (UNFPA), United Nations High Commissioner for Refugees (UNHCR), United Nations Children's Fund (UNICEF), United Nations Research Institute for Social Development (UNRISD), World Food Programme (WFP), World Health Organization (WHO), and the World Bank.

Agency Goals and Functions

One of the principal motivations underlying the establishment and operation of international agencies was to provide vehicles for directing resources—economic, technical, and technological—from resource-rich countries to resource-poor countries. Other political, economic, and social interests also shape the motivations and activities of agencies. Moreover, the fact that international agencies are generally not freestanding institutions, but part of larger sociopolitical units, is one of several characteristics that affect their mission, administrative organization, philosophy, policy, and activities.

The purposes of both UN and non-UN agencies whose work relates to food and nutrition can be summarized by one or more of the following goals: establishing technical norms, providing funding, providing technical assistance, or delivering services. Within the UN system, the various agencies were established with distinct, yet complementary, mandates and were given different, but often overlapping, sectors of action. Thus, WHO and FAO were set up as technical agencies with responsibilities for technical norms and technical assistance, whereas UNICEF was designed to support and deliver services through funding and technical support, and the World Bank was designed to provide funds.

Obstacles, Challenges, and Persistence

In their efforts to further the health and welfare of populations with respect to food and nutrition, international agencies face multiple challenges. An examination of these challenges helps to explain the gaps between stated goals and realities of agency activities that make them frequent subjects of controversy and criticism. Some of these challenges relate to the structure of international collaboration and conflict regardless of the focus of action, while others are specific to characteristics of social action related to food and nutrition.

A primary challenge for establishing complementary activities at country and community levels is that agencies' activities are based on widely differing philosophies of how to promote and sustain development. Bilateral agencies represent countries with different economic and political agendas. These differ not only between nations, but also within nations, as is evident from the policy changes that accompany shifts in government when different political parties are in power. Within the UN system itself, there are also different philosophies and constituencies, which are evident not only between agencies, but also within them. The NGOs and PVOs represent still other sets of values and theories about what needs to be done and how to do it.

International agencies face serious challenges in reconciling definitions of needs as perceived on one hand by technical advisers, high-level political representatives, and international advocacy groups, and on the other with the needs articulated by recipient groups, from national-level politicians and civil administrators to regional and community-level spokesmen. These conflicting interpretations arise from multiple sources and cover a range of issues, including ethical concerns and competing values about fairness, justice and "whose reality counts," priorities for action in the face of limited resources, and differing perspectives on the causes and consequences of food and nutrition problems. A related factor that affects many aspects of food and nutrition policies and programs is that most agencies, especially the bilaterals, have to answer to the political constituencies who control the resources they require to carry out their work. Indeed the basic organization of development activities into the categories of "donors" and "recipients" create structural barriers that pose significant challenges to meeting population needs.

Another common problem, which relates to the demands from "donor constituencies," is that the time frame for research, program development, and evaluation is typically much too short. As a consequence, agencies are forced to take shortcuts that jeopardize the achievement of goals. As a result, the potential to learn from experience is reduced, and there are inadequate opportunities to make adjustments to improve programs.

Special challenges for food and nutrition activities stem from the fact that throughout the world they relate to multiple and very different social sectors. Food is the provenance of agriculture and various economic sectors of producers and marketing concerns. It is also the source of nutrients, which are the provenance of nutrition and health sectors. Both national governments and international agencies tend to divide food and nutrition responsibilities among multiple organizational units, which often results in conflicting goals and serious fragmentation of efforts. Even within a particular sector, such as health agencies, differing orientations may result in conflicting approaches to nutrition and health education in communities.

In 1977 the UN established the Subcommittee on Nutrition (SCN), under the aegis of the Administrative Committee on Coordination (ACC), as a mechanism for communication among the various UN agencies with responsibilities in food and nutrition. The ACC/SCN, which meets yearly and compiles and disseminates technical reports through its office in Geneva, Switzerland, also seeks the participation of bilaterals and NGOs. This small organization has no mandated authority to resolve differences but provides a forum for exchange and debate. Its existence is threatened by hostility from some of its constituent agencies who fear that SCN activities may reveal weaknesses in their own operations, and at least one of SCN's components, the Advisory Group on Nutrition (AGN), which was composed of senior experts from outside the UN system, has been dismantled.

EUROPEAN
RELIEF
COUNCIL

Commerce Secretary (later President) Herbert Hoover inspects food shipments for the European Relief Council in the early 1920s. Food was sent to help Europe recover from the devastation of World War I and its aftermath. COURTESY OF ARCHIVE PHOTOS, INC.

The example of the tribulations of the SCN provides a glimpse of the shortcomings in motivations, organization, and action that are typical of international agencies. There are, however, two critical questions to answer before recommending curtailing or abolishing these agencies. The first is, "Would the poor and hungry be better off without these agencies?" Historical comparisons of situations where the agencies have and have not been active reveal that the presence of the agencies has been favorable. Without them, the only major interests affecting food and nutrition are commercial and political—neither of which care much about the poor.

The second question is, "Can the system or its constituents be improved?" Greater intellectual attention is required to address such important issues as updating the mandates of international agencies to modern realities, instituting better accountability for all international agencies (including bilaterals and NGOs), and increasing resources to improve diet and nutrition worldwide. At the level of agencies, a high priority is developing better methods for more effective cooperation between agencies and populations. While there are many difficult barriers to improving agency functioning, dedicated people who work in and with international agencies find many opportunities to make improvements.

See also **Codex Alimentarius**; **Food and Agriculture Organization (FAO)**; **Food Supply and the Global Food Market; Food Trade Organizations; Government Agencies; Political Economy.**

Gretel Pelto
Jean-Pierre Habicht

INTESTINAL FLORA. "The entire world is covered with a layer of feces. Granted it is thicker in some places than in others, but a solid layer, nevertheless. . . ." This is how a wizened professor used to begin his clinical parasitology course for microbiology graduate students. Naturally all the students laughed, only to learn during the ensuing months that the statement is profoundly true. The lesson also bears truth in that fecal microorganisms arise from within the bowels of the digestive tract. The human intestine is home to an invisible and remarkable biosphere of living organisms dedicated to preserving its own existence. Humans serve as host to these billions and trillions of organisms that function in effect as a single living entity.

In fair exchange, during our lifespan, our gut flora provides us with health, protects us from disease, and serves as the major labor force to digest almost everything we eat—from artichokes to zebu.

The population of microbes that inhabit our intestines is made up of hundreds of different species of bacteria and other organisms. By far the vast majority of these are anaerobic, which means they do not multiply in the presence of oxygen. Since few if any anaerobes are defined as classic pathogens, by and large these anaerobes are only of interest to culinarians because they function to metabolize and break down what we eat and make it available to be absorbed and used as fuel and energy for our own body. Other species that require air (oxygen) to live are more commonly known by the general public, and a few have even achieved stardom, mainly because of their predilection to cause disease. Thus, certain bacteria such as *staphylococcus*, *E. coli*, *salmonella*, *shigella*, *enterobacter*, and others have become well recognized, if not feared—almost to the point of being a phobia—by some people, especially in the United States. Most people seem to be confused by too many overstated, highly publicized warnings, along with too many recommendations from too many different sources.

A list of the scientific names of all the different microorganisms that inhabit the human gut, sometimes described as autochthonous flora, would be very lengthy. Some understanding of science is required, however, in order to appreciate the very complex relationship we have with the microbial world living inside and on our bodies, which in turn help maintain the delicate balance between health and disease. Most important is the fact that each living human being has a rather steadfast and distinct microbial profile. This profile is almost as identifiable as a fingerprint.

When foreign bacteria are introduced to our profile, the ecosystem reacts rather quickly to disallow these species to proliferate. Accordingly, disease is not a normal finding; rather, we, for most of our existence, maintain ourselves in a general state of good health.

Some remarkable studies have demonstrated that even when our intestinal microbiologic profile is disrupted to the point of causing disease, for instance, in the case of traveler's diarrhea, the body mounts a tremendous effort to return itself to its normal healthful state, and in doing so somehow the original microbial profile returns. What we eat and how old we are does play a major role in the overall state of our live-in microbial population, and on occasion shifts of our profile do occur. For example, this happens when the microbes adjust to accommodate the various types of food we ingest. So, if we eat a diet of all starches, those species of organisms which thrive on starches will increase their relative numbers in relation to the frequency and amount of starch which we consume. When one considers diseases that are due to intestinal microbiota, it is also important to know what "pathologic bolus" means. Simply put, this phrase refers to the minimal number of pathogenic organisms needed to be ingested in order to cause a specific disease. It is usually expressed as numbers in powers of ten per gram or milliliter of menstruum. This number ranges from very large to very small, depending on the specific organism and disease. So, while certain diseases require huge numbers of bacteria in order to initiate illness, others require very few bacteria.

For example, not all *salmonella* species are pathogenic, and those that are generally require that a large pathologic bolus be ingested to produce illness. On the other hand, most species of *shigella* are intrinsically "pathogenic," and it takes only a small number to cause symptoms. It has been found, in this example, that *salmonellae* generally are susceptible to destruction by acidity of the stomach, and few survive to enter the intestines where the actual infection takes place. Shigellae, on the other hand, are able to withstand the acidity of our gastric juices and arrive in the intestine viable and ready to set up (unwanted) residence and cause disease.

Other major factors also play heavily in defining health and disease. Paramount to this struggle are the status of our overall nutritional habits and secondly the maintenance of the immune system and understanding how it functions to protect us from invading organisms.

In general, well-fed people are less likely to catch infectious diseases of any sort, and with some exceptions, the incidence and severity of dysenterylike diseases are also lessened if we follow a well-balanced diet. The amazing increase in the average height of individuals after the introduction of better food and balanced diets in certain Third World populations, which occurred in one single generation, is testimony to the tremendous impact diet plays in this regard. Individuals who suffer from underlying diseases and conditions that compromise the normal function of our immune system are much more vulnerable to life-threatening diseases caused by bacteria, viruses, and other organisms than are average citizens. Likewise, those who have lost protection due to impairment or destruction of the skin are much more likely to become ill. The causative agents in these cases are produced not only by recognized pathogens, but also come from normally benign species of so-called normal (or commensal) flora. Almost 90 percent of mortalities in burn patients are due to infection and sepsis. Furthermore, most of these deadly infections are produced by the patient's own intrinsic internal microorganisms. Notable for this discussion is that most foodborne diseases are indeed usually attributed to microbial species of the enteric type—"enteric" meaning those normally found in the digestive tract. When they are allowed to proliferate in nutrient-rich unrefrigerated foods such as potato salad, bacterial and viral "food poisoning" is likely, and outbreaks continue to afflict even the most civilized nations.

The most common cause of both direct and cross-contamination of foods, which ultimately can lead to such outbreaks, is unofficially labeled in medical vernacular the "fecal/hand/mouth" route—not a polite description, but accurate. Furthermore, although refrigeration and proper storage—and to a lesser degree chemical disinfection—are important, human hands remain the most villainous of vectors of food-borne disease. More important, frequent handwashing with regular soap and hot water remains the absolute best means of prevention.

See also **Digestion**; **Eating: Anatomy and Physiology of Eating**; **Health and Disease**.

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Fritz Blank

INTRAVENOUS FEEDING. *See* **Enteral and Parenteral Nutrition.**

INUIT. The northern indigenous peoples known as Eskimo or Inuit (not including the Russian Inuit and Yupiget) numbered approximately 143,582 in 2002. In the United States, Alaskan Eskimos (Inuit, Yupiit, Yupiget, and others) numbered 55,674 according to the 1990 census (U.S. Bureau of the Census, personal communication, May 2002). In Canada, Inuit numbered 41,800 in the 1996 census, while the nation of Greenland, formerly a Danish territory, had an Inuit population of 46,108 in 2001. Alaskan Eskimos live in rural coastal villages, along northern rivers, in isolated island or northern interior valleys and, increasingly, in regional population centers such as Anchorage, Barrow, Fairbanks, Kotzebue, and Nome. In Canada, despite rising migration rates to the south, most Inuit live in fifty-five rural communities located in Nunavut, the Northwest Territories, Quebec province, Newfoundland, and Labrador. In Greenland, too, Inuit live in coastal villages, although those who live in population centers such as Nuuk are increasing.

In Alaska, Canada, and Greenland, names such as Inuit, Yupiit, and Yupiget identify Eskimos as "the people" or "the real people." Regardless of location or name, food is a critical feature of identity for all. (The term "Eskimo" is used here because it includes all groups.) Identity is often expressed as a longing for locally harvested and prepared foods by those who find themselves separated from traditional homeland communities. Local foods are referred to as "our" food, "real" food, or, in Alaska, simply "Eskimo" food. In Canada, such foods are called "country" food. Among the Alaskan Yupiget of St. Lawrence Island, for instance, the term *neqepik* means "real" food, while imported foods are called *laluramka* or "white people's" food (Jolles, 2002).

Across the north, dietary habits and cultural meanings attached to food are similar, due partly to adaptation to a common arctic ecosystem and partly to similar socioeconomic conditions, which keep unemployment rates as high as 50 to 80 percent. Under such conditions, subsistence-oriented hunting, fishing, and gathering activities, vital to community survival, are performed year-round. In Nunavut, Canada, alone, replacing subsistence foods with equivalent amounts of beef, chicken, and pork would cost an estimated $30 to $35 million annually.

Types of harvested foods depend on local environments and overall resource availability. In 2002, in In-

Whale and walrus meat drying in the open air at Hoopers Bay, Alaska. FROM AN ANTIQUE PHOTOGRAPH, COURTESY OF THE LIBRARY OF CONGRESS.

galiq, Little Diomede Island, Alaska, for example, severe weather plus political and physical isolation at the Russian-American border one mile distant necessitated a substantial dependence on local foods. Diomede subsistence resources include bearded seals, ringed seals, spotted seals, walrus, and polar bears. In summer, the community harvests migrating water fowl such as auklets, puffins, and murres, along with their eggs. In late summer, wild greens and berries are harvested and stored. In winter (December through mid-May), the community takes Alaska blue king crabs through the sea ice and trades a portion of the harvest with mainland Alaskan Eskimo communities for unavailable foods such as caribou. Altogether, Ingaliq subsistence foods include more than forty marine mammal, plant, avian, fish, and shellfish resources. Local harvests in Diomede and elsewhere in the North are supplemented with expensive, imported, commercially available goods from Native cooperative stores, Hudson Bay Company franchises, and other small multipurpose stores found throughout the north.

In Alaska, meat and fish are the centerpieces of Eskimo diets and constitute 90 percent of locally harvested foods. In addition, communities take several types of whales: bowhead, gray, minke, and beluga, or white. Reindeer (introduced in the late 1890s by the U.S. government and managed by local villages), moose, caribou, and a newly reintroduced resource, musk oxen (available to hunters in 1995) are also taken. Numerous migratory seabirds are hunted during late spring and early fall, as is the ptarmigan, a permanent resident. Fish are prominent in southwestern coastal diets, especially salmon. Herring, tomcod, Arctic char, grayling, flounder, sculpin, and halibut also contribute to the diet. Clams are taken from walrus stomachs. Ground squirrels, once commonly harvested for their furs and their meat, are seldom taken any more. While meat is the mainstay, wild greens and berries are much sought. At least thirty species of plants are collected for food purposes from the land and from the beaches (Jones, 1983; Schofield, 1989, 1993).

For Canadian Inuit, diet in the early twenty-first century also consisted of two major classes of food, Inuit food or "country" food, and *Qallunaat*, or "white people's" food. "Country" foods include caribou, Arctic hare, ptarmigan, ringed seal, bearded seal, walrus, polar bear, beluga whale, migrating fish (Arctic char, Atlantic salmon, and Pacific salmon), and migratory birds (Canada goose, common eider, king eider, and black guillemots). "White people's" food includes items shipped from southern Canada and purchased at local stores, including fresh fruits and vegetables, canned goods, processed foods, and dry goods.

In Alaska, especially in the most northern communities, it was once common to consume uncooked meats. This has become less common with the introduction of such modern conveniences as microwaves, refrigerators, propane-fueled stoves, and the like. However, in Canada, the preference for uncooked meats is still a significant cultural feature. This practice became a powerful marker of Inuit identity in the post–World War II era as Canadian Inuit experienced more sustained contact with Europeans and Canadians of European descent such as missionaries, teachers, and administrators. Consumption of raw or frozen foods, a practice typically disdained by non-Inuit, intensified boundaries separating Inuit and non-Inuit (Brody, 1975), and fostered increased social unity and political activism among Inuit who sought to protect and promote their hunting and fishing rights and to achieve local resource management in Inuit homelands.

Greenland Inuit obtain their food from two major sources: local land, seas, and lakes (called "country" food) and through local store purchases and via mail order. The main subsistence foods are ringed seal, beluga whale, caribou, bearded seal, and polar bear as well as a wide variety of fish, including cod, capelin, Atlantic salmon, Arctic char, and Greenland halibut. One feature that distinguishes the Inuit of Greenland from Canadian and Alaskan Eskimos is the abundance of small-scale fisheries, which include fish plants that provide a number of settlements with seasonal employment (Dahl, 2000). In addition to subsistence production, many Greenlandic Inuit are also involved in large-scale commercial fishing operations, and fishing products, including shrimp, Greenlandic halibut and crabs are Greenland's major exports. Many of the companies are owned and maintained by Inuit. Finally, there are approximately sixty sheep farms in southwest Greenland that produce lamb and other products for both domestic and international markets.

Food management in Eskimo communities combines traditional practices with modern convenience. Subsistence meats are often "half-dried" on outdoor meat racks, cooked (boiled), and stored in containers of seal oil or, alternatively, stored in home freezers, either "half-dried" or fresh. Greens, roots, and berries are more often stored in freezers, although some residents also use seal oil. Traditional underground or semiunderground food caches are gradually becoming a part of the past, while home freezer storage and consumption of fresh frozen foods has become increasingly common. In the late twentieth century and early twenty-first, in spite of significant changes in food storage methods, locally harvested foods from the land and the sea remained a major component of Eskimo food consumption. However, while "country" food or "real" food still defines ethnic and cultural boundaries in the North, "white people's" food is increasingly popular among young people, whether in Alaska (Jolles, 2002), Canada, or Greenland (Searles, 2002). The presence of contaminants in locally harvested foods is a major concern in the Arctic, for example, PCP, and is under discussion in all of the affected regions. It is unclear how this information, along with changing lifeways, will modify Eskimo diets.

See also **Arctic; Canada: Native Peoples.**

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IODINE. Iodine is an essential dietary element necessary for normal development and function of all vertebrates. Its sole physiological function is as a constituent of the thyroid hormones, thyroxine and triiodothyronine. It is removed from the blood by the thyroid gland for storage in organic form where it is found as iodinated amino acids in peptide linkage in thyroglobulin, a high-molecular weight protein.

Iodine is widely but usually sparsely distributed in nature, so that in vast areas of the world the supply in customary diets is marginal or insufficient. It has been estimated that over two billion persons are at risk of disorders attributable to iodine deficiency. Among these disorders are goiter, impaired intellectual function, growth retardation, reduced fecundity, lowered work capacity, increased rates of fetal loss and infant mortality, deafness, and in extreme instances a well-defined but somewhat varied constellation of physical findings collectively known as cretinism. Cretins are recognized by severe mental deficiency, disturbances in gait, impaired or absent hearing, and other neurological defects, but the signs and symptoms in these individuals may be subtle. These features merge with those of the less impaired members of the same community or nearby countryside where they may appear in lesser severity.

The iodine content of edible plants is largely dependent on the iodine content of the soil on which they are grown. The iodine content of foods of animal origin depends on the iodine in their food. Iodine is concentrated in milk, and is found in relatively high concentration in sea fish, who are at the upper levels of the food chain that contains algae. Some sea fish concentrate iodine from sea water. The only structure among the vertebrates that contains a significant amount of iodine is the thyroid gland.

Role of Iodine in Disease

For centuries the disorders arising from iodine deficiency have been recognized in well-defined regions. These have been called "goiter belts." Switzerland was included in the goiter belt until the iodine deficiency in that country was corrected in the first half of the twentieth century. Until recent years iodine deficiency was a recognized disorder in the United States, especially the Midwest and West, where goiter was commonplace. Iodine deficiency has been a major public health problem in the Andean region and eastward, in large areas of central and north Africa, in the Middle Eastern countries, in India, and in eastern and central Europe, and even today in localized regions of western Europe. Fortunately, remarkable headway has been made in elimination of iodine deficiency through various methods of supplementing diets.

Goiter is only one of the many consequences of iodine deficiency, and is relatively trivial when compared with the damaging effects of iodine deficiency on the nervous system. From the human point of view, it is more correct to speak of "endemic mental deficiency" than "endemic goiter."

Endemic thyroid disease has traditionally been considered a feature of iodine deficiency in the mountainous regions of the world. Endemic thyroid disease is found in regions of high elevation, but has also been common where glacial run-offs occur and in floodplains where there has been chronic leaching of the soil. Such geographic regions include the Gangetic plain and much of India and southeastern Asia, the Himalayan region, and central Africa, where the iodine deficiency disorders are frequent and severe; the coastal regions of western Europe are marginally iodine deficient. Endemic iodine deficiency can be detected almost anywhere with currently available sensitive techniques. In the United States until recently the mean intake of iodine was excessive, but recently has been rapidly falling into a normal range. The recent precipitous fall in iodine consumption in the United States has led to concern that iodine deficiency may again become a problem if the present rate of decline continues. The need for monitoring iodine intake is apparent. This is customarily done by measuring the iodine content of urine from a fair sample of the population under observation.

The optimal daily adult iodine intake is about 150 μ g/day, about half that for children and infants. This figure rises to about 200 μ g during pregnancy, but under normal circumstances there is wide latitude in intake because of the ability of the normal thyroid system to compensate for varying levels of supply. The thyroid and pituitary through a feedback relationship provide a highly efficient regulatory system. If iodine intake falls below about 50 μ g/day the pituitary gland becomes stimulated to increase its iodine uptake and hormone production, and, if the iodine supply exceeds needs, the pituitary shuts down appropriately.

Iodine is readily absorbed by the stomach and upper gastrointestinal tract. Iodine in chemical combination is released in the gut and absorbed; it may be rapidly taken up by the thyroid gland or excreted in the urine. Only a small fraction appears in the stool. Exceptions occur when iodine is in chemical combination with such drugs used as radio-contrast agents and amiodarone, the widely used cardiac medication.

Iodine Deficiency and Disease

Certain chemical agents found in some foods interfere with the uptake or utilization of iodine by the thyroid. Among these are the cyanoglycosides found in cassava (manioc), a component of millet, and a variety of chemical agents and some unidentified substances found in the effluent water from rock formations and in factory discharges. It must be stressed that the inhibitory effect of these substances may be bypassed if there is an ample supply of iodine in the diet, but their effect may be critical if the iodine intake is marginal or lower.

When marginal or low iodine intake is identified in a geographic regions such as a district or country, an effort should be made to correct the deficiency. A variety of techniques have been employed. These include distribution of iodine solution to school attendees, candies containing potassium iodide, addition of iodine to drinking water, and the use of canisters containing iodine that is slowly released into sources of drinking water. None of these methods has proved to be widely accepted. In addition, it should be stressed that the primary target for the prevention of neurological damage due to iodine deficiency is the pregnant and nursing mother.

Prevention of Iodine Deficiency

The most effective and widely employed method for correcting iodine deficiency is salt iodization. The technique is simple, inexpensive, and effective. Potassium iodate rather than iodide salts is used because it is more stable when mixed with salt. Nevertheless certain problems must be corrected. Unscrupulous traders may sharply increase the cost of iodized salt to the consumer. If improperly stored the iodine may sublime and be lost from the salt. If addition of iodine by the manufacturer is not done carefully the salt may be overiodinated. In certain cases, especially those in which people have nodular goiters resulting from prolonged iodine deficiency, thyrotoxicosis may result, which may be subtle in onset and chronic, with unwanted or disastrous results. Careful and continued monitoring of dietary supplementation by iodized salt must be done, as with all food additives.

Promotion of salt iodization, especially in areas of particular need in the developing world, has been a health priority of many public and private agencies, including the World Health Organization, UNICEF, the International Council for Prevention of the Iodine Deficiency Disorders, and others. One of the principal problems with programs of salt iodization is that governments tend to lose interest, and the programs lapse, leading to recurrence of the iodine deficiency disorders. Again, constant monitoring is the key to continued success.

Injections of heavily iodinated poppyseed and other oils have been tried in mass campaigns, first in New Guinea; these methods have since been widely employed elsewhere. These are the same oils that have been widely used as radio-contrast agents. The results have been impressive. The iodine is slowly released from the oil and may be effective for two or more years. The oral route has also been used to administer the oils, but effectiveness is less prolonged. The disadvantages of programs using iodinated oil are principally cost and the requirement for sterile needles and trained personnel, which may be difficult to obtain in remote regions. Iodine-induced thyrotoxicosis may occur after administration of iodinated oil.

A unique and successful method of iodine distribution has recently been introduced. This method can be used in regions where iodine can be drip-added to irrigation water. It has been used in the desert regions of western China with salutary human benefit, and with a highly satisfactory effect on livestock production. The problems with this method are the need for skilled personnel to add the iodine to the irrigation system at the right time and rate, and the fact that it is only feasible when it is possible to add iodine to irrigation water. A somewhat similar technique that has proved beneficial is adding iodine to a municipal water supply. As with other methods of iodine supplementation, skilled maintenance of the program is essential, and the subsequent appearance of thyrotoxicosis is unknown.

Summary

Iodine is thinly distributed in the earth's crust, and much of the human population lives in regions that have marginal or insufficient iodine. Mountainous regions, floodplains, and regions where there has been extensive leaching of iodine from the soil may not provide sufficient iodine for human needs. The result is the appearance of iodine deficiency disorders, which include neurological damage, goiter, increased fetal and infant mortality, deafness, and diminished human energy and resulting economic underproductivity. Iodine deficiency is a major public health problem for a large fraction of the world's population.

Wherever marginal or insufficient iodine exists, implementation of iodine supplementation is required. This may be done by supplementing table salt with iodine, administration of iodinated oil by injection or orally, or addition of iodine to the drinking water. It is essential that a monitoring system be in place to ensure that the population is receiving an adequate iodine intake. Care must be exercised to avoid an excess of iodine, which might induce thyrotoxicosis.

See also **Body Composition; Fluoride; International Agencies; Malnutrition; Nutrition; Nutrition Transition: Worldwide Diet Change; Salt; Sodium; Trace Elements.**

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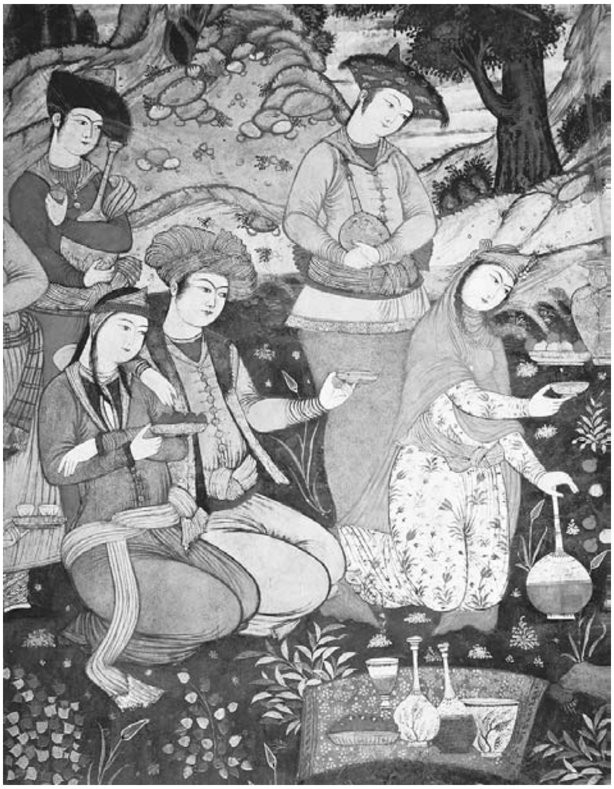
IRAN. The art of sophisticated cookery in Iran can be traced to antiquity. It has, according to existing literature, preserved its basic mode of preparation for more than a thousand years, enhanced by refinement of dishes and new recipes created in the kitchens of royalty and ordinary folk. Iranian food is prepared with such delicate subtlety that every ingredient used can be tasted and every aromatic spice added can be appreciated.

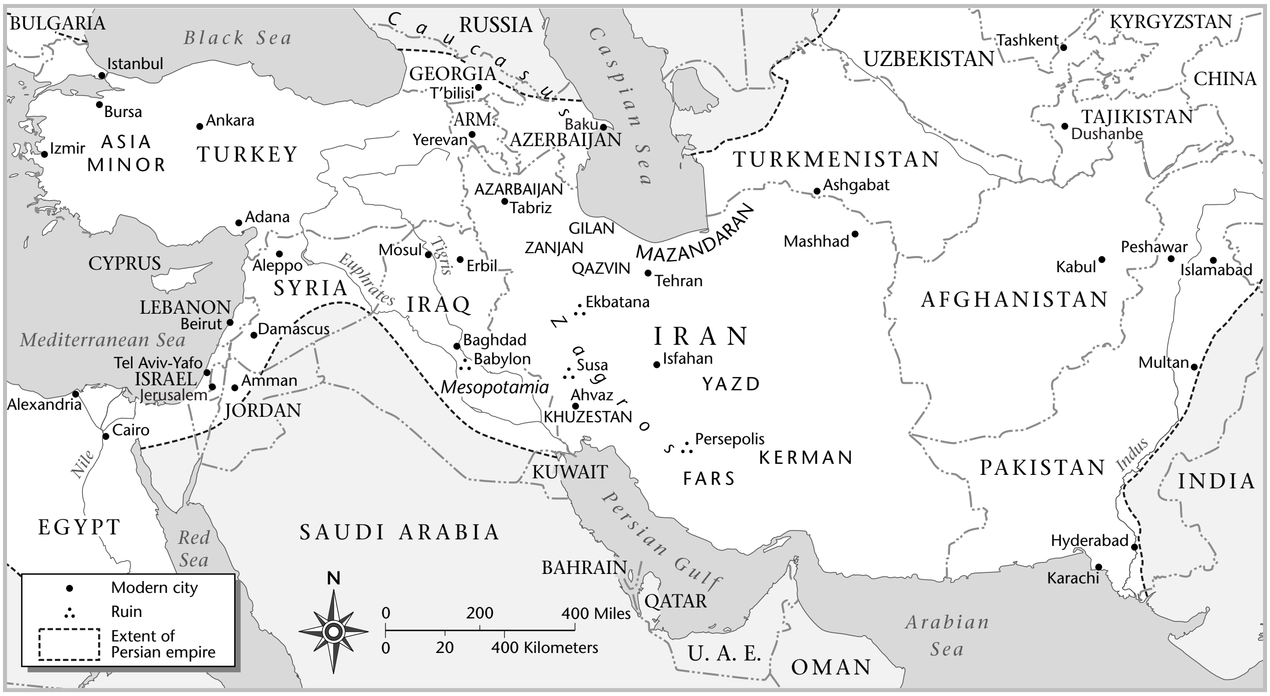


Detail of a seventeenth-century miniature showing an outdoor banquet of Abbas I of Persia. The carafes on the small carpet contain red wine. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

Food of Ancient Persia

History. The Persian Achaemenid empire, founded by Cyrus the Great in 549 B.C.E., dominated the ancient world for almost two centuries. At the height of its power it extended from the Indus in the east to Asia Minor and Egypt in the west, uniting Medes, Persians, and Parthians, as well as many other tribes and peoples, in fealty to the dynasty. Presumably the people living in that vast expanse with its varied climates each formed their own culinary culture according to indigenous food products, naturally available, grown, or reared. Yet all cultures converged at the Achaemenid court and were elaborately manifested at the table of the king of kings.

There are no known recipes left of that period. The references to food in the Avesta and Elamite tablets from Persepolis dated 509–494 B.C.E. indicate that the Achaemenid diet consisted of dairy products from cows, sheep, goats, and mares; meat from oxen, rams, goats, and wild or reared fowls; grains for making bread; ales; wines; dried fruit; and nuts and seeds also used for pressing oil.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RUSSIA
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KYRGYZSTAN
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UZBEKISTAN
CHINA
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GEORGIA
T'bilisi
TAJIKISTAN
Dushanbe
Bursa
Ankara
ARM.
Baku
Izmir
ASIA MINOR
TURKEY
Yerevan
AZERBAIJAN
TURKMENISTAN
Ashgabat
AZARBAIJAN
Tabriz
Adana
GILAN
MAZANDARAN
Mashhad
CYPRUS
Aleppo
Mosul
Tigris
Erbil
ZANJAN
QAZVIN
Tehran
Kabul
Peshawar
Islamabad
Euphrates
SYRIA
IRAQ
Ekbatana
AFGHANISTAN
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Each season, the nomad kings and the court moved from capital to capital. Winter was spent in Babylon or Susa, where the wine was fermented from dates and grapes; spring in Ecbatana, where meat, dairy products, and herbs were ample; and autumn in Persepolis, where fruit, wild vegetables, and seeds were in abundance.

Narratives by Greek authors of the period reveal the sumptuous preparation and the abundance of food in that fertile realm. Ctesias (405–397 B.C.E.) and Dinon indicate that 15,000 men ate daily in the court of the Achaemenid king of kings. The Greek writer Polyaenus (second century C.E.) recounts that the food brought to the court for distribution as well as for the preparation of three meals a day was formulated by Cyrus and engraved on a bronze column. It included great quantities of different grades of wheat, barley, and rye, floured or treated; grains of corn and parsley; salt; male livestock; gazelles; poultry; geese; pigeons; small wild birds; dairy; watercress; onions and garlic; pickled radishes and beetroots; cured capers; juice of sweet apples; conserve of sour pomegranates; honey; oils of almond, terebinth, sesame seed, and acanthus; raisins dark and light; nuts; sweetened seeds; vinegar; mustard, anise, cumin, celery, and safflower seeds; saffron; cardamom; and dill flower. Xenophon (430–355 B.C.E.) notes that what was served at the king's table was prepared in exquisite taste by expert cooks and bakers who were engaged in a constant search for new recipes and would invent a variety of pastries and cakes.

Herodotus (fifth century B.C.E.) relates that the Persians ate varied desserts and sweets. Birthdays were celebrated by giving great feasts. Side dishes, served at regular intervals, punctuated the introduction of the principal dishes. Large animals, including big fowl like ostrich, were stuffed and roasted whole; birds were stuffed and seasoned with capers. Meat cured in sophisticated fashion was served.

The Greek historian Diodorus Siculus (first century B.C.E.) reflects on the variety of delicacies brought from Persia to Babylon, in particular fish from the Persian Gulf. Polyaenus remarks on the exquisite mixture of cardamom and other spices, vinegar, and pepper, and upon the use of aromatic herbs from which oil was also extracted for medicinal purposes.

It is said that soldiers normally received meat and bread, but on long journeys and campaigns were sustained by onion soup and bread. To this day *eshkaneh*, basically made with onions, flour, and turmeric, is cooked in different parts of Iran. Seasonal or dried herbs and fruit—dried or fresh—are added, and, combined with one or two eggs, the dish can serve a big family. It remains the food of the populace, while the stuffed beast or fowl, *boghlameh*, is served mainly at tribal feasts by those who can afford the luxury. Pierre Briant, quoting Polyaenus, remarks in *Histoire de l'Empire Perse* (p. 300) that when Alexander the Great defeated Darius III and seized Persepolis (331 B.C.E.), ordering the bronze pillars to be destroyed, he said with laughter that such a diet weakens the body and the mind and was the cause of the defeat of the Persians.

Following Alexander's demise, his successors, the Seleucid Greek rulers (323–64 B.C.E.), were overthrown by the Parthians of western Iran. The Parthians (250 B.C.E.–224 C.E.) revived the national spirit that came to full flowering under their successors, the Sassanians (224–652 C.E.). The culinary culture of the aristocracy and preparation of food in this period are revealed in a rare Pahlavi manuscript, "King Husrav and His Boy" (translated: J. Unvala, Paris), a reliable source that withstood the destruction of libraries by the Islamic army in 636 or 637. In the text Khosrow II and a companion discuss, among the pleasures of life, the variety of Epicurean cuisine. Some dishes are in certain ways similar to what is eaten in the early twenty-first century in certain parts of Iran. For example, the boy recommends that the meat of a two-month-old kid fed on mother's milk and cow's milk marinated with herbs be cooked and served with whey (*kashk*). In Yazd (central Iran), Kerman, and Azerbaijan, *bōzghōrmēh* is still a popular dish. It features chunks of goat's meat or mutton as a dominant substitute, fried with chopped onions, seasoned with turmeric and cinnamon, sprinkled with tarragon and mint or saffron, and topped by thick yogurt or *kashk*. As for sweets, almond, walnut, and pistachio are used in making delicate cookies, as they were many years ago. A jelly made with quince juice is now called *mōjassamēh-ye beh*. In jams and preserves the peel of *baalang*, a large citrus fruit, is still popular in Fars and Gilan provinces. Quince jam continues to be made in most parts. Cucumber and walnut jams and pickles are remembered recipes in Qazvin.

Other later sources, too, elaborate the sophisticated Sassanid cuisine. An eleventh-century scholar, Tha'alebi of Neishapur, describes in his "History" a variety of dishes including wild birds and other game, fish, lamb, and veal marinated in vinegar, mustard, stock, garlic, dill, and green and black cumin, or in yogurt, flavored with spices, and stewed, broiled, or roasted according to different recipes; barbecued chicken flavored with cane sugar, skewered and grilled; stuffed vine leaves; puddings made of rice, milk, honey, butter, eggs, and rosewater; and delicacies and sweets using countless aromatics. He mentions that peasants marinated their meat in brine and pomegranate juice.

Festivals. Festivals were frequent in ancient Persia. For the ancient Persian herdsmen and farmers, the revival of nature in the spring was a terrestrial renewal of life, so people equated the New Year with the spring equinox. Before the equinox, reverence for the seven *Ēmshāspands* (archangels) in the Zoroastrian religion was symbolized in seven cereals and pulses grown in clay pots to predict the quality of the next harvest. In the five leap days (the year being 360 days) preceding *Nōwrūz* (New Year's festival), festivities would begin. Food, including milk and honey, sweetmeats, nuts, and dried fruits, was prepared and bonfires were lit on rooftops to attract the *Farvahars*, or guardian angels of the ancestors, who would descend for the annual reception in which wining and dining continued for five days following *Nōwrūz*.

Yaldā is still celebrated, marking the birth of Mithra on the longest night of the year. Throughout the long night of *Yaldā*, fresh fruit specially preserved for the occasion, seven kinds of nuts, and a range of dried fruit were consumed in a joyous vigil held to drive out the darkness in anticipation of the sun's rebirth. Apart from *Mēhrgān* or *Sadēh* little is known of other such festivals.

After the Arab invasion in the seventh century, a great number of Zoroastrians migrated to India, taking with them their culinary culture. However, the art of Persian cookery and the etiquette of eating (*ādāb-é sōfrēh*) at a spread (*sōfrēh*) laden with a colorful array of food survived. These, in later years, highly influenced the Arab, the Ottoman, and the Indian culinary cultures.

In the eighth century, Iranians who helped the Abbasid caliphs gain power passed on the refined Sassanid recipes to Baghdad. This is apparent in a range of cookery books written in Arabic in subsequent centuries.

In the fifteenth century, the haute cuisine that evolved at the Ottoman court was in the style of the Teimurid court of Persia. From the sixteenth century, when a descendant of the Teimurid dynasty in Iran established the Moghul empire in Delhi, the first cookery books, written in Persian and Urdu by Iranian scholars of the imperial court, appeared. In parallel, cookery books were written in Iran by master chefs in the Safavid court and in the nineteenth century in the Qājār court of Nā ser od-Dīn Shāh, showing further refinement in the art of cooking, of rice, in particular.

Modern Iranian Cuisine

Rice. Rice in Iran is steamed to a unique perfection, bringing out its full flavor and fragrance, turning the grains into light, fluffy *chēlōw* (plain rice) that may be eaten with *khōrēsh* (stew) or grilled meat (*chēlōw kabāb*). Rice can be steamed with meat, herbs, vegetables, sour cherries, or pulses in many varieties, colors, and mixtures (*pōlōw*) as a crisp crust (*tah-dig*) is formed at the bottom of the cooking vessel. It can be garnished with saffron, barberries, and slivers of orange peel, pistachio, and almond. Rice with beaten eggs, yogurt, and saffron, steamed with layers of cooked meat, eggplant (aubergine), or spinach turns into yet another sumptuous dish known as *tahchin*.

The best rice is grown in the Caspian provinces of Gīlān and Māzandarān; it is also cultivated in limited quantity in the Lenjān district of Ēsfahān and along the Qēzēl Ōzan River near Zanjān. The major grades of quality long-grain rice, with their elongated form and characteristic fragrance, Sadri Dōmsīah and Tārōm, are the best known for perfume and taste.

Stews. Iranian cuisine in general is the art of cooking the available nutrients in a way that pleases the eye and the palate and balances the functions of the body. Recipes consider food's properties and elements to formulate an equation in which the ingredients blend harmoniously, each counterbalancing the excess effect of the other on the digestive system.

Khōrēsh, derived from the Persian verb *khōrdan* (to eat), is a kind of stew prepared to these rules. The base for every *khōrēsh* is fried onions (garlic is added in the northern and southern regions), meat or poultry, the appropriate spices and seasoning. These are left to simmer in water to a desired consistency, then lightly fried vegetables, herbs, or fruit are added. Depending on vegetables and herbs in season, countless varieties are made all over Iran. For example, chopped mint and parsley would make *khōrēsh-é na'najafari* with celery, or, in the spring, rhubarb, greengages, acanthus, or young green almonds with verjuice (sour grape juice) as seasoning. The famous *khōrēsh-é fēsēnjān*, which turns into a thick light or dark brown sauce, is made of ground walnuts seasoned with pomegranate juice or paste and has a sweet and sour taste. The cooling effect of pomegranate juice balances the warm and rich property of walnuts. This is an autumn and winter *khōrēsh* customarily made with duck, or with chicken or meatballs as substitutes. In late autumn it can be made with ripe walnuts and pomegranate juice. In winter chunks of eggplant or pumpkin, dried prunes, and apricots may be added. It is then called *mōtanjan.* A further derivation is *anār-āvīj* (pomegranate paste or juice and herbs), prepared in the Caspian region. Another speciality is *khōrēsh-é ghōrmēh-sabzi* made with mixed herbs and red kidney beans (in the south, black-eyed beans) with whole dried limes used for fragrance, freshness, and seasoning. Also common is *khōrēsh-e gheimeh* (diced meat) with split peas, served plain or with fried potato sticks and dried lime as seasoning or eggplant, zucchini (courgettes), or celery with sour grapes as seasoning, quinces, or apples with sweetened vinegar as seasoning, etc. A luxury, known from the imperial court of the Qājārs (nineteenth century), is *gheimēh-mōrassa'* (jeweled diced meat), which in place of split peas uses skinned whole pistachios with ample saffron for aroma and color.

Khōrāk and side dishes. *Khōrāk*, also derived from the verb *khōrdan* ('to eat') cooked with or without meat, cover an extensive range and reflect the significant contributions of Gīlān and Azerbaijan provinces. Among these dishes are *kabāb*, a variation of charcoal-grilled meat, fowl, or fish; *shāmi*—meat cooked with split peas pounded and kneaded with eggs, ground cumin, and saffron, shaped in a round patty and deep-fried; *kūkū*, a form of thick puffed omelette or soufflé of different vegetables or herbs; *dōlmēh*—stuffed vegetables or vine or cabbage leaves; *tās-kabāb*, meticulously arranged layers of onion, meat, tomatoes, carrots, eggplant, potatoes, and quinces or apples (depending on the season), sprinkled with cardamom and cinnamon, chopped dried lime, and prunes steam-cooked in its own juice on low heat; *kashk-bādēmjān*—fried eggplant topped with *kashk* (whey) and tastefully garnished; *mīrzāghāsēmi*, grilled eggplant cooked with garlic, tomatoes, and eggs. Side dishes are prepared with various vegetables cooked or raw and mixed with yogurt seasoned with aromatic herbs.

Fish. Fish is cooked in a variety of ways in the Caspian Sea provinces and alongside the Persian Gulf and the Arabian Sea. In the Khuzistan region well-spiced baked fish seasoned with tamarind is among the specialities whereas in the Caspian area it is barbecued or stuffed with herbs, including dried pomegranate seeds, baked and served with bitter oranges. The Caspian caviar is an important item for export, and the large grey and the rare golden of the Iranian coast are famous among connoisseurs.

Bread. Bread or *nān* is revered as a gift from God. Except in the rice-growing areas along the Caspian coast, it is the staple food of Iranians. *Khōrēshs* and *khōrāks* are eaten with *nān* as well as rice. Made in a flat form, the most common varieties of bread are *sangak* (baked on pebbles), *tāftūn*, thin *lavāsh*, thick *barbari*, *nān-é shīrmāl* (dough mixed with milk), and crispy *nān-é rōghani* (dough mixed with butter).

Soups. *Āsh* is the general name for a thick soup made with herbs, rice, or pulses with or without meat, served plain or variably seasoned. It is another prominent and universal feature of Iranian cuisine. The recipe for *āsh-e sac* (spinach soup) has been passed down from the Sassanid era. *Āsh* cooked using barley, wheat, or noodles and *kashk* is a convenient dish in tribal life. *Ābgūsht* (literally meat juice) is made with mutton, onions, turmeric, chickpeas, pinto beans, tomatoes, potatoes, and dried lime; the stock is separated and the rest is pounded into a paste. It is the sustaining food of all classes. Other variations of *ābgūsht* are derived from this basic form. Another soup is known as *kallēh-pācheh* (sheep's head and pig's feet in a bouillon); when homemade, tripe is often added. *Halīm is* a homogeneous porridgelike soup made with wheat and pounded meat of lamb, turkey, or goose, garnished with melted butter and powdered cinnamon. *Kūftēh* refers to tiny to very large meatballs in onion-based soup. The *kūftēh tabrīyi* of Azerbaijan is so large that it can hold a chicken, an egg, prunes, barberries, orange peel, and almonds in its center.

There are cold soups for summer. *Ābdūgh*, a soup made from cucumber, raisins, and herbs in diluted yogurt is everybody's meal. *Ēshkanēh*, made with fresh fruit such as sour cherries, is both refreshing and filling.

Confections and preserves. A common confection is *hālva*, prepared from flour, butter, diluted sugar, saffron, and rosewater. *Tar hālva*, a sophisticated version of *hālva*, is prepared with ground rice instead of flour and with crushed orange peel or yellow rose petals. Other well-known desserts are *shōllēhzard*, made with rice, water, butter, sugar, saffron, and almond slivers and garnished with cinnamon and crushed pistachio; *masqati*, made with starch, water, sugar, butter, cardamom, and almond slivers; and *yakhdarbēhēsht*, prepared with starch, milk, and sugar. All are perfumed with rosewater or orange-blossom water.

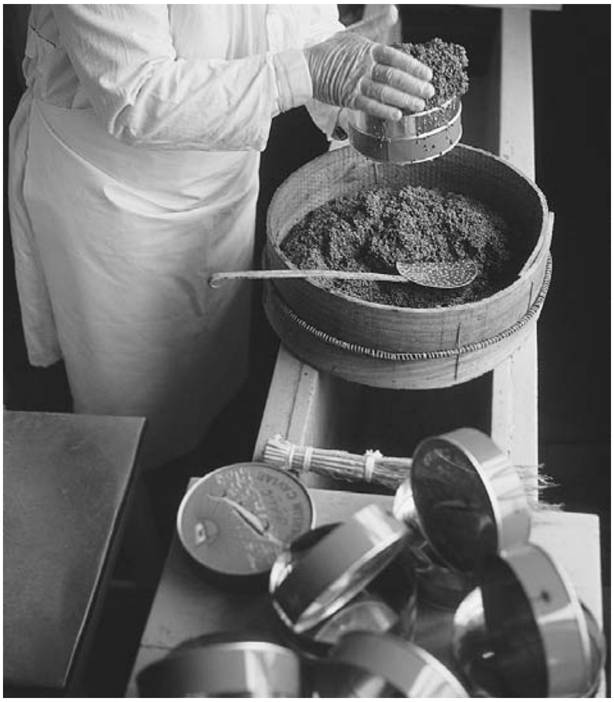
Jams, preserves, *torshis* (pickles), and sherbets (soft and refreshing cold drinks) such as *sērkangēbin*, made of sugar water, vinegar, and mint, and others prepared with the juice of rhubarb or various fruits, are prominent features of Iranian culinary culture. The techniques of long conservation of herbs, vegetables, meat, fish, and dairy have been passed on from one generation to another and have been developed in homes mainly by women, the keepers of the household.

Cookies and pastries. Cookies and pastries in Iran are generally delicate in form with a subtle aroma, prepared with variation on basic recipes in different regions. *Bāghlava*, made with phyllo pastry, finely ground almonds or pistachio, sugar and light syrup, flavored with cardamom and rosewater, finely cut into small diamond-shaped pieces, is a popular confection. Now commercially produced, it was conventionally a homemade product except in Yazd, where confectioners, as a cherished tradition, have specialized in its production. Similarly, numerous *petit fours*, made with finely ground rice or chickpeas or coconut or almond, are produced. Apart from Yazd, as examples, Esfahān specializes in the production of *gaz* (nugat); Qum in *sōhān* (a kind of fudge made of germinated wheat, garnished with crushed pistachio); Kērmānshāh and Qazvīn in *nān-é bērēnji* (rice cookies) and *kāk* or *nān-é yōkhēh* (a fine phyllo made of flour, butter, eggs, and milk, rolled and cut into small pieces, baked and sprayed with powdered sugar); the specialty of Shīrāz is *nōghl* (sugared slivered almond or pistachio, or muskwillow seed). In rural and tribal areas, *kōlūcheh*, a kind of shortbread, is popularly produced, mainly for festivities.

Street food. Hot steaming beetroots, grilled pumpkins, baked potatoes, boiled broad beans, and cooked lentils served with powdered Persian marjoram seed sold by peddlers in winter, and liver *kabābs* rolled in flatbread with or without fresh herbs and chopped onions sold all year round are characteristic features of the popular culture. As further examples, a number of puddings and sweetmeats as well as dried barberry or prunella soaked in water for the juice can be added to the list.

Persian food has not reached the international market. Until the early decades of the twentieth century, people holding high functions or the aristocracy saw to their business in the outer quarters of their home. They were fed together with their employees, assistants, and guests by the *kārkhānēh* (workshop), as the kitchen was known in a big household. It was in such kitchens that great chefs trained cooks who specialized in certain branches of cooking and accepted apprentices to ensure the continuity of the tradition.

Commercial sale of food was limited to *qahvēhkhēneh* (coffee or, in fact, tea houses), where basic dishes are prepared; *chēlōw-kabābīs*, where only rice and kabobs are served; and certain shops that function only very early in the morning or late in the evening, selling one item like rice pudding, *halīm*, or tripe. Restaurants are a post–World War I phenomenon mainly introduced by Armenian, Caucasian, and Russian émigrés from the former Soviet Union. They introduced their own cookery rather than commercializing the Persian cuisine.



Modern Iran is famous for its high-quality caviar. This scene is from a caviar cannery in Bandar Pahlavi. © ROGER WOOD/CORBIS.

Feasts and rituals. Cookies, dried fruit, nuts, and sweets are prepared for *Nōwrūz* (the New Year festival). The traditional dish for New Year's Eve is *sabzi-pōlōw* (rice with herbs) with fried or smoked fish. On New Year's Day *rēshtēh- pōlōw* (noodles with rice), spiced and artfully garnished, is served. Festivities end with a picnic on the thirteenth day, at which *āsh-é rēshtēh* (noodle soup made with herbs, pulses, and *kashk*) and *bāghēla-pōlōw* (rice steamed with broad beans and dill) are the main features.

Observation of religious mourning is customary during the first ten days of the first month of the lunar Islamic calendar to commemorate the martyrdom of Hossein, the grandson of the prophet Muhammad. The occasion includes offerings in the form of food and puddings to the poor. Rice and *khōrēshs* are served in the evenings. On the tenth day, the well-to-do offer puddings such as *shōllēhzard* or *hālva* to ensure good health for the loved ones. In the month of Ramadan a whole range of sophisticated condiments of fine quality are made available for those fasting and feasting during daylight hours.

See also **Bread; Feasts, Festivals, and Fasts; Herbs and Spices; Herodotus; Islam; Mesopotamia, Ancient; Rice; Soup; Stew; Zoroastrianism.**

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Maryam Matine-Daftary

IRELAND. *See* **British Isles.**

IRON. Iron is the second most abundant mineral on earth and is an essential nutrient for nearly all organisms. Iron is necessary for many varied functions in mammals, including the synthesis of DNA, the generation of energy from macronutrients by aerobic respiration, and the transport and metabolism of oxygen. Iron is highly reactive and is potentially toxic at high levels of intake; therefore, its utilization and storage present a major challenge for biological systems. Cellular iron exists primarily in its reduced ferrous (Fe^{+2}) and oxidized ferric (Fe^{+3}) states, and conversion of the mineral between these states serves to catalyze many reactions. One example is Fenton's reaction, whereby hydrogen peroxide is converted to highly reactive hydroxyl radicals ($^{\cdot}OH$).

$Fe_2^+ + H_2O_2 \rightarrow Fe_3^+ + OH^- \ {}^{\cdot}OH$ (Fenton's reaction)

Both ferric iron and the hydroxyl radicals generated by free iron in this reaction directly damage tissues by randomly inducing DNA strand breaks and by oxidizing and thereby damaging cellular proteins, lipids, metabolic cofactors, and nucleic acids. Therefore, it is not surprising that most iron in the cell is bound or sequestered by proteins, so that the concentration of free iron is very low (usually less than 1 × 10–18 moles per liter). Many iron-binding proteins are enzymes that harness and bring specificity to the reactive properties of iron, whereas other proteins store or transport iron (Table 1). Protein-bound iron can accept electrons during enzyme-catalyzed reactions, enable proteins to recognize and bind substrates, and assist in the formation of defined protein structures.

Dietary Forms and Factors Affecting Iron Requirements

The Recommended Daily Allowance (RDA) for iron is 8 milligrams per day for men and postmenopausal women and 18 milligrams per day for premenopausal women. Adult males contain about 4 grams of total body iron (50 milligrams per kilogram of body weight), whereas menstruating women contain 40 milligrams per kilogram of body weight. Full-term infants are born with sufficient

TABLE 1

Representative proteins that bind iron

Protein	Function
Transport and Storage Proteins	
DMT1	Intestinal iron uptake
FP1	Intestinal iron export
Ferritin	Iron storage
Enzymes	
Ribonucleotide reductase	Synthesis of DNA precursors
Cysteine dioxygenase	Amino acid metabolism
Oxygen carriers	
Hemoglobin	
Myoglobin	

iron stores to meet metabolic demands for the first 4 months of life. Breast milk contains 0.2 mg iron/liter; breast-feeding infants receive about 0.27 milligrams per day.

There are two natural dietary forms of iron: (1) inorganic salts of ferric iron, and (2) iron bound to a cyclic carbon ring called heme in the form of hemoglobin and myoglobin in meat products. Inorganic iron is readily liberated from food in the acidic lumen of the stomach but is not absorbed well in the small intestine because of its poor solubility at physiological pH and because it is sequestered by many dietary components that hinder absorption, including phytates, polyphenols, calcium, and fiber. Therefore, only a small percentage of injected iron salts are actually absorbed into the body, thereby indicating that iron salts have a low bioavailability, or ability to be effectively absorbed. However, other low-molecular-weight dietary components bind inorganic iron and facilitate its absorption. These compounds, which include vitamin C and lactic acids, are commonly found in citrus and deciduous fruits and are known as metal chelators. In addition, an unidentified "meat factor" present in animal tissue also enhances the absorption of iron salts. Finally, heme iron has a much greater bioavailability than iron salts because fewer factors interfere with its absorption and it displays greater solubility in water. Hence, heme iron can account for up to 35 percent of absorbed iron in diets when accounting for only 10 percent of total dietary iron intake. In the United States, artificially fortified foods in the form of fortified grain products are a major source of dietary iron and account for nearly 50 percent of all iron consumed.

Iron absorption and transport from the intestinal lumen to the circulatory system is tightly regulated and complex. Enterocyte cells, which are responsible for the uptake and transport of nutrients from the intestinal mucosa, mediate the uptake and transport of iron to the plasma. These cells, once mature, function for only 48 to 72 hours before they are shed and excreted. The capacity of the mature enterocyte to transport inorganic iron is determined very early in its development and is inversely proportional to plasma iron status. The enterocyte iron transport protein, DMT1 (divalent metal transporter), facilitates iron uptake from the intestinal lumen into the enterocyte. DMT1 concentrations at the cell surface are increased when whole-body iron stores are depleted, which increases the rate of cellular iron accumulation into the enterocyte once it is matured. The induction of DMT1 protein synthesis results from increased DMT1 messenger RNA levels. During iron deficiency, the iron regulatory protein (IRP) binds to the 3' untranslated region of the DMT1 messenger RNA and increases its stability. Heme iron is transported into the enterocyte from the intestinal lumen by an unidentified heme iron receptor, and cellular enzymes in the enterocyte release iron from the heme ring. Iron is exported from the basolateral surface of the enterocyte to plasma by the iron transport protein ferroportin1 (Fp1). Fp1 is believed to assist in the direct transfer of iron to a soluble plasma iron transport protein called transferrin. Transferrin facilitates the delivery of two molecules of iron among the sites of absorption and storage and to all tissues and organs. The transferrin-iron complex enters the cell by binding to a specific protein, the transferrin receptor, which is present on the plasma membrane of all cells. Once transferrin binds to its receptor, the receptor-transferrin complex is engulfed by the cell, forming an internal vesicle called an endosome. Once in the cell, iron is released from transferrin by the acidification of the endosome, and the transferrin receptor is recycled to the cell surface where it can bind additional transferrin molecules.

Iron Physiology

Intestinal absorption is the primary mechanism that regulates whole body iron concentrations. There are no specific mechanisms to remove excess iron from mammals. Inorganic iron excretion is limited because of its low solubility in aqueous environments and therefore daily iron loss is minimal in the absence of blood loss. Fecal (from shed enterocytes and biliary heme products), urogenital, and integumental losses account for 4 mg/day of iron loss. Menstruation, blood donation, and pregnancy also can cause significant iron loss. Variations in iron status and requirements are influenced by individual genetic makeup as well as by differences in menstrual losses. The latter averages 0.6 mg/day but can greatly exceed that value in the individual, resulting in a need to absorb an additional 3 to 4 mg/day to maintain adequate iron status. An additional 4 to 5 mg/day of iron must be absorbed during pregnancy. States of rapid growth during childhood through adolescence also increase iron requirements.

Most absorbed iron is used by the bone marrow to make hemoglobin, an abundant protein that binds and distributes oxygen throughout the body. The remaining iron is distributed to other tissues where it is incorporated into iron-requiring proteins or stored. Nearly 70 percent of total body iron is present in red blood cells bound to hemoglobin. Another 15 percent is bound to metabolic enzymes and numerous other proteins, including muscle myoglobin, which transports oxygen to the mitochondria, and cytochromes, which act as electron carriers during respiration. The remaining iron is stored in the liver, spleen, and macrophages and can be distributed to other cells during states of dietary iron deficiency. The primary iron storage protein is ferritin, which is a hollow sphere comprised of 24 protein subunits. One ferritin molecule can store about 3,000 ferric iron molecules that can be mobilized readily when required. There are two types of ferritin subunits, heavy-chain and light-chain ferritin. Heavy-chain ferritin sequesters Fe^{+2} and oxidizes it to Fe^{+3}; light-chain ferritin aids in the formation of the mineral iron core within the protein. Tissue, gender, hormones, and iron status can influence the ratio of heavy-chain and light-chain subunits that comprise a ferritin molecule, but the physiological significance of this ratio is not well understood.

Consequences of Altered Iron Status

Iron deficiency is the most common of all micronutrient deficiencies in the world, and the anemia that results affects an estimated 2 billion people. Dietary iron deficiency results in reduced iron stores in the liver, bone marrow, and spleen, followed by diminished erythropoiesis, which is the production of red blood cells, and anemia, and ultimately results in decreased activity of iron-dependent enzymes. Iron uptake in the intestine is responsive to total body stores such that iron-deficient individuals display increased iron absorption as described above. Clinical manifestations of iron deficiency include impaired endurance exercise due to an inability to deliver oxygen to tissues, microcytic anemia, glossitis, and blue scerra. Maternal iron deficiency during pregnancy is associated with several adverse outcomes for the newborn infant, including premature delivery, low birth weight, permanent cognitive deficits, developmental delay, and a wide range of behavioral disturbances. The onset of anemia and depletion of tissue iron concentrations occur concurrently, whereas the other negative consequences of iron deficiency occur after hemoglobin concentrations fall.

The tolerable upper level intake for iron for adults is 45 mg/day; intakes that exceed this level result in gastrointestinal distress. Dietary overload can occur, although it is uncommon, except in individuals with primary hereditary hemochromatosis, an iron-storage disease, which can result in up to fifty-fold increases in storage iron deposits. Hemochromatosis most commonly results from a common genetic mutation or genetic polymorphism in the HFE gene that is prevalent in populations of European descent but can also result from mutations in other iron-related proteins including a transferrin receptor. The HFE protein is involved in intestinal regulation of iron accumulation, but its precise biochemical function is unknown. This genetic disorder, if untreated by regular phlebotomy, results in liver cirrhosis, cadiomyopathy, arthritis, and cancer.

See also **Gene Expression, Nutrient Regulation of; Nutrients; Nutrient Bioavailability**.

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IRON COOKSTOVE, THE.

The cast-iron cookstove, a constructed range that totally encases the fire, is a relatively recent development in the history of cookery, and an outgrowth of earlier cooking devices made of stone, brick, clay, and tile. The English term "stove" has a history of its own, and has been used for centuries to designate a variety of early cooking devices in which the fire was not enclosed. For example, one precursor to the cookstove involved a raised hearth which, like the later ranges, was waist high, but supported open fires. These, along with structures for partially enclosed fires and portable braziers called stoves, are helpful in tracing the origins of what was to become the nineteenth-century cast-iron cookstove.

Early History

For thousands of years before the advent of cookstoves, people cooked over open flames. Depending on materials and technologies at hand, various cultures have worked out a cooking surface heated by a fire below. These are exemplified by the Russian domed clay stove and the Japanese *kamado*. Some had holes in the cooking surface to bring cooking pots into direct contact with the flames. Their open fires were easily tended but smoky and somewhat inefficient. More advanced early cultures, among them the Chinese Han Dynasty, used the ceramic *tsao*, a very early range in which the fire was enclosed. The late medieval period and the Renaissance brought many changes because of the greater use of iron. With the growth of cities and consolidation of power, there was a trend toward elaborate cuisines and larger kitchens. Commercial establishments and wealthy or aristocratic households, having more means and more need, were the first to explore various types of "stoves."

The stew stove, one of these cookstove progenitors, was a bank or row of open-top or grill-like "burners," each over its own fire. Its role in the kitchen was as an adjunct to the large roasting fireplaces. For example, the stew stoves of sixteenth-century Italian chef Scappi were made of brick and clay; those of his contemporaries were often made of tile or stone. In such stoves, the fire was not totally enclosed, but they offered individually regulated temperatures and a waist-high surface. In later centuries, this form was sometimes adapted to quantity cookery, using permanently installed large cast-iron or copper kettles, each over their own fireboxes, and used for the preparation of substantial stews and soups. The German architect and engineer Georg Andreas Böckler designed a brick range that followed this principle (Frankfurt, 1666); subsequently others devised cast-iron frames and fireboxes. Like Scappi's stoves, they were usually limited to professional kitchens.

Renaissance ironworkers built on smelting and casting innovations of the medieval period, and developed cast-iron stoves. Böckler's *Furnologia, or: The Art of Domestic Stoves* described such a stove, one that produced coals to be used in a fireplace and another with a hori-

A BRICK STOVE

Directions for Making Preserves . . . When a chafing-dish cannot be procured, the best substitute is a brick stove with a grating to burn charcoal."

Mary Randolph, *Virginia Housewife*, 1824

zontal surface for household cooking. Subsequently, the English industrial revolution improved blast furnaces, increased production, and popularized iron stoves in both professional and industrial cookery, and in privileged households. For example, Denis Diderot recorded their use by French candy makers in his *Encyclopédie*, 1758.

Northern Europeans (especially Germans and Scandinavians) had stoves early, possibly as a response to their cold winters. In England they were sometimes installed alongside the grate system, used as free-standing ranges, and sometimes employed steam, ultimately developing into the English institution, the AGA stove.

The American Cookstove

Cookstoves were not new to the colonies: Mary Randolph suggested a brick version (probably a stew stove) in 1824.

By the end of the 1700s early American scientists such as Benjamin Franklin and Count Rumford had worked out further ideas leading to the development of home cookstoves. In the early 1800s New Yorker Jordan Mott manufactured the first American stoves, supplementary adjuncts to the traditional hearth. At first quite small in size, they were placed free-standing in front of the fireplace, their stovepipes carrying the smoke to the fireplace chimney. As they became larger and more complex, they usurped the hearth entirely and were installed directly within the fireplace.

The antebellum period brought many cookstove innovations, among them expanded surface area, multiple lids, dual ovens, warming ovens or shelves, additional storage space, and water boiler shelves. By 1850, most urban middle-class hearths had given way to stoves. The changeover was uneven, slower to reach the lower economic levels and more remote areas.

The cookstove itself demanded new designs for pots and pans. Age-old legs and rounded bottoms, so workable on the hearth, were no longer effective, and were replaced by flat bottoms that could absorb heat by direct contact with the heated surface. A few boiling kettles retained the rounded bottom and short legs (to prevent tipping), and were set into an open lid hole, the hottest setting possible; others were further redesigned with bottom insets that fit down inside the open lid "eye." Trade catalogs of the mid- to late nineteenth century continued to reflect a period of hearth-stove overlap, and supplied cooking utensils for both. With increasing specialization, stovetop equipment expanded to include such adaptations as saucepans, boilers, kettles, skillets, pancake and waffle irons, coffee roasters, toasters, and short-handled utensils.

How They Worked

The workings and maintenance of cookstoves were demanding. Between the firebox and the chimney, a series of manual dampers and levers controlled the air and smoke flow, the rate of burning, and consequently the cooking temperatures. The fire was lit with all dampers open, after which adjustments redirected the heat and smoke to a passageway surrounding the oven to heat it. As the ovens were without self-regulating thermostats, overheating was prevented by opening oven doors temporarily, cutting down on the fire's air flow. To maintain temperature, the cook checked the relatively small firebox, testing for heat by hand, and stoked it frequently. Such instructions on cookstove management were included in nineteenth-century cookbooks.

Cooking temperatures were also controlled by the position of the pot on the stovetop. The area nearest the firebox was by far the hottest; the farthest corners were the coolest. As the oven was hottest near the wall between the firebox and the oven, one used the farthest side of the oven and turned the pans regularly (rather than positioning the shelves). Cookstoves were notoriously eccentric. A good cook learned their vagaries and adapted.

There was now more choice in fuel. Hardwoods were preferred over soft, as always, as they created more heat and lasted longer. Coal was preferable to wood in that it produced more heat for a longer period of time and was

HOW TO LIGHT THE STOVE

A fire for cooking purposes is best made in an iron box, or, as it is usually called, a stove, or range. . . . We control the amount of heat obtained from the fire by dampers in the stove and pipe. . . . Put into the fire-box, first, shavings or loose rolls of newspaper, letting them come close to the front; then fine pine kindlings, arranged crosswise, that the air may circulate freely between the pieces.

Mrs. D. A. Lincoln, *Boston School Kitchen Text-Book*, 1887 easier to procure and handle in urban kitchens, but it triggered debates over possible danger from its fumes.

General Assessment

Cast-iron cookstoves brought about a major revolution in many aspects of cookery, notably the technology of the kitchen, the character of cuisine, and the role of home cooks.

The new "ranges" influenced cooking technology throughout the Western world. In cultures that had little iron, the designs of cast-iron stoves were applied to newer versions of their earlier traditional stoves. For example, the Russian domed stove evolved into a clay-covered brick bank stove, at first used by the upper classes, and eventually adopted into peasant homes. The Alsatian brick cookstove and the Bavarian stone and tile stove followed a similar pattern.

The attraction of new stoves overcame their shortcomings. Cooks benefited from waist-high, flexible cooking, less bending and lifting, less smoke, and no ash in the food. Their ovens achieved and maintained desired temperatures in far less time, enabling daily baking, and permitted more flexible menus. They heated the house more efficiently in winter, and were easily taken apart and reassembled in summer kitchens. However, in comparison with hearth cooking, they did not roast or bake well, were notoriously drafty and finicky, and required arduous cleaning. Some decried the loss of the hearth, declaring that the center of family life was threatened and with it the family itself.

The cookstove had far-reaching effects on cookery and the domestic life of nineteenth-century men and women. Well suited to city life and the growing cash economy, it eliminated the task of producing one's own fuel. Women, now changing their role from farm producer to city consumer, enjoyed the convenience, and

THE COAL STOVE

Stoves for coal should be carefully put up, as if the pipe gapes, the coal gas may occasion death.

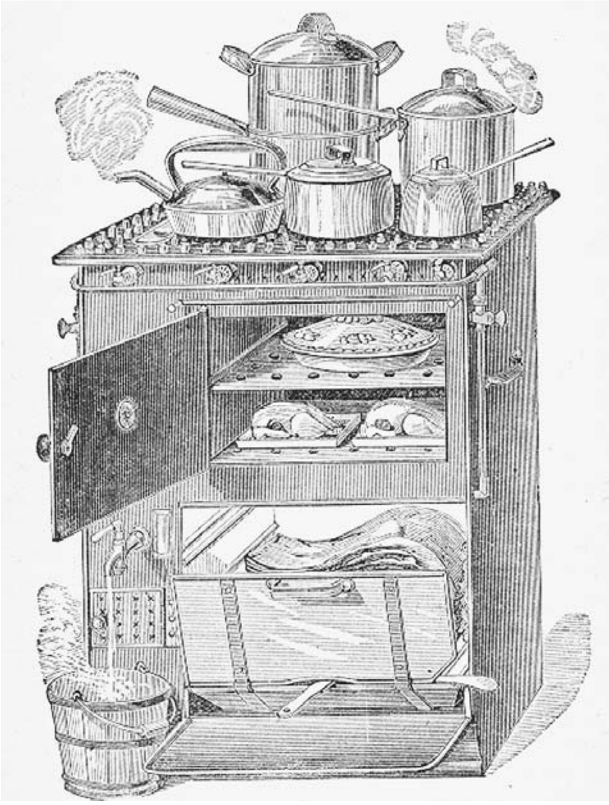
Catharine Beecher, *Treatise on Domestic Economy*, 1841

Anthracite coal is one of the most difficult fuels for the beginner to manage; but once having learned its requirements, it will be found one of the most satisfactory and constant of friends.

Maria Parloa, *Home Economics*, 1898

You may take the poetry of an open wood fire of the present day, but to me in those early days it was only dismal prose, and I am grateful to have lived in the time of anthracite coal.

Diary of Mary Bennett, 1868



Cooking with gas is not as new as many people think. This 1884 gas stove advertisement depicts an iron cookstove with all units working at full capacity. ROUGHWOOD COLLECTION.

THOREAU ON STOVES

I used a small cooking-stove for economy . . . but it did not keep fire so well as the open fireplace. Cooking was then, for the most part, no longer a poetic, but merely a chemic process. . . . The stove not only took up room and scented the house, but it concealed the fire, and I felt as if I had lost a companion. You can always see a face in the fire.

Henry David Thoreau, *Walden*, 1846

used their growing discretionary time for philanthropic community welfare. Growing interest in fashionable dining likewise stimulated a far wider range of daily cooking and baking. Simultaneously, a drop in the cost of sugar, flour, and spices led to elaborate home baking, candy making, preserving and canning, and the consumption of snack foods. The gradual development of chemical leaveners, well adapted to the quickly fired cookstove, replaced much yeast baking and encouraged new and revised recipes—especially for quick breads and iced layer cakes.

See also **Hearth Cookery.**

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ISLAM.

This entry includes three subentries:
Shiʿite Islam
Sunni Islam
Sufism

Shiʿite Islam

Shiʿa comprise 10 to 15 percent of the world Muslim population, and are concentrated in the Middle East, particularly in Iran, where Shiʿism is the state religion. Shiʿa differ from the majority Sunni Muslims in matters of religious authority and leadership arising from disputes over the legitimate succession to Muhammad, with Shiʿa supporting the claim of ʿAli, grandson of the Prophet, and his family and descendants. The teachings of the Qurʾan are strictly interpreted and followed. However, the basic pattern of observances, including food-related behavior, is similar for Shiʿa and Sunnis.

Role of Food in Religious Tradition

Islamic food practices are derived first from the Qurʾan and secondly from the hadith—the sayings and deeds of Muhammad. Pre-Islamic Arabs had few food prohibitions, and these were more a matter of local custom, specific to particular tribes. The food laws of the Qurʾan provided one way of uniting the tribes in common observances, at the same time differentiating the Muslims from the Jews. The use of food to create and maintain boundaries and common identities is common among the world's religions.

Islamic law influences diet by prohibiting or restricting certain foods, based on Jewish dietary laws as mentioned in the Qurʾan, and by requiring fasting and feasting at specific times of year. It also enjoins moderation and reasonableness in all things and commends hospitality. Food was strongly linked to hospitality in Arabic cultures and the sharing of food was encouraged by Muhammad as a means of creating common bonds and sharing in common blessings.

Shiʿa follow general Qurʾanic food regulations. In the Qurʾan food is mentioned frequently as a fundamental beneficence, a Divine blessing. Believers are exhorted to eat of the good things with which God has supplied them and are given only minimal dietary restrictions. Forbidden, or *halal*, is that which dies naturally, blood, swine's flesh, and that over which any name other than God's has been invoked. Also prohibited are meat of the ass, of carnivorous animals such as the tiger, fox, dog, and leopard, which kill prey by using their paws, and of birds of prey. Alcohol is forbidden, along with any other substance that is debilitating to the faculties. The meat of permitted animals is only *halal* if slaughtered in accordance with Islamic law, by cutting the throat while pronouncing the words "Bismillah. Allah Akbar" ("I begin with God's name: God is great").

Further food regulations are contained in the hadith and have been elaborated over time by various schools of Islamic jurisprudence. Foods are allocated to one of the five categories of action in Islamic law: obligatory, recommended, neutral, disapproved, or prohibited. Each school of jurisprudence categorizes foods differently, though the differences between Shiʿa and Sunnis is, on the whole, of little practical everyday significance. Foods or parts of animals forbidden based on exclusively Shiʿite hadiths include hare and porcupine, fish without scales, sea creatures with shells (except shrimp is allowed), rabbits, and certain body parts such as the gallbladder and spleen.

Qurʾanic food laws are seen as a sign of God's will, but there is no sin in eating prohibited foods in small quantities if essential to sustain life. Sunnis generally permit the consumption of meat slaughtered by Jews or Christians, while Shiʿa do so only if necessity dictates. As in all religions, the strictness with which dietary laws and guidelines are observed differs with social status and circumstances, depending on the commitment to practice.

Fasting

There are different categories of fasting in Islam: those that are obligatory; those that are recommended but which may be broken without penalty; those that are blameworthy and discouraged; and those that are forbidden. Obligatory fasts include the month of Ramadan, expiatory fasts performed as *kaffarah* (atonement) for breaking the Ramadan fast, and those performed in fulfillment of a vow. The chief obligatory fast is Ramadan. Shiʿa generally break the fast a few minutes after the sun has set and commence the fast a few minutes before dawn. In both instances the intent is to ensure that the full fasting period is observed. The exemption categories for the fast are similar for Shiʿa and Sunnis, though with some variations in interpretation. For Shiʿa fasting is not valid if it would cause or aggravate illness or intensify pain or delay recovery; to do so is to cause harm, which is prohibited. Pregnant women in the final trimester and nursing mothers ought to break their fast if there is danger of harm. To continue fasting in such circumstances is not valid. In both instances breaking the fast is optional for Sunnis. Acute hunger, unless life-threatening, is not a sufficient reason for Shiʿa to break the fast, but is acceptable to Sunnis. There are other differences relating to travelers, to what precisely breaks the fast, and to what is required in the way of restitution for infractions. The most serious infraction, sexual intercourse with a spouse, is punished with extended fasting and fines in both Shiʿite and Sunni law; such fines include freeing a slave, feeding sixty poor, or fasting for two consecutive months.

Muhurram, the first month of the Muslim year, is a time of major public affirmations of Shiʿa beliefs. The one-day fast of Ashura, which falls on the 10th of Muhurram, was, according to Sunni tradition, instituted by Muhammad in imitation of the Jewish practice of marking the deliverance of the children of Israel from the Pharoah. Although the fast was soon abrogated in favor of Ramadan, it remained as a voluntary observance. For Sunni Muslims Ashura is a joyous festival, commemorated precisely because it is Sunnah—the Way of the Prophet. But for Shiʿa it is a time of mourning, the anniversary of the murder of Husayn, son of ʿAli and grandson of Muhammad, by the Caliph Yazid at the battle of Kerbala. Husayn opposed caliphate rule and was killed in an attempt to restore the imamate. Shiʿa mark this occasion with large public parades, at which loud lamentations are accompanied by beating of drums and penitents who scourge themselves with whips or knives. In some places dancers enact scenes from Kerbala and decorated replicas of the martyrs' tombs are carried through the streets. A specific Shiʿa practice during Muhurram is the provision of food and drink to the community. In Shiʿa neighborhoods children distribute ladles of water to passersby, while tables of food may be set up for the poor. This allows believers to symbolically compensate for the fact that Husayn was allowed to die hungry and thirsty while, at the same time, alleviating the thirst and hunger of the oppressed.

Supererogatory fasts are meritorious for all Muslims on any day when fasting is not specifically forbidden. The first and last Thursdays and the 13th, 14th, and 15th of each month are particularly auspicious, as are a number of other days during the year. It is reprehensible to single out Fridays or Saturdays for fasting, or to fast on Naw Rouz (New Year) or on the day preceding Ramadan. Fasting is forbidden on the first days of ʿId al-fitr and ʿId al-adha. For Shiʿa fasting is also forbidden on the 9th of Muhurram, as on this day the enemies of Husayn fasted in preparation for the battle of Kerbala.

Holidays and Festivals

Shiʿa observe the major Islamic festivals of ʿId al-fitr and ʿId al-adha, as well as commemorating many events in the lives of the Imams. ʿId al-fitr is a three-day festival following the Ramadan fast and is celebrated to give thanks to God for providing the strength to complete the fast. It is marked with visiting, gift-giving and preparation, and exchange of favorite foods. Specially prepared sweet dishes are characteristic of the festival, giving it the popular name of Sweet Id. ʿId al-Adha, the feast of sacrifice, is a four-day public holiday occurring at the end of the pilgrimage to Mecca. It celebrates Abraham's complete obedience to God in being willing to sacrifice his son Ishmael, and God's dispensation in allowing Abraham to substitute a sacrificial ram. At public ceremonies the imam sacrifices a sheep for the community. Every Muslim who can afford it should sacrifice at home a goat, lamb, cow, or camel and share the meat with family and friends and with the poor.

ʿId al-Ghadir, held on the eighteenth day of the month of pilgrimage, is a Shiʿite feast instituted in 962 C.E. to commemorate the events of Ghadir Khumm, when Shiʿa believe that the Prophet designated ʿAli as his successor. This is not observed by Sunnis.

See also **Fasting and Abstinence: Islam**; **Ramadan**.

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SUNNI ISLAM

"Islam" comes from the Arabic word meaning 'peace' and 'submission'. For Muslims around the world it is a way of life requiring absolute submission to the will of God. Islam dates from 622 C.E. and is based on the prophetic revelations of Muhammad. From its Middle Eastern roots Islam has spread around the world and, with over a billion followers, is the second largest of the world's religions, after Christianity. About 15 percent of Muslims live in the Arab world and another 25 percent in Africa. Substantial parts of Asia are predominantly Muslim, with Indonesia having the largest Muslim community. There are also significant Muslim populations in Europe and the Americas. The three main Islamic sects are the Sunni, who comprise about 90 percent of all Muslims, Shiʿites, and Sufis. In addition, there are numerous small sects and subsects, such as Ahmaddis, ʿAlawites, and Wahhabis, that differ in degrees of orthodoxy and practice.

Although they accept the divine status of the Jewish and Christian revelations, Muslims believe that Muhammad was the "Seal of the Prophets," the last of God's messengers. The word of God as revealed to Muhammad is recorded in the Holy Qurʾan, the infallible guide to Muslim conduct. Further guidance is provided by the *sunna*, the authoritative example of the Prophet, whose words and deeds are recorded in the *hadith* (literally 'tiding' or 'information'; more broadly 'every word, deed, and approval attributed to Muhammad'). "Sunni," derived from "sunna," describes allegiance to the ways of the Prophet. Within the Sunni tradition there are four schools of jurisprudence (Hanifis, Malikis, Shafis, Hanbalis) that differ in their interpretations and applications of religious law, including some minor issues related to food.

Role of Food in Religious Tradition

Prior to the advent of Muhammad, food practices among the Arab peoples of the Middle East were diverse. The establishment of common Islamic food laws united these diverse groups, at the same time differentiating the new religion from Judaism. In several places in the Qurʾan, Muhammad refers to the restrictive food laws of the Jews as a burden imposed on them for sins, noting that there were few food restrictions prior to the revelation of the Torah (4:160; 6:146). While he retained certain elements of Jewish food law, such as the prohibition on pork, Muhammad proclaimed food as a general beneficence, a gift from God to be enjoyed by His people without undue burden. "O ye who believe! Eat of the good things that We have provided you, and be grateful to Allah if it is Him ye worship" (2:172).

Islamic laws regarding food are found particularly in three Qurʾanic *suras* (chapters), The Cow (2), The Table (5), and Cattle (6), respectively. In addition, the sayings and actions of Muhammad, as recorded in the *hadith*, provide detailed guidance to acceptable food practices. Food is classified as lawful (*halal*) or unlawful (*haram*). Between these is the category of doubtful or suspect (*mashbooh*). *Halal* signifies food that is acceptable in the sight of God; it includes all food that is not classified as *haram* or *mashbooh*: milk from cows, sheep, camels, and goats, honey, fish, vegetables, fruit, legumes, nuts, and grains. Most animals are *halal*: "Lawful unto you (for food) are all four-footed animals, with the exceptions named" (5:1). However, to be *halal*, meat must come from animals slaughtered ritually in a way (similar to Jewish practice) intended to spare them unnecessary suffering. The words "Bismillah. Allah Akbar" ("I begin with God's name: God is great") are pronounced over the animal as its throat is slit, allowing the blood to drain. In fact, kosher food is generally acceptable to Sunni Muslims: "The food of the People of the Book is lawful for you, and yours is lawful unto them" (5.5). Also, similar to kosher practice, in the marketplace meats and other products are certified *halal* by authoritative Islamic agencies and are stamped with a *halal* seal.

The opposite of *halal* is *haram* food—that which is unacceptable. Pork is the preeminent example of a *haram* food, the only meat specifically forbidden in the Qurʾan. Blood, and that which dies naturally (carrion), as well as food over which any other name than God's has been invoked, are *haram* (5.3). Also prohibited in the *hadith* are flesh of the ass, carnivorous animals, such as the tiger, fox, dog, and leopard, which kill prey by using their paws, and birds of prey. Fish must be alive when taken from the sea or river, and only fish that have fins and scales are allowed, which excludes shellfish and eels. Shrimp are generally considered *halal*; however there is some disagreement over this within the Hanafi school of jurisprudence. Land animals without ears, such as frogs and snakes, are prohibited. Foods contaminated by *haram* substances themselves become *haram*. Alcohol is *haram*, along with other mind-altering substances. However, there are several references to wine in the Qurʾan that illustrate changing attitudes toward alcohol: wine is acknowledged to have some benefit, but which is outweighed by harm (2:219); believers are exhorted not to pray while under the influence of intoxicants (4:43); and it is expressly prohibited as "an abomination of Satan's handiwork" (5:90). The latter, together with guidance found in the *hadith*, forms the basis for most modern interpretations, which view alcohol as both morally and socially unacceptable. Other intoxicants that cloud the mind are also forbidden, though this is a gray area. For example, the chewing of *qat* (“khat,” *Catha edulis*), a plant whose leaves contain a mild stimulant, is common in Yemen. Coffee consumption has also been controversial at times, though sixteenth-century attempts to ban it proved impossible to enforce. While coffee is a symbol of hospitality in some Arab countries, it may be avoided by devout Muslims. It is worth noting though that some Muslims, notably Sufis, interpret the Qurʾanic verses in other ways and do not prohibit wine. Wine drinking is also acceptable to ’Alawites, especially in a sacramental context.

If a person is uncertain whether a food is *halal* or *haram*, then it is *mashbooh*—doubtful or suspect—and should be avoided. Ingredients such as emulsifiers, gelatin, and enzymes used in processed foods fall into this category as the animal origin of the constituents may be unknown. Some food manufacturers and Islamic authorities produce lists of foods and ingredients classified as *halal* or *haram* as a guide to food choice.

There are regional, social, familial, and individual variations in the strictness with which food laws are adhered to. Some Chinese Muslims, for example, openly consume pork. Concern for one’s health or obligations stemming from hospitality are reasons for transgressing normative food behaviors. “But if one is forced by necessity [to eat forbidden foods], without wilful disobedience, nor transgressing due limits—then is he guiltless. For Allah is Oft-forgiving Most Merciful” (2:173).

Fasting and Feasting

Fasting (*sawm*) is one of the Five Pillars of Islam and, as such, is an important religious duty. Muslim fasts require complete abstention from food and drink between the hours of sunrise and sunset. Fasting at different times of year may be obligatory (*wajib*), recommended (*mustahab*), discouraged (*makruh*), or forbidden (*muharam*). The main obligatory fast of the Muslim calendar is that of Ramadan, which lasts for the entire month. Also obligatory is fasting for kaffarah—atonement for infractions of the Ramadan fast—and fasts made in fulfillment of vows. Fasting is considered *mustahab* on all days of the year on which it has not been prohibited. It is specifically stressed for the thirteenth, fourteenth, and fifteenth of each month in imitation of the Prophet, and on Mondays and Thursdays. *Ashura* is a one-day fast held on the tenth day of Muhurram, instituted by Muhammad in imitation of the Jewish holiday Pesach (Passover), which marks the delivery of the children of Israel from the Pharoah. Although *Ashura* was replaced in the second year of Muhammad’s dispensation by Ramadan, it remains as an optional fast.

It is *makruh* to single out Fridays and Saturdays (the Muslim and Jewish Sabbaths) for fasting or to fast on the day preceding Ramadan or on *Naw Rouz*. Fasting is *muharam* on the days of the ʿId al-Fitr and ʿId al-Adha festivals. To be valid, fasting must be undertaken with correct spiritual intent (*niyyah*), which should be renewed each day. Fasting is incumbent on all sane adult Muslims, with exemptions made for pregnant, nursing, and menstruating women, for travelers, and for those in ill health. The exceptions are seen as evidence of the statement that Allah does not want to place an undue burden on His people (2:185). Deliberate infractions of the Ramadan fast are subject to either *kaffarah* (atonement) or *qada* (restitution), though unintentional lapses are not punished. Some differences exist between schools of jurisprudence as to the detailed practices and penalties associated with fasting. For example, Sunnis may break the fast if they suffer acute hunger; Shiʿites may not unless there is risk of illness.

Certain foods have a particular symbolic value because they recall the practices of Muhammad. Thus, fasts are traditionally broken with dates and water, followed by lentil soup and often a salad before the main course, which is more a matter of local custom.

Holidays and Festivals

During the Ramadan fast Muslims may consume more food than at other times of the year, for Ramadan is an essentially joyous occasion, a time for giving thanks to God. Feasting in the evening is common, and special foods are commonly prepared at family and community meals. Ramadan food specialities vary across Islamic cultures, for example, Syrian *shakreeyeh* (lamb in minty yogurt sauce), Turkish *kaahk Ramazan* (sourdough crescent rolls), and Moroccan *harira* (lamb and lentil stew).

At the close of Ramadan comes the three-day festival of ʿId al-Fitr, commonly known as “Sweet Id.” The celebration is a way of thanking Allah for providing Muslims with the strength to have fasted successfully, and it is marked with feasting and gift-giving. It is characterized by the serving of sweet dishes, such as *sawaiyan*, a fine vermicelli boiled with milk and sugar. In Malaysia, *ketupat*, rice cooked in coconut leaves, and *rendang*, a spicy beef dish, are prepared especially for this occasion. ʿId al-Adha, the feast of sacrifice, occurs at the end of the pilgrimage to Mecca. It was previously a four-day festival, now much diminished, in which all adult male Muslims sacrificed a lamb, goat, or cow. Islamic prescriptions require that the sacrificial meat be divided into three equal portions: one for the family, one for friends, relatives, and neighbors, and one for charity. This is in remembrance of God’s mercy in allowing Abraham to sacrifice a ram instead of his son, Ishmael. *Ashura* is a joyous occasion for Sunnis, though it is a solemn historical remembrance for Shiʿites.

See also **Africa: North Africa; Asia, Central; Christianity; Fasting and Abstinence; Feasts, Festivals, and Fasts; Holidays; Iberian Peninsula; Iran; Judaism; Middle East; Religion and Food.**

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SUFISM

Sufis are members of a small Islamic sect that arose as a protest against the growing worldliness of Muslims after the time of the Prophet. Sufis strive to imitate the words and deeds of Muhammad, and traditionally adopt a life of poverty and abstinence. Although Sufism is firmly anchored in orthodox Islamic doctrine, it emphasizes the inner pursuit of love, obedience, and devotion to God over concern with the outward law or *shariʿa*, and is often associated with mysticism and esotericism. There are hundreds of Sufi orders that have developed within different cultural contexts so that there is no one Sufi way.

Role of Food in the Sufi Tradition

Sufis are guided by the *adab*, written treatises that prescribe manners or norms of conduct modeled on the life of Muhammad, which includes the food sayings and practices of the Prophet in minute detail. Muhammad praises the virtues of hospitality, generosity, and moderation, and food was and is clearly seen as a means of encouraging these virtues. As an integral part of the daily spiritual life of Sufis, food provides a way of sharing in the greatest of Divine blessings, of creating unity among people and of linking to all creation. Hospitality and eating together were highly commended by Muhammad and, since early times, Sufis have been associated with the serving of food to others. Communal kitchens and guest lodges for feeding the poor and travelers were features of early Sufi settlements, a tradition that continues in Sahas, or Sufi centers where massive concrete tables may serve up to one hundred diners at a sitting. At *moulid* festivals, feeding stations are set up to offer food and drink to passers-by.

Food Symbolism and Rituals

There is extensive use of food imagery and metaphor in Sufi writings. Sugar and other sweet foods represent the sweetness of piety and community with God, while salt symbolizes purity and incorruptibility. Bread is regarded as sacred in Islam and is treated reverentially. Through the pronouncement of *Bismallah* during the bread-making process, the bread is imbued with spiritual power or *baraka*, which is shared by those who eat the bread. The transformation of the raw wheat to finished bread is used as an analogy for Sufi spiritual development.

Sufi ritual observances (*dhikr*) are concerned with remembrance of God through exaltation and praise. Singing, dancing, and drumming are commonly part of such rituals, as is sharing of food. For example, *ashura* is a dish that takes its name from the festival celebrated by all followers of Islam. During preparation of the *ashura*, Mevlevi Sufis stir the pot in a special way while pronouncing the name of God. Sharing the *ashura* then becomes a way of spreading remembrance of God in the form of bodily nourishment.

Holidays and Festivals

Sufis observe general Muslim holidays and festivals. *Ashura* has particular significance for Sufis and Shiʿa. In addition, they celebrate numerous saints' days, or *moulids*. Major *moulid* festivals attract hundreds of thousands of people and can last for two to three weeks. Sufi orders set up hospitality stations (*khidamet)* in public buildings, in tents, or simply on cloths spread on the ground. Drink and (usually) food are offered to passers-by, and must be accepted as the food contains the *baraka* of the saint being honored and therefore confers spiritual blessing on the recipient. For the poor, these stations provide an additional opportunity for physical as well as spiritual nourishment.

Fasting and Feasting

Fasting is an essential feature of Sufism, especially during the forty-day retreat undertaken by initiates in many orders. Early Sufis placed great emphasis on asceticism in the pursuit of self-control and suppression of worldly desires. Eating was seen to be an important source of potential harm to the new initiate, and there are many Sufi stories of extreme restraint. Later, excessive fasting came to be viewed as unfavorably as excessive eating, for the message of the *adab* was one of moderation. Indeed, Muhammad even enjoined His followers to break a fast if invited to eat, for to refuse an invitation to share in God's blessing was wrong.

Food and Social Circumstance: Prescriptions and Proscription

While the asceticism of early Sufism has largely disappeared, gluttony is frowned upon and moderation is enjoined. Sufis follow Qurʾanic injunctions regarding food and are usually fastidious about observing the prohibition on pork consumption. While many Muslims do eat meat other than pork, Sufi teachings recommend that such meat be consumed only in small quantities. Some orders, both ancient and modern, have praised vegetarianism as a more compassionate practice, and have viewed animal consumption as conducive to animalistic behavior.

See also **Fasting and Abstinence: Islam; Iran; Islam: Shiʿite Islam; Islam: Sunni Islam; Middle East; Religion and Food.**

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Paul Fieldhouse

ISRAEL. *See* **Judaism; Middle East.**

ITALY.

This entry includes four subentries:
Northern Italy
Southern Italy
The Italian Meal
Tradition in Italian Cuisine

NORTHERN ITALY

Northern Italy occupies an area that stretches from the southern Alps south to the Po valley and from the northernmost coast of the Tyrrhenian Sea in Liguria west to the coast of the Adriatic Sea on the northeastern side of Italy. Northern Italian cuisine is distinguished from those of Central, Southern Peninsular, and Insular Italian by the predominant use of butter, cream, cheeses, rice, potatoes, baccalá (dried salted codfish), polenta (corn mush), wines used for cooking, hams, sausages, beef, chicken, and venison, and the occasional use of a much lighter olive oil—produced in limited quantities in the regions of Emilia-Romagna, Veneto, Trentino, and Lombardy—than that of the south.

It is the culinary expression of eight regions where dumplings of all sizes and shapes have been prepared since at least the twelfth century B.C.E. Processed regional foods also include regional meat and fish specialties, such as *Bresaola* (Valle d'Aosta air-dried beef), *Mocetta* (Valle D'Aosta's air-dried mountain goat ham), *Mosciame* (Ligurian dried filet of tuna and dolphin), *Missoltitt* (Lake Como's sun-dried smelts), *Gianchetti* (blanched baby anchovies), *Ciccioli* (lard-rendered pork scraps), *Speck* (Alto Adige's air-cured bacon), *Mortadella* (baloney from Bologna), and several varieties of *Prosciutto* (air-dried ham).

Northern Italian cuisine favors mild-tasting, creamy, meat-rich, and nutritious dishes inspired by a territory that is an extended vineyard. It has also produced many dishes and specialties that originated with ancient Roman Catholic religious traditions. Besides creating Christmas and Easter specialties such as *Panettone* (Christmas fruitcake), *Colomba* Pasquale (a dove-shaped cake prepared during Easter), *Uovo di Pasqua* (chocolate Easter egg), Northern Italian cuisine also includes dishes that follow Catholic Church mandates regarding food including "no-meat-on-Friday" or "fat and meat during Carnival prior to Lent" with specialties such as *Crostoli* (fried, and sometimes twisted, ribbons of dough), also called *Sfrappole*, *Fritole*, *Chiacchere*, *Lattughe*, *Nastri*, *Grostul*, or *Zeppole*, depending on the regional dialect.

BOILED MEAT

Boiled meat was less desirable than roasted meat in many societies. A story told by Marcel Rouff (Hazan, 1980, p. 273) illustrates how one cook overcame this prejudice. Dodin-Bouffant served it to the Prince of Eurasia, who was offended at first to be served such a low-status food, but he soon changed his mind about boiled beef. When Dodin-Bouffant's formidable boiled beef finally arrived—reviled, despised, and an insult to the Prince and all of gastronomy—it was monstrously imposing, borne on a huge platter, and held so high and at arm's length by the head chef that at first the anxious guests were unable to catch a glimpse of it. However, when it was lowered onto the table with straining caution, there were several minutes of stunned silence. Each guest recovered his composure in a characteristic way. Rabaz and Magot inwardly berated themselves for having doubted the Master; Trifouille was seized with panic before such genius; Beaubois trembled with emotion. As for the Prince of Eurasia, his reaction wavered among the worthy desire to make a duke of Dodin-Bouffant, as Napoleon had wished to make a duke of Corneille (a seventeenth-century French dramatist); a wild longing to offer the gastronome half of his fortune and his throne if only he would agree to oversee his banquets; annoyance at being taught such an obvious lesson; and impatience to taste the heady enchantments of the culinary marvel set before him.

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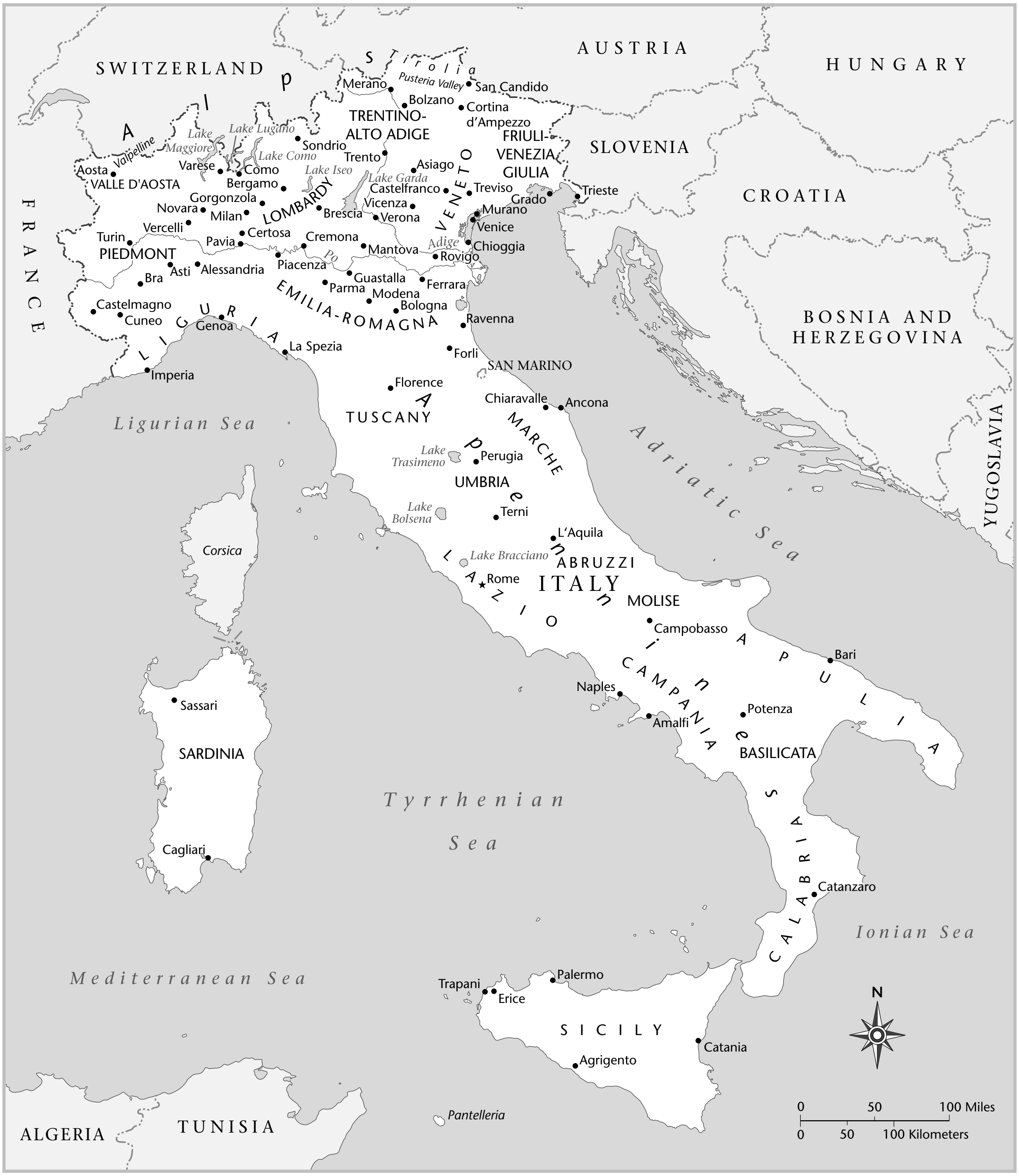
Favorite ingredients of this cuisine are wild foods such as frogs, snails, truffles, mushrooms, and nuts. Typical first-course dishes of Northern Italy include stuffed ring- or square-shaped pasta—tortelli, tortellini, tortelloni, ravioli, agnoli, agnolotti, pansotti, capelletti, and capellacci—served either in clear broth or topped with sauces**.** Northern Italy is also home to gnocchi (finger-sized potato dumplings), lasagna, world-famous cheeses —Gorgonzola, Fontina, Taleggio, Mascarpone, Parmigiano Reggiano, and Grana Padano—and innumerable


SWITZERLAND
AUSTRIA
HUNGARY
SLOVENIA
CROATIA
BOSNIA AND HERZEGOVINA
YUGOSLAVIA
FRANCE
ALGERIA
TUNISIA
ITALY
A l p s
Tirolia
Pusteria Valley
Merano
San Candido
Bolzano
Cortina d'Ampezzo
TRENTINO-ALTO ADIGE
FRIULI-VENEZIA GIULIA
Valpelline
Lake Maggiore
Lake Lugano
Lake Como
Lake Iseo
Lake Garda
Sondrio
Trento
Asiago
Aosta
VALLE D'AOSTA
Varese
Como
Bergamo
Gorgonzola
Novara
Milan
LOMBARDY
Brescia
Castelfranco
Treviso
Grado
Trieste
Vicenza
Verona
VENETO
Murano
Venice
Turin
Vercelli
Certosa
Pavia
Cremona
Mantova
Adige
Rovigo
Chioggia
PIEDMONT
Asti
Alessandria
Piacenza
Po
Guastalla
Ferrara
Bra
Parma
Modena
Bologna
EMILIA-ROMAGNA
Castelmagno
Cuneo
Genoa
LIGURIA
Ravenna
La Spezia
Forli
Imperia
SAN MARINO
Florence
Chiaravalle
Ancona
TUSCANY
MARCHE
Ligurian Sea
Adriatic Sea
Lake Trasimeno
Perugia
UMBRIA
Lake Bolsena
Terni
Appennines
L'Aquila
Corsica
Lake Bracciano
ABRUZZI
LAZIO
Rome
MOLISE
Campobasso
APULIA
Bari
CAMPANIA
Naples
Sassari
Potenza
Amalfi
SARDINIA
BASILICATA
Tyrrhenian Sea
Cagliari
CALABRIA
Catanzaro
Ionian Sea
Mediterranean Sea
Trapani
Palermo
Erice
SICILY
Catania
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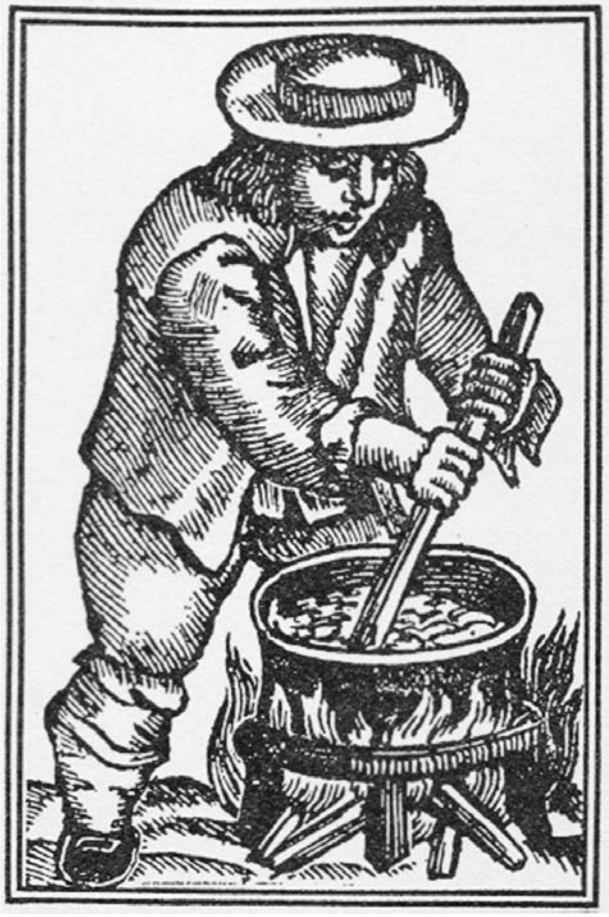
varieties of risotto (creamed rice): risotto with truffles (*Risotto con Tartufi*), buds of hops (*Risotto ai Bruscanzoli*), red-and-white chicory (*Risotto al Radicchio*), dandelion (*Risotto coi Brusaoci*), frogs (*Risotto con le Rane*), *snails (Risotto e Lumache*), baby pig tails (*Risotto con Codine di Maiale*), chicken livers (*Risotto con Fegatini di Pollo*), filets of lake perch (*Risotto con Filetti di Pesce Persico*), sausage meat (*Risotto con Luganege*), peas (*Risi e Bisi*), asparagus (*Risotto e Sparaghi*), artichokes (*Risotto coi Carciofi*), porcini mushrooms (*Risotto ai Funghi*), and squid with its black ink (*Risotto Nero alle Seppie*).

Northern Italian desserts are creamy and rich rather than sweet: *Zuccotto* (Lombardy's cupola-shaped whipped



Polenta maker. From a woodcut printed in Milan about 1860. ROUGHWOOD COLLECTION.

cream and chocolate trifle), *Profiterol* (Lombardy's chocolate-glazed and cream-filled pastry puffs), *Tiramisu* (Venetia and Lombardy's layered zabaglione trifle), *Monte Bianco* (Piedmont's liqueur-flavored chestnut and whipped cream dessert), *Strudel* (Alto Adige's fruit-filled strudel), and *Sbrisolona* (Emilia-Romagna's dry pound cake).

Food portions for Northern Italian meals are small or moderate. What is considered most important is the variety of courses and the type of dishes, not the amount of food. Classic meals are served either with wine or mineral water, which can be sparkling or natural. Over time, multicultural influences from abroad, especially of German, central European, or U.S. origin, have introduced the serving of beer (*birra*) or coke (*coca*) with certain specialties such as *Wuerstel con Crauti* (German sausages with sauerkraut) or pizza. Sweet beverages, sodas, or milk shakes may be graciously tolerated by Italians if they are served by foreigners with classic Northern Italian meals, but they are not recommended according to classic serving standards.

Northern Italy is comprised of several small geographically defined areas distinguished by specialty dishes that feature locally grown and foraged foods.

The Alpine Range Area

The Alpine Range Area contains portions of northern Piedmont and northern Friuli-Venezia Giulia and the regions of Trentino-Alto Adige and Aosta. In the south, the Alpine Range gradually opens onto a wide valley of well-tended fruit orchards and vineyards and an expanse of farmlands and plains.

Trentino-Alto Adige. Three cultural traditions (German, Italian, and Ladin [northern Italian and Swiss]), which at times have clashed politically, have produced a cuisine that offers an array of specialties made with potatoes, cabbage, barley, and rye or other foods procured by hunting or forest foraging. Specialties in Trentino-Alto Adige use snails, chestnuts, wild nuts, wild mushrooms, and meats from domesticated animals. The region's cuisine reflects the taste for wines and *Grappa* (brandy made from distilled grape skins; also regionally called "schnaps"), preserved and air-cured or smoked sausages and meats, slow-cooking stews and soups with barley, freshwater fish from volcanic lakes and glacial streams, lots of sauerkraut, dumplings of all sizes and shapes, dry and long-lasting rye breads, and simple fruit-rich desserts such as Strudel.

Specialty dishes of this region reflect the influences of German and Swiss cuisines and include *Risotto al Teroldego* (rice with red Teroldego wine), *Spezzatino alla Pusterese* (paprika-flavored beef stew), *Tortel di Patate* (potato pancakes), *Torta di Mele* (apple cake), *Carre di Maiale con Crauti* (pork shoulder with sauerkraut), *Pollo al Cren* (stewed chicken in horseradish gravy), and *Camoscio alla Tirolese* (stewed mountain goat Tirolean-style).

Veneto and Friuli Venezia Giulia. Both of these northeastern areas of Italy share a border with Austria, and lie near Slovenia and the former Yugoslavia. Both Veneto and Friuli Venezia Giulia are renowned for their vegetables such as radicchio (a red winter lettuce similar to chicory), fennel, and asparagus. Both regions are also famous for their sausages and hams, for example, a prosciutto from San Daniele, as well as a fruity sparkling white wine (*Prosecco di Conegliano*). Venice and Trieste, port cities on the Adriatic Sea, boast a thriving fishing industry.

Specialty dishes of this area reflect both the cultural influences of German and Slavic cuisines and the foods available from the land and sea. Some of the most notable dishes include *Lasagna al Papavero* (lasagna with a poppy seed stuffing), *Suf* (a watery corn mush), *Cialzons* (stuffed pasta pockets), *Verze Impinide* (stuffed cabbage leaves), *Capriolo in Salmi* (stewed deer), *Us in Fonghet* (eggs with porcini mushrooms), *Risotto al Tagio* (rice with eel and shrimp), *Polenta e Osei* (corn mush and roasted birds), *Sardele in Soar* (marinated and fried anchovies),

PANETTONE

Panettone appeared in northern Italy around the fifteenth century. Professional bakers probably developed panettone since the process involved is highly complex and requires facilities and equipment that the home kitchen of the past lacked. As the bread's popularity grew, people began to speculate about its origin. The most popular legend concerns a young Milanese nobleman who fell in love with the daughter of a baker, named Toni. To impress the girl's father, the young man disguised himself as a baker's boy and invented a sweet, wonderful bread of rare delicacy and unusual size with a top shaped like a church dome. This new, fruitcakelike bread enjoyed enormous success, with people coming to the bakery in droves at all hours to purchase the magnificent *Pan de Toni* (Tony's Bread).

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and *Insalata di Radicchio alla Vicentina* (Vicenza-style radicchio salad with bacon dressing).

Valle d'Aosta and Piemonte (Piedmont). These regions both fall within the Alpine Range Area and the Piedmont and Lombardy Plain Area, and share borders with France and Switzerland. This geographical proximity is reflected in similar methods of food production and culinary traditions influenced by French and Swiss cuisines. The cooks of Valle d'Aosta and Piemonte, like those of Trentino-Alto Adige, use mushrooms, truffles, berries, and nuts foraged on the southern mountain slopes.

Valle d'Aosta's recipes use *Jambon de Bosses* (cured ham), *Bresaola* (cured beef), *Mocetta* (mountain goat ham), chunky soups topped with mountain cheeses, stews made with game, for example, mountain goat, deer, hare, and pheasant, *lard d'Arnad* (bacon lard), frogs, snails, white and black truffles, fleshy and thorny cardons (or cardoons, relatives of the artichoke), rare ovuli mushrooms (egg-shaped *amanita avoidea*), celery, cabbage, asparagus, potatoes, carrots, and cold-climate grains—rye, buckwheat, barley, and lots of corn mush (polenta). Piemonte is home to the world-renowned sparkling white wine, Asti Spumante, *Savoiardi* (ladyfinger cookies from the province of Savoia), *Gianduiotti* (chocolates made in Turin), and Fontina cheese.

Typical dishes of these regions include *Grissini* (thin bread sticks), *Bagna Cauda* (mixed vegetables with anchovy oil dip), *Griva* (meat loaf wrapped and baked in pork caul), *Minestra di Riso*, *Latte*, *e Castagne* (chestnut chowder with rice), *Tajarin* (very fine ribbon pasta similar to angel hair), *Lumache al Barbera* (snails stewed in red Barbera wine), *Leper alla Vignarola* (hare stewed in wine and grapes), *Rane Ripiene* (stuffed frogs), and *Zabajone* (egg custard with Marsala wine).

Lombardy

The wealthy, industrialized region of Lombardy is located within the Piedmont and Lombardy Plains Region and shares its eastern border with Switzerland. The cuisine of this region includes lots of rice, plenty of meat, some olive oil, brightly colored, expensive ingredients such as saffron and candied fruit, famous soft cheeses named for the town or area where they originate—Gorgonzola, Taleggio, and Certosa—lake or river fish, and pasta pockets. Lombardy is also famous for its ice cream factories.

Lombardy's specialty recipes feature hearty, one-dish meals: *Buseca* (stewed tripe), *Caseula* (sausages, spare ribs, and ham hocks with stewed cabbage), *Polenta Vuncia* (corn mush with butter, cheese, and sage leaves), *Luc-*

PORCHETTA

Although eating meat was regarded as disgusting by the upper classes in imperial Rome, pork, along with bread, was distributed among the poor in the streets to maintain order.

Porchetta, roast suckling pig, is probably of Etruscan origin, and remains popular in areas that once comprised Etruria. A young pig is deboned, stuffed with a mixture of herbs, salt, and pepper, and roasted whole in a wood-burning oven. There are regional differences in the stuffing: stalks and leaves of wild fennel and garlic in Umbria, wild herbs in the Marches, and rosemary and garlic in Rome. In Sardinia, the dish is called *porceddu* and is flavored with myrtle leaves. While the herbs vary, pepper is its most distinctive spice.

At one time, *porchetta* may have been a mountain food, favored in the winter and prepared primarily for feasts. *Porchetta* has become a regular item at fairs and weekly markets such as *porta portese* (the Sunday morning market) in Rome, where it is sold from the back of trucks or wagons. The slices of *porchetta* are served between the halves of a roll without accompaniments.

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Truffle harvesting near Norcia, Umbria, Italy. © Owen Franken/CORBIS.

cio in Stufato (wine-moistened stewed pike), *Laciaditt* (apple fritters), *Cotoletta alla Milanese* (Milan-style breaded veal cutlet), *Frittata di Rane* (a frittata with frog), and *Zuppa alla Pavese* (Pavia-style bread soup with cheese and raw eggs).

Liguria

Liguria, located in the southern portion of Northern Italy, borders France and touches the Piedmont and Emilia-Romagna areas as well as Tuscany, a region of central Italy. It is a coastal region and its port cities—Genoa, La Spezia, and Imperia—provide its cooks with fish and other varieties of seafood. The copious use of locally produced olive oil is undoubtedly the most notable ingredient in Ligurian cuisine, an element that distinguishes it from the other regional cuisines of Northern Italy. It is used in raw, cooked, and fried dishes, for making pasta sauces with nuts and herbs, for moistening bread, and in desserts.

Ligurian cooking reflects its proximity to the food resources of the Ligurian Sea and the limited agricultural resources of its geography. Nevertheless, this region has given the world several popular dishes, for example, focaccia (olive oil bread) and pesto (a pasta sauce made of basil, pine nut, and garlic). Seafood common in Ligurian recipes includes breams (*paraghi* and *saraghi*), red mullets (*triglie*), herring (*nasello*), swordfish (*pesce spada*), mussels (*muscoli*), blanched baby anchovies or sardines (*gianchetti*, also called *bianchetti*), and air-dried filets of delfin or tuna (*mosciame*).

Typical Ligurian dishes include *Trofie al pesto* (twisted pasta dumplings with pesto sauce), *Pansoti alla Salsa di Noci* (pasta pockets filled with an herb stuffing and topped with walnut sauce), *Moscardini alla Genovese* (Genoa-style stuffed squid), *Torta di Bietole* (swiss chard quiche), *Stoccafisso in Umido* (dried codfish soaked and then stewed), *Mitili alla Spezzina* (La Spezia-style stuffed mussels), *Castagnaccio* (chestnut-flour cake moistened with olive oil), and several stuffed vegetable dishes, for example, stuffed artichokes or zucchini flowers.

Emilia-Romagna

Emilia-Romagna, with its eastern coast along the Adriatic Sea, is probably the culinary divide between Northern and Central Italian cuisines. It is centrally located and touches the regions of Piemonte, Lombardy, Veneto, Liguria, Tuscany, and the Marches. In addition to its plentiful seafood resources, which include sole, hake, herring, mullet, turbot, monkfish, grouper, clams, mussels, cuttlefish, and mantis shrimp, Emilia-Romagna is famous for its lasagna, ragu (a meat sauce), meat-filled tortellini, and Parmesan cheese (Parmigiano Reggiano). The city of Modena is well known for its prosciutto, balsamic vinegar, and several sausage specialties, which include *Coppa* (pork sausage), *Pancetta* (pork belly sausage), *Cotechino* (pork meat and rind sausage), *Mortadella*, and *Zampone*, pork leg stuffed with meat and rind. Parma is also famous for its prosciutto.

Typical dishes that incorporate Emilia-Romagna's specialties include *Brodetto* (fish and seafood chowder), *Canocchie Al'olio e Prezzemolo* (shrimp snappers in olive oil and parsley dressing), *Anolini in Brood* (ring-shaped pasta pockets in broth), *Polpettone alla Bolognese* (Bologna-style meat loaf), *Erbazzone all'Emiliana* (Emilia-style quiche of onions and greens), *Cotechino in Galera* (cotechino sausage encased in meat loaf and cooked in red wine), *Asparagi alla Parmigiana* (Parma-style asparagus with Parmesan cheese), *Fagioli e Cotiche* (beans cooked with boiled pork rinds), *Bollito Misto* (mixed boiled meats), and *Lumache alla Piacentina* (Parma-style stewed snails). *Piadina*, a thin, parched, unleavened bread wheel, is also a specialty of this region.

Parmigiano Reggiano and Grana Padano

No discussion of Northern Italian cuisine can ignore two of its fine cheeses, Parmigiano Reggiano and Grana Padano. Both must be matured very slowly.

Parmigiano Reggiano, usually called Parmesan cheese, has been made regionally since the early thirteenth century and has become a symbol of classic Italian cuisine. It is a semi-fat, hard, flaky cheese made of raw cow's milk, recognizable by its large, wheel-shaped forms, covered by a yellow wax rind, and marked with the dotted brand name, Parmigiano Reggiano. Commonly used as a grated cheese, it has a delicate, fragrant, and unique flavor that it imparts to foods. Under Italian law, Parmigiano Reggiano has a prescribed ripening period, usually about two years. It is produced according to traditional Parmigiano Reggiano methods in plants located in specific areas of Emilia-Romagna, which include Parma and Reggio-Emilia. Other Northern Italian locales that produce Parmigiano Reggiano are Bologna, Mantova, and Modena.

Grana Padano is cooked, cylindrical, semi-fat, hard, grainy cheese. First made at the beginning of the millennium by Cistercian monks in Lombardy, near Chiaravalle, it became known as *grana* (literally, 'grain') due to its grainy consistency. It is commonly used as a table cheese, but, like Parmigiano Reggiano, it is also used as a grated cheese. It is produced in the Po Valley and Delta region in Bologna, Mantova, Asti, Cuneo, Brescia, Como, Cremona, Milan, Trento, Treviso, Venezia, Verona, Ferrara, Piacenza, Ravenna, and other cities throughout the area.

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Elisabeth Giacon Castleman

SOUTHERN ITALY

For the purpose of this entry, southern Italy is defined as Rome and all areas south of Rome (see map). Many ethnic groups, such as the Greeks, Spaniards, and Arabs, have passed through southern Italy over the millennia and influenced its cuisines. Traditionally, southern Italians have been much poorer than their northern counterparts. The poverty of the south has resulted in unique regional cuisines that bear little resemblance to the dairy-based cuisines of the north. Rome, traditionally part of middle Italy, today has a cuisine more southern than northern in temperament.

Interestingly, the ancestors of most Italian Americans are from the South; the dire poverty of southern Italy led to large-scale emigration from regions like Campania, Calabria, and Sicily to the United States. It follows logically that Italian-American cuisine is mainly derived from the cuisines of southern Italy. Pizza, pastas with tomato sauce, organ meats, and eggplant-based dishes are all common components of both southern Italian and Italian-American cuisine. Southern Italy is a historically poor region, and so the population used what they had available—inexpensive ingredients like capers and olives, hot peppers, garlic, and anchovies—to create flavorful and unique dishes. Unlike the northern pastas from regions such as Emilia-Romagna, southern pastas are made without eggs and from harder flour and are often shaped rather than rolled, resulting in a chewier pasta like *orecchiette* ("little ears") from Apulia (Puglia) or *conchiglie* (shells) from Campania. These less-rich pastas need heavier sauces.

In the South there are few cows, so beef, butter, and cream are not part of the diet. The favored cheese is *mozzarella di bufala*, which is made here wholly or largely from buffalo milk (that is, the milk of the water buffalo, not that of the American bison), which has a distinctive taste. There are also goats and sheep—yielding meat and cheeses—and pigs and chickens. Lamb dominates mountain cooking. In the past, young spring lamb was reserved for important occasions such as Easter or weddings and baptisms, but today it is more common and often available year-round. Near the coasts, saltwater fish such as *spigola* (sea bass), *orata* (bream), and *dentice* (dentex, a fish related to the porgy), as well as a variety of shellfish and cuttlefish, are available.

Olive oil is produced around the Apennines and in southern Apulia, and is used all over the South. Suitable soil and temperature contribute to an abundance of vegetables and fruits, and many types of herbs are also produced. Eggplant is a major food item, as it grows better in the South than in the North and can be prepared in many different ways; *melanzana*, the Italian word for eggplant, derives from *mela insana* ("noxious apple").

Rome, Naples, and Sicily are places that non-Italians are familiar with; however, there are other regions in Southern Italy, and some of their food culture is also described here.

Rome

Rome is truly the Eternal City. Its rich and fascinating history includes the elaborate public and private feasts held by ancient Roman emperors. That said, modern Roman cuisine is actually quite simple and much influenced by other regions. Dishes are prepared simply with a few inexpensive ingredients. Antipasti are not elaborate, pasta sauces are quick to prepare, and there is a large variety of vegetables (especially leafy greens).

Historically, Rome was the place where cattle were butchered, and so Romans are famous for their use of the *quinto quarto*, or fifth quarter, the organ meats and parts of the cattle that were left over after butchering. Two famous Roman dishes, *coda alla vaccinara*, a stew of oxtail braised for a long time with celery, carrots, onions, tomatoes, herbs, and spices in white wine, and *rigatoni alla pajata* or *pagliata*, short, tubular pasta with beef or veal intestines in a tomato sauce, were born around the communal slaughterhouse in Testaccio.

A popular meat is lamb, which is usually roasted in the oven (*abbacchio al forno*) and served with potatoes. Examples of other meat dishes considered very Roman are *pollo alla Romana*, chicken with red and yellow peppers; *saltimbocca alla Romana* (literally, jump into the mouth) made of thin slices of veal, prosciutto, and sage; and *trippa alla Romana*, which is tripe in a tomato and mint sauce.

Bucatini all'amatriciana (tubular pasta with bacon and tomato sauce) originated from country kitchens, where bacon, olive oil, and fresh tomatoes were plentiful. Fettuccine Alfredo is just *pasta al burro* (pasta with butter) from Alfredo's restaurant in Rome. Some other popular pasta sauces are *cacio e pepe* (pecorino cheese and pepper), *carbonara* (bacon, eggs, and pecorino and Parmesan cheeses) and *arrabbiata* (hot pepper and tomatoes). *Gnocchi alla Romana* are dumplings made of semolina, eggs, milk, and cheese. *Spaghetti alla puttanesca* (literally, spaghetti whore-style) is made with olives, anchovies, and capers.

There are also soups, all with some version of pasta in them, such as *stracciatelle* (literally, "little rags"), so named from the thin batter of egg, flour, and Parmesan that is poured into the chicken or beef broth used. Others feature herbs, such as lentil soup flavored with *nepitella* (wild mint) and bean soup flavored with rosemary. There are also *minestra de ceci e pasta* (soup with chickpeas and pasta) and *zuppa di arzilla* (fish soup).

Romans say it takes four people to make a proper salad: a spendthrift for the oil, a miser for the vinegar, a wise man for seasoning, and a madman for mixing. *Panzanella* is bread salad with tomatoes, cucumbers, onion, basil, and dressing. A classic Roman winter salad is *puntarelle*, shoots of a particular variety of chicory with a bitter undertone, tossed with a dressing made with olive oil, anchovies, garlic, and lemon juice. Some salads are a mix of greens sometimes called *misticanza*, preferably with the addition of *rughetta* (also called *rucola*, *rocola*, and, as it is in English, *arugula*). More recently tomatoes, shredded carrots, and even canned maize (corn) may be added to salads.

Artichokes are also seasonal and popular as in *carciofi alla Romana* (Roman style), which are stood upright in a pan as they cook with garlic, mint, parsley, and an abundant drizzle of olive oil. Another famous preparation is made from *romanesco* artichokes, which are round and lack a spiny choke. These reach gastronomic heights when prepared *alla giudia* (Jewish style), in which the artichokes are flattened and deep-fried to look like golden sunflowers and their leaves have a delicious nutty crunchiness. This dish has contributed to the fame of the restaurants in the Roman ghetto.

Also popular in Rome are such stuffed vegetables as tomatoes stuffed with rice and mozzarella, or zucchini stuffed with chopped meat. Then there are vegetables, mainly greens, that are prepared *all'agro* (with a lemon-juice dressing) or *in padella* (stir-fried).

Rome is partial to frying: *fritto misto* (mixed fry) can contain shrimp and *calamari* (squid); or artichoke and brain; or different cheeses; or a mixture of vegetables; or *supplì al telefono*, a croquette of rice with mozzarella cheese in the middle—when one bites into it the mozzarella flows out in long threads, as in a telephone cord. The famous *fiori di zucca* (zucchini flowers) are stuffed with mozzarella and anchovy and dipped in batter before frying. Cod is also batter-dipped and fried (*baccalà filetti)*.

Pecorino romano and ricotta are the most favored cheeses. Ricotta, a soft sheep's milk cheese, is prepared inside wicker baskets.

Rosette (hollow, very crisp rolls) are very characteristic of Rome, as is *casareccio*, a chewy, peasant-style bread.

Favorite desserts in Rome are fresh fruits, especially strawberries from Nemi (a town on the outskirts of Rome), or *macedonia* (fruit salad). Many other popular desserts have originated elsewhere, such as *tiramisu* (literally, "pick me up"), made of mascarpone (a very creamy, soft cheese, typically made from cow's milk), ladyfingers, coffee, and other ingredients specific to the home or restaurant; *torta de la nonna* (cake with custard and pine nuts); *panna cotta* (boiled cream), served with a variety of toppings, such as berries, chocolate, and caramel; *profiteroles* (mounds of little cream puffs drizzled with chocolate); and *gelato* (ice cream) in flavors such as lemon, coconut, orange, and pineapple, frozen and served in a container made of the skin or shell of its source.

Examples of foods reserved for specific festive occasions in Rome are lentils with *cotechino* and *zampone* (varieties of pork sausage), served on New Year's Eve; *porchetta* (roast stuffed pork), traditional at the festival of Noantri in Trastevere; *pan giallo*, a fruit-and-nut cake served at Christmas; *bigne di Giuseppe* (fried doughnuts), filled with cream or chocolate eaten for Father's Day; and *maritozzi* (raisin buns), traditional for Lent.

Campania and Naples

Naples has long guided the gastronomy of the region and its cooking has had the most influence on the way non-Italians regard Italian food. It is said that the true Neapolitan is poor, but likes to eat well and is proud of the invention of three of the tastiest food items: pizza, tomato sauce, and macaroni. Poor immigrants exported Neapolitan cuisine, rich in tomato sauce, garlic, olive oil, and black olives, to the United States and elsewhere. As meat and seafood were out of reach for the poor at home, the transported cuisine used more meat but fewer vegetables; the classic Italian-American dish, spaghetti with meatballs, for example, is not common in Italy. Immigrants also used more garlic and oregano.

But Naples was a kingdom that in the households of the nobility also had a refined cuisine that required extensive effort; a simple *ragù* (sauce), for example, took many hours to prepare. The master of the kitchen of the noble palaces was the *monzu* (a term derived from the French *monsieur*), a combination of cook and artist, revered and respected by all. He was responsible for the preparation of elaborate and rich court cuisine with dishes like *braciolla* (stuffed beef roll), mozzarella *in carozza* (fried mozzarella sandwich), and *timballi* of pasta or rice with eggplant, cheese, and tomato. Desserts like *baba* (a cake made of yeast dough with syrup) and *sfogliatelle* (literally, "little sheets"—flaky pastry wrapped around sweet items) were lavish and unusual. *Spumone*, an ice-cream confection in strips of colors, is also native to Naples.

The cuisine of Campania and of Naples is rich in vegetables and pasta, often layered in casserole dishes. But the Neapolitans also prepare refined seafood dishes such as *zuppa di vongole* (clam soup), or spaghetti *con le vongole in salsa bianca* (with clams in white sauce), or *cozze in culla* (tomatoes stuffed with mussels and a mixture of capers, chopped parsley, oregano, and bread crumbs). A Neapolitan dish still eaten at home is *minestra marinata*, made with pork fat and boiled greens. The richness of the soup depends on the economic conditions of the family; this was the basic daily meal until the arrival of pasta.

The people of Naples were the first to accept the tomato from the New World, at a time when other Europeans believed it to be poisonous.

Arguably, Naples's biggest contribution to world cuisine is pizza. Royalty played an important role in the development of pizza: For example, *pizza Margherita* reflects the three colors in the Italian flag (basil for green, cheese for white, and tomato for red) and was created specifically for King Umberto I's consort, Queen Margherita. Queen Maria Carolina, the moody and autocratic wife of King Ferdinando I of Naples, offered pizza to her entire court.

In the towns of Campania, including Naples, life takes place in the streets. In the working-class districts of Naples, the streets seem to consist of one long outdoor food shop. This tradition has roots in the past when people spent most of their days outdoors. Housing was cramped and uncomfortable, but the weather was warm, very conducive to outdoor living. Even today, one can observe that people spend much time in bars or in piazzas or just sitting on chairs in front of their doors. Until 1800, all kinds of food were eaten outdoors, including macaroni, pizza, and seafood. There was the macaroni vendor, for instance, who scooped out pasta from huge cauldrons and for a few pennies more offered it with tomato sauce or with boiled *polpi* (octopuses) served in a cup with their steaming fragrant broth.

Sicily

Sicily, the Mediterranean island in the sun, close to North Africa, enjoys strong Greek and Arab influences. Its cuisine, specifically its cooking style, has influenced the food culture of Italy and of other parts of the world. On the eastern side of the island, the cuisine is sober and mild, avoids sweet and sour tastes, and is less generous with sugar in sauces; whereas in the western part of Sicily, the influence is Saracen, with strong contrasts and flavors. It is thus not surprising that one of the specialties of Trapani, a seaport in northwestern Sicily, is *cuscusu* (couscous).

The dish more people associate with the island than any other is caponata, a cooked eggplant delight consumed cold and made with a number of ingredients such as celery, capers, anchovies, chilies, olives, tomatoes, and vinegar. It comes in many varieties; some are purely vegetarian, whereas the Palermo version can also contain fish.

Eggplant dishes are definitely favored in Sicily, as are tomatoes and pasta. Pasta varieties are abundant and are often baked into *timballi* (timbales); the most famous of these is *timballo di anellini*, made with ring-shaped dried pasta, *balsamello* (béchamel sauce), ground beef, chicken, peas, and vegetables, all wrapped in lettuce leaves and baked in a mold. A local specialty is spaghetti *con sarde* (with sardines), often prepared with raisins and nuts as well. Sicilian pizza is usually thicker than other varieties, and has anchovies. The fish of the Adriatic Sea are different from those of the Tyrrhenian Sea, and in Sicily there are swordfish from the warm water.

Sicilian cuisine has its own terminology: *arancini* (literally, little oranges) are fried balls of rice, meat, and grated cheese; *quaglie* (quails) are eggplants sliced open and fried in oil; and *falsemagre* (false thins) are meatballs made with salami, hard-boiled eggs, parsley, and other ingredients. Eggplant dishes are often given the appellation *Norma*, as in spaghetti *alla Norma*.

The cheese-making tradition in Sicily is very important. Cheese is a nourishing food that can be processed at the household level and is easily transported and preserved. That is the reason for the heavy reliance on cheese by poor people. Some of the favorites are *pecorino Siciliano*, a cheese with a hard consistency that is made from the ewe's milk and is aged and salted; *Ragusano*, a pear-shaped cheese made from cow's milk, which received its name from the practice of suspending the cheese from a beam with a cord; *caciocavallo Palermitano*, similar to Ragusano but having a pungent odor and a piquant flavor due to the type of grass eaten by the cows; *tuma*, pecorino before it has been salted; and *primosale*, salted only once (*provola* is a smoked version).

Ricotta is made from fresh ewe's milk and is extensively used in Sicilian cooking. Salted and baked ricotta cheeses have been developed in response to the need to preserve them. *Canestrato* owes its name to the pattern created by the wicker baskets in which it is pressed. It is made from ewe's or cow's milk and probably originated from attempts to make pecorino, for which it can be substituted in cooking.

Sicily exceeds all the other regions of Italy in its abundance of sweets, fruits, and ice creams. Candied fruits, sweets made with almond paste, and ice cream are available everywhere. *Cassata* (brick-shaped sponge cake filled with ricotta, candied fruit, and marzipan) may be the most famous of Sicilian desserts. Many of the recipes for Sicilian sweets come from monasteries, and until the turn of the twentieth century their entire production went to the clergy and to Sicily's aristocrats. Some recipes remain a mystery: the nuns of Santo Spirito, for example, refuse to reveal their secrets for making the sweet dessert they sell at their convent in Agrigento, or at the orphanage in Erice. Fortunately, these traditional sweets live on during the religious festivals such as Easter, when desserts made from almond paste in the form of fruits, sheep, and patron saints are sold.

Apulia

Apulia is a region in southeasternmost Italy producing wheat and a variety of vegetables—tomatoes, artichokes, lettuce, fennel, peppers, and onions—citrus fruits, olives, almonds, figs (some dried with almond flavoring), and grapes. Add to this a sea full of fish, as well as fields for grazing, and the result is a variety of ingredients that can easily be combined into a sumptuous cuisine.

Homemade pasta is found in unusual shapes like the *orecchiette* traditionally paired with broccoli rabe, or *cavatelli* (literally, little plugs). For Sunday dinner a favorite is *maccheroni al forno* (baked macaroni), a pie filled with little meatballs, sliced hard-boiled eggs, pieces of artichoke, salami, and cheese. *Ciceri e tria* is composed of fried pasta strips with chickpeas.

Since the sea surrounds three-quarters of the area of Apulia, seafood products are abundant and popular. Sea turtle, oysters, mussels, cuttlefish, and octopus are cooked in simple ways, sometimes even eaten raw in the markets. The dominant meat is lamb, roasted, stewed, or even fried. *Gniumerieddi* are lamb innards cooked with pecorino cheese. Beef is used for either meat sauce or small meatballs, possibly because in poorer times the only cattle to be slaughtered were old and produced tough steaks.

Due to the popularity of lamb and the enormous flocks, cheese made from sheep's milk is very popular, including fresh ricotta and pecorino. A typical snack of this region is the *calzone* (literally, big sock), pizza dough spread with onions, black olives, capers, tomatoes, pecorino cheese, anchovies, and parsley; closed and pinched around the edges; and baked in the oven.

Homegrown yellow and white melons, sweet watermelons and grapes, and *cotognata*, a quince concentrate, are considered appropriate choices for ending a meal.

Abruzzi e Molise

Most of the great cooks of Italy come from the region of Abruzzi, where the fame of the local cooks, who were often highly sought-after by nobles living in other parts of the kingdom, began in the sixteenth century. This geographical area is known for strong flavors: *peperoncino* (hot red pepper) is used to flavor many dishes, and a favorite sauce for pasta is *aglio, olio e peperoncino* (garlic, olive oil, and hot red pepper), which can be heavy going for those not accustomed to spicy food. *Alla chitarra* (guitar-style) is a well-known pasta named after the utensil used for cutting it.

Ideally, the cuisine of Abruzzi is divided between that of the sea and that of the mountains. The first has the classic *brodetto* (fish stew of many different fish) as a principal dish. Other dishes include fried fish and fish in sauces served with pasta, as well as freshwater fish, such as mountain trout and river shrimp. Lamb is the popular meat: *agnello all'arrabbiata* (literally, angry lamb) is a favored spicy entrée. Pizza *sette occhi* is a dessert in which the pastry strips resemble seven eyes.

Among the unique dishes of Molise is *p'lenta d'iragn*, a white polenta made with potatoes and wheat, and served with tomato sauce. *Scamorza* (a cheese similar to mozzarella) is a popular item from the region and is usually served grilled.

Basilicata and Calabria

Basilicata is known for spicy cuisine: as its inhabitants were poor, they made their fare more interesting with the use of spices, such as ginger. Sausages in some parts of northern Italy are still called by an old name for Basilicata (*lucania* or *licanica* or *luganega*), and so are some pasta dishes, such as *cavatelli alla lucana* with mushroom and sausage, or *cavateglie e patate*, pasta and potatoes with a ragù of rabbit and pork. Pasta dishes are often named after towns, such as *orecchiette alla Materana* (a town in Basilicata), which has a sauce made of vegetables and arugula. Other pasta dishes are frequently served *all'arrabbiata.*

In Calabria, pizza is called *pitta* (flat) and is served without tomatoes; *ciambotta* (big mixture) is a vegetable stew of eggplant, potatoes, tomatoes, and onions; *morseddu* (little morsel) is a traditional breakfast dish of pork-tripe stew with liver and herbs served in a pitta; *licurdia* is onion-and-potato soup; and *millecosedde* (thousand things) is a soup of dried beans and vegetables with pasta.

See also **Pasta; Pizza.**

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Judit Katona-Apte

THE ITALIAN MEAL

Meals are a central part of Italian family life. Italians are passionate about food and eating, and much of their socializing is done around the sharing of meals. As with most cultures, there are specific dishes associated with specific Italian holidays. Unlike many Western societies, however, Italians have not embraced a multitude of foreign and ethnic ingredients. Although Italian cities have many more foreign and fast-food restaurants than they did ten years ago, most Italian restaurants—and indeed most homes as well—take a more traditional and conservative approach to meals. "Fusion" and "nouvelle cuisine" are not terms commonly associated with Italian meals.

Fast food is popular with the young. Eating fast food is more a social than a culinary experience, and signifies conformity to a peer group, an identity independent of one's household, modernity versus tradition, and being in the company of, and behaving according to the rules of, chosen friends as opposed to family.

Due to Italian attention to tradition, there are reactions. Movements such as *il ricupero* (the retrieval) and *la riscoperta* (the rediscovery) are founded to maintain tradition in the modern world. The best-known such initiative is the "slow-food movement" that began in Italy in 1986 to challenge "fast food," which was believed to harm health, destroy the environment, and wipe out traditional cuisine. By 1999, thirty Italian towns had designated themselves "Slow Cities," where regional tradition in food, parks, and similar values are emphasized over traffic, neon signs, noise, and fast-food chains.

Shopping and Meal Preparation

The traditional Italian housewife shopped daily. Her morning visit to the open-air market was a form of ritual. In separate stalls she would purchase fruits and vegetables, fish or meat, eggs, cheese, and *salumi* (cold cuts), depending upon what was in season and what she needed. If she needed something more in the afternoon, she could pop out to the *latteria* for fresh milk, the *alimentari* (grocery store) for bread, cold cuts, cheese, and packaged foods, the *macelleria* for meat, or the *frutteria* for fruits and vegetables. These small family-owned stores populated every neighborhood. Today, however, things are changing. Supermarkets, especially the megastores, are rapidly replacing small neighborhood shops.

The designation of housewife (though she is likely to be a working woman) above is deliberate, for in traditional Italian society gender roles are closely associated with food preparation. In the home, women are responsible for meals. Men may cook occasionally or prepare a specific dish, but the responsibility for daily cooking rests with women.

Eating Out

Average Italians do not socialize in their homes with friends and acquaintances; meals at home are usually shared with family members. Eating in restaurants with family, friends, and business associates is quite common. On weekends it is not unusual to see extended families of four generations eating at a large table. There are many different types of eating places, as described below.

A *ristorante* is traditionally a proper restaurant. *Ristoranti* have attractive table settings, starched tablecloths and napkins, and numerous choices for every course. To be a waiter is a career opportunity, and many stay with the same restaurant for a lifetime. Female waiters are still infrequent but are increasing in number.

A *trattoria* is a small eatery with a limited menu. An *osteria* is a less sophisticated eating place frequented by neighborhood people, with a few characteristic dishes. Both are simple, family-run operations, in which people often sit at common tables, large sheets of butcher paper under their plates. A pizzeria is an eating establishment specializing in pizza. Some serve only pizza, salads, and antipasti (appetizers), while others also serve pasta dishes and a limited choice of meat dishes.

An *enoteca* is distinguished by its large selection of wine; a limited selection of dishes is served there, usually comprising cold salads and other appetizers. Recently, many have started serving a limited menu of hot foods. A *tavola calda* (snack bar serving hot food, often cafeteria-style) is not considered a restaurant and is used for quick snacks, usually at lunchtime. A *rosticceria* (rotisserie or grill) sells ready-to-eat foods such as grilled chicken, pizza by the slice, roasted potatoes, cooked vegetables, and some baked-pasta dishes to take home. Some of these distinctions are disappearing in the modern world; it is chic today to call a restaurant a *trattoria* or *osteria*, and *enoteche* have become popular eating places.

Coffee Bars. Bars serving mainly coffee during the day are a very important part of Italian social life. The number of ways Italians drink coffee seems to be endless: *espresso* (small but strong), *cappuccino* (espresso with steamed milk), *lungo* (with extra steam), *ristretto* (very strong), *caffe latte* (with much hot milk), *macchiato* (spotted with milk), *corretto* (with a shot of brandy or grappa), *doppio* (double), and *caffee Haag* (decaffeinated), to mention just a few. Romans claim that the quality of the coffee is determined by the three Ms: *Mano*, *Macchina*, and *Miscela* (hand, machine, and mixture). Italians drink their espresso quickly, unlike other Europeans, who sip it for a long time. Bars also serve fruit juices (*spremuta* or *sugo*), as well as *gelato* (ice cream), *granita* (flavored ices), and, recently, iced tea during the hot season.

People gather in bars to have a drink and a snack. They stand at the counter and read the newspaper. As Italians are avid soccer aficionados, they are likely to be loudly discussing last night's game. Bars that have tables, especially outside, charge extra for sitting at them.

Food Events

Historically, Italians had their major meal, or *pasto*, in the middle of the day, and then rested. Workers would go home to eat and return to the workplace in the afternoon. Today, distances are greater and more people work away from home, and so in many households, *pranzo*, the main meal, is now eaten in the evening. The exception is the Sunday midday meal, considered by many to be the most important meal of the week. On Sunday afternoons (often post-Mass), extended families will gather for large, lengthy multicourse meals.

Breakfast, *piccola colazione* or *prima colazione*, is not a major meal for most Italians. It is usually taken at a bar and includes coffee (often cappuccino) with a pastry such as a *cornetto*, the Italian equivalent of a croissant. There are many types of *cornetti:* plain, or filled with chocolate, cream of rice, jam (called *marmellata*), or custard. Other popular pastries are the brioche and the doughnut.

Structure of a Meal

Most people, when they think of an Italian meal, think of pasta. And while an Italian meal is much more than that, it is indeed the pasta (or at any rate the pasta course) that sets the Italian meal apart. The common American or European practice of serving stews and braises over noodles, rice, or dumplings is not found in Italy. Instead, these starches are served on their own, as a separate course. (The exception is potatoes, which are considered a vegetable, not a starch, and are often served with grilled meats.) Normally, the starch course will be prepared with its own separate sauce, though in the home the starch may be served with the sauce from a stewed or braised dish, followed by the meat from the same dish as a second course.

At first glance, a meal in Italy appears strictly structured. The traditional meal contains at least four courses: the antipasto; the *primo* (first course) of pasta, rice, polenta, or soup; the *secondo* (second course) of meat or fish; and the *dolce* (dessert). However, these multicourse meals are no longer daily occurrences for most Italians. At home, they may have just one or two courses for dinner, and the order of these limited courses contains some flexibility. While the *primo* would never follow the *secondo* (as is obvious from the names), Italians will eat meals of antipasto followed by *primo;* or *primo* followed by antipasto; or, less commonly, antipasto followed by *secondo*, or *secondo* served with selected antipasti on the side. They will not, however, eat two dishes that are considered *primo* together, such as soup followed by pasta, a sequence common in central European meals but shunned by Italians.

Despite eating fewer courses at home, Italians tend to regard eating out as an occasion for a more traditional three- or four-course meal. Bread, wine, and water accompany all meals (except, of course, breakfast), no matter how many courses are served.

Antipasti

Formal meals start with antipasti. There is tremendous range and regional variation, and in many situations an antipasto could be considered an elaborate meal by itself.

There are several bread-based preparations that may be included with an antipasto. Most typical are *bruschetta* (known in Tuscany as *fett'unta*)—toasted or grilled bread rubbed with garlic and drizzled with fruity olive oil (chopped tomatoes or other toppings can also be added); and *crostini*, thin slices of toast covered with an assortment of pastes made from chicken livers, mushrooms, truffles, artichokes, olives, bone marrow, and so forth.

One may find any or all of the following on an antipasto table: marinated cold vegetables such as eggplant, zucchini, whole small onions, and peppers; boiled greens such as spinach, *cicoria* (chicory), and broccoli rabe; anchovies, seafood salad, and mushrooms marinated in olive oil; frittatas (unfolded filled omelettes); *affettato* (cold cuts) of cured meats such as salami, prosciutto, mortadella, smoked tongue, and sausage.

There are also cheeses, especially mozzarella, Parmesan, and pecorino. The favored cheese is *mozzarella di* *bufala*, which is made at least partly from buffalo milk (that is, the milk of the water buffalo, not that of the American bison) and has a distinctive taste. Some popular cold antipasti are not on the buffet but can be ordered from the menu. Perhaps the most famous example of this is prosciutto and melon (or in season, figs). Other popular ordered antipasti are carpaccio (very thin slices of raw beef or fish), and *bresaola* (cured air-dried beef) drizzled with olive oil.

Antipasti can also be fried and served warm. *Crocchette* (croquettes) are popular; one type is *suppli* (rice balls filled with cheese or ground meat, dredged in breadcrumbs, and fried). There are olive *ascolane* (fried stuffed olives), *baccalà filetti* (dried salt cod, fileted and fried), and vegetables dipped in batter and fried. The famous *fiori di zucca* (zucchini flowers) are stuffed with mozzarella and anchovies before being dipped in batter for frying.

Primo

Primi piatti or just *primi* are felt to constitute the first course of an Italian meal, though they follow the antipasti. This course includes either pasta, rice, gnocchi, or polenta with sauce, or soups containing pasta, rice, or *farro* (spelt—an ancient variety of wheat).

Pasta et al. The variety of pasta shapes and sauces is seemingly infinite. Regions and even villages often have their own specific creations. A few examples are offered here.

It is important for Italians to match the shape of the pasta with the sauce, though they allow much flexibility. Certain pastas are always mentioned within the context of a sauce, such as *bucatini all'amatriciana* (tubular pasta with a tomato and bacon sauce), or *fettuccine all'Alfredo* (fresh egg noodles with butter, cream, and Parmesan), or *spaghetti alla carbonara* (spaghetti with bacon, eggs, cheese, and pepper); but substitutions can be made. At restaurants, waiters recite what is available by the shape of pasta—penne, spaghetti, fettuccine—and expect the customer to state what sauce should go on it. While almost any combination is possible, there are "rules." One general rule is that smooth sauces are appropriate on long pasta, and sauces with chunks of vegetables or meats are better on small pasta shapes, which trap the chunks. Another is that fresh egg pastas work better with butter-based sauces than olive oil–based ones. In the dairy-rich north of Italy, fresh egg pastas are very popular, whereas in the olive oil–dominated south, dried or eggless pastas predominate. An important "rule" is that all pastas are consumed without a spoon (that is, with just a fork), even spaghetti.

Fresh egg pastas include noodles such as fettuccine, *tagliarini*, and *pappardelle* (all ribbon-shaped in various widths), and filled pastas such as ravioli, tortellini (small, hand-pinched, ring-shaped), and *agnolotti* (small, half-moon-shaped). Popular dried pastas include spaghetti, penne (short, thick, tubular, cut diagonally), and *farfalle* (bowties). Some pasta types are quite specifically associated with a certain region, as is the case with *orecchiette* (little ears), a traditional pasta from Apulia *(Puglia).*

POLENTA AND SHRIMP

1 cup polenta or quick-cooking cornmeal
1 tsp. salt
5 cups of water or milk (or part water, part milk)
2 tbsp. butter
2 pounds shrimp, shelled and deveined
1 lb sausage (kielbasa or chorizo), cut into slices
1 onion, sliced
3 slices of bacon (optional)
1/4 cup vegetable oil (less if bacon is used)
2 cloves of garlic
Seasoning: salt, pepper, and cayenne to taste

Make polenta: bring 5 cups of water or milk (or part water, part milk) to a boil in a heavy pot (best to use nonsticking surface). Lower the heat to simmer, add salt and slowly add the polenta (best sprinkled by hand) and stir with a wire whisk or wooden spoon until it forms a mush. This should take from about 7 to 15 minutes. If the cornmeal is less processed it may take a little longer. Add butter and mix it in.

Make shrimp: cut bacon into 1-inch pieces and render in large frying pan. When most of the fat has separated, add the onion and garlic and stir fry for 3–5 minutes. Add the shrimp and seasoning, and cook until it turns pink, then add the sausage and stir until sausage is warmed through.

Pour polenta into serving platter, and pour shrimp mixture on top. Serve at once.

Risotto is a uniquely Italian way of cooking rice, resulting in a dish with a creamy consistency. Risotto is best made with special types of rice such as *arborio*, *canaroli*, or *vialone nano*. Popular renderings include *Milanese* (that is, with saffron—*risotto Milanese*, unlike other risottos, is traditionally served with osso buco, a meat dish, as a *secondo)*, *con funghi* (with mushrooms), *con frutti di mare* (with seafood), and *nero* (with squid ink).

Polenta (thick cornmeal mush) is typically a northern dish. It can be soft and creamy with a sauce on top (often tomato with sausage and pork ribs), or it can be cut into shapes and baked, fried, or grilled. It is traditionally a cool-weather dish served on a wooden plate.

Gnocchi (dumplings) are either *di farina* (made from wheat flour) or *di patate* (made from potato). There are also *gnocchi alla romana*, made of semolina flour and traditionally served on Thursdays in Rome. *Crespelle* (crepes) may also be a first course and can be filled with meat or with cheese and spinach.

Sauces. Most pasta sauces are either butter- or olive oil–based. Tomatoes are probably the next most frequent ingredient, particularly in the south. An important component of baked pastas from Emilia-Romagna is *balsamella* (béchamel sauce). Whatever the sauce (called *sugo* or *salsa*), the most important thing is just to moisten the pasta with it; Italian pasta is served with much less sauce than its American counterpart.

The best-known sauces are probably *ragù alla bolognese*, made of vegetables, tomatoes, cream, and beef and simmered for a long time, and *pesto alla genovese*, a mixture of fresh basil, garlic, pine nuts, pecorino cheese, and olive oil that is traditionally served over a mixture of *trenette* (thin strips of pasta), potatoes, and green beans.

Other popular pasta sauces are *quattro formaggi* (four cheeses); *boscaiolo* (woodsman-style), containing mushrooms, peas, ham, tomatoes, cream, or whatever the chef wants to add "from the forest"; *arrabbiata* (literally, angry), a tomato sauce with hot peppers; as well as many for seafood (which are served without cheese).

Secondo

The *primo* is followed by a usually more austere second course of meat or fish and *contorno*, a vegetable or salad side dish.

Meats and fish. Meat and fish can be prepared in a variety of ways: grilled, roasted, or baked; braised with vegetables; fried, as in *fritto misto* (mixed fry); or boiled (*bollito*) and served with *salsa verde* (a piquant green sauce made with parsley) or *mostarda* (a sweet-and-sour condiment). Regional specialties include *fiorentina*, a Tuscan T-bone steak usually served rare, and osso buco, veal shanks in butter, garlic, anchovies, grated lemon peel, and herbs from Lombardy. *Trippa alla bolognese* is tripe with bacon, onion, garlic, and parsley, while *trippa alla romana* is tripe with tomatoes and mint. *Fegato* (liver, usually calf's liver) can be prepared *alla veneziana*, (with onions), or with sage, or grilled, or Milan-style (dipped in egg and bread crumbs and fried). Large porcini mushrooms are often treated like meat: grilled and drizzled with olive oil, garlic, and parsley as a *secondo.*

While lamb is more popular roasted or grilled, veal is prepared in many different ways. *Saltimbocca* (literally, leap into the mouth) is a dish of veal, prosciutto, and sage associated with Rome, while *scallopine alla bolognese* is veal layered with prosciutto and boiled potatoes. Thin slices of veal are often prepared in light sauces flavored with Marsala or lemon juice.

Chicken and turkey are also favored. *Pollo alla diavola* is a spicy chicken: in Abruzzi it is sautéed with hot red pepper, in Tuscany with black pepper, and in Florence with ginger. Chicken Marengo is named after a battle won by Napoleon and contains chicken, brandy, tomatoes, olives, crayfish, and poached eggs on toast. Stuffed turkey is popular in Lombardy.

Pork is extremely popular, either as chops, roasted with fennel and rosemary as in porchetta, or made into sausages like *zampone* and *cotechino*, the former stuffed into pigs' feet.

Game, especially *cinghiale* (wild boar), *lepre* (hare), *piccioncino* (squab), venison, and pheasant, is available in season.

There is an abundance of both freshwater and saltwater fish, such as *spigola* (sea bass), *rombo* (turbot), *orata* (bream), *dentice* (dentex, a marine fish related to the porgy), and *sogliola* (sole), as well as tuna, swordfish, and *anguilla* (eel). These fish are often served grilled. *Frittura di paranza* is a dish of small fish fried in oil. Fish baked with potatoes is also a favored preparation.

Seppie (cuttlefish), *calamari* (squid), *polpi*, *polpettini*, and *moscardini* (types of octopus), and a variety of shellfish are also consumed. There are more shellfish in Italy than there are popular terms in English for them; for example, *scampi*, *gamberi*, *gamberetti*, *gamberoni*, *mazzancole*, and *canocchia* may be types of shrimp, prawn, or crayfish. *Cozze* and *muscoli* are mussels, and *vongole* (clams), *poveraccia* (poor or small clams), and *vongole veraci* (true or large clams) are all popular. There are many varieties of shellfish used mainly for antipasti such as *dattero* (date mussel—so called because its shell resembles the fruit), and various others called *cuore di mare* ("heart of the sea"), *tartufo di mare* (truffle of the sea), and so on.

Contorno. Vegetables are frequently just boiled and served at room temperature, to be drizzled with olive oil and lemon. Sometimes they are marinated in olive oil. More creative ways of cooking them include *sformato*, a creamed pudding of vegetables such as spinach or zucchini; *agrodolce*, a sweet-and-sour preparation; *in padella* (stir-fried, often with hot peppers and/or garlic); and *trifolato*, sautéed with garlic and parsley in olive oil.

Carciofi (artichokes) are seasonal and very popular. They can be prepared in a variety of ways; two favorites are *alla romana* (Roman style—made with garlic parsley, mint, and olive oil), and *alla giudia* (Jewish style—deep-fried whole, or cut into wedges and fried, or stuffed). Other popular stuffed vegetables are tomatoes stuffed with rice and mozzarella, zucchini stuffed with chopped meat, and eggplant stuffed with cheese or bread crumbs.

Fresh salads are usually dressed with olive oil and vinegar. *Panzanella* is bread salad made with stale bread, tomatoes, cucumbers, onion, and basil. *Caprese*, a dish of sliced tomatoes and mozzarella drizzled with olive oil and chopped basil, is available in Italian restaurants all over the world.

A classic seasonal Roman salad is *puntarelle*, shoots of a particular variety of chicory, picked while still young and tender and tossed with a dressing made with anchovies, garlic, and lemon juice. Some salads are a mix of greens and may include *rughetta* (also called *rucola*, *rocola*, and, as it is in English, *arugula*).

Dolce

The next course in the Italian meal is dolce (dessert). Due to geography and climate, there are abundant varieties of fruit available most of the year, though the more interesting ones are seasonal. Many berries, figs, grapes, *nespole* (medlars—round orange-colored fruit of a tree in the rose family, which, like the persimmon, is inedible until overripe), watermelon, and Sicilian blood oranges are still seasonal. Fruits are either served in bowls of water, or cut into large chunks on a platter (watermelon), or as fruit salads; if a mixed salad, it is called *macedonia*, but salads of specific fruits, such as berries, are also possible.

The best-known Italian dessert today is *tiramisu* (literally, "pick me up"), composed of mascarpone (a very creamy, soft cheese, typically made from cow's milk), ladyfingers, coffee, and other ingredients specific to the home or restaurant. Then there are zabaglione, a light fluffy whip of egg yolks and Marsala; *torta della nonna* (grandmother's cake), made with custard and pine nuts; *panna cotta* (boiled cream), served with a variety of toppings, such as berries, chocolate, and caramel; *profiteroles* (mounds of little cream puffs filled with ice cream and drizzled with chocolate); *crem caramel; zuppa inglese* (literally, "English soup"), a triflelike concoction; and many different types and flavors of *gelato*. Other desserts are based on ricotta (for instance, cannoli, crisp pastry shells filled with sweetened ricotta), almonds, sponge cake (for example, *cassata*, often flavored with an alcoholic beverage such as maraschino—a wild-cherry liqueur), and chestnuts. *Monte bianco* (Mont Blanc) is a seasonal dessert of chestnut puree, brittle meringue, and whipped cream. *Crostate* are open-faced tarts filled with ricotta or jam.

Though it is technically the last course, the Italian meal does not quite end with dessert. Italians always drink their espressos after, not with, their dessert. And with or after the coffee, there are always *digestivi*—alcoholic beverages so named because they are believed to help digestion. They are made with herbs or fruit. *Amaro* (for example, *averna* and *montenegro*), *sambucca*, and *limoncello* are popular examples. The meal may also finish with almond biscotti, called *cantucci* in Tuscany, which are dipped in Vin Santo (literally, holy wine), Moscato, or Marsala—sweet dessert wines.

See also **Crustaceans and Shellfish**; **Pasta**; **Slow Food**.

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TRADITION IN ITALIAN CUISINE

The reason so many people fall in love with Italy has much to do with its cuisine. Italian cooking has been influenced by diverse groups of people and places, historically and in modern times. The Americas, for instance, had a huge influence on Italian cuisine. Tomato sauce, polenta, and anything *piccante* (hot) would not exist in Italian cuisine without the introduction of tomatoes, maize (corn), and peppers—all plants native to the Americas.

The world has adopted parts of Italy's cuisine, but not the structure of its meals. In Italy a meal is a leisurely sequence of events served in courses on separate plates, each appearing in the appropriate sequence. Americans often find it frustrating for a meal to be so lengthy, but, for Italians, dinner is often the main event and the focus of celebrations.

The cooking style is usually quite simple. There are no really elaborate sauces, and what sauces do exist are used only in small amounts, just enough to moisten pasta or delicately anoint meat or fish. Italian chefs claim, with some justification, that the secret to Italian cooking is *sapori e saperi* (flavors and skills), which implies doing little to excellent fresh ingredients.

Similarities and Differences

While there are many differences between regions, and between households within a region, the concept of Italian food would not exist unless there were many similarities as well. There is a tendency for food experts to stress the differences instead of the similarities within the Italian food tradition. But there is much that links it as a single cuisine. Some examples are the structure of the meal, the pasta course, and potatoes used as a vegetable rather than as a staple source of carbohydrates. There is also the ubiquitous antipasto of sausages and cheeses. The types of sausage and cheese may be local—in *Remembrance of Tastes Past*, Davide Paolini estimates over sixteen hundred types—but nonetheless they are all cold cuts and cheese served on a plate before the pasta course. There are also rules common to almost all Italian cooking, such as not pairing cheese with seafood, or lemon with tomato sauce.

Having said all that, there *are* regional cuisines, and restaurants tend to be specific to a region. A restaurant serving dishes from too many regions would not be popular with Italians. There are also many foods associated with specific localities. Among the best-known examples

Many traditional Italian dishes can be traced to the Renaissance or Middle Ages. This simple preparation of prawns and clams with parsley reflects the continuity of this rich culinary tradition. Prepared at San Fruttuoso, Italy, in 2000. © OWEN FRANKEN/CORBIS.

are pizza with Naples, saffron risotto with Milan, Austrian-type dumplings with Trentino, balsamic vinegar with Modena, *fiorentina* steak with Tuscany, polenta with Venice, prosciutto and Parmesan cheese with Parma, *ragù* with Bologna, pesto with Genoa, truffles with Umbria, sheep's-milk cheese with Sardinia, and chocolate with Perugia.

Festivals

Every Italian region has a tradition of its own with regard to Carnival, Easter, Christmas, and other holidays. Most foods prepared for them are sweet, but there are some savory dishes as well.

The best-known New Year's dish is lentils with *cotechino* or *zampone* (both pork sausages, the former stuffed into a pig's foot). The lentils represent coins and thus richness. *Croccanti* are brittle caramel and almond candies, which, molded into various shapes, decorate the center of the table at New Year's dinner. *Torta della Befana* is a fruit tart with a bean hidden inside (whoever finds the bean is crowned king or queen for the day) and is traditional for the Feast of the Magi.

For San Giuseppe Day on 19 March, *sfince* (called *zeppole* in Naples), fried dough seasoned with honey of Saracen origin, is popular in Sicily. For the feast of San Giovanni on June 24th, *tortelli* filled with greens and ricotta are traditional in Parma. *Amatriciana*, a pasta sauce of bacon and tomato, is traditionally served on the Sunday following *Ferragosto* (Assumption Day). *Bigne di Giuseppe* (fried doughnuts) filled with cream or chocolate are eaten for Father's Day in Rome.

Carnival is a holiday full of food symbolism. Mardi Gras is literally Fat Tuesday, and the term *Carnevale* derives from Old Italian *carnelevare* (removal of meat). Both of these are major celebrations to initiate Lent, a period when people deprive themselves of some favorite food or other pleasure. *Quaresimali*, for example, are hard almond cookies prepared especially for Lent. *Pizza del giovedi grasso*, two circles of pizza with a filling of pork, cheese, eggs, and lemon, is served on the last Thursday before Lent. *Maritozzi* (raisin buns) are traditional for Lent in Rome.

On the Amalfi Coast and throughout much of the South, there is *migliaccio di polenta*, a casserole of polenta, sausage, and cheese. In Abruzzi, a Carnival dish of crepes in broth with Parmesan is consumed. Carnival is also an occasion for simple fritters: *chiacchiere* in Lombardy, *cenci* in Tuscany, and *frappe* in Rome may sound quite different, but they look and taste very similar—fried crunchy pastry strips sprinkled with powdered sugar. *Sanguinaccio* (literally, "blood pudding") is a chocolate dessert served at Carnival time around Naples.

A large variety of foods are made to celebrate Easter, from soups to main dishes to sweets, with egg as the dominant ingredient. *Pancotto*, for example, is bread soup containing butter, oil, salt, cheese, and egg, and is a traditional Easter dish in Lombardy. *Brodetto* is an egg-and-lemon soup made at Easter in Florence. An Easter *torta* (cake) can be sweet or savory. *Torta Pasqualine*, for example, is an Easter dish from Liguria traditionally made with thirty-three sheets of very thin pastry, to symbolize each year of Christ's life. The sheets are filled with greens, artichokes, ricotta, and hard-boiled eggs.

Pizza can also be savory or sweet. *Pizza di Pasqua ternata* is a sweet Easter pizza topped with preserved fruits and nuts from the Umbrian town of Terni. *Ciambella* or *brazedela* is a ring-shaped, traditional Easter breakfast bun in Emilia-Romagna. In Naples, Easter is celebrated with *pastiera*, a type of ricotta pie. *Colomba Pasquale* (Easter dove) is a popular bird-shaped Easter cake.

Every Italian region has its own tradition with regard to Christmas sweets. Instead of fruitcake, there are a variety of fruit breads. In Liguria there is *pandolce*, made with candied fruits, nuts, and flavorings. In Tuscany there is *panforte*, also called *panforte di Siena*, a hard, flat concoction popular since the thirteenth century. This characteristic sweet, made of toasted nuts stirred into hot honey caramel, has many virtues, including the fact that it can be stored for long periods of time.

Since the 1950s, *panettone* (literally, "Tony's bread") has become popular all over Italy at Christmas time. The custom of consuming *panettone*, especially during the year-end holiday season, spread from Milan throughout Italy. There are variations, however. *Pampepato* is a Christmas cake from Ferrara made with pepper, chocolate, spices, and almonds. In Rome the Christmas cake is *pan giallo*, a fruit-and-nut cake, originally made with saffron, thus its name, which literally means yellow bread.

In Naples women prepare for the arrival of Christmas with delicacies made of *pasta di mandorla* (marzipan) and with *struffoli*, tiny pieces of soft pastry formed into balls, fried, coated with honey, and sprinkled with bright and colorful candied sugar and pieces of candied fruit peel. Sicily has *cuccidatu* or *bruccellato*, a ring-shaped cake stuffed with dried figs, raisins, and nuts, and spiced with cloves and cinnamon.

Christmas also provides its share of savory specialties. In many homes, fish is the preferred main course for Christmas Eve dinner. In Lombardy, stuffed turkey and *tortelli* (similar to ravioli) filled with squash and crushed amaretto cookies are traditional for Christmas, while in Bologna tortellini (small, hand-pinched, filled ring-shaped pasta) is traditional for Christmas Day.

Papassine is a traditional Sardinian sweet for all occasions—Easter, Christmas, and All Saints' Day, for example—made with dried fruit, lard, orange, and eggs.

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J-K

JAMS, JELLIES, AND PRESERVES. An atmosphere evoking both enchantment and delight surrounds the consumption of jams, jellies, and preserves. Children and adults alike enjoy sweet quince paste from Spain, orange marmalade from Scotland, candied fruit from France, or ginger in heavy syrup, an English specialty. No doubt they would be surprised if told that there is not the least gastronomical ambition to be found in the origin of these delicacies—only the need to preserve fruit and other plants. They would be even more surprised to find out that the earliest confectioners were apothecaries, and the first preserves nothing but medicines. Sick people were very lucky in those days: they were permitted to eat sweetmeats to their hearts' content.

Preserving Food

Since prehistoric times, people have been very concerned about starvation, so they have protected themselves against hard times by storing the products of their crops and harvests. Various preserving methods were elaborated over the course of centuries; the earliest ones consisted in storing fruits far away from air and light, desiccating them, or preserving them in an antiseptic bath.

In the first century C.E., the Roman agronomist Columella described these techniques in his work *De re rustica*. According to Columella, the ideal means to preserve pears or peaches consisted of putting them in small wooden boxes, which were to be carefully closed so that air could not get in. As for figs and grapes, they were to be dried in the sunshine. Finally, Columella suggested the use of a preservative to retard decomposition, called *conditio* (from Latin *condire*, 'to condite, or preserve'. This use of *conditiones* to preserve food was called *conditus* (or *conditum*). There are various types of *conditiones*—salt, vinegar, sweeteners—that have preservative properties and do not exclude each other; in other words, their effects are cumulative.

Fruit pickled in vinegar and salt. Apicius, a Roman gastronome who lived in the time of Columella, preserved peaches in a mixture of salt, brine, and vinegar. Pickled fruit and vegetables are the modern version. But by its very nature, fruit needs sweet *conditiones*, which emphasize its flavor and heighten its fragrance. Since they did not know of the existence of sugar (see below), the ancients suggested several alternatives.

Fruit preserved in sweet wine. One alternative was *passum*, a high-alcohol, very mild wine made of raisins and used by Columella for pears and plums. The fruit was picked a short time before becoming ripe and was placed in a terracotta receptacle coated with pitch. It was then covered with *passum* so as to be soaked in liquor. A plaster-coated lid was placed on top. These *conditi in passum* can be seen as the forerunners of today's fruit in liquor.

Fruit preserved in wine syrup. Also used was *sapa* or *defrutum*, grape must that has been cooked and reduced by two-thirds or one-third, respectively. Columella used it for apples, pears, and sorbs. To make sure they were submerged in the syrup, a handful of dried fennel was placed on top. The lid was carefully coated with plaster and pitch so that air could not get in. This fruit bath of thick sugary grape juice is the forerunner of fruit preserved in syrup, which is now sterilized in order to protect it against decomposition.

Fruit preserved in sweet-sour pickle. Columella also concocted a sweet-sour *conditio* with vinegar and either *sapa* or *defrutum* for sorbs, plums, sloes, pears, and apples picked before they were fully ripe. They were then dried for one day in the shade. A mixture consisting of equal parts vinegar and *sapa* or *defrutum* was poured on the fruit. Columella recommended adding a bit of salt to prevent infestation by small worms or other animals. Finally, he made it clear that the fruit could be preserved even longer by adding two-thirds of *sapa* and one-third of vinegar. Our cherries in vinegar, which are served with stews and pâtés, are based on the same principle: they are covered with a bath consisting of a sweet element (two-fifths of sugar) and vinegar (three-fifths). We should not be surprised at the use of salt in the Roman recipe. It is a flavor enhancer, provided it is used in small quantities.

Apicius suggested another sweet-sour *conditio* based on *sapa* and blackberry juice. It was poured on blackberries placed in a glass vessel. The author specified that they could be preserved for a long time in this manner.

Melomeli and Marmalade. And—last but not least—there is honey. Its preserving properties have been recognized for a very long time. The corpse of Alexander the Great is said to have been kept in honey. Columella therefore claimed that honey stopped putrefaction and protected a corpse from decomposition for several years. Columella was, however, reluctant to use it for his fruit *conditi*, as he believed that fruit preserved in honey lost its flavor. J. André, in *L'alimentation et la cuisine à Rome*, suggests that his reluctance might be due to the fact that the production of honey was rather limited in those days.

Nevertheless, Apicius used honey as a *conditio* for figs, apples, plums, pears, and cherries: "Gather them carefully with their stalks and put them in honey so that they do not touch each other." Apicius paid particular attention to quinces, which he preserved in a mixture of honey and *defrutum*: "Choose faultless quinces with their twigs and leaves, and put them in a receptacle, and pour over honey and *defrutum*; you will keep them for a long time." In fact, Columella also made an exception for quinces, and he likewise recommended preserving them in honey. According to Columella, quinces should be picked when the sky is clear and the moon on the wane; they should be wiped and put into a new receptacle filled up to the rim with excellent very liquid honey, so that each fruit is covered. Not only does this method preserve fruit, but it also yields a drink called *melomeli* (from Greek *melon*, 'quince' and *meli*, 'honey'), administered to sick people when they run a fever.

The Greek physician Dioscorides, who was Columella's contemporary, gave a slightly different recipe in his herbarium entitled *De materia medica*. *Melomeli*, which he called *cydonomeli* (from Cydonia in Crete, where the best quinces were produced), appears in the chapter about wines: "First of all, quinces should be deseeded, then entirely covered with honey, which becomes good after one year and tastes like *oenomeli* (honeyed wine)." So, according to Dioscorides, quinces are to be deseeded first—in other words, opened and not left whole—unlike Columella's recipe.

Additionally, Dioscorides gave two recipes for *cydonites oenos*, "quince wine." In the first one, quinces are to be cut in pieces like turnips and then deseeded. For twelve pounds of fruit, forty liters of must are needed to cover them. The mixture should macerate for thirty days until the wine gets clearer. In the second recipe, quinces are crushed and the juice is squeezed out. The proportion is five liters of juice to one pint of honey, and the whole is then mixed up.

Melomeli and *cydonites oenos* have the same therapeutic properties: they are astringent, facilitate digestion, relieve dysentery, and are good for people with liver, kidney, or urinary ailments—a real cure-all, if you add the antipyretic qualities ascribed by Columella to his *melomeli*.

According to modern-day experimentation with these ancient recipes, both *melomeli* and *cydonites oenos* are slightly fermented drinks tasting like mead, with a very fruity and particularly original flavor. Dioscorides was actually right when he compared them to honeyed wine.

It is rather surprising to note that *melomeli* (also spelled *malomellus* in the seventh century), which is not a jam, is the origin of the word "marmalade," derived from it via Spanish *membrillo* and Portuguese *marmelo*, both meaning 'a quince'. Indeed, before it became, from the seventeenth century onward, "a jellied conserve of Sevilla oranges (with such alternatives as lime, grapefruit, lemon, or ginger), marmalade was a preserve confected from quinces boiled with honey or sugar" (Wilson, 1985, p. 15).The ancients did not know marmalades made of citrus fruit (they were introduced by the Arabs in the Middle Ages—see below), but they created jelly, jam, and quince paste.

Quince Paste

In the second century C.E., the Greek physician Galen wrote that the Romans were importing quince paste (*meloplacounta*, derived from *melon*, 'a quince', and *plakounta*, 'a tablet') from the Iberian Peninsula: "It is firm and hard, and has been brought to Rome in very large quantities. It consists of honey and crushed quinces cooked in honey." It is not only a delicacy, but also a medicine aimed at strengthening a debilitated stomach, as the distinguished physician put it.

So, according to Galen, quince paste originated in Spain. It has remained up to now a specialty of the Iberian Peninsula (*pasta de membrillo* in Spain and *marmelada* in Portugal). Unfortunately, Galen does not give the recipe for this confection. It is, however, to be found in a late text of Byzantine origin attrributed to the last representative of Greek medicine, Paul of Aegina (seventh century): "Six pounds of quinces are cooked in wine until they have softened up. Then they are crushed. Eight pounds of honey are added and the whole is cooked slowly until the mass doesn't leave the slightest trace on the hand. Various drugs are added to the paste, which is eventually divided into half-ounce tablets."

Quince Jelly

Galen also gives the recipe for a drug based on quince juice that he claims to have invented and is particularly appropriate for stomach ailments. This drug survived for centuries under the name of *diamelon* or *cydonitum*. Its preparation involves mixing two parts quince juice, two parts honey, and one part vinegar. Ginger and pepper are optional. The mixture is cooked until it has thickened to the consistency of honey (*melistos pachos*). Modern-day experimentation with this ancient recipe has yielded a beautiful translucent red jelly with a pleasing peppery flavor.

Quince Jam

In the fourth century C.E., the Roman agronomist Palladius revived Galen's quince jelly, which he called *cydonitum*. He added a second formula: "You first peel ripe quinces, you cut them into small pieces, excluding the hard parts you may find inside. You then boil them in honey, until the mixture has been reduced by half, and you sprinkle it with fine pepper while they are cooking."

If the ancients did indeed know about pectic fermentation (pectin makes the process of jelling possible), they did not make the most of it. In fact, they only applied it to quinces, which are actually rich in pectin; when they are cooked with an acid (like vinegar in *diamelon*), jelling takes place almost automatically. C. Anne Wilson, in *The Book of Marmalade*, explains that the ancients preferred fruit "in their fresh, uncooked state to fruit preserved in wine, syrup, vinegar, or honey." Quinces were an exception, because, if not totally ripe, they remained hard even in honey. It was to avoid that risk that quinces were precooked. This led to the discovery of pectic fermentation. "The high pectic content of some other sharp fruits may never have been discovered because there was no incentive to precook them in honey. So quinces remained unchallenged in the field of the pectin-jellied conserve."

Another Fruit Jam

There is another jam in Greco-Roman medieval literature: *diaoporon* or *medicamentum ex pomis*, which is at the same time an antidiarrheic and good for digestion. Various fruits (apples, pears, pomegranates, and especially quinces) are cooked in honey, *sapa*, and must (the pulp and skins of grapes)—"*donec omnia quae indita sunt liquata in unitatem quadam coeant*"—until all ingredients have been reduced to a uniform mass, according to Celsius, a Roman physician of the first century C.E. As for Columella, he indicated that *diaoporon* must be cooked—"*donec crassamen in modum fecis existat*"—until it has reached the consistency of feces. This is in fact what it looks like when it has been cooked in that manner. Its flavor, however, is not unpleasant, as Celsius experienced ("*id gustu non insuave est*"). This is a rather surprising comment for Celsius, since he wrote at the beginning of his treatise, *De Medicina*, that "all *condita* are unserviceable for two reasons, because more is taken owing to their sweetness, and even what is moderate is still digested with some difficulty."

Fruit and Honey Syrups

The ancients also knew of other fruit and honey preserves. Criton, a Greek physician who lived at the beginning of the first century C.E., created *diaroion*, the forerunner of grenadine. It is made of pomegranate juice, cooked until it has reached the consistency of lime (*gloiou pachos*), honey, and, optionally, drugs such as myrrh. *Diaroion* is particularly appropriate in the treatment of mouth ailments.

Then, there is the blackberry-based *diamoron*, a famous remedy created by Heras (a contemporary of Criton), which is still mentioned in modern pharmacopoeias. It is prepared in the same way as *diaroion* and has the same therapeutic effects. It has also been found to be effective in treating gum inflammation.

Nougat and Marzipan

The ancients paved the way for honey and dried-fruit preserves with almonds as the main ingredient. This mixture eventually gave birth to marzipan and nougat, and the Arabs (see below) developed the manufacturing technique.

At the end of the fifth century B.C.E., the *Hippocratic Corpus*—in fact, just a few parts were written by Hippocrates himself—gives an interesting formula to cure pleurisy. The ingredients are honey (with an emollient effect on the throat), scilla (a bulbous herb useful as an expectorant), and almonds (with well-known cough-suppressing properties). The recipe is as follows: "Cut scilla bulbs into slices and cook them in water; when they have boiled, tip the water; pour water again and cook the scilla again until it looks mushy and well cooked); crush it in equal pieces, add roasted cumin, white sesame, fresh almonds; crush all these substances in honey." This may be the forerunner of marzipan.

As for Galen, he suggested a cough mixture made of sweet almonds and honey with other dried fruit such as pine kernels (which also have cough-suppressing properties), grilled flaxseeds, flag, and tragacanth gum (which have the same therapeutic effects). A modern version is to cook the mixture and let it cool down under a weight. The result is a delicious candy tasting like the famous black nougat from Provence served at Christmastime.

The Arab Contribution

It was not until Arab times (in the times of the Caliphate of Baghdad, more particularly the Abbasid dynasty) that there was some progress in the sciences. It should be noted, however, that much of the confectionery technology attributed to the Arabs was in fact developed in Sassanian Persia and known to the Byzantine Greeks. Further, sugar was not much used in the Near East until a system of irrigation could be developed and a source of wood could be found for processing it.

First, the Arabs introduced sugar in medicines and in cooking. Sugar diluted in water yielded a new confection called *sharab* in Arab and *syrupus* in Latin. Sugar syrup was used to manufacture various preserves and sweetmeats, more particularly *sharab al-fawaki* (*syrupus de fructibus*), an updated version of *diaroion* and *diamoron* in which Arabs replaced honey with sugar and used various comfits and sweetmeats such as fudge, tatty, and marshmallow.

Moreover, the Arabs went deeper into the subject of pectic fermentation. They created the first marmalades of citrus fruit; most of them, however, were candied in honey, not in sugar: an example is the lemon marmalade of Avicenna (980–1037). (Islamic traditions often use honey over any other form of sugar although they were one of the first to have sugar.)

In Spain, the Arabs developed the traditional fruit pastes (see above) by creating new varieties with roses, violets, orange peels, kernels, and green walnuts (well known in Byzantine Armenia). They were also made with honey. As for the traditional quince paste, it was sugar-candied from the thirteenth century onward.

Finally, the Arabs developed dried-fruit pastas and created various kinds of marzipan and nougat—sometimes with honey, sometimes with sugar.

Pseudo-Mesue: the father of European confectionery. Pseudo-Mesue, a twelfth-century physician probably of Italian origin, was the person who introduced Arab confections into Christian countries. He also invented new ones. He wrote jam recipes (apple, plum, peach) that were revolutionary for his time because they were made with sugar, not with honey.

It was not until the late Middle Ages that confectionery developed into what it is now. New recipe books evidencing this evolution were published. *The Libre de totes manieres de confits*, drawn up in the fifteenth century and written in Catalan, had many imitators during the Renaissance. They include: *De secreti* by Alexis of Piedmont (Venice, 1555), the preserves-maker of the French physician and astrologer Nostradamus (Lyons, 1555), and *The Treasurie of Commodious Conceits and Hidden Secrets* by John Partridge (1573).

See also **Apicius; Candy and Confections; Compote; Condiments; Fruit; Greece, Ancient; Hippocrates; Islam; Middle East; Rome and the Roman Empire; Sugar and Sweeteners; Sugar Crops and Natural Sweeteners; Syrup**.

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Translated from the French by Christian Labarre

JAPAN.

This entry includes two subentries:
Traditional Japanese Cuisine
Contemporary Issues in Japanese Cuisine

TRADITIONAL JAPANESE CUISINE

The Japanese eat three meals a day, and afternoon and late-night snacking is normal. This popular expectation of three meals a day dates to the middle of the Edo period (1600–1868) (Tsuji and Ishige, 1983, p. 306). One traditional definition of a meal in Japan is that it includes rice, soup, pickles, and at least one side dish. In normal home cooking these components are usually served together rather than as separate courses. In specialty restaurants, the main course is sometimes served first accompanied by sake (rice wine), followed by rice, soup, and pickles to mark the end of the meal.

Rice

Rice has been cultivated in Japan in wet paddies for about two thousand years. Introduced from southern China, the preference in Japan has always been for a glutinous, short-grained variety. Traditionally rice is boiled or steamed, and in modern kitchens it is usually prepared in automatic rice cookers.

The words for cooked rice in modern Japanese, *meshi* and *gohan*, are also used to mean a "meal." The degree to which rice has been the central staple of Japanese food is debated (Ohnuki-Tierney, 1993, pp. 30–43), and historically rice has been supplemented by other carbohydrates, such as millet and sweet potatoes. Nonetheless rice is idealized as the core of any Japanese meal. If noodles constitute the main starch of a meal, rice is not served, but such a meal is also considered more of a snack than a proper meal. Gretchen Mittwer points out that the midday noodle snack became popular in early historic periods, when only two meals per day were eaten (Mittwer, 1989, p. 23).

Rice, sake, and the pounded-rice paste called *mochi* are powerful symbols in Japan. Rice and its products symbolize the relation of Japanese people to their deities, the nature of community in Japan, and Japan's history and aesthetics, and in the end rice is a symbol of the Japanese self (Ohnuki-Tierney, 1993, pp. 8–11, 127–131).

Soups

Three major ingredients, which may be used together or separately, create the basic stock of a Japanese soup (dashi). The first is *katsuo-bushi*, or dried bonito. The bonito is dried and processed to create hard, woodlike pieces that are easily stored. A planelike tool is used to take shavings from it that are dropped into hot water, then strained out. Instant powders are often substituted. The second major ingredient is kelp (*konbu*), which is also available as an instant powder. *Konbu* and *katsuo-bushi* often are used together to create a stock. The third ingredient, shiitake mushrooms, are boiled with or without kelp to create a vegetarian soup stock used, for example, in *shoojin-ryoori*, the vegetarian cuisine of Buddhist temples (Ishige, 2000, p. 1178).

Two main types of soups are based on these stocks. Clear soups *(suimono)* are considered light and elegant and are served in lacquered bowls with lids. A bit of salt and soy sauce is added to the broth along with two or three small bits of solid food, perhaps a piece of fish, a sliver of vegetable, and an aromatic garnish. When the lid is lifted, the delicate fragrance escapes, and the aesthetic arrangement of the solid foods within the bowl is an added enjoyment (Tsuji, 1980, p. 151).

Miso soups comprise the second major class of soups. Miso is a paste made from soybeans and barley inoculated with a fungal culture and allowed to cure for a year or more. A great variety of misos exist, some smooth, others chunky. They range in color from light beige (called "white") to medium red or brown to nearly black. Some are sweet, while others are quite salty. Because this is a bean-based ingredient, miso soups are a rich source of protein.

To make a miso soup, a variety of miso is selected and dissolved in hot stock. The cook adds seasonal vegetables, such as parboiled fiddlehead ferns or eggplant, and perhaps a few cubes of tofu (white, mild-tasting curds made from soy milk). Miso soup is more common than the clear soups, and more filling as well.

Pickles

Japanese pickles (*tsukemono*) are primarily pickled vegetables. They exist in great variety and add texture and diversity to even a simple menu. Originally pickling preserved vegetables for use through the winter, but pickles have come to occupy a place in the menu year-round.

Daikon radishes, Chinese cabbages, cucumbers, eggplants, and turnips are often pickled. Rubbing the vegetable in salt, then placing a weight on top to force out liquids is a common method, as is packing the vegetables in miso, sake, sake lees, or rice bran. The use of vinegar is a relatively less-important pickling method in Japan (Yoneda, 1982, pp. 89–92).

Green, unripened Japanese plums *(ume)* are the only fruit regularly pickled, and they are prepared with salt and red perilla leaves *(shiso)*. The resulting pickle, called *umeboshi*, is salty, sour, and red. It is considered an appetite stimulant, consequently it is often served with breakfast (Richie, 1985, p. 85). *Umeboshi* is commonly used to flavor *onigiri*, a favorite picnic food, which is a ball of rice with something inside.

Traditionally pickles were made at home, and many regional specialties developed. However, most consumers buy pickles in supermarkets or department stores. There open vats of decoratively arranged pickles are displayed, and the attractively pungent smells are obvious immediately upon entering the store. Pickles are also frequently sold as regional souvenirs.

0 150 300 Miles
0 150 300 Kilometers
CHINA
RUSSIA
Hokkaido
NORTH KOREA
Sea of Japan
SOUTH KOREA
Honshu
Tokyo
Kyoto
Osaka
JAPAN
PACIFIC OCEAN
Shikoku
Kyushu
Izu Islands
East China Sea
Philippine Sea
Ryukyu Islands
N
Okinawa

Side Dishes

Side dishes, *okazu*, add savor to the rice that is traditionally understood as the central portion of the meal. Non-Japanese people are tempted to call some of these the entrée of the meal, as the side dishes might include grilled fish or deep-fried pork *(tonkatsu)*, but this is at odds with the traditional understanding. Side dishes could also include sweet vinegared cucumbers, steamed enoki mushrooms, or *hijiki* seaweed stewed with carrots. A simple meal might have only one side dish, but elaborate meals would have many. Some major *okazu* include salads, tofu, seafood, and meat.

Salads. Traditional salads are served cold and can be divided into two basic categories, vinegared salads *(sunomono)* and salads with heavier dressings *(aemono)*. The vinegar-based dressings usually include a basic soup stock (dashi) and soy sauce and might also include some fruit juice, ginger, or grated daikon radish as well. Heavier dressings are often made with pureed tofu, ground sesame seeds, or miso.

Like the soups, which call for seasonally available fillings, salads highlight seasonal materials, including fruits, vegetables, and fish or shellfish. Depending on the materials, some might be steamed, parboiled, or grilled in preparation, but they are always cooled and dried before the salad is assembled. Typical salads might include crab with thinly sliced cucumbers in a vinegar and ginger

Seaweed has been an ingredient in traditional Japanese cookery for many centuries. It is a rich source of iodine and trace elements. Shown here is kelp. COURTESY OF FIELD MARK PUBLICATIONS.

dressing or parboiled spinach dressed with ground sesame seeds, soy sauce, dashi, and a bit of sugar (Tsuji, 1980, pp. 241–242, 247, 253).

Tofu. Mentioned above as a common ingredient for miso soup and as a base for thick dressings, tofu has attained worldwide recognition. It was originally brought to Japan from China, perhaps in the 900s by the delegations of Buddhist priests who studied there. As priests were allowed to eat neither meat nor fish, this high protein food was doubtless appreciated. By the 1100s tofu was widely used in Japan.

To make tofu, soybeans are cooked, then strained. The resulting liquid is soy milk. A coagulating agent is added to the soy milk, and the resulting curds are shaped into blocks. Tofu is an inexpensive ingredient that lends itself to many styles of preparation. In the 1780s two best-selling books each promised one hundred tofu recipes (Richie, 1985, pp. 34–41).

Two simple ways of serving tofu are popular. *Hiyayakko* is chilled tofu cut into bite-sized pieces and served with a dipping sauce of soy sauce and grated ginger or chopped scallions. *Yudoofu* is tofu cut into cubes and heated in hot water seasoned with kelp. Once warm, the cubes are lifted out and dipped in a heated sauce flavored with grated daikon radish.

Iridoofu is made by stirring tofu over heat with bits of carrots, shiitake mushrooms, and snow peas. *Dengaku* is tofu roasted on bamboo skewers, then spread with flavored miso and roasted again.

Tofu can be deep-fried. Cut into thick slices and dredged in potato starch, it is fried to make *agedashi-doofu* and is served with a sweetened soy sauce dip. Cut into thin slices and double-fried, *usuage* is often sliced in thin strips and used in boiled dishes because it holds together well, or it is used as a small edible pouch for sweet vinegared rice to make *inari-zushi.*

In addition to the raw and fried versions, tofu is freeze-dried. This product is easily stored, and when reconstituted with water, it has a distinctive spongelike texture. It is often simmered with vegetables or put into soups. Known commonly as *koori-doofu* and *shimi-doofu*, this tofu is also called *kooya-doofu* or Kooya tofu. It is said that monks on cold Mount Kooya discovered their tofu was frozen. When in their thriftiness they used it anyway, they were pleasantly surprised.

Seafood. Japan is surrounded by the sea. Both cold and warm currents lap the islands, creating a variety of ecological niches. This in turn supplies Japan with a variety of fish, shellfish, and marine vegetables. The general attitude in Japan is that the freshest fish are best enjoyed raw. Fish that are not as fresh should be grilled with salt, and fish of even lesser freshness should be stewed with soy sauce or miso (Ishige, 2000, p. 1177).

Since the Edo period raw fish has been served as sashimi, sliced into bite-sized pieces and garnished. Grated daikon radish or wasabi, a Japanese root product related to horseradish that adds pungent flavor, is provided along with a small side bowl of dipping sauce. The radish or wasabi condiment is added to the dipping sauce to taste, then the fish slices are dipped and eaten. In casual home cooking this dipping sauce might simply be soy sauce, but in restaurants it is often soy sauce reduced with sake (Tsuji, 1980, pp. 159–160). Before the Edo period raw fish was usually served as *namasu*, in which it is sliced and marinated in flavored rice vinegar, but with the advent of commercial-scale soy sauce production, the shift was to sashimi (Ishige, 2000, p. 1177).

Also in the Edo period sushi arose, originally a means of preserving fish. The fish was salted, then packed in cooked rice. With lactic acid fermentation, the rice developed a vinegarlike taste and preserved the fish, but the rice was discarded when the fish was served. By the 1400s people began to eat the rice as well, and in the Edo period slices of fresh fish were served atop small mounds of vinegared rice, often with a dab of wasabi added to the top of the rice (Ishige, 2000, p. 1177). This came to be known internationally as sushi, but more properly this style that developed in Edo (now Tokyo) in the early 1800s is *nigiri-zushi.* The older tradition of western Japan, particularly of Osaka, was to pack vinegared rice into a mold, cover the rice with marinated fish, remove the contents from the mold, then slice the resulting loaf into bite-sized pieces (Richie, 1985, p. 15; Tsuji, 1980, p. 288).

A great many vegetables are harvested from the seas. Kelp was mentioned above for its importance in making soup stock. *Wakame* is often used as a solid ingredient in soup and might be mixed with a variety of seaweeds in vinegared salads. Agar-agar *(kanten)* is important in traditional confections. Nori is well known as the nearly black paperlike sheets that wrap certain types of sushi (Tsuji, 1980, pp. 54–55, 72–73, 79–80, 97).

Meat. Eating meat was long a taboo in Japan. An imperial decree against eating several kinds of meats was issued in 675 C.E. In the Heian period (ninth to twelfth centuries), with the increased importance of Buddhism, meat eating largely disappeared in cities, though professional hunters were still active in remote areas. Nevertheless animals were not raised for slaughter. Cattle existed only for pulling carts and plows, and even their milk was not used. Buddhist priests were further enjoined from eating fish also, but the general populace ignored this stricture (Ishige, 2000, p. 1176).

Following Ishige's assertion that "traditional cuisine" is that of the Edo period, beef, popularized in the Meiji period (1868–1912), might be outside the focus of this article (Ishige, 2000, p. 1181). The innovations of the Meiji period succeeded, however, because they adapted to the norms of traditional cuisine (Cwiertka, 1999, p. 54), and the smooth shift eventually came to be seen as continuity.

With the opening of Japan to the West in the 1850s, the country quickly began to incorporate aspects of Western life, often with a catch-up mentality. In the 1860s the first slaughterhouse for cattle was built, and by the early 1870s beef eating was a fad. In 1873 the emperor endorsed the new custom. This gave rise to the dish called sukiyaki, in which beef is simmered in a traditional broth of sweetened soy sauce and sake along with other traditional items, such as grilled tofu, shiitake mushrooms, and chrysanthemum greens *(shungiku)* (Richie, 1985, pp. 21–25). The popularization of pork seems to have followed in the 1930s in the form of *tonkatsu*, a deep-fried, breaded pork cutlet (Richie, 1985, pp. 49–51).

This popular acceptance of distinctly foreign foods is paralleled in Japanese history by tempura, the crisply coated, deep-fried fish and vegetables known around the world. The Portuguese were a presence in Japan in the second half of the sixteenth century, and they apparently batter-fried their fish. The method spread, and by the mid-1700s tempura was popular, sold mainly from street carts (Ishige, 2000, p. 1177).

Beverages

The two most representative beverages of Japan are tea and sake. Tea was first imported into Japan in the 800s from China. The tea was formed into bricks, then allowed to cure by fermentation. These blocks of tea were powdered and boiled. After some popularity among the aristocracy, tea drinking in Japan died out. It was reintroduced in the 1200s, this time as powdered green tea. This is the tea of the famed tea ceremony of Japan, but its popularity was limited, perhaps due to the complex rituals associated with the drink. Sometime in the 1600s tea was reintroduced to Japan, this time as an infusion made with the green leaf. This style of tea has become dominant in Japan and is served in homes, offices, and restaurants. In the Meiji period black, Western-style tea was introduced, and by the 1920s it was widely popular (Ishige, 2000, pp. 1180, 1182; Kumakura, 1999, p. 40).

Sake, like rice and *mochi*, carries symbolic importance. It is offered to Shinto deities both at home altars and at large public shrines, and it is the drink that seals the marriage in any Shinto wedding ceremony. Although sake has a long history, modern sake is clear and has a higher alcohol content (15 to 17 percent) than before the twentieth century. Steamed white rice is inoculated with a mold called *kofi* (*Aspergillum oryzae*), which starts the fermentation. About two days later, sake yeast (*Saccharomyces cerevisiae*) is added. Including refining, sake is produced in forty-five to sixty days. Sake does not improve with age; it should be consumed soon after production. Special cups and serving bottles are used for sake, and a fairly elaborate serving etiquette accompanies pouring drinks. While beer and whiskey are more popular than sake, the serving etiquette of these two drinks is based on that of sake (Tsuji, 1980, pp. 336–340).

Seasonality

The Japanese often pride themselves on the seasonality of their traditional food. In the mass market many foods are available without regard to season, but most traditional Japanese meals include seasonal aspects. As noted above, the solid ingredients in soups and the selection of materials for salads both announce the season in everyday meals.

Certain foods are only harvested and sold seasonally. The puffer or blowfish (fugu), which can quickly kill the eater if the poisonous liver is not properly removed, is available only in cold months, when the poison is said to be less potent (Richie, 1985, pp. 47–48). A fragrant and expensive mushroom, *matsutake*, is only found in the fall. The *ayu*, a fresh-water fish rather like a trout, is a food for early summer.

Some special days are marked by serving particular dishes. On 7 January it is traditional to eat a rice porridge made with seven springtime herbs *(nanakusa-gayu).* In August, on the day of the ox as calculated by a traditional ephemeris, people eat grilled eel (or more innovatively some form of beef) to strengthen themselves to withstand the remaining days of summer. On the first day of winter many homes serve *tooji kabocha*, pumpkin cooked with sweet *azuki* beans.

Other foods are served differently in different seasons. Some prefer *soba* noodles served cold with a small cup of cold dipping sauce on the side, but the same noodles are more often served in a bowl of hot broth in the winter. Early in the Edo period sake was warmed only in fall and winter (Ishige, 2000, p. 1180). Since then it has often been served warm throughout the year, but after the 1990s cold sake experienced a resurgence, especially in the summer. Miso soup as served in the cuisine of the tea ceremony is a blend of red miso with white. In the depths of winter the mixture is almost completely red miso, which is considered hearty and warming. Into spring more white miso is blended in, and by summer it is almost completely white miso, which is considered a much lighter dish.

The dishes and plates on which food is served are also seasonally appropriate. The deep, warm-looking bowls of winter gradually give way to the flatter, more airy and open-looking bowls of summer. Glass, because it reminds one of ice, is used to give a cool look to a set of summer dishes. Dishes might also have painted decorations appropriate to the seasons, such as cherry blossoms for spring or colored leaves for fall.

Seasonal sweets. Seasonality is also marked in Japan by serving sweets associated with particular seasons or holidays. The doll festival is a minor holiday on 3 March. Families with girls display elaborate sets of decorative dolls that represent the imperial court of the Heian period. Girls might have parties at their homes and serve two traditional foods, *hishi-mochi*, diamond-shaped multicolored sweets made with puffed rice, and *amazake*, an unclarified, milky-white sake sweetened and flavored with ginger. *Arare* and *amazake* are sold in department stores and local convenience stores ahead of the festival date and are often shared as snacks (*o-sanji* or *o-yatsu*) for afternoon breaks in offices and other workplaces. While people with daughters to celebrate on this day have an obvious reason to buy and serve these sweets, many others do so as well. These two dishes are recognized as seasonal foods and are available once a year.

Other minor holidays are associated with particular sweets, such as the vernal and autumnal equinoxes, boys' day (5 May), and the celebration of the full moon of fall. The cherry blossom season also has its own associated sweets.

The New Year. Of all the holidays in Japan, New Year's is by far the most elaborate. It is celebrated on 1 Janu-

BENTO BOX

Japanese *bento*, or *obento*, is a meal compartmentalized in a lidded box, usually made of lacquered wood. Often square or rectangular in shape, there are also round and oval types in which cut bamboo leaves are used to separate each food item. A *bento* box typically contains rice, pickles, braised vegetables, and a protein such as fish, poultry, or meat, each placed in individual sections. The new, internationally popular *bento* box lunch, served in a humble wooden or plastic box and usually offered by Japanese restaurants, is directly related to the *makunouchi* (meaning "between curtains") *bento* developed during the Edo period (1600–1868). This type of box lunch was intended as a conventional meal to be eaten during intermission at kabuki plays. During the same period, a more stylish type of *bento* box, called *shokado bento*, evolved in Osaka. In this type, each food item is placed in a small individual porcelain or lacquered wood dish, and then in a larger lacquered square or rectangular box. *Shokado bento* are not meant to be used as portable lunch boxes. Displaying colorful food rather artfully (much like traditional *kaiseki*, the elegant multicourse meals served prior to formal tea ceremonies), the *shokado bento* can be ordered in restaurants and other formal settings.

During the Meiji (1868–1912) and Taisho (1912–1926) periods, and with the arrival of railway stations, the *eki-ben* (meaning "station meal") box evolved. These boxes, although made of plastic or other lightweight material, are still available, often offering regional foods related to the station where people board the train. *Eki-ben* is, perhaps, also related to the original lunch-on-the-go given to the soldiers of the Heian period (794–1192). Once called *tonjiki* (meaning "soldier's meal"), *onigiri* is a handful of rice with salty fish or pickles set in the center and wrapped triangularly with *nori* (dried laver sheet), a common red algae.

Consistent with the Japanese appreciation for specificity, there are various types of *bento* box meals related to the particular individual or event. For example, a mother might prepare *tsugaku bento* for her child's school lunch or *aisai* (meaning "beloved wife") *bento* for her husband to take to work. *Koraku bento* are prepared for outdoor activities (for example, hiking), *domu bento* are sold at baseball stadiums, and *hokaben bento* are take-out meals.

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Corinne Trang

Contemporary variation on a traditional bento box as served at a Japanese restaurant in New York City, 2002. PHOTO CORINNE TRANG.

ary of the Western calendar, and most stores and offices are closed until 3 January. Special trains run all night shuttling people to major Shinto shrines, where they pray for a good year. Children receive envelopes containing money from their parents, relatives, and family friends, and large bundles of postcards with New Year's greetings are delivered on New Year's Day.

Through December many workplaces and university clubs hold year-end parties. These are often elaborate feasts of traditional Japanese food washed down with copious amounts of beer, whiskey, and sake. These parties are called *boonen-kai*, literally a gathering for "forgetting the year," specifically burying grudges of the past. Some groups host more abstemious Christmas parties instead, at which the food is usually Western and the drinks include sparkling wine.

In the last few days of the year, a New Year's delicacy called *mochi* was made traditionally. Glutinous rice was steamed, then put in a large mortar standing about two and a half feet tall and two to three feet in diameter. One person would swing a large mallet, pounding the mass of rice, while a second person reached in and turned the rice between each stroke. The resulting dough was cut into small balls or rolled into a large sheet and later cut into squares. Today, most people buy processed *mochi.*

It is traditional that no (substantial) cooking takes place for the first three days of the new year, so elaborate side dishes are prepared at the end of the year and beautifully arranged in decorative lacquered boxes for the New Year feast. While many housewives preserve this tradition, others order these traditional dishes ahead of time from caterers.

On the last night of the year, it is traditional to eat buckwheat noodles, *soba*, called *toshi-koshi soba* (crossing-the-years *soba*). The noodles are served in a hot broth, typically garnished with scallions, fish sausage *(kamaboko)*, or perhaps a piece of batter-fried shrimp (tempura). These long and thin noodles are eaten in the hope that life may be long and thin (virtuously upright).

On the morning of 1 January the family eats the most ritually elaborate meal of the year together. The foods prepared for this meal are called *o-sechi ryoori.* Many are good luck foods because of some pun or metaphorical connection with desired traits. The meal typically begins with a drink of *otoso*, a sweet, spiced sake. A sweet life is further ensured by eating such foods as small candied fish or chestnuts in a sweet potato comfit. Red snapper *(tai)* is eaten because its name recalls the word *omedetai* (auspicious). Sweetened black beans *(mame)* are eaten to become hard working *(mame)* in the new year. A kind of seaweed, *kombu*, is eaten because it sounds like the word for being happy *(yorokobu).* Special chopsticks made of willow are often used at this meal so in the new year the family members will be as flexible in body and mind as a willow tree.

The single most important dish of this meal, however, is the soup, called *ozooni.* Many regional variations of this soup exist. In eastern and northern Japan (including Tokyo) it is typically a clear soup with a few vegetables, while in the west (including Kyoto and Osaka) the soup is made with white miso. Regardless, if it is soup for New Year's morning that has *mochi* in it, it is called *ozooni.* This pounded rice paste, *mochi*, is considered the very essence of rice (Ishige, 2000, p. 1176). Since for centuries rice was a food for the elite and a traditional offering to the Shinto deities, to eat rice essence helps begin the new year right. Traditionally *mochi* is eaten instead of rice for the first three days of the year. Besides being eaten in soup, it is also boiled and dipped in a mixture of sugar and powdered soybeans *(kinako)* or grilled, wrapped in small strips of nori seaweed, and dipped in sweetened soy sauce.

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James-Henry Holland

CONTEMPORARY ISSUES IN JAPANESE CUISINE

The twentieth century, and a few decades preceding it, was for Japanese cuisine a time of diminishing contrasts and increasing variety. During this period the food habits of the Japanese people advanced in two opposite directions. On the one hand, the dietary practices thus far restricted to the urban population spread to all areas of the country. On the other hand, it was a time of revolutionary change in the range of available foodstuffs and in applied cooking techniques. Never before had foreign food infiltrated Japanese cuisine to such an extent as it did during the twentieth century.

The Making of a National Cuisine

By the 1950s, the abundant regional variety and sharp class distinctions in diet that had been characteristic of premodern Japan gave way to a relatively homogeneous cuisine. The discrepancy between the sophisticated meals of the elite, the simple fare of the townsfolk, and the meager nourishment of peasants gradually faded away. Although the trade in local specialties flourished under the rise of capitalism, regional flavor had become by the late twentieth century the exception rather than the rule in the dietary culture of the Japanese people (Noguchi, 1994, pp. 323–326).

Urbanization has been largely responsible for the blending of regional food habits in modern Japan. The migration of great numbers of Japanese to Korea, Manchuria, and other colonies, and their repatriation after 1945, contributed to it as well. Modern food preservation technologies, such as canning and freezing, along with the popularization of foreign food, also played an important role in making the Japanese diet uniform. The increasing impact of mass media and home-economics education, as well as rising living standards, were other crucial factors in this process.

First of all, the rice-centered meal pattern consisting of a serving of rice, a bowl of soup, pickles (*tsukemono*), and side dishes had by the mid-twentieth century become a national standard. This pattern developed around the thirteenth century in the kitchens of wealthy warriors and monks, spread to less affluent samurai and townspeople during the following centuries, but only became the norm in peasant households in the wake of World War II. The daily diet of the rural population of Japan had thus far been composed of hearty soups; various types of millet, buckwheat, and barley, rather than rice, were their staples. Although rice has, since ancient times, been the most important crop in Japan, forming the center of its economy, a rice-based diet has for centuries been unattainable for the majority of the population (Ohnuki-Tierney, 1993, pp. 30–43).

The same holds true for soy sauce—nowadays regarded as the prevalent Japanese flavoring, the essence of Japanese cuisine. It should be mentioned that before the modernization of the country began in the late nineteenth century, peasants constituted more than 80 percent of the population. It is only since the beginning of the twentieth century that soy sauce has become affordable for every Japanese family. Before this shift took place, soybean paste (*miso*) had been the principal flavoring in farm households. Along with the factors mentioned earlier, the increased efficiency in production and retailing of soy sauce in the twentieth century helped it assume the position of Japan's national condiment.

Multicultural Eating

World War II is generally regarded as the watershed between the traditional and modern culinary culture in Japan. The food shortage of the 1940s diminished dietary prejudices, the American Occupation (1945–1952) instigated a powerful Westernizing influence, and the 1960s economic boom provided the means for the majority of the population to re-create affluent meals of the past and to mimic foreign food fashions (White, 2002, pp. 64–73).

Indeed, the economic affluence of the 1970s and 1980s supported extensive Westernization of Japanese food habits. A clear decrease in rice, soybean, and fish consumption, and a concomitant rise in red meat, dairy, and wheat consumption is just one of many indicators of this shift.

The year 1971 serves as a symbolic point marking the beginning of Japan catching up with the rest of the world in culinary culture. In that year the first McDonald's outlet was opened in Tokyo, soon followed by other American fast-food chains, ice-cream parlors, and steakhouses. The late 1980s and early 1990s witnessed the rise of the so-called ethnic food (*esunikku ryori*) boom. The ethnic-food category encompassed a variety of South and Southeast Asian cuisines as well as other culinary rarities such as Caribbean and Ethiopian cooking. This interchange of trends has turned Japanese cities into multicultural melting pots, hardly different in this respect from their counterparts elsewhere in the world. French, Italian, Chinese, Korean, and Indian are ubiquitous geographical headings on restaurant billboards in contemporary Japan.

Not only the restaurant culture underwent extensive transformation during the last decades of the twentieth century. Japanese home menus are less adventurous, yet by no means do they lack foreign influence. Most foreign dishes are incorporated as side dishes into the rice-centered meal pattern with soup and pickles. Dishes such as curried rice, spaghetti, and Chinese-style fried noodles are exceptions to this rule as they already constitute a meal.

The school lunch system, introduced in 1947 by the Allied Occupation authorities as a means of improving the nutrition of Japanese children, had a profound impact on the Westernization of Japanese home cooking. School lunches differed markedly from the typical Japanese meal in their strong emphasis on bread and milk, often combined with Western-style dishes such as curry stew, hamburger steak, spaghetti with meat sauce, and salad (Ehara, 1999). The kinds and combinations of foods served at school not only influenced children's tastes, but also indirectly affected the meals served in their homes. The postwar generations of children raised on such school lunches have grown into adults with tastes distinctly different from those of their parents and grandparents. The mass media and home-economics education provided Japanese women with the skills and expertise to satisfy the new food tastes of their families.

When Japan's older generation eats out, more likely than not, the meal of choice will be found in a quiet country inn, as in this dinner served at Miyabo Roykan in Kanazawa, Japan. © BOB KRIST/CORBIS.

Accommodating Foreign Food

Although internationalization of Japanese cuisine has been proceeding rapidly from the 1960s onward, it was not entirely a product of post–World War II decades. The first signs of Western influence could already be seen in the late nineteenth century, soon after the opening of Japanese ports to foreign trade and the launch of a series of social and economic reforms.

Young Japanese prefer to drink beer and eat *yakomono* (grilled foods) rather than more traditional dishes. Grilled chicken and fish (shown here) are among the most popular. PHOTO BY ANDRÉ BARANOWSKI.

The first Western-style restaurants in Japan opened in the 1860s in port towns that were designated to receive foreign ships and accommodate Western settlements. These restaurants were at first targeted exclusively at Western clientele. With the growing popularity of Western-style dining among the Japanese upper classes, however, Western-style restaurants began to cater to the Japanese customer as well. By the late 1880s, each provincial city in Japan had at least one Western-style restaurant, and within the next few decades a great many Western-style diners (*yoshokuya*) mushroomed throughout the country. They provided less affluent Japanese citizens with domesticated versions of Western-style dishes, such as fried fish, beefsteak, veal cutlet, croquettes, omelets, and stew. These dishes were not served as components of set menus consisting of several courses, as was the general practice at more expensive establishments, but were to be ordered à la carte and usually served accompanied by a plate of Japanese-style boiled rice. For the working classes, these Western-style diners were their only opportunity to try food that was different from what they usually had at home. Western-style cookery was not to enter Japanese folk kitchens until several decades later.

The early twentieth century did witness, however, the rise of a hybrid style of Japanese-Western home cooking among the nouveau-riche class of white-collar urban professionals. Middle-class housewives looking for diversion in their domestic chores ardently embraced this new eclectic cuisine (Cwiertka, 1998, pp. 49–54). Next to Western-style dishes, Chinese-style recipes began to be prominently featured in household literature from the 1920s onward—a decade after cheap eateries run by Chinese immigrants became popular in Japanese cities. Western and Chinese cooking techniques such as pan-frying, stewing, and deep-frying of breaded meat and fish enlarged the variety of Japanese cookery. By the 1930s, the Japanese-Western-Chinese culinary triptych was firmly established as the foundation of modern Japanese foodways. The incorporation of Western-style and Chinese-style dishes into the diet of the Japanese armed forces contributed greatly to the popularization of this new food among all segments of society (Cwiertka, 2002, pp. 7–15).

Food Safety

From the 1970s onward, when rice-centered cuisine had reached the entire population and was about to be challenged by the encroachment of foreign food, a concern about sufficient food supply gradually shifted toward food safety (Jussaume, Hisano, and Taniguchi, 2000). Consumer awareness about the risks of food contamination and the connection between environmental pollution and food production grew steadily. In 1973, the National Association of Consumer Cooperatives (now known as the Japan Consumer Cooperatives Union) began to emphasize food safety in its marketing strategies. Various consumer groups advocating organic farming and reduction of food imports became active all over Japan. The issue attracted wide public attention in the late 1980s and early 1990s, when pressure from the United States and some European countries to open Japan's rice market met with violent opposition in Japan. A current example of the mainstreaming of the food-safety movement is the fact that the Japanese public strongly opposes genetically modified foods despite assurances from the Japanese government about their safety.

With the first Japanese case of bovine spongiform encephalopathy reported in 2001, and an increase in the incidence of child obesity and coronary diseases, it seems that Japanese consumers have not only added Western foods to their menus, but now have some of the same worries about food as Europeans and Americans.

See also **China**; **Korea**; **Southeast Asia**; **Tea**.

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Katarzyna J. Cwiertka

Ceramic bucket for kugel and steamed pudding. Saarland, Germany, circa 1890–1915. Used in cooking classes of the *Verein für Fraueninteressen* (Women’s Topical Club) in Landau, Germany, until about 1918. The club membership was largely Jewish. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

JUDAISM. Jewish food is primarily defined by the dietary laws of Judaism. The Judaic religion is prescriptive in the selection, cooking preparation, and consumption of specific food items. Daily practice is meticulously structured to comply with Jewish law, the Halakhah, and the community of Jews is organized as a community of religiously complying eaters. Specific dishes, food combinations, and cooking preparations are prescribed for religious festivals. Throughout their history of multiple migrations and diaspora (dispersion), the Jews have been in contact with different cultures, languages, and cuisines. This has generated a diversified Jewish cuisine.

Dietary Laws

Under the classifying terminology of kosher versus nonkosher, the system of dietary prescriptions and prohibitions in Judaism primarily involves the consumption of animal flesh, and is codified in the Pentateuch, in Leviticus (chapter 11). Typical edible animals are domestic, have a vegetarian diet, and are physiologically “plain,” that is, not affected by any disease or anatomical or physiological defect. In fact, as Mary Douglas has pointed out in *Purity and Danger*, the dietary prohibitions of Leviticus include a biblical narrative logic. They are organized along the mythological lines that structure the cosmological section of Genesis. Thus the animal kingdom is classified into three categories: those living on the earth, those living in the water, and those living in the air. In the first category, only mammal quadruped ruminants with split hooves are allowed on the Jewish table. Striking exceptions to this rule are emphatically mentioned in the text. Among the animals living on the earth, the swine, the camel, the hare, and the rock-badger are specifically excluded from the Jewish table because they satisfy only one condition for edibility; that is, either they are a ruminant, or they have a split hoof, instead of both conditions required. The category of animals living in the air also functions as an exclusive system, when it provides a list of animals strictly prohibited on the table. Most of these animals are carnivorous birds, while the bat is eliminated for being a flying mammal, an utmost abomination by the Leviticus standards. Finally, animals living in the water should have fins and scales to be considered “pure” and edible, while those crawling on the earth or living underground are also considered “impure.”

In addition to these dietary prohibitions concerning the selection of animals based on anatomical and physiological criteria, biblical law forbids the consumption of blood (Deuteronomy 12:23) and the mixture, in the kitchen and at the table, of dairy foods and meat dishes (Exodus 23:19). The former rule thus requires the strict observance of slaughtering techniques designed to evacuate the largest amount of blood from meat cuts before they are distributed to the marketplace. Some secular scholars have interpreted the regulation of Jewish food practices by religious law and sacred scriptures as evidence that the idea of God is at the core of the Jewish table. This spirit, although viewed by some as being motivated by hygienic concerns, has generated a complex system of community institutional organization that involves the technical training of rabbinical slaughterers (*shohatim*), their appointment in slaughtering houses, and the establishment of a system of verification of the

Vollſtändiges
praktiſches Kochbuch
für die jüdiſche Küche

The 1910 edition of Josephine Gumprich's *Complete Practical Cookbook for the Jewish Kitchen,* which first appeared at Trier, Germany, in 1888. This book was popular with Jews in Europe and ran through several editions. Roughwood Collection.

enforcement of dietary laws. The latter requirement is often handled by secular agencies, in collaboration with local rabbinical authorities. In New York, for example, the presence of the largest urban Jewish population in the world has generated a system in which the state government is in charge of the enforcement of kosher laws in the local food stores, especially those selling meat displayed as being kosher (Fried, 2000).

Jewish Festival Foods

At the core of all Jewish festival tables is the sanctified bread, or challah. Oven-baked and usually excluding dairy ingredients, the loaves are braided, though other shapes can be found in various Jewish traditions. Another typical festive dish is the Ashkenazic gefilte fish (Yiddish, "stuffed fish"), opening sabbath or holiday meals as a good omen. Most holiday menus are linked to the religious festivals and have a narrative function. Examples include the fried pastries served during Hanukkah. The holiday of Hanukkah is a ritual celebration of the biblical section narrating the Maccabees' victory over the Seleucid Greeks in the second century B.C.E. and the following miracle that kept the ritual oil lit for eight days in the Second Jerusalem Temple after it had been devastated by the Greek armies. Thus, in the Jewish communities of central and eastern European origin, the tradition requires that latkes, fried potato pancakes, be served. The equivalent in the Jewish traditions of the Mediterranean and the Middle East is usually fried buns served with honey. Purim celebrations include the baking of multiple pastries, a playful reminder of the defeat of Haman. Thus, Ashkenazic families serve *hamantashen* or "Haman's hats," poppy seed–filled triangular pastries.

The Jewish festival of Passover, a ritual narration of the Jewish slaves' exodus from Pharaoh's Egypt, includes special food prescriptions. During the eight days of the holiday, the only bread allowed for consumption is unleavened bread, to commemorate the bread that the slaves took in their hasty overnight flight from slavery. This unleavened bread, called matzo in Hebrew, is industrially baked today as a thin square flat cracker according to the Ashkenazic (eastern and central European) tradition. In Sephardic (Mediterranean and Middle Eastern) traditions, matzo has a round shape. The Passover food restrictions also require that no leavened substance be included either in the kitchen and menus or in the household at all. Some North African Jewish communities exclude rice from their Passover diet. Some also exclude chicken for fear of finding grain in the gizzard. Thus most Passover pastries and carbohydrate dishes are prepared with matzo flour or cracked matzo. Ashkenazic Jews traditionally serve matzo balls boiled in chicken soup, matzo brei (a fried, egg-coated matzo pancake), while North African Jews often enjoy the flavors of a couscous made out of cracked matzo.

Shavuot, or festival of the Torah, is marked by the consumption of honey and dairy foods, with which the Torah is allegorically identified. *Blintzes*, cheese pancakes, are displayed on Ashkenazic tables, while Sephardic traditions include yogurt or *baklava*. The favorite dishes served for Rosh Hashanah (Jewish new year) include heavily sweetened dishes such as the Ashkenazic *tzimmes* (a sweet carrot and raisin stew) and honey cake, all of which are designed to welcome a good and sweet new year. The fall festival of Sukkoth (also Sukkot) includes *borsht*, a beet and cabbage-based soup, served in households of Polish origin.

Sabbath Foods

The Jews' food history is characterized by their many migrations and their status as a minority group. From this viewpoint, it is as diverse as Jewish cultures, languages, and community experiences have been, as Jews have related to the multiple cultures and populations they have been in contact with throughout the world. Jewish food has operated, both practically and symbolically, and not unlike Jewish languages, as Jewish versions of local nutritional habits. An illustration can be found in most dishes served for the most important holiday of the Jewish ritual calendar, the Sabbath. The *tshulent* is the Ashkenazic version of this sabbatical dish. The Yiddish name of this dish includes two French words, *chaud* ('warm') and *lent* ('slow'), a linguistic combination testifying not only to the many influences on Jewish culture and languages, but also to the specifically Jewish character of this dish's cooking technique. It is in effect cooked slowly for about twelve hours between the beginning of Sabbath (Friday night) and the Saturday lunch. This long and slow cooking is the result of the sabbatical prohibition on lighting fire during the twenty-four hours between Friday night and Saturday night. This implies that once the Sabbath candle is lit on Friday evening, any food starting to cook then will end up being overcooked when it is consumed on Saturday. In North Africa and the Middle East, this dish is called by either of the Arabic terms *dfina* or *tfina* ('buried'), *skhina* or *hammin* ('warm'). The first set of terms refers to the burying of the pot underneath blankets or even in an underground oven designed to keep warmth in. The second set of terms refers to the permanent warmth of the dish. All Sabbath dishes are composed of heavy and varied ingredients found in the local marketplace: beef, grain, potatoes, vegetables, peas or beans. In eastern North Africa, the tradition was to use green vegetables such as spinach or Swiss chard, fresh fava beans, or cardoons. This ingredient use is probably a custom borrowed from local Muslim neighbors. Muslims of these regions serve very green dishes for major holiday dinners, in the belief that green was the Prophet's favorite color. Thus local Jews have integrated this color symbol into their own major holidays.

The many migrations that have affected the Jews of eastern Europe, North Africa, and the Middle East throughout the twentieth century have resulted, in the early twenty-first century, in the massive secularization of the Jewish migrants in the hosting countries. Traditional Jewish food has thus become a marker of ethnic identity rather than a part of religious observance. On the other side, these traditional dishes, because they are the last ritual items to be given up in the process of Jewish secularization, constitute practical and social frameworks allowing religious observance to be maintained, even in its minimal scope.

See also **Bagel**; **Bread, Symbolism of**; **Christianity**; **Diaspora**; **Fasting and Abstinence: Judaism**; **Feasts, Festivals, and Fasts**; **Islam**; **Passover**; **Religion and Food**; **Taboos**; **United States: Ethnic Cuisines**.

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Joëlle Bahloul

JUICE. *See* **Fruit; Grapes and Grape Juice.**

KASHRUT, LAWS OF. *See* **Judaism; Passover.**

KELLOGG, JOHN HARVEY.

John Harvey Kellogg (1852–1943) was born in Tyrone, Michigan. When he was four years old, his family moved to Battle Creek, Michigan, where his father was one of the founders of the Western Reform Institute, a Seventh-Day Adventist health clinic specializing in hydrotherapy ("the water cure") and vegetarianism. The Seventh-Day Adventists were the largest American religious denomination to endorse vegetarianism. Kellogg enrolled at Bellevue Hospital College in New York after completing his undergraduate work, where he studied medicine. In 1876, upon completion of his studies, Kellogg took over administration of the Western Reform Institute. He subsequently changed its name to the Sanitarium and enforced a strict vegetarian culinary regimen. Under his guidance, the Sanitarium was visited by America's rich and famous people and Kellogg's beliefs became widely disseminated.

Assisted by his younger brother Will K. Kellogg (1860–1951), John H. Kellogg experimented with rolling, flattening, and baking whole grains. The resulting flakes were a culinary success at the Sanitarium, and the Kelloggs decided to mass-produce and sell them through mail order. Imitators soon sprang up and churned out numerous similar products, including Grape Nuts and Post Toasties developed by C. W. Post, who had been a patient at the Sanitarium. Kellogg's creation had launched the commercial cold cereal industry.

John Harvey Kellogg also rolled other products, such as nuts, thus creating nut butters, which he believed were a substitute for cow's butter. While nut butters were made from all available nuts, peanuts were the least ex-

Photo portrait of John Harvey Kellogg. COURTESY AP/WIDE WORLD PHOTOS.

pensive nut. The Kelloggs created the Sanitas Nut Food Company, and again Will was placed in charge. Due in large part to the efforts of the Kellogg brothers, peanut butter quickly became an American favorite.

To develop further the commercial possibilities, the Kelloggs incorporated the Toasted Corn Flake Company in 1906. John H. Kellogg was the majority stockholder, but he distributed part of this stock among the Sanitarium doctors. Will Kellogg bought up the stock until he personally owned the majority of shares. Will promptly put his signature on the box and renamed the company that was ultimately to become Kellogg Co. To enhance sales, Will added sugar and other additives to the recipe and increased sales through advertising not as a health food for the ill, but as an enjoyable and convenient breakfast food for everyone. The two brothers went through years of legal battles over the name, but in the end Will won. For years the brothers never spoke to each other.

Later, John Harvey Kellogg confronted a variety of other problems. About 1906 the Seventh-Day Adventists excommunicated Dr. Kellogg and eventually severed ties with the Sanitarium. However, he survived until the Depression hit, and the Sanitarium began to lose money. It continued in operation until 1942, when it was sold. Kellogg died the following year.

Will Kellogg remained as president of the Kellogg Company until 1929, but remained as chairman of the Board until his death in 1951. In 1930 he established the W. K. Kellogg Foundation in Battle Creek, one of America's foremost philanthropic institutions.

See also **Breakfast; Cereal Grains and Pseudo-Cereals; Cereals, Cold; Peanut Butter; Wheat.**

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Andrew F. Smith

KETCHUP. *See* Condiments.

KITCHEN GADGETS. One of the earliest recorded uses of the term "gadget" was in 1886 as a nautical term referring to a small, somewhat specialized contrivance. It is unclear when the term first entered kitchen parlance, but the *Oxford English Dictionary* records the earliest use of the expression "kitchen gadget" as 1951 in the *Good Housekeeping Home Encyclopedia*, which remarked that kitchen gadgets are often discarded because it takes too much time to clean them.

A popular contemporary taxonomy of kitchen technology must account for the essential ambiguity of the term. Terms like "gadget," "utensil," "accoutrement," "tool," and "appliance" overlap. A kitchen gadget may be a specialized artifact used for the preparation of a single kind of dish or for performing one specific function across a variety of dishes. As such, it can be distinguished if only in a general sense from the broader term "kitchen utensil," which would include multipurpose and essential kitchen equipment, such as chefs' knives and large appliances like ovens and refrigerators. In modern usage the term "kitchen gadget" also may be pejorative. It is often used to refer to novelty items, gimmicky and cheap kitchen equipment that purports to ease the burdens of homemakers. As the usage in the *Good Housekeeping Home Encyclopedia* indicated, gadgets may be the kinds of products that accumulate in the back of kitchen drawers until they are discarded. Another aspect of the gadget is its symbolic character. Gadgets may be displayed as items that represent taste, newness, or status.

Although the term "gadget" originated in the late Victorian era, it is often used retroactively to refer to pre-Victorian forms of specialized kitchen equipment. Providing an account of early kitchen tools is difficult as such items rarely made their way onto household inventories. It is well established that, apart from the kitchens of the aristocracy, pre-Victorian cookery, at least in the British Isles, was almost entirely a matter of boiling in a pot, cauldron, or kettle; baking in an oven or on a bake stone; and roasting on a spit. A number of devices were designed to assist the pre-Victorian cook with each of these kitchen tasks.

Victorian Gadgets

The jack was one of the most useful Victorian aids. Roasting spits, also known as "broches," "peakes," or "flesh pikes," were mounted in the fireplace. A jack is a device that rotates the roasting spit without the constant attention of the cook. A great variety of techniques for spit rotation were designed over the years. The earliest jacks relied on a system of weights akin to those in a weight-driven clock for their slow and steady movement. Another early form of jack was the smokejack, first imported into England from Germany in the second half of the sixteenth century. The force of air and smoke rising in the fireplace chimney powered this kind of jack. Perhaps the most unusual were the animal-powered jacks, which relied on animals, such as dogs or geese. Geese were considered a better source of power, as dogs quickly became bored with the work and were far craftier than geese at shirking their duties. The most popular kind of jack was the windup or spring jack, which the Swedish botanist and noted traveler Pehr Kalm observed in almost every English home he visited in 1748.

Another kitchen implement from this era was the tin roaster. In its earliest form, a piece of wood lined with reflective tin was placed next to the meat to reflect the heat back and increase cooking efficiency. This arrangement evolved into a small and elegant device that only occupied the width of the fire bars. The tin roaster consisted of a tin enclosure to reflect heat back onto the meat, a dripping pan, and a door on the front through which the cook could baste and otherwise attend to the meat. Tin roasters often incorporated that other essential roasting gadget, a windup or bottle jack.

Another common kind of hearth-front gadget was the toaster. Hearthstones, a variety of toasting forks, and hinged devices mounted on the side of the hearth were all used to toast bread. One of the more common devices was the hearth toaster, a long-handled piece of cast iron that held the bread between small arches that could be swiveled to toast both sides of the bread.

Boiling and simmering called for some arrangement to regulate temperature by shifting pots closer to or farther away from the fire. The most basic technique used a series of pothooks or hangers of varying lengths. Another technique used a chain wrapped around a rod so it could be rotated. The chimney crane was perhaps the most elegant of these devices. The rod and hook techniques could only be used to move a pot up and down, whereas the chimney crane could move a pot through three dimensions. This afforded much more precise heat regulation than the hook or rod techniques and allowed the cook to move the pot out of the fireplace without directly picking it up. The chimney crane saw wide use, especially in southeastern England from the sixteenth century through the eighteenth century.

Within the great houses, an altogether more sophisticated battery of kitchen equipment existed. For example, inventories of the British estate Ham House from the 1670s and 1680s list sixty-two kinds of items. This list includes such specialized equipment as a tin apple roaster, colanders, a tin grater, a three-chain jack, a fish kettle and a carp pan with false bottoms, numerous larding pins, several mortars and pestles, pastry peels, a "rowling" (rolling) pin, skimmers, lark spits, iron toasting tongs, a wooden whisk, and a sieve (made of hair) along with the sundry common items like knives, pots, pans, and skillets.

The list of items at Ham House includes a number of "basons" (basins) of undesignated use. It is a safe assumption that they may be freezing basins. Hannah Glasse published several editions of *The Art of Cookery Made Plain and Easy* from 1747 on. Each edition included instructions for making ice cream using two pewter basins, one with a tightly fitted lid enclosed within the larger basin. She suggested two kinds of basins. One, manufactured in France, was tall and cylindrical; the other was three-cornered and wedge-shaped. The wedge basin was used with three other identically shaped basins so the cook could make a multihued circle of ice cream.

During the Victorian era, the use of the hand-cranked ice cream machine became widespread. The English inventor William Fuller sold a pamphlet titled *A Manual Containing Numerous Original Recipes for Preparing Neapolitan Ices* along with a hand-cranked machine patented in 1853. The machines of Fuller and his competitors were popular with professional confectioners and the wealthier and innovative set. They were not in common use at the household level. The first hand-cranked machine was patented in the United States in 1848, and domestic versions were available in the 1860s. By the 1880s numerous hand-cranked machines were designed for the domestic market, and many were still available in the early twenty-first century. The basic ice cream machine is a coopered wooden bucket into which an enclosed rotating chamber is inserted. A hand crank rotates the chamber. The chamber is surrounded by ice and salt, which reduces the chamber's temperature low enough to congeal its contents.

Some of the characteristic beliefs of modernity are that everything can be known and that all nature can be mastered if one applies sufficient time, expertise, and specialized technology to the task. This positivism was the prevalent mindset of the Victorian era. It should come as no surprise that the term "gadget" originated in the 1880s as the Victorian era saw an immense explosion in the

TABLE 1

Gadgets and their requisites

Gadget	Requisite
Jack: weighted	Hearth
Jack: smoke	Hearth and flue
Jack: windup or bottle	Hearth
Jack: animal-powered	Hearth and obedient dog or goose
Tin roaster	Hearth
Toaster	Hearth or for modern forms electricity
Pothooks and hangers	Hearth
Chimney crane	Hearth
Tin apple roaster	Hearth
Ice-cream maker: manual	Ice, salt, and muscle power
Ice-cream maker: electric	Electricity and either ice and salt or a refrigerator with a freezer compartment
Eggbeater	Muscle power
Stand mixer	Electricity and a variety of attachments, such as a whisk, flat paddle, or dough hook. Numerous other gadgets can be powered by a stand mixer, such as can openers, slicers and shredders, food grinders, fruit and vegetable strainers, grain mills, citrus juicers, pasta makers, and sausage stuffers.
Cafetiere	Ground, roasted coffee and hot water
Espresso maker	Hot water or electricity and finely ground, roasted coffee beans
Goblin	Electricity and tea
Coffee grinder	Electricity and roasted coffee beans
Coffee roaster	Electricity and raw coffee beans
Percolator	Electricity or alcohol for heat and roasted coffee beans
Drip coffee machine	Electricity, filter, and roasted coffee beans

development of small and highly specialized tools. This proliferation of specialized technology existed across all spheres of human activity, including the domestic, where kitchen gadgets flourished. The number of kitchen gadgets invented or in widespread use for the first time during the Victorian era was immense.

A book like Isabella Beeton's *The Book of Household Management* (1861) was representative of this Victorian positivism. Beeton set out in 1,112 pages to inform the homemaker how to micromanage every aspect of domestic economy. Her list of thirty-seven essential kitchen utensils, including a bread grater, was far more involved than the kitchen inventories of most British households in the preceding century.

This era saw the invention of many new kitchen gadgets, including the apple peeler, other specialized peelers, the mechanical eggbeater, the mechanical dough mixer, bread toasters, potato mashers, coffee grinders, food choppers, and waffle irons. The African American inventor John Thomas White was issued a patent for a lemon squeezer in 1896. It consisted of two pieces of wood connected by a hinge. The bottom piece included a slotted opening so the juice of the lemon could pass through when the two pieces were squeezed together.

Modern Gadgets

Many modern kitchen gadgets are simply updated and electrified forms of kitchen gadgets developed in the Victorian era. The aforementioned home ice-cream makers are representative of this trend. In the 1950s electric models of the ice-cream maker were introduced. The earliest models simply replaced the hand crank with an electric motor. Models from the late 1960s were designed to fit into a refrigerator freezer. In the 1960s the two most prevalent kinds of contemporary ice-cream makers were developed. The relatively inexpensive prefreeze models featured an insert filled with refrigerant that was prefrozen in the refrigerator freezer. The second kind of ice-cream maker used a small, built-in freezer to congeal the ice cream or sorbet.

The toaster is another updated item. The first electric toasters were built in the early twentieth century immediately after the invention of a nickel and chromium alloy, trademarked as NiChrome, was used to make the first high-temperature electric heating elements. The first commercially viable electric toaster was the General Electric D-12, an open affair mounted on a ceramic base. Electrical toasters underwent a number of innovations, including metal and plastic enclosures and various slot sizes to accommodate changing tastes in bread. Toasters designed specifically for bagels have become common. The combination toaster and oven was popular in the 1980s, but its acceptance has steadily declined due to its general ineffectiveness at both toasting and performing the duties of a small oven.

The toaster oven is one of the more widespread representatives of the multiple-function gadget. The numerous representatives of these devices range from the ill-fated combination nutmeg grater and corkscrew patented by George Blanchard in 1856 to the kitchen equipment advertised on late-night television that can do "all this and so much more." Perhaps the most successful multipurpose kitchen gadgets are the appliances manufactured by companies like Bosch, KitchenAid, and Sunbeam derived from the 1884 eggbeater design of the African American inventor Willie Johnson. His eggbeater was powered by a driving wheel in conjunction with a system of gears and pulleys that rotated a set of beaters, blades, or stirrers.

The eggbeater was an updated and mechanized version of the kitchen whisk that further evolved into a wide variety of gadgets. One of the most significant was the electric mixer. The first American patent for an electric mixer was filed in 1885 by Rufus W. Eastman. The earliest electric mixers were large, clunky machines that in the twenty-first century would look more at home in a wood shop than in the kitchen. By the 1930s at least a dozen manufacturers made electric mixers, including the nearly ubiquitous Hobart (KitchenAid) and the Hamilton Sunbeam. The Sunbeam Mixmaster model M4A, which was first manufactured in 1930, was relatively streamlined in comparison to its competitors. Its name "Mixmaster" eventually became the generic term for a stand mixer.

The new stand mixers were not really gadgets so much as constellations of gadgets. The Sunbeam Mixmaster was advertised as capable, given the right attachments, of mixing, mashing, whipping, creaming, stirring, beating, extracting fruit juice, chopping, grinding, and blending. A twenty-first century advertisement for the KitchenAid Stand Mixer lists attachable accessories that include a can opener, a rotor slicer and shredder, a food grinder, a fruit and vegetable strainer, a food tray, a grain mill, a citrus juicer, a pouring shield, a pasta maker, a sausage stuffer, a flat beater, a dough hook, and a whisk.

Coffee and tea have inspired quite a few gadgets over the years, including kettles, cafetieres, espresso makers, goblins, grinders, roasters, percolators, and drip machines. The tea goblin or the teasmade is one of the more unusual kitchen inventions. This was a British invention of the 1930s that made tea on a timer. Goblins often featured alarm clocks, lamps, heating elements, and devices for placing the tea into the hot water. Coffee was traditionally prepared by the Turkish method of boiling the coffee until the development in 1806 in Germany of the percolator by the American Count Rumford, who saw coffee drinking as an alternative to the hard-drinking lifestyle of German workers. The drip coffee maker soon followed. Early models were heated by burning alcohol, replaced by electrical elements in the early twentieth century. Other inventions included the steam espresso maker, which forces steam through the ground coffee until it is condensed on the other side, and the cafetiere, of which the most popular model worldwide is the Danish Bodum. Americans have preferred drip and percolator models, and Italians have preferred espresso makers that rely on various mechanisms, from pressurized cylinders to straight steam pressure, to force steam through the coffee grounds.

Coffee and espresso makers have accumulated attachments to much the same extent as the stand mixer. The difference lies in the purpose of these attachments. Coffee and espresso appurtenances are components of the machine designed to complement a cup of coffee rather than to perform a wide range of kitchen tasks. These appurtenances include devices for scalding and frothing milk and grinding coffee built directly into the machine. Some coffee makers emulate the tea goblin. On a timer, they grind the coffee beans, insert the grounds into the filter, and then make the coffee.

Kitchen equipment is tied to representations of status, and coffee-making equipment is an ideal example. The first electric percolators were designed as elegant table centerpieces, and most coffee was preground and sold in vacuum-sealed tins. By the 1980s percolators were no longer considered the height of sophistication. An elegant North American coffee drinker used a drip coffee maker and ground his or her own beans. By the twenty-first century, a European method was preferred. An Alessi-designed cafetiere or an Italian espresso maker, such as one of the pressurized La Pavoni machines, or even a stovetop steam-pressured espresso maker signified good taste.

See also **Beeton, Isabella; Coffee; Preparation of Food; Utensils, Cooking.**

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Wesley Dean

KITCHENS, RESTAURANT. With the debut of executive chef Gray Kunz's $1 million kitchen at the restaurant Lespinasse in New York City's St. Regis Hotel in 1994, the restaurant kitchen became a showplace and status marker for American chefs. Cast-iron ranges from France, cool-to-the-touch induction stoves from Japan, fast-churning ice-cream machines from Italy have become de rigueur for any cook worth his *fleur de sel.* But despite the push for state-of-the-art technology in kitchen design, the organization of the staff and the layout of the workspace have not changed much since Georges-Auguste Escoffier's day.

Kitchen Organization

In addition to codifying and modernizing the culinary repertoire, Escoffier is credited with streamlining the organization of the kitchen. "I myself have often been forced to make profound changes in my restaurant service to meet the need of the ultra rapid pace of modern life," he wrote in his memoirs at the turn of the twentieth century (p. 119). His solution was a kitchen organization based on principles of efficiency and division of labor that grew out of the Industrial Revolution. The tasks involved in assembling the meal are divided among different "stations" (*parties* in French), each with its team of cooks. The various elements of any finished dish may come from as many as five or six stations. Together, the team of chefs in the kitchen is known as the *brigade.* In English, the chefs who prepare the places during service are known collectively as the line. It is interesting to note that in many kitchens, no matter their ethnicity, French kitchen terms are usually mixed up with whatever language is spoken.

At the top of the kitchen hierarchy is the executive chef. In a hotel, the executive chef oversees all food preparation in the property's various food service outlets; the role is largely administrative. In a restaurant, the executive chef's duties are usually more hands-on. Now that so many restaurant chefs have multiple restaurants under their command, however, their role has also become more administrative in scope. Below the executive chef is the *chef de cuisine*. This is the person directly in charge of managing the kitchen. The cooks all report to the *chef de cuisine*, who in turn reports to the executive chef. To help oversee the smooth management of the kitchen, the *chef de cuisine* usually has one or two *sous-chefs* (literally "under chefs"). The responsibilities of the *sous-chefs* are often divided by meal period—for instance there will be a lunch *sous-chef* and a dinner *sous-chef.* The breakdown of the *chefs de partie*—"station chefs" or "line cooks" in English—is determined by the breadth and scope of the menu (not to mention the space available in the kitchen) and their tasks at hand. Thus, the *saucier* is responsible for making the sauces and stocks. Because of the emphasis Escoffier placed on sauces in his culinary repertoire, the saucier traditionally holds an exalted status in the kitchen. The *rôtisseur* is responsible for meats and roasts, the *poissonier*, fish. A *grillardin* does the grilling, a *potager* makes the soups (*potages*, in French). Vegetables and other side dishes are the charge of the *entremetier*. The *friturier* mans the fryer. The *garde-manger* is in charge of the cold pantry, from which issues forth hors d'oeuvres, salads, garnishes, and other cold preparations. During the eighteenth and nineteenth centuries, when large presentation pieces and ornate garnishes were an important element in traditional French service, the role of the *garde-manger* was elevated in status. The *pâtissier* is in charge of the pastries and other baking. A *chocolatier* would be responsible for chocolate items. Further divisions and subdivisions are also possible.

Depending on the demands placed on the staff, within the different stations there may be multiple cooks and assistants. Young apprentices known as *commis* or *stagiaires* are plentiful in large kitchens, for they are generally strong, eager, and willing to work for little pay. A *tournant* is an experienced chef who can fill in at any station should the cooks become backed-up during service (referred to colloquially in English as "being in the weeds"), or should someone not show up to work.

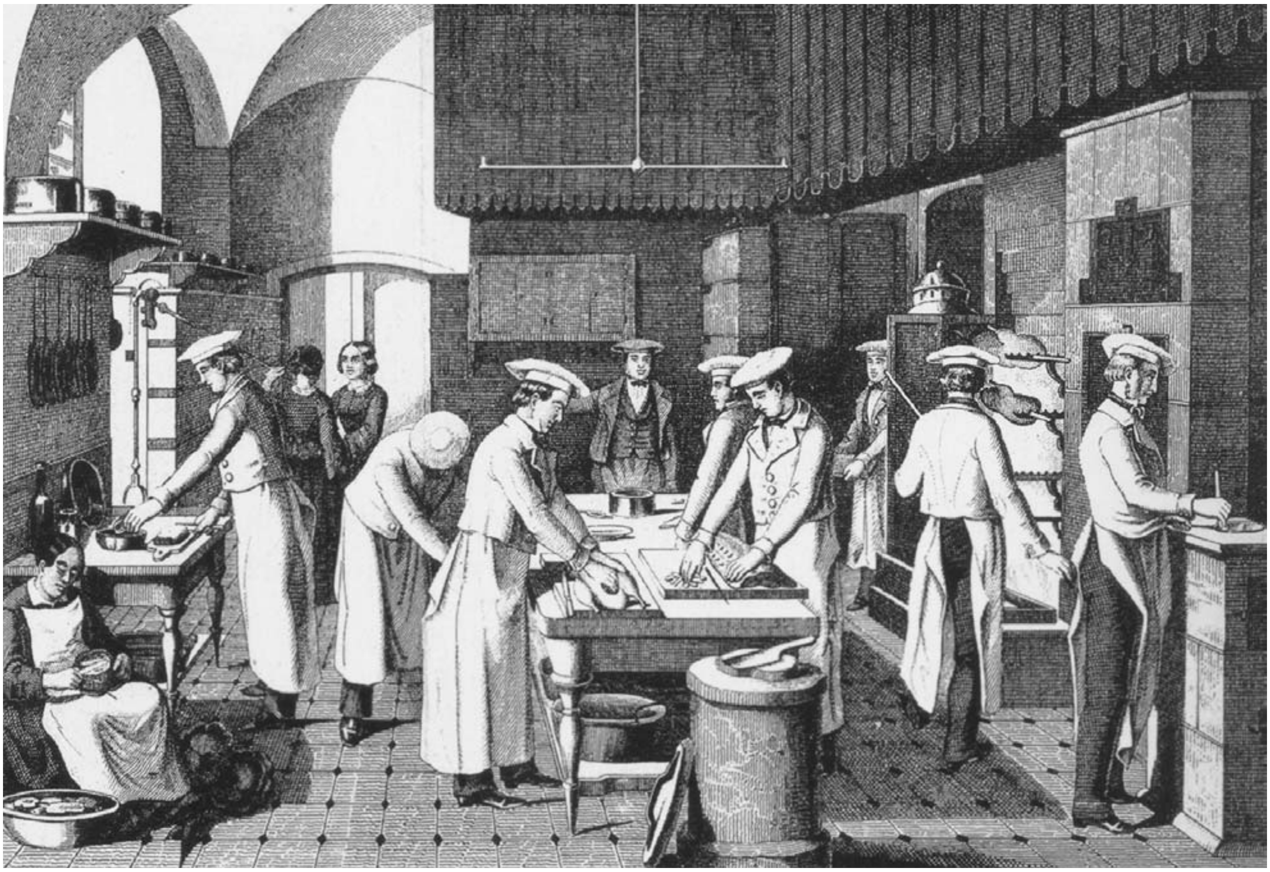
The expediter (*aboyeur*, in French, or "barker") is the person to whom the orders from the dining room are given by the waitstaff or, more likely these days, by the computerized ordering system. This is the role the executive chef often takes during service (often to the dismay of the staff; most executive chefs make poor expediters). The expediter is responsible for timing the preparation of a table's order so that all of the various components from the different stations are completed at exactly the same moment. This ensures that the food is served at its prime and contributes to the smooth operation of the restaurant and the maximum satisfaction of each guest is an important task.

Variations among Kitchens

The breakdown of the *brigade* differs from restaurant to restaurant. In reality, only the largest, most expensive restaurants follow Escoffier's organization to the letter, but a surprising number are based on his model. Most kitchens are organized around a compressed version of the traditional hierarchy. With modern technology and convenience foods (of which, based on his memoirs, Escoffier would likely have been a champion), it is possible for as few as three line cooks to turn out hundreds of meals, albeit of questionable quality.

Perhaps the most important factor in determining the organization of the kitchen is the menu, which itself is an outgrowth of the overall concept of the restaurant. The array of dishes, the variety of cooking techniques, and the intricacy of garnishes all have a direct impact on the way the kitchen functions. In planning the menu it is imperative that the chef consider the impact new items will have on each station of the kitchen. The second most important factor in the design of the kitchen and the division of labor is the physical layout of the space. No matter how heavy the demands placed by the menu on a particular station, if there is not enough space for the cooks to work comfortably, efficiency will suffer. Kitchens also reflect the personality and management style of the chef in charge. Some chefs prefer to divide stations based on the natural divisions of the menu. Thus, you will sometimes hear stations referred to by the terms "hot apps" (hot appetizers) or "salads."

Different styles of cuisine require different divisions of labor. In Italian restaurants, the pasta station becomes supremely important. In seafood restaurants, naturally, multiple fish cooks are required. Some types of cooking require a different organization altogether. Chinese restaurants are able to offer a vast number of dishes because of the way the kitchen is set up. Each chef has a workspace with at least one wok (usually several) and a



The classic restaurant kitchen drew for its inspiration upon the structure and labor organization of the royal kitchens of Europe. Depicted here is the well-organized kitchen of the Hofburg (royal palace) in Berlin in 1861. Note that all the cooks are wearing uniforms that define their station or pecking order in the hierarchy of the kitchen command. ROUGHWOOD COLLECTION.

huge array of ingredients at the ready. One dish at a time is prepared and sent out to the table as it is finished. This accounts for (or results from) a style of eating that is totally different from the Western model. In Japanese restaurants, the cooking is sometimes done right in front of the guests by the principal chef and his assistants. Although in the West we are familiar with this set-up in sushi and *teppanyaki* restaurants, in Japan other types of restaurants are molded into this configuration. Exemplary Mexican, French, and Italian restaurants in Tokyo are set up according to this sushi-bar model.

Although the "open kitchen" concept became popular in restaurant design in California in the 1980s and has since spread throughout the country, these kitchens, which afford diners a peek into the inner workings of the restaurant, are usually organized according to the traditional French model, not the Japanese. Similarly, the rise in popularity in the 1990s of "chef tables"—dining tables actually located in the thick of the kitchen commotion—offer an up-close view of the fine-dining kitchen.

Some American chefs make a point of shunning the traditional hierarchical organization of the kitchen altogether. The two most renowned are probably Alice Waters at Chez Panisse in Berkeley, California, and Barry Wine at the former Quilted Giraffe in New York City. Both chefs pride themselves on the democratic ideology that governed their kitchens, giving each cook a more or less equal say in the decision-making process. Although the reasons behind the adaptation of this democratic model were very different—Waters came out of the Berkeley hippie movement of the 1960s and 1970s; Wine aspired to have the most innovative and creative restaurant in the high-flying 1980s—both succeeded in producing world-class restaurants that attracted international acclaim.

Social Interaction

Because of the high-pressure environment of most restaurant kitchens, they act as crucibles of social interaction. Despite formidable attempts to organize the kitchen into a smooth running "assembly line," systems and chains of command often break down. George Orwell's *Down and Out in Paris and London* (1933) offered a vivid glimpse of life in a large Parisian kitchen at the beginning of the last century. Some seventy-five years later, the grit of kitchen life has again captured the popular imagination, with tell-all books such as Anthony Bourdain's *Kitchen Confidential* (2000) topping bestseller charts. In *Kitchens* (1996), sociologist Gary Fine offers a more scholarly portrait of kitchen life. Fine produced an ethnographic sociological study of work and human interaction in the restaurant kitchen environment. Fine spent several months in the kitchens of four restaurants that covered the spectrum of dining establishments from chain to fine dining. His study examines kitchen life through the filters of economic, class, and aesthetic considerations. He notes:

> [Cooks] face enormous challenges, toiling in an environment less pastoral than infernal. Cooks must ready the kitchen several hours before customers arrive, not knowing precisely how many to expect. Preparation must permit flexibility, depending on the walk-in trade and last-minute reservations. They must then be ready to cook numerous dishes, simultaneously and without warning, with sufficient speed that those with whom they must deal—servers and ultimately diners—do not become frustrated. Cooks have several masters. Restaurants are both service and production units, and, so, cooks work simultaneously for customers and management (p. 19).

Fine's findings emphasize the importance of the organization of the kitchen on the overall success of the restaurant and on the satisfaction derived from those who work in the restaurant kitchen environment.

See also **Chef**; **Escoffier, Georges-Auguste**; **Kitchen Gadgets**; **Kitchen Pantry and Larder**; **Places of Consumption**; **Preparation of Food**; **Restaurants**; **Serving of Food**; **Workers, Food**.

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Mitchell Davis

KOREA. Owing to the popularity of Korean barbecue (*kalbi* and *pulgogi*) outside Korea, Korean cuisine is often thought of as meat-based when compared with other Asian cuisines. However, in essence it has for centuries depended largely on vegetables and, to a lesser degree, on seafood. In fact, the consumption of animal products (beef, pork, chicken, eggs, milk, and dairy products) in Korea increased more than twenty times in the last three decades of the twentieth century, mainly due to economic affluence.

0 50 100 Miles
0 50 100 Kilometers
CHINA
Najin
Ch'ŏngjin
HAMHUNG PROVINCE
Kimch'aek
Sinŭiju
Hamhung
Hŭngnam
NORTH KOREA
Korea Bay
Sea of Japan
Wŏnsan
P'yŏngyang
Namp'o
Songnim
Sariwŏn
Ch'ŏrwan
Haeju
Kaesong
Ch'unch'ŏn
Puch'on
Seoul
Inch'on
Sŏngnam
Suwŏn
Ch'ŏngju
SOUTH KOREA
Andong
Yellow Sea
Taejŏn
Taegu
Chŏnju
KYONGSANDO PROVINCE
Ulsan
CHOLLADO PROVINCE
Masan
Kwangju
Pusan
Korea Strait
N
Cheju
Cheju Do
JAPAN

Chinese, Japanese, and Western (particularly American and Italian) influences are becoming increasingly visible, especially outside the home. Yogurt and Western-style sweets have become the staples of Korean children, and American fast-food chains (McDonalds, KFC, and Pizza Hut), particularly popular among the youth, are successively enlarging their share of the Korean restaurant market. Koreans of older generations prefer Chinese restaurants, which have been popular for several decades, to the more recent Japanese and Italian establishments. Chinese food is often cooked at home as well.

Yet, despite all these foreign influences, the daily fare of most Koreans, outside or inside the home, still consists of rice, soup, and side dishes—a meal structure that has barely changed for centuries.

The Korean Meal

There are few differences among the food Koreans consume at each meal. Supper is usually more elaborate than breakfast and lunch, but generally speaking, every meal is centered on plain boiled rice (*pap*), soup (bouillon-like *kuk* or a more hearty *t'ang*), and pickled vegetables (*kimchi*). Side dishes (*panch'an*) extend this core, and their number depends on the occasion. Three to five side dishes are the norm in contemporary households.

Stews (*tchigae*, *tchim*, *chŏn'gol*) and soused or sautéed greens (*namul*, *pokkŭm*) constitute the majority of side dishes, complemented by grilled dishes (*kui* or *sanjŏk*) made of seafood, beef, pork, or chicken. Stews tend to acquire the position of a semi-main dish, as does *pulgogi*, turning into a center of the meal accompanied by a bowl of rice, smaller *panch'an*, and dipping sauces. Big-bowl dishes such as fried rice (*pokkŭmbap*), beef soup with rice (*sŏlŏngt'ang*), and mixed rice (*pibimbap*) are served in a similar fashion, with small portions of greens and pickles on the side.

Rice boiled or steamed with beans, other grains, or vegetables may be served instead of plain boiled rice. A variety of wheat and buckwheat noodles (*kuksu*) also frequently appear on the Korean table. Noodles are usually served in soupy liquids, while stuffed dumplings (*mandu*) can be either steamed, panfried, or simmered in soups (*manduguk*). Noodles and dumplings are popular lunch dishes. Flavored rice porridges (*chuk*) are less commonplace than rice, noodles, and dumplings, but still retain a notable place in Korean cuisine.

Chili pepper, sesame (seed and oil), garlic, and spring onions, along with soy sauce (*kanjang*), soybean paste (*toenjang*), and red bean paste (*koch'ujang*) constitute what might be called a Korean "flavoring principle." The combination of all or a selection of these ingredients gives Korean dishes their characteristic taste. Ginger, semisweet rice wine (*ch'ŏngju*), and honey or sugar are the other crucial components of the Korean flavor.

Kimchi

Pickled vegetables, generally referred to by the name of *kimchi*, are the most basic, indispensable element of every Korean meal. Neither a feast nor a most meager fare would be complete without it. For centuries *kimchi* was the sole side dish to accompany the staple of Korea's poor, whether it was barley, millet, or, for the fortunate few, rice. It was also a fundamental meal component in affluent households. Three kinds of *kimchi* were always served, regardless of how many side dishes were to appear on the table. To a contemporary Korean, rice and *kimchi* are the defining elements of a minimal acceptable meal. Yet, it is *kimchi*, not rice, that is regarded as the symbol of Korean culture.

There are hundreds of varieties of *kimchi.* Every region, village, and even family used to cherish its own special recipe, applying slightly different preparation methods and using slightly different ingredients. Napa cabbage (*Brassica chinensis* or *Brassica pekinensis*) made into *paech'u kimchi* is the most common type, followed by radishes (*Raphanus sativus*) made into *kkaktugi kimchi.* Basically, vegetables are placed for several hours in brine, washed with fresh water, and drained. Then, flavorings such as ginger, chili pepper, spring onions, garlic, and raw or fermented seafood are added, and the mixture is packed into pickling crocks and allowed to age.

Since the 1960s, when factory-made *kimchi* appeared on the market for the first time, the number of urban families who continue to make their own *kimchi* has gradually diminished. With the rising consumption of meat and seafood, and the popularization of Western-style food, the quantity of *kimchi* consumed by Koreans has declined as well. An average Korean consumes approximately forty pounds of *kimchi* on a yearly basis.

Yet, *kimchi* is still considered to be the most important element of the Korean meal and quintessentially Korean by Koreans and foreigners alike. Despite this cultural symbolism, *kimchi* has evolved relatively recently to the form we know today. The so-called "white *kimchi*" (*paek kimchi*), which is still popular in the early twenty-first century, resembles most closely the original version.

The addition of chili pepper came about in the mid-eighteenth century and gave *kimchi* its characteristic red color and pungent taste. Fermented seafood (*chŏtkal*), which has been included in the pickling from the late nineteenth century onward, not only enriched the taste of *kimchi*, but also increased its regional diversity. While at the end of the seventeenth century only eleven types of *kimchi* were classified, the regional variety of *chŏtkal* (some regions use shellfish, others anchovies or other kinds of fish) contributed to the development of several hundred varieties of *kimchi.* The type of vegetables that are pickled also changed. Gourd melon, cucumber, and eggplant have been used since ancient times; today napa cabbage and radish are the most common varieties.

The Table Setting

With a few exceptions, all components of the meal are on the table at one time. A set of a spoon and metal chopsticks is used while eating. Rice, soup, and other liquids are eaten with the former, side dishes with the latter. Soup and rice are served in individual bowls, but side dishes are often shared by more than one diner. Nowadays, bowls are usually made of stoneware, steel, or plastic, but for special occasions white porcelain tableware is used. In the past, the upper classes dined from brass bowls in the winter and porcelain ones during the hot summer months. A silver set of chopsticks and a spoon was considered most elegant. Less affluent sections of the population generally dined from earthenware, using wooden chopsticks and spoons. According to Korean etiquette, it is considered inelegant to lift bowls from the table. They stay on the table during the entire meal, unlike in the rest of East Asia, where it is customary to lift bowls up to the mouth while eating.

The majority of restaurants in Korea have two dining areas: one with Western-style tables and chairs, and one with an elevated floor where customers seated on cushions dine at low tables. Similarly, most Korean households use Western-style tables with chairs on a daily basis (the table is usually placed in the kitchen), but share meals at a low table with short legs, seated on cushions laid on the floor, when guests are entertained.

The most traditional dining setting is a small table designed for one or two persons. In upper-class households, there was no common dining room and such tables were laid in the kitchen and carried out to different parts of the house, where family members dined, divided according to age, gender, and position. Such dining arrangements reflected the hierarchical ideology of premodern Korea. The shared dining table with short legs became popular in the early decades of the twentieth century and by the 1960s spread all over the country, widely replacing the ubiquitous individual table. This transition was followed by the diffusion of Western-style table and chairs in the 1980s. Yet, even today, traditional tables designed for one are still used in some restaurants, student apartments, and average Korean households.

Food and Drink for Special Occasions

From the fifteenth century onward, Confucianism began to replace Buddhism as the strongest cultural influence in Korea. Various festivals and their celebration in Korea are closely related either to Buddhism or to Confucianism. These events are always marked by special food, with noodles, red beans, and many kinds of rice cakes playing a prominent role in festive meals and snacks. Because Korean meals traditionally did not include desserts, festivals were among the few occasions when sweet snacks were served, except in upper-class families, where sweet afternoon snacks were regularly prepared.

Throughout the ages, each festival food has acquired a symbolic meaning or a function that justifies its use at a specific occasion. Noodles, for example, are appropriate for birthdays because they symbolize long life. Red-bean porridge (*p'atchuk*) with sweet rice balls (*kyŏngdan*) eaten on the day of the winter solstice is said to prevent colds and drive away ghosts. Colorful rice cake (*mujigae ttŏk*) is prepared for a child's first birthday in the hope that the child will enjoy a wide range of accomplishments.

Certain occasions are inseparable from the food that is served during their celebration. The Harvest Moon Festival (*Ch'usŏk*), for example, is unimaginable without pine needle–scented rice cakes (*songp'yŏn*), and lunar New Year's Day celebrations (*Sŏllal*) would not be complete without rice cake soup (*ttŏkkuk*). "How many bowls of rice cake soup have you eaten?" is a polite way of asking about someone's age, as if failing to eat a bowl of rice cake soup would deprive a person from a complete New Year's experience.

Garnishing (*komyŏng*) is taken very seriously in traditional Korean cooking and becomes especially pronounced in festival food. Three-color garnish is made with egg yolk (yellow), egg white (white), and Korean watercress (green). Five-color garnish includes these with the addition of chili pepper threads (red) and stone-ear mushrooms (black).

Drinks are another medium used to celebrate special occasions. *Porich'a*, scorched-rice tea made by boiling water over the rice that sticks to the bottom of the cooking pot, used to be the most important daily beverage in Korea. Today, along with water, it remains an important drink to accompany meals. For celebrations, most Koreans drink either *soju* or beer. *Soju* is a kind of distilled liquor made of grain or sweet potatoes, with an alcohol content of up to 45 percent. Although it is often claimed to have been introduced to Korea in the thirteenth century through trade with the Mongols and Chinese, it is not clear whether the contemporary version has any connection with its ancestor apart from the name. Beer was introduced by the Japanese in the late nineteenth century and began to be produced on a large scale in the early 1930s.

A large variety of homemade wines (which are strictly speaking ales) flavored with ginseng, pine needles, chrysanthemum, cherry, plum, or apricot blossoms, herbs, and fruits were popular before the turn of the twentieth century. The ban on homemade wines during the Japanese colonial period (1910–1945) had a devastating effect on this part of the Korean tradition. The use of rice for wine making continued to be prohibited after the liberation, due to the shortage of rice. The ban on rice wine was lifted in 1971, and various efforts have been undertaken since to revive local wine making in Korea. In 1985, for example, the government designated many traditional wines as cultural assets. *Makkŏlli*, a milky rice wine with an alcohol content of 6 to 8 percent, also known under the name "farmer's wine" (*nongju*), is one of the most popular alcoholic drinks in contemporary Korea.

Alcohol is never drunk in Korea without elaborate snacking. Practically all side dishes can be served for this purpose and are called *anju* at such occasions. *Anju* can be small like French hors d'oeuvres or Spanish tapas but are not always small. Stews and large savory pancakes (*chŏn*), including vegetables, meat, and seafood, are typical snacks to accompany drinking.

The Historical Overview

The foundation of Korean cuisine was formed between the seventh and thirteenth centuries, with important modifications taking place in the eighteen and nineteenth centuries. As was the case with other aspects of Korean culture, Korean cuisine developed under the strong influence of its powerful neighbor—China. As in adjoining regions of East Asia, rice and fermented soybean products (soy sauce, soybean paste, and soybean curd) occupy a prominent place in the diet of the Korean people. The "rice–soup–side dishes" structure of the meal and the use of chopsticks to consume it are other indicators of the

Korean men celebrating the traditional Confucian New Year, which includes both prayers and food. Photographed 1 January 1988 in Seoul, Korea. © NATHAN BENN/CORBIS.

impact that Chinese civilization exerted on Korean foodways. The emphasis on five elements in Korean cuisine, for example, five flavors (salty, sweet, sour, hot, and bitter) and five colors of garnish, has Chinese origins as well. It should be emphasized, however, that despite this heritage, Korean cuisine has developed into a distinctive entity of its own, with more differences from Chinese cuisine than similarities to it.

The technology of rice cultivation was brought to the northern parts of the Korean peninsula from China, probably late in the second millennium B.C.E., but rice became a staple of the Korean diet only in the Silla period (668–935 C.E.). In fact, before the second half of the twentieth century, rice was not a staple for everyone, but was rather a symbol of wealth. The old phrase "white rice with meat soup," for example, connotes the good life, while tacitly acknowledging that not everyone could afford either rice or meat. Millet, barley, and buckwheat accompanied by *kimchi* and vegetable soup were the daily fare of the majority of the Korean population.

Vegetarian Buddhist influences in Korea did not, apart from the clergy, have much impact on food habits. Beef, pork, lamb, chicken, and various types of game were regularly consumed by the Korean upper classes. Still, before the economic growth of the 1970s, the eating of meat was a luxury for the common people in Korea. Farmers, who formed the majority of the Korean population, rarely ate meat except for three days in summer when dog stew was served and a special day in winter when sparrow, wild boar, or wild rabbit was prepared. In both cases, the eating of meat was intended to strengthen physical resistance to extreme weather conditions (Walraven, 2002).

The techniques for making wine and *chang* (a semiliquid predecessor of soy sauce and soybean paste) were also introduced from China, and by the seventh century were already highly advanced. This was also the time when fermented seafood (*chŏtkal*) developed, along with vegetables preserved in salt. The latter eventually evolved into *kimchi* pickles.

Chili pepper was brought to Korea at the end of the sixteenth century, most probably via Japan. It became widely cultivated a century later and by the twentieth century was an integral part of Korean cuisine. As well as being an indispensable component in *kimchi* making, chili pepper contributes to the flavoring of the majority of Korean dishes through chili pepper powder (*koch'u karu*) and red bean paste (*koch'ujang*). Both are not only used extensively in the kitchen but often appear on the table as a relish.

It should be mentioned that the extensive use of chili pepper, and consequently the pungent taste of Korean cooking, was not originally characteristic of all Korea, but rather a feature of the Kyŏngsang province occupying the southeastern part of the peninsula. The diet of the southwestern provinces and the territory covering contemporary North Korea used to feature less spicy dishes than was the case in Kyŏngsang. Urbanization and the development of modern transport and communication networks led to the gradual decline of regional differences

Street vendors in Kyoonggi-do, South Korea, peel and chop vegetables to prepare kimchi, a spicy cabbage relish served with most Korean meals. © MICHAEL FREEMAN/CORBIS.

in the Korean diet. These differences, however, have by no means completely disappeared. Ch'ŏrwŏn, for example, is famous for *makkŏlli* wine, Ch'unch'ŏn for its chicken barbecue (*talkkalbi*), and Hamhung province for its cold noodles (*naengmyŏn*). The cooking of the southwestern provinces tends to be generally less spicy than the rest of the country. Chŏlla province, in particular, tenaciously retains its culinary distinctiveness.

Along with a gradual decline in regional differences and the democratization of the Korean foodways, the twentieth century marked the time of the modernization of production, processing, distribution, and consumption of food in Korea. This started during the Japanese occupation and continued in South Korea after the Korean War (1950–1953).

The Japanese introduced modern farming techniques and Western-style food processing. The railway system and the highway network erected by the colonizer led to the centralization of markets and modernization of retailing. Japanese and Korean physicians created the foundation of Korean dietetics, and affluent Korean women got acquainted with the Western science of nutrition through Western-inspired Japanese home economics education.

After the Korean War, South Korea continued to modernize under the strong influence of the United States. American dietary influences have become particularly visible since the 1980s but have not been widely welcome. While foreign products are desirable for the status and novelty they impart, the Korean people generally disapprove of the country's growing reliance on food imports (Pemberton, 2002; Bak, 1997). The increasing consumption of meat, for example, led to a rise in the number of livestock in Korea, making this mountainous country with almost no pasture largely dependent on imported feedstuffs. This and similar issues play an important role in the dietary consciousness of the Korean population today.

See also **China; Condiments; Fermented Beverages Other than Wine or Beer; Places of Consumption; Rice; Soup; Southeast Asia; Soy; Wine, Nongrape**.

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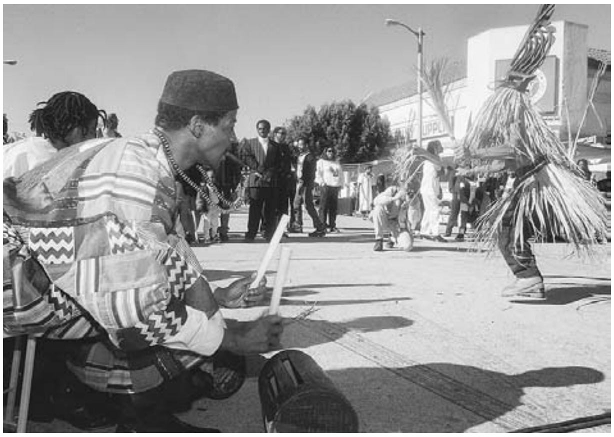

Dancer dressed as Chi Wara, the antelope who represents New Year at a Kwanzaa festival in Leimert Park, Los Angeles. COURTESY AP/WIDE WORLD PHOTOS.

KOSHER LAWS. *See* **Judaism; Passover.**

KWANZAA. Unlike December holidays steeped in centuries-old traditions, Kwanzaa, the African American year-end feast, was not established until 1966 by Maulana Karenga, a cultural nationalist. The celebration, which occurs annually from 26 December to 1 January, is based on a compilation of several harvest festivals and celebrations from around the African continent. During the holiday week most Kwanzaa celebrants use a menu of traditional African American dishes, foods from the “mother continent,” and foods from the African diaspora. The word “Kwanzaa” comes from the Swahili expression “matunda ya kwanza,” meaning ‘first fruits of the harvest,’ but the American Kwanzaa is distinguished from the African one by the addition of a second “a” in the second syllable.

The holiday was originally celebrated by cultural nationalists who wished to express pan-African solidarity. In the intervening years, however, it has become a rapidly growing tradition with over 18 million people of all political leanings and in all walks of life celebrating the week following 26 December as a time of feasting, fasting, and self-examination.

The holiday is not designed as a replacement for or alternative to any of the other year-end festivities like the Christian Christmas, the Jewish Hanukkah, or the Hindu Divali (Festival of Lights, celebrating Laksmi, the goddess of wealth; also called “Diwali” or “Dewali”). Rather, it is a time for reflection and self-examination that can replace or be celebrated jointly with any or all of the year-end holidays.

The celebration of Kwanzaa is guided by the Nguzo Saba, the seven principles of self-awareness, so each day of the week-long festival is devoted to the celebration of one of the building blocks of self-awareness.

Umoja—Unity
Kujichagulia—Self-Determination
Ujima—Collective Work and Responsibility
Ujamaa—Cooperative Economics
Nia—Purpose
Kuumba—Creativity (The feast of karamu is held on this day and is a public celebration at which the community gathers to celebrate the holiday.)
Imani—Faith

The number seven is at the core of the celebration. There are seven days, seven principles, and seven symbols of the holiday. The *mazao* are the fruits of the harvest that are a part of the celebration table, and the *mkeka* is the mat on which they are arranged. The *kinara*, the seven-branched candlestick, holds the *mishumaa saba*, the seven candles (three red, three green, and one black) that are lit every evening: first the black candle, symbolizing the people, and then, alternating, the red and green candles, symbolizing the principle that without struggle, there is no attainment.

Each Kwanzaa table has a centerpiece. On each centerpiece there are *muhindi* (also *vibunzi*), ears of corn, one for each child in the family who is still at home. If there are no children in the family, there is a single ear to remind the celebrants that, in the words of the proverb, “it takes a village to raise a child.” The *kikombe cha umoja*, the chalice of unity, is the cup that is passed around or from which the ceremonial libation is poured. Finally, there are the *zawadi*, gifts, which should be educational and emphasize growth and self-knowledge.

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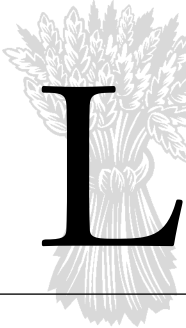

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LABELING, FOOD. Food products offered for sale in the United States are subject to a number of legal requirements regarding what information must, may, and may not appear on the package label. Food labels serve many purposes. The label identifies what the product is and how much of it there is, alerts individuals to the presence of allergenic ingredients, and provides nutritional information to enable consumers to make healthy dietary choices. Many of the regulations governing food labeling are extremely detailed, often specifying the placement and minimum type size of required information.

The term "label" refers to any written, printed, or graphic matter on the food's immediate container. "Labeling" includes the label and any other written, printed, or graphic matter accompanying the product in commerce (e.g., point-of-sale pamphlets). Most label information is required to appear on either the "principal display panel" (PDP) or the "information panel." The PDP is the part of the label most likely to be displayed to, and examined by, consumers under customary conditions of retail sale. The information panel is generally the panel contiguous to, and to the right of, the PDP. If that panel is unusable or too small, the next panel to the right of it may serve as the information panel. If the top of the container is the PDP, the information panel may be any panel adjacent to the PDP.

Government Agencies and Governing Laws

The U.S. Food and Drug Administration (FDA) is the federal government agency that administers and enforces labeling requirements for all foods (except meat and poultry) under the Federal Food, Drug, and Cosmetic Act (FD&C Act) and the Fair Packaging and Labeling Act. The U.S. Department of Agriculture (USDA) administers and enforces labeling rules applicable to meat and poultry products under the Federal Meat Inspection Act and the Poultry Products Inspection Act. While the FDA does not require, or offer, prior approval of food labels, the USDA requires government approval of most meat and poultry product labels prior to their use in U.S. commerce.

Other federal agencies play a role in regulating food labeling as well. The U.S. Customs Service requires country-of-origin marking on the labels of imported food products. The U.S. Treasury Department's Bureau of Alcohol, Tobacco, and Firearms (BATF) regulates the labeling of alcoholic beverages. The Federal Trade Commission (FTC) regulates the advertising of food products.

Federal law preempts inconsistent state laws in most areas of food labeling, but there are some aspects of labeling where states may and do impose their own requirements. For example, some states have promulgated their own labeling requirements regarding safety warnings, use-by or sell-by dating, and religious dietary laws.

General prohibition against misbranding. Federal law provides that a food product may be deemed "misbranded" if any part of its labeling is false or misleading. This general provision establishes misbranding even where no specific regulatory requirement has been violated. A food also may be deemed misbranded if any required information is not presented prominently enough—that is, likely to be read and understood by the ordinary consumer under usual conditions of purchase and use.

Mandatory Label Information

Statement of identity. The statement of identity (i.e., the name of the product) must be presented on the PDP. Both the FDA and the USDA have regulations establishing "standards of identity" for certain foods. These regulations prescribe the composition of a food and specify the name of the food to be used in labeling. For example, a food composed of tomato concentrate, vinegar, and spices must be identified as "catsup," "ketchup," or "catchup." However, not all statements of identity are dictated with such specificity. For any given product, the statement of identity is one of the following:

1. The name of the food as specified in any applicable federal law or regulation, such as a standard of identity (e.g., "ketchup") or a federal common or usual name regulation (e.g, "peanut spread")
2. The common or usual name of the food, established by common usage (e.g., "French toast")
3. An appropriately descriptive term (e.g., "hard candy")
4. A fanciful name commonly used by the public when the nature of the food is obvious (e.g., "candy corn").

WAYNE BRAND
TRADE MARK REGISTERED IN U.S PATENT OFFICE
ESTABLISHED 1863.
FANCY QUALITY
CONTENTS 1 LB. 4 OZ.
TINY GREEN LIMA BEANS
PACKED FOR EDGETT-BURNHAM COMPANY. NEWARK, NEW YORK.
PACKED FOR EDGETT-BURNHAM COMPANY. NEWARK, NEW YORK.

Label (circa 1910) for a can of fancy lima beans showing the food product on one side and the company trademark on the other. While these old labels are attractive graphically, food labeling has evolved considerably since that time, with a full listing of ingredients, nutritional analysis, bar codes for scanning the price, and even country of origin. ROUGHWOOD COLLECTION.

Net quantity of contents. The net quantity of contents must be presented on the PDP of the food label in measures both English avoirdupois (i.e., ounces, pounds, etc.) and metric (i.e., liters, grams, etc.). For meat and poultry products, the net contents declaration is required to appear only in avoirdupois measure.

Nutrition facts. The amounts of certain nutrients present in one serving of the food product must be presented in the "nutrition facts" panel. Similar products have the same serving size so that consumers can easily compare nutrient levels. Nutrition facts must state the serving size (i.e., the size of one serving) and, unless the product contains only a single serving, the number of servings in the package. Generally, the following nutrients must be declared: calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, vitamin A, vitamin C, calcium, and iron. If other vitamins or minerals are added to the food, they also must be declared.

The graphic requirements for nutrition facts are highly detailed. Nutrition facts generally must appear on the PDP or the information panel. They must appear on the same panel as the ingredients list and the signature line, unless there are space constraints.

Raw fruits and vegetables and raw seafood, which frequently are sold in unpackaged form, are exempt from mandatory nutrition labeling. Instead, the twenty most frequently consumed varieties of fruits, vegetables, and seafood are subject to voluntary nutrition labeling guidelines that apply to retailers of these products. Single-ingredient raw meat and poultry products are likewise subject to a voluntary, retail-level nutrition-labeling program. It should also be noted that restaurant and food-service foods are exempt from nutrition-labeling requirements.

Ingredients list. Each ingredient present in a food product must be listed by its common or usual name in descending order of predominance by weight. While most ingredients must be identified by their specific name, use of generic names is permitted for certain ingredients (e.g., "spices," "natural flavor"). Special rules apply to the listing of certain types of ingredients. For example, chemical preservatives must be listed by their name, followed by a description of their function—such as "BHT (a preservative)." Certified color additives must be identified by their specific name (e.g., "Yellow 5" or "FD&C Blue 1 Lake"), but color additives not subject to certification may be listed using a generic term (e.g., "artificial color") or a specific name followed by a description of its function (e.g., "caramel color").

An ingredient that itself contains two or more ingredients must be listed in one of two ways:

1. By declaring the common or usual name of the ingredient followed by a parenthetical listing all of its components—for example, "milk chocolate (sugar, cocoa butter, milk, chocolate liquor, soy lecithin, vanilla)," or
2. By listing each component of the multicomponent ingredient without declaring the multicomponent ingredient itself—for example, "sugar, cocoa butter, milk, chocolate liquor, soy lecithin, vanilla."

The ingredients list may appear on either the PDP or the information panel, but it usually appears on the information panel. It must appear on the same panel as the nutrition facts and the signature line unless space constraints prevent such placement.

Signature line. The name and place of business of the manufacturer, packer, or distributor is typically called the "signature line" and must be presented on the same panel as the ingredients list and nutrition facts (usually the information panel), unless space constraints preclude such placement. If the name is not that of the manufacturer, it must be preceded by a qualifying phrase stating the firm's relation to the product (e.g., "manufactured for" or "distributed by"). The signature line must include a city or town, state (or country, if outside the United States), and ZIP code (or mailing code if outside the United States). A street address must be provided unless the firm is listed in a current city or telephone directory.

Label Information Required in Specific Cases

In specific circumstances—particularly when additional information could protect or otherwise benefit the consumer—specialized labeling may be required.

Warning and information statements. Certain products are required to present warning or information statements on their labels. For example, foods containing the artificial sweetener aspartame must bear the following statement in capital letters: "phenylketonurics: contains phenylalanine." Other food products required to bear warning or information statements on their labels include the following:

1. Foods that contain the fat replacer olestra
2. Foods that contain the artificial sweetener sorbitol (daily ingestion of 50 grams or more)
3. Foods that contain the artificial sweetener mannitol (daily ingestion of 20 grams or more)
4. Foods that contain dry psyllium husk and that bear a health claim linking consumption of soluble fiber from psyllium husk with reduced risk of coronary heart disease
5. Irradiated foods
6. Fresh eggs (in consumer packages)
7. Foods packaged in self-pressurized containers and intended to be expelled from the package under pressure
8. Foods that contain, or are manufactured with, chlorofluorocarbon or other ozone-depleting substances
9. Juices or juice-containing beverages that have not been processed so as to produce a minimum five-log (i.e., 100,000-fold) reduction in the most resistant pathogen of public health significance (e.g., *E. coli*) likely to occur in that product
10. Meat and poultry products that require special handling to maintain wholesomeness
11. Foods that contain any meat or poultry that is not ready-to-eat.

Juices. Certain categories of food products are subject to special labeling requirements. Among the most commonly consumed of such products are the numerous varieties of juices available on the market. Any beverage containing fruit or vegetable juice is required to present a percent juice declaration (e.g., "100 percent juice" or "contains 50 percent orange juice"). This declaration must appear near the top of the information panel and is usually placed directly above the nutrition facts. If a beverage contains less than 100 percent juice and its statement of identity includes the word "juice," it must also include a qualifying term such as "drink," "beverage," or "cocktail." If one or more of the juices in the product is made from concentrate, the statement of identity must be qualified with the words "from concentrate" or "reconstituted."

Country-of-origin marking. Imported foods are required to bear country-of-origin marking (e.g., "product of Italy"). Country-of-origin marking must appear in a conspicuous place and as legibly, indelibly, and permanently as possible. Placing country-of-origin marking immediately beneath the signature line is often ideal. If the signature line states a U.S. address, it should be followed by country-of-origin marking to avoid misleading consumers about the product's geographic origin.

Flavor designation. If the label (other than in the ingredients list), labeling, or advertising for a food makes a representation (such as by words or pictures) about the food's primary recognizable flavor, that flavor is considered its "characterizing flavor" and must accompany the statement of identity on the PDP.

Nutrient content claims. If a food product's label includes a relative nutrient content claim (e.g., "reduced fat," "light," or "added calcium"), the nutrient content claim must be accompanied by information identifying the reference food and explaining how much the nutrient in question has been reduced or added. In addition, use of certain nutrient content claims triggers the need to include additional nutrient declarations in the nutrition facts. For instance, a claim about potassium content triggers the requirement to declare the actual potassium content in the nutrition facts.

Optional Label Information

Nutrient content claims. A nutrient content claim is any representation that characterizes the level of a nutrient in a food product (e.g., "low fat," or "sugar free"). A nutrient content claim must comply with the specific criteria for that particular claim. For instance, to make a "low fat" claim, a food must contain three grams or less total fat per reference amount customarily consumed (RACC). (The RACC, as established by the FDA, is the amount of food normally consumed per eating occasion by persons four years of age or older.)

A label statement about the actual amount or percentage of a nutrient in a food ("5 grams of fat per serving") is permitted, provided it is truthful and not misleading and does not characterize the level of the nutrient in the food. If the statement implicitly characterizes the level of the nutrient ("just 5 grams of fat per serving"), it is an implied nutrient content claim and must either meet the requirements for the implied nutrient content claim ("low fat"), or bear a disclaimer that the food does not meet those requirements ("just 5 grams of fat per serving, not a low-fat food"). Statements such as "contains the same amount of potassium as a banana" or "as much calcium as milk" are permitted, provided the reference food qualifies as a "good source" of the nutrient and the labeled product has at least an equivalent level of the nutrient per serving.

Health claims. A health claim is any representation that characterizes the relationship between any substance and a disease (such as coronary heart disease) or health-related condition (such as hypertension). A "substance" is a specific food or component of a food. A health claim must either be authorized by FDA regulation, or be an accurate representation of a current "authoritative statement" of a scientific body of the U.S. government with official responsibility for public health research related to human nutrition (e.g., the National Institutes of Health). Health claims based on an authoritative statement require premarket notification to FDA—an example is the FDA-approved health claim regarding the substance potassium and the conditions hypertension and stroke. Since 2001 the FDA has authorized the following health claims by regulation:

TABLE 1

Health claims authorized by FDA

Substance	Disease or Health-Related Condition
calcium	osteoporosis
sodium	hypertension
dietary fat	cancer
saturated fat and cholesterol	coronary heart disease
dietary fiber in grains, fruits, and vegetables	cancer and coronary heart disease
soluble fiber from specific food sources (e.g., oat bran, oatmeal, psyllium husk)	coronary heart disease
fruits and vegetables	cancer
folic acid	neural tube defects
sugar alcohols	dental caries
soy protein	coronary heart disease
plant sterol and stanol esters	coronary heart disease

USDA regulations currently prohibit meat and poultry products from bearing health claims.

Like nutrient content claims, health claims must comply with both general requirements applicable to all health claims and specific criteria for the particular health claim being made. For example, to be eligible to bear a claim about soy protein and risk of coronary heart disease, a food must contain at least 6.25 grams of soy protein per RACC, must qualify as a low-cholesterol and low-saturated-fat food, and must qualify as a low-fat food.

To bear a health claim, a food may not contain disqualifying levels of certain nutrients—total fat (13 grams), saturated fat (4 grams), cholesterol (60 milligrams), or sodium (480 milligrams)—per RACC or per labeled serving. Under what is known as the "jelly bean rule," a food making a health claim must contain per RACC, prior to any nutrient addition, a minimum level of at least one of the following nutrients: vitamin A (500 international units or more), vitamin C (6 milligrams or more), calcium (100 milligrams or more), iron (1.8 milligrams or more), protein (5 grams or more), or dietary fiber (2.5 grams or more). The purpose of the so-called jelly bean rule is to prevent a food of little nutritional value from bearing a health claim simply because the food has been fortified. Reasonably, the health claim that links sugar alcohols to dental caries is exempt from the jelly bean rule.

The wording and placement of health claims are highly regulated.

Structure and function claims. A truthful statement that a food or any ingredient helps maintain a structure or any function of the body may be made in labeling (e.g., "cranberry juice may help maintain a healthy urinary tract"). The manufacturer or distributor making the claim must have scientific evidence supporting the claim.

Other claims. A number of other claims that may be made on food labels are also regulated. The FDA has requirements for claims that a food is "fresh" or "healthy." The USDA has regulations defining "organic." The FTC limits the use of the claim "new" to a period of six months after a product is introduced into the market. Provided the information given is truthful and not misleading, a food may bear a claim about the presence of an ingredient perceived to add value ("made with real fruit") or about the absence of a nonnutritive ingredient ("no preservatives").

Symbols on food labels. Food labels may bear a variety of symbols or logos. Some of these are required. For example, irradiated whole foods are required to carry the radura symbol (i.e., the international symbol of food irradiation, which resembles a flower in a circle), and all meat and poultry products are required to bear the USDA official inspection mark. Other symbols are optional. These include the Uniform Product Code (UPC; the most familiar bar code) and symbols indicating that a food product is kosher.

Recipes and miscellaneous information. Food labels may carry a wide variety of other optional items, including such things as recipes, promotions, and "romance copy" (e.g., information extolling the virtues of a product or describing its history). Such information is permitted, provided it is truthful and not misleading.

Prohibited Label Information

Any information that is false or misleading in any particular will render a product misbranded. In determining whether a food label is false or misleading, both affirmative representations and omissions of material facts may be considered. Certain information is clearly prohibited from the labeling of food products. This includes unauthorized nutrient content claims (for instance, claiming "high in omega-3 fatty acids"), health claims not authorized by FDA or supported by an authoritative statement, and disease claims (for instance, claiming "helps lower blood pressure" would subject a product to regulation as a drug).

Language Specifications

All mandatory label information in the United States must appear in English. If labeling includes foreign language words of a type that are likely to bring the product to the attention of consumers who do not understand English, then all mandatory information must appear in both English and the foreign language. Certain foreign language words will not trigger dual-language labeling—for example, an accepted name for which there is no English equivalent (such as "antipasto"), a foreign name used in a standard of identity (such as "spaghetti"), and the use of one or more foreign language words in a brand name, motto, or trademarked design.

In Puerto Rico and other U.S. territories where the predominant language is other than English, the predominant language may be substituted for English, except in the case of the USDA inspection mark on meat and poultry products, which must appear in English.

See also **Additives; Food Politics: United States; Government Agencies, U.S.; Health and Disease; Inspection; Marketing of Food; Nutrition**.

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LACTATION. Lactation refers to the ability of mammals, warm-blooded, backboned animals, to nourish their young with milk produced by the mammary glands. Many other distinguishing features separate mammals into families that include over four thousand species. The milk of each species is specifically engineered for the growth and developmental needs of that species. In fact studies of the characteristics of the milk can predict the growth rate of both body and brain and the developmental maturity of the offspring at birth. It is also possible to predict the feeding patterns that vary from the whale, which feeds its young every three to four days and has extremely high-fat milk (50 percent), to the human, who initially feeds the infant every two to three hours and has low-protein, low-fat milk (3.4 percent). Some of the world's finest scientists have turned their attention to human lactation and have not only deciphered the micronutrients of human milk but have studied the nutrient needs of the human infant, especially as they pertain to brain development and physical growth. Research also has explained the physiology of human lactation.

Historically, in times of wealth and prosperity, women of higher socioeconomic levels have sought substitute feedings for their infants to "free" themselves of the burden of breast-feeding. Dogma and ritual have developed in different cultures of the world around nursing. It is significant that the Qur'an states that women should nurse their infants for two years. In the Old Testament, the Book of Psalms refers to the value of mother's milk. Pope John Paul II stated that the women of the world should provide their milk for their infants.

When bottle-feeding became more available for the average mother due to the discovery of sterilization, followed by the availability of prepared formulas, the trend toward bottle-feeding increased from 1930 to 1950. Well-educated women led the march to the bottle because they wanted to raise their infants by the book, with scientific information. In the second half of the twentieth century, these same educated women sought a different mode of childbirth in which the mother was prepared and in control. Concomitant with this, well-educated women began looking at breast-feeding as the most appropriate course for their infants.

In 1978 a bipartisan congressional committee charged with the responsibility of designing a health plan for the United States established the year 1990 as the target date for accomplishing several health goals. In addition to statements regarding decreasing hypertension, obesity, and smoking, the committee stated that 75 percent of women should leave the hospital breast-feeding and at least 35 percent should still be breast-feeding at six months. Many of the goals were not accomplished, and in 1990 they were rewritten with a target date of 2000. In 2000 they were rewritten for 2010, aiming at 75 percent of mothers initiating breast-feeding, 50 percent continuing for six months, and 25 percent continuing for a full year. The World Health Organization Code for Infant Feeding was developed in 1981, and the most industrialized countries of the world endorsed this policy, which supported breast-feeding and rejected the promotion of artificial feedings and advertisement of these feedings to the public. The United States did not sign until 1994. The Institute of Medicine, through the Subcommittee on Nutrition during Lactation, confirmed the position that all women, under ordinary circumstances, should breast-feed their infants and further stated that breast-feeding was ideal, even if the mother's diet was not perfect. The American Academy of Pediatrics, joined by the American College of Obstetrics and Gynecology, stated in 1997 that infants should be exclusively breast-fed for five to six months. They further stated that breast-feeding should continue as weaning foods are added through the first year of life and then for as long thereafter as the mother and the infant choose

Significance of Breast-Feeding to Health

Why have all of these important groups spoken out so strongly in favor of breast-feeding? The knowledge that human milk is for the human infant has been accepted for centuries. In the late twentieth century, however, considerable scientific investigation established unequivocally that breast-feeding is associated with a reduced incidence of infection in the infant, including reduced incidences of gastrointestinal, upper and lower respiratory, ear, and urinary tract infections. Immunologic data have shown reduced incidences of childhood-onset cancers, especially lymphoma and acute lymphocytic leukemia. Crohn's disease, celiac disease, and childhood-onset diabetes also are reduced when infants are breast-fed for at least four months. Probably the most dramatic information published in multiple articles is the relationship between breast-feeding and infant development. A study by Niles Newton compared the developmental progress of breast-fed and bottle-fed three-year-olds. Alan Lucas, Ruth Morley, T. J. Cole, and others reported a multisite study that compared premature babies given their mother's milk by feeding tube with infants given premature-infant formula. The group studied them at eighteen months and followed them until seven and a half to eight years of age. The study showed an 8.5-point difference when the data were adjusted for socioeconomic status and education of the mother. The eighteen-year study by L. John Horwood and David M. Fergusson in New Zealand showed a measurable difference at eighteen years of age in school outcomes and behaviors related to whether or not the children were breast-fed in infancy. Although these studies have been criticized for design flaws, many scientists accept their findings. These results are in addition to the compelling psychologic benefit to the mother and the infant in their relationship during breast-feeding.

Facilitating the Decision to Breast-Feed

A mother needs an opportunity to make an informed decision about how to feed her infant. If a mother comes to pregnancy without any information on this process, it is the health care provider's responsibility to see that she is well informed about the benefits of breast-feeding for her baby, for herself, and for society so she can make a decision that will be optimal.

The economic benefit of breast-feeding. A simple calculation of the cost of buying formula does not reflect completely the monetary benefits of breast-feeding. It costs between $60 and $80 a month to purchase infant formula, $700 to $1,000 for the first year of life. Careful studies in controlled populations, such as in health maintenance organizations, have demonstrated in multiple reports that infants who are not breast-fed have an increased number of illnesses, visits to the doctor, prescription medications, and hospitalizations compared with their breast-fed counterparts. The estimate per infant of the health care costs not to breast-feed is between $600 and $1,000 per year. This estimate does not include the reduction in the onset of chronic illnesses that may last a lifetime, such as diabetes, Crohn's disease, and allergies.

Benefits to the mother. The benefits of breast-feeding to the mother are often ignored. Women who breast-feed return to their prepregnant, physiologic states more rapidly. The uterus involutes, the postpartum blood loss is reduced, and the woman returns to her physiologic weight as well. Among other possible benefits are reduced incidences of long-term obesity, breast cancer, ovarian cancer, and most remarkably long-term osteoporosis. Although breast-feeding is not a contraceptive, it significantly affects the fertility in the childbearing years by suppressing ovulation.

Establishing lactation. Critical information about the mother's potential for a good milk supply is obtained during pregnancy. When the obstetrician does the early examination of the breasts in the first trimester, the breasts should be evaluated with respect to their potential for producing milk. Unusually small, unusually large, asymmetric, or tubular-shaped breasts may pose a problem. Prior surgery of the breast should be discussed. Lumpectomies and augmentation mammoplasty are not contraindications. Reduction mammoplasty, however, may pose a problem if the integrity of the ducts was interrupted. The obstetrician should also evaluate the breasts' responses to the hormones of pregnancy, the degree of increase in size of the breasts, and changes in the areola and nipple. The obstetrician should discuss with the mother her intentions to breast-feed and address any questions she may have. The mother should be encouraged to attend breast-feeding preparation classes, which are commonly available at hospitals with maternity services and at local mothers' groups.

The breast prepares for lactation during pregnancy by enhancing the ductal system and developing lacteal cells that will produce the milk. From about sixteen weeks in gestation on, the breast is capable of making milk if the fetus is delivered. During pregnancy the placenta produces a prolactin-inhibiting hormone (PIH) that blocks the breast from responding to the abundant prolactin of pregnancy. Once the placenta is delivered, the PIH drops, and the breast responds to the hormones oxytocin and prolactin.

The key response of the breast following delivery is called the ejection or letdown reflex, prompted by two major hormones, oxytocin and prolactin. Oxytocin causes myoepithelial cells to contract. Thus when the baby stimulates the breast by suckling, a message is sent via the peripheral nervous system to the mother's brain and pituitary to release oxytocin, which in turn causes the myoepithelial cells that surround the alveoli and the ductal system to contract, ejecting the milk from the ducts. Suckling at the breast also stimulates the release of prolactin, the hormone that stimulates the lacteal cells to produce milk. Prolactin is not released unless the breast is stimulated. Oxytocin, however, may be released when the mother sees her baby or hears her baby cry or as a result of other stimulating sensory pathways.

It is recommended that the infant be put to breast as soon after delivery as is possible. The infant has been sucking and swallowing in utero, consuming considerable amniotic fluid, from about fourteen weeks gestation on, so he or she is ready to begin breast-feeding.

To put the infant to breast, the infant is held with his or her abdomen against the mother's and the infant looking directly at the breast. The mother supports the breast with her hand, keeping her fingers behind the areola and gently compressing it. The mother strokes the center of the infant's lower lip with the nipple. This stimulates the infant to open his or her mouth, extend his or her tongue, and draw the nipple and the areola into his or her mouth. The baby's tongue compresses the elongated nipple and areola against his or her hard palate. The peristaltic motion of the tongue stimulates the letdown reflex, and milk is released and swallowed. Infants should be fed when hungry, which is eight to twelve times a day initially. No other food or drink is necessary during exclusive breast-feeding for up to six months.

See also **Baby Food; Dairy Products; Milk, Human**.

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LAMB. *See* **Mammals; Meat; Sheep.**

LAMB STEW. Lamb stew is a preparation in which tough cuts of lamb (by definition, taken from a sheep younger than one year of age in Europe or younger than two years of age in the United States, at the time of slaughter) or mutton (lamb's counterpart on the older side of the dividing line) are cut into small pieces, seared in hot fat, and simmered slowly in a flavored liquid until moist and tender; in the process, its liquid medium becomes a glossy sauce rich with the flavors of the meat. The tender, high-status rack portion of the lamb comprises only four percent of its live weight. Most other parts of the meat—leg, shank, shoulder, breast, neck, arm, and trim—increase in both flavor and toughness with the age and activity level of the sheep. Such cuts are best prepared with a method that can at once tenderize the meat, preserve its moistness, and mellow its flavor. Stewing fits these needs particularly well.

Stewing is most effective on older, tougher cuts of meat rich with collagen—a stiff protein found in connective tissue. With ample exposure to sufficiently high temperatures for a length of time relative to the muscle's toughness, slow stewing converts collagen to gelatin, yielding tender bits of meat perfumed with the cooking liquid, and a sauce rich with sheen and body. A simmer just below the boiling point is ideal, as such a temperature is sufficiently hot to make the gelatin soluble over time, yet gentle enough to keep the muscle moist and tender, rather than causing constriction and exudation of most of its juices, as would occur under a rolling boil. Such processes constitute the physical and chemical basis of stewing lamb. The cooks and the influence of the prevailing culture determine whether the stew is made with breast, shoulder, or neck; cooked in a clay, cast iron, or copper-bottom pot; or flavored with rosemary and red wine, dill and lemon, or cardamom and ginger.

A testament to the effectiveness of the stewing method for lamb and mutton (here used somewhat interchangeably, owing to the varied legal definitions) is the plethora of national, regional, and individual variations found in a diverse array of cultures. (See the Table for some of these variations.) Throughout Europe and the Mediterranean, lamb stews are typically flavored with ingredients like wine, garlic, rosemary, thyme, parsley and other herbs, and bacon, onion, carrot, celery, cabbage, tomato, or potato. From northern to southern Africa, lamb stews vary from the Moroccan *tangine* (or *tagine*) to Ethiopian versions with butter and *berbere*, a chili and spice paste, to South African European-style stews of lamb and legumes. In China, lamb stews are flavored with fermented sauces; in India, they are thickly flavored with spices, nuts, and yogurt, as they are in many other parts of Asia. Throughout much of Oceania and in parts of the United States, where lamb is big business, the stews incorporate flavors from throughout Europe, Africa, and Asia. Even in traditional cuisines of North America, where lamb is a relative newcomer, it is often substituted for indigenous meats, as an example, for alpaca meat in the Andean stew *huatia*.

TABLE 1

A sample of national and regional variations of lamb stew

Region/Country, Name(s)	Key Flavoring Ingredients
Europe	
Spain, *estufado de cordero*	Chorizo sausage and blood sausage, garlic, wine.
France, *navarin d'agneau; printanier*	Turnips, root vegetables, wine; spring vegetables.
Norway, *lammestuing*	Cabbage and peppercorns.
Ireland, Irish stew	Potatoes and onions.
Basque region	Garlic, onions, carrots, potatoes, wine.
Africa	
South Africa, *lensieskos*	Lentils, ginger, tomatoes, chili, garlic.
Ethiopia, *sega wat*	Butter, onion, *berbere* chili and spice paste.
Morocco, lamb *tangine*	Carrot, chickpeas, spices, garlic, *harissa* chili paste.
Eastern Asia	
India, *kashmiri gosht; badami gosht*	Nuts, yogurt, onions, spices including cardamom, cloves, turmeric, coriander, chilies, saffron.
China, hot pot	Soy sauce, chili paste, garlic, ginger, scallion, rice wine.
Americas	
Native Andean, *huatia*	Uncultivated herbs, chilies.
Cuba, *chilindron de carnero*	Bacon, lime, onion, bell pepper, tomato, garlic, cumin, oregano.
Middle East and Arab World	
khoresche esfanaj	Lemon, dill, and green vegetables.
keshkeg herriseh	Porridge of lamb and wheat with onion, bay leaf.
Syria, *yukhnee*	Tomatoes, garlic, onion, spices.
Persia, *khoresh qormeh sabzi*	Red beans, onion, turmeric, lemon, fresh herbs.
Persia, Armenia, Morocco, and elsewhere	Apricots, garlic, onion, lemon, spices including turmeric, coriander, ginger, cayenne, cumin.
Turkey, *pirpirim asi*	Assorted pulses, uncultivated greens.
Sephardim, *msouki*	Onion, garlic, fava beans, fresh peas, *harissa* chili paste, nutmeg.
Egypt, *fatta*	Pilaf-style rice and bread with stewed mutton.

But it is in the Middle East and the Arab World, more than anywhere else, where lamb stew has the broadest variety of manifestations—from a lamb-and-wheat porridge, to a stew with fresh dill and lemon, to some with red beans or fava beans, or with other legumes, many with apricots and spices, and even more containing tomatoes.

While there is likely no definitive answer as to why lamb stew is so important in the Middle East, there are some strong clues, both material and intangible, that can help to explain its centrality. The most evident reason is that Mesopotamia is the home of the domesticated lamb, with a tradition of raising sheep for wool and meat that goes back more than ten thousand years. Nearly as ancient is lamb's religious significance: roasted sheep ranked high in status among the early Semitic sacrifices, both prebiblical and biblical; and the paschal lamb of both Passover and Easter underlie references to Christ as the "Lamb of God." Even today, Christians in the Middle East and Mediterranean traditionally serve roast lamb for Easter; Sephardim serve stewed lamb for Passover; and Arabs serve roast or stewed lamb for nearly every feast—births, marriages, and death anniversaries, in addition to those of strictly religious celebrations.

Moreover, elements of lamb stew indicate some of the shared values of Middle Eastern culture. Societies of the Middle East as well as others consider it good etiquette to serve food in tender bite-size morsels as a display of time, effort, and hospitality on the part of the host, who would not have guests struggle to consume their food. Whole roast lamb is often presented and served off the bone, in contrast to the European tradition of displaying a formidable roasted joint or whole animal. A rich stew of lamb also highlights the accompanying rice, couscous, bread, or grain, accompaniments of simple integrity that complement the richness of the lamb. Many Middle Eastern people also place additional value on the local origins of the sheep, which is considered far superior to imported lamb, beef, or poultry, and is certainly preferred to pork, forbidden among observant Muslims and Jews.

Lamb stew has a deep history and tradition, a common base with seemingly infinite variations, a strong, complex, and pervasive flavor, and firm entrenchment in the surrounding culture. It is often seen as symbolic of the people and region of the Middle East.

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Jonathan Deutsch

LANGUAGE ABOUT FOOD. Foods can be named according to different levels of generality. The basic level terms (Rosch, "Principles of Categorization") are the most consistent across languages in that translation equivalents can be readily found. Examples of basic level terms are "apple," "potato," "rice," "coffee," "turkey," "salmon," and "snails." This level often corresponds to scientific taxonomies. More specifically, varietal or breed terms tend to be compounds consisting of a modifier plus a basic term, as in "Jonathan apple," "jasmine rice," "sockeye salmon," or "green-lipped mussel."

Higher level categories are more variable across languages than are basic level terms and often result in different, incompatible classifications. Whether a tomato is a fruit or a vegetable depends on the purpose of the classification. For scientific purposes, it is a fruit (as are squash and bell peppers), since it contains the seed for reproduction. However, for culinary purposes, a tomato is a vegetable in Europe and North America. In Taiwan, where tomatoes are eaten for dessert, along with sweet fruits, it would be a fruit. English-speakers classify potatoes as vegetables, but German-speakers are not likely to consider the *Kartoffel* (potato) to be included in the German word *Gemüse*, translated as "vegetable" but not coextensive with the English category.

There are many named categories based on cultural, dietary, and religious practices. According to Jewish dietary laws, the term *kosher* designates foods acceptable for Jews to eat, and *tref* (a Yiddish word) designates pork, shellfish, and other foods forbidden to eat. Another distinction is between *milchig*, describing dairy products, and *fleishig*, describing meat products, which include poultry but not fish. Items from these two categories are not to be eaten at the same meal. *Pareve* products are made without milk or meat, and can be eaten at dairy or meat meals.

Foods can be classified by their primary biochemical composition into carbohydrates, proteins, and fat for health and other dietary purposes. Vegetarians distinguish between "vegans," who eat no animal products, and "ovo-lacto-vegetarians," who eat eggs and milk products.

There are many informal and slang words for food in general: "chow," "grub," "mess," and "eats" are a few examples.

Words for Meals

English has various names for the customary times of day when people eat. "Meal" is a general term that includes breakfast, lunch, and supper (or dinner). "Dinner" is the largest meal, which can be midday or evening, depending on the region and culture. "Supper" is an evening meal, but for many people in the United States, "supper" and "dinner" are synonyms. The *Longman Lexicon of Contemporary English* (p. 217) contrasts meal terms for the British middle class and working class, and for Scotland in general. British middle-class words are similar to American usage, with the addition of "(afternoon) tea." In Scotland and among the British working class, "dinner" is served at noon, tea is served around 4 P.M., "(high) tea" is a light cooked meal served between 5 and 6 P.M., while "supper" is a small meal between 9 and 10 P.M.

In contrast to "meal," the term "snack" refers to food eaten between meals. Fancy or elaborate meals, especially those served on special occasions, are termed "feasts" or "banquets."

For meals with several courses, the courses are generally named according to the order in which they are served. In English the first course is the "appetizer" (or "starter" or "hors d'oeuvre"), followed by the main course or "entrée," and finally the "dessert." Although many English culinary terms are taken from French, usually with the French meaning, the sense of "entrée" has undergone a slight semantic shift. Traditional formal French dinners typically consisted of five courses: the *hors d'oeuvre* (literally "out of the work," often a soup or pâté), then the *entrée*, usually fish, followed by the *plat principal* (or *plat de résistance*, *pièce de résistance*), then *fromage* (cheese), and finally *dessert*.

Cooking Vocabulary

Preparing food by cooking is a universal practice in human societies, and every language has words to differentiate cooking methods. In English, "cook" is a general term with more specific words: "boil" (cook in water), "bake" (cook with dry heat in an enclosed space), "grill" or "broil" (cook over/under an open flame), "roast" (originally, cook on a spit over an open flame, but now partly synonymous with "bake"), and "fry" (cook in fat). English has highly specific words, including "steam," "poach" (cook gently in water), "deep-fry" or "French-fry" (submerge in hot oil), "sauté" or "pan-fry" (fry quickly in fat), or "stew" (cook slowly for a long time), "simmer" (gently boil), "braise" (sauté then simmer), and "barbecue." A relatively recent addition is "microwave."

Although German is closely related to English, the same concepts are expressed with somewhat fewer words. *Kochen* can mean "cook in general" or "boil" as a specific cooking method. *Braten* covers pan-frying, grilling, and broiling, while *backen* is the general word for "bake." Other words are *sieden* (boil, simmer), *rösten* (roast), and *grillen*, a specific term for grilling. *Dünsten*, *schmoren*, and *dämpfen* (braise, stew) are more specific.

Polish, like German, uses one word, *gotawać*, for cooking in general and for boiling. Other words are *smażyć* (fry), *duscić* (stew), and *piec* (bake, roast).

In Japanese the general term for cooking is *nitaki* or *ryoori-suru* (prepare food). *Niru* is a general term for boiling, with two subterms: *yuderu* for boiling solid food and *taku* for boiling or steaming rice. *Musu* means 'steam'. *Yaku* covers baking, roasting, broiling and frying, but there are specific words as well: *ageru* (deep-fry), *itameru* (stir-fry), *aburu* (grill or broil).

The general term for 'cook' in Mandarin Chinese is *shāo*. Its basic meaning is 'burn', and in context it can also be interpreted as 'bake', 'roast', or 'boil'. Other cooking words are *zhŭ* (boil), *zhēng* (steam), *chăo* (stir fry) and *jiān* (fry in a little oil), *zhà* (deep-fry), and *káo*, a general word which covers baking, roasting, and broiling. More specific words include *dùn* (stew in broth or sauce) and *mēn* (cook slowly in a covered pot).

Amharic, a Semitic language spoken in Ethiopia, uses the term *bessela* (cook), with specific words for cooking methods and type of food cooked: *fella* for boiling liquids, *k'ek'k'elle* for boiling solid food, *gagger* for baking bread, *t'ebbese* for frying or roasting meat, and *k'olla* for parching grain.

In general, languages have a variety of different words for cooking methods based largely on whether water, oil, dry heat, or an open flame is used. There is almost always a specific word for "boil," and often this is also the general word for "cook." Grilling (broiling), baking, roasting, and frying can be denoted by different words, but frequently these are combined into one or two general words.

Eating and Drinking Vocabulary

All languages have words for eating and drinking. In English, the distinction is whether solids or liquids are consumed. German, in addition to *trinken* (drink), contrasts *essen* (eating by humans) and *fressen* (eating by animals). Navajo has a general word for "eat," and several specific ones whose use depends on the amount, shape, and consistency of the food eaten. (Corresponding distinctions occur in Navajo verbs for handling food, but not in verbs for cooking, which depend on the cooking method.)

English has two sets of specific verbs for eating. The first set comprises intransitive verbs for eating meals or amounts of food: these include "dine," "lunch," "snack," and "nosh." The second set comprises transitive verbs that describe the manner of eating or drinking: these include "gobble," "munch," "nibble," "lick," "guzzle," "sip," "wolf down," and "slurp" (Fellbaum and Kegl, 1989).

Words for Wine

Although we can perceive only four basic tastes—sweet, sour, bitter, and salty—we can perceive thousands of odors. These odors fall into a few basic categories: floral, ethereal, musky, resinous, foul, and acrid (Ackerman, p. 11). The sense of smell is extremely sensitive and selective. "Our olfactory threshold is about 6,000 to 10,000 times as sensitive as that for taste" (Amerine et al., 1959, p. 483). What we perceive as taste is really a combination of taste and smell.

A very large, creative vocabulary has been developed to describe the taste and smell of wines, and new words are continuously invented. The vocabulary includes scientific-technical terms mostly used by experts (for example, "malo-lactic fermentation," "botrytis nose"), and widely used varietal names, like "Chardonnay" and "Pinot Noir." Some words are descriptive: for example, wines can be "sweet" and "dry." However, a large part of the vocabulary consists of words that have both a descriptive and evaluative component. A wine with a high acid content can be "tart," if it is judged desirable, or "sour," if undesirable. A wine's "body," a function of dissolved solids (tannin, acids, and fruit extracts) and alcohol, can be either "heavy" or "light," words that are evaluatively neutral. "Rich" and "big" are positive terms for "heavy," while "coarse" is negative. "Thin" and "watery" are negative terms for the neutral term "light."

The purely descriptive and descriptive-evaluative words are usually divided into the following three categories: "Taste"—sweet or dry (residual sugar or no sugar), sour (acidic), and bitter (tannic); "bouquet and aroma"—the smell of the wine; and "texture"—the feel of the wine in the mouth. This last category of texture includes body, and also includes sensations such as prickliness from certain acids and astringency from tannin. Positive texture words include "smooth" and its synonyms "soft," "silky," "velvety." Negative descriptors include "rough," "hard," and "harsh."

The numerous descriptors for specific tastes and smells are based on a similarity to some fruits, vegetables, or other objects. Wines can be "fruity," "vegetal," or more specifically, have the taste or smell of any fruit (cherry, apple, melon), vegetable (green bean, asparagus, bell pepper), spice (cinnamon, nutmeg), or herb (thyme, peppermint). Wines can also be "meaty," "yeasty," "perfumed," "flowery," or "smoky." These specific descriptors are nouns or adjectives derived from nouns.

Perhaps the most interesting, most discussed, and most ridiculed aspect of wine description is based on metaphor. "Body," the weight of the wine, gives rise to an open set of semantic extensions. Since heavy things are usually big, various size words are used as synonyms: "huge," "massive," "mammoth." Other metaphors based on the human body include "muscular," "brawny," "fat," "fleshy," "stout," "beefy," "big-boned," and "chunky" for heavy wines, and "lean," "sleek," "sinewy," "svelte," and "thin" for light wines.

The "structure" of a wine is its solid components—"the combined effect of elements such as acidity, tannin, glycerin, alcohol and sugar as they related to a wine's texture" (Steiman, p. 231). The concept of structure has generated terms like "backbone," "frame," and "framework."

Especially interesting and creative are metaphors based on personality and character. Wines, whose properties are immediately apparent, can be "generous," "approachable," "assertive," "bold," "brash," "loud," "sassy," "flamboyant," or "in-your-face." Wines with subtler properties are "shy," "sly," "reserved," "reticent," or "subtle." Many terms based on human personality are mainly evaluative: "agile," "charming," "classy," "diplomatic," "friendly," "graceful," "polished," "refined," and "elegant" are positive, while "aggressive," "stingy," and "mean" are negative.

Some wine descriptors are based on age and the life cycle. "Young" and "old" are a function not only of when a wine was made but also of its stage of development from grape juice to drinkable wine to vinegar. Wines that are too young can be "immature," "green," "closed," "dumb" (mute), "tight," (tightly closed, tightly wound), or "locked in." Wines at the peak of drinkability are "open," "mature," "ripe," "developed," "evolved," or "mellow." Wines that are too old can be described as "withered," "dying," "decrepit," "over-the-hill," or "senile."

"Balance" is the way in which the various wine components interact. Positive descriptors include "balanced," "harmonious," "integrated," "focused," "formed," "coordinated," and "well-defined." Negative words are "unbalanced," "unharmonious," "diffuse," "disjointed," "uncoordinated," and "muddled."

In the vocabulary of wine description, synonyms can be added for existing concepts. "Big" is a conventional word for full-bodied wines, and general mechanisms of semantic extension allow speakers to generate descriptors like "gigantic," "towering," or "elephantine" to express the same idea with greater rhetorical effect.

French, German, Italian, Spanish, and other languages spoken in wine-growing countries also have extensive wine vocabularies that cover scientific-technical, common descriptive, and evaluative meanings. Vocabularies for beer, coffee, and tea have many parallels, and even share many of the same words (for example, "rich," "light," "deep").

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LAPPS. The Sami (Lapps) are a native minority of northern Norway, Sweden, Finland, and the Kola Peninsula in Russia. Their territory was once much larger than it is today, especially in Finland. The Sami land is not homogeneous, but is divided into different ecological zones ranging from the coast of the Arctic Sea via the high mountains of Scandinavia to the northern forests. From a historical perspective, this territory supports various types of economies, with a focus on reindeer breeding, reindeer hunting, hunting combined with fishing in the sea and in lakes (in some regions combined with small farms), or pursuit of sea mammals. It is also important to connect the economy to different types of consumption with the emphasis on reindeer meat or milk, game and fish, and seal. Vegetables, berries such as cloudberries, bilberries, and lingonberries, and (infrequently) bread can also be seen as complements. Mercantile goods like flour, coffee, liquor, and horse meat, complete the picture.

The transition from hunters and fishers to reindeer herders began at different times in different parts of the widespread Sami territory. For example, the Sami practice of reindeer hunting combined with a nomadic lifestyle has existed in Sweden ever since the end of the Middle Ages.

The reindeer has long been the comprehensive symbol of Sami food culture, and today reindeer meat is exploited by restaurant culture of the Nordic countries, outside of the Sami territory. There one can find it on menus as roast reindeer (for example, under the name of *suovas*) or as small pieces of meat in a sauce with mashed potatoes and lingonberry (*renskav*).

Formerly the Sami used almost every part of the reindeer as food, including viscera, minced and cooked udder, hooves, and the brain (as an ingredient in bread). Reindeer cheese was once considered a delicacy, even as a commercial product, as were the tongue and heart. Reindeer milk could also be mixed with angelica and sorrel.

A Lapp herding reindeer on the tundra near Arrisovarre, Norway. © FARRELL GREHAN/CORBIS.

Samis traditionally boiled meat and fish. Dried fish (salmon and pike) were a replacement for bread and were also a trade commodity. In the nomadic society there was no oven in the Sami tent—the infrequently consumed bread was made of purchased barley (and later, wheat) on the hot hearth.

Breakfast was not a traditional Sami meal. In the nineteenth century it became a coffee meal or snack. Boiling meat and fish at noon and in the evening was the most common kind of traditional cooking. The principal meal was served in the evening. Traditionally, cooking in Sami culture was a male duty.

After the slaughtering of reindeer, a symbolic meal was traditionally served. This *renkok* (formerly and especially in gastronomic literature referred to as *lappkok*) consisted of marrowbone, liver, tongue, or heart boiled in a fat gravy. One can find such a meal at restaurants, especially in Lapland. Also, until the twentieth century, the Sami served a feast with boiled meat and a fat gravy after a successful bear hunt.

The money market has brought Western foodstuffs to the Sami food culture—at first as status food but gradually more and more as basic food—but at the same time, reindeer meat has retained its strong symbolic value for Sami identity.

See also **Canada: Native Peoples**; **Inuit**; **Mammals, Sea**; **Nordic Countries**; **Russia**; **Siberia**.

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LAROUSSE GASTRONOMIQUE. The chef Prosper Montagné's *Larousse gastronomique* was first published in France in 1938. Alongside Georges-Auguste Escoffier's *Le guide culinaire* and Louis Saulnier's *Le répertoire de la cuisine*, the *Larousse gastronomique* became one of the key reference works on French national and regional cuisine for the professional chef. The *Larousse gastronomique* is a reference text that codifies a history of the French culinary arts from the distant past to the present day in encyclopedic form. Entries cover such items as culinary terminology, foods, kitchen equipment, techniques, national cuisines, regional French cuisines, and historically significant chefs and restaurants.

Montagné's work signaled a break with the preceding era of French cookery as exemplified by the architectural creations of Marie Antoine Carême. Montagné emphasized dishes that were simple by Carême's standards, and the shortened menus were delivered in the Russian style service—meals were served in courses on individual plates. This philosophy inspired the name of his culinary encyclopedia. Montagné covered the range from the relatively new haute cuisine to French provincial and home cooking with some attention to classic dishes of other nations.

Three editions of the *Larousse gastronomique* have been published in English. The first edition, published in 1961, was an Anglo-American venture edited by Charlotte Turgeon and Nina Froud. A fairly direct translation of the Montagné text, this edition included updated food science entries and English and American measurements. One translator is the noted British food writer Patience Gray and it concludes with an additional reading list compiled by Elizabeth David.

Jennifer Harvey Lang edited the English second edition, published in 1988, from the 1984 French edition compiled and directed by Robert J. Courtine. Courtine's introduction describes the first edition as a monumental work, albeit one in need of some refurbishment. These new editions take into account technical innovations, advancements in food science, and a new culture of dining characterized by simpler meals and a dietary palette expanded through travel and global commerce. Yet the core achievements of Montagné, including his recipes and technical advice on classical and regional French dishes, are preserved.

For the third English edition, published in 2001, Jennifer Harvey Lang worked from a new French edition edited by Joël Robuchon, the president of the Gastronomy committee of the Librairie Larousse. This edition claims to have retained the classic dishes and techniques of the original edition with a newfound sensitivity to global influences in technique, presentation, ingredients, and recipes. It is 1,350 pages, over 150 pages longer than the preceding English edition and it includes two hundred new recipes and four hundred new entries.

The *Larousse gastronomique* no longer sits alone—if it ever did—on the shelves of professional chefs. Although considered a classic reference text on classical French dishes, ingredients, and techniques, the contemporary chef has access to numerous books that cover the same ground. Furthermore, the third edition addresses some elements of a growing interest in fusion cuisine and the cuisines of other nations, but it cannot provide the detail of more specialized cookbooks. Nevertheless, it covers an immense breadth of culinary material, justifying its continued importance.

See also **Carême, Marie Antoine**; **Chef, the**; **Cookbooks**; **Escoffier, Georges-Auguste**; **France**; **Gastronomy**.

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LAST SUPPER, THE. The final meal of Jesus with his followers in Jerusalem the evening before his crucifixion on the orders of Pilate in or around 30 C.E. is called the Last Supper. During the meal Jesus is said to have expressed a desire to be remembered by breaking bread and sharing a cup of wine, inspiring the central ritual of Christianity variously called the Eucharist, Mass, Lord's Supper, or Holy Communion. Leonardo da Vinci's fresco, executed in Milan in the 1490s, is probably the best-known pictorial representation of the Last Supper.

The participants left no firsthand reports of the Last Supper. Instead, varying accounts were handed down and recorded two or more decades afterward in books eventually collected into the New Testament (Matt. 26:17–30, Mark 14:12–25, Luke 22:7–38, John 13–17, and 1 Cor. 11:23–29). These and noncanonical sources, notably *Didache* 10 and 9 (in presumed chronological order), are the origin of a variety of liturgies, including washing one another's feet (John 13:14), so the details are open to conjecture.

Throughout his mission Jesus shared meals so enthusiastically that he was accused of being a glutton and a drunkard (Luke 7:33–34; Matt. 11:18–19). Thus it is plausible that he would have told companions to seek out an upper room in a house, where he organized supper before being seized by Roman authorities.

In the eastern Mediterranean the standard beverage, staple, and accompaniment were wine or water, bread, and a range of relishes, including fish. These all featured in both Jesus' reported sharing (such as the mass distribution of loaves and fishes) and early versions of the subsequent Christian agapes (love feasts) and Eucharists (thanksgivings).

Any familiar religious shape to the last meal would have been Jewish, since Jesus did not seem to have intended to inaugurate another religion. In that context the presence of women might have been quickly ignored in favor of twelve male disciples representing the twelve

The Last Supper is a recurring image in Christian art. This scene is a detail from the tympanum of the late-thirteenth-century cathedral at Strasbourg, France.

tribes of Israel. Some sources associate the Last Supper with Passover, the Jewish holiday of unleavened bread and spring lamb, which presumably would have taken the group to Jerusalem and which subsequently provided the timing of Easter, along with the symbol of Jesus' own sacrifice.

His followers soon believed that Jesus used distinctive words of institution over the bread and cup. These might have emerged from Passover procedures, as argued by Joachim Jeremias in *The Eucharistic Words of Jesus* (1966), and Jesus would surely have employed some form of Jewish thanksgiving or *berakah* standardly used as a grace before food. Yet Dennis E. Smith and Hal Taussig, in *Many Tables* (1990), argue for a Greco-Roman setting for the meal or more plausibly for early interpretations, so the bread and cup derive from the formal *deipnon* or dinner and subsequent *symposion* or talking over a shared drinking cup.

In Paul's influential version, probably written in 53–54 C.E., the key points are that Jesus took a loaf of bread, gave thanks, broke it, and said: "This is my body which is given for you. Do this in remembrance of me." After supper Jesus said: "This cup is the new covenant in my blood. Do this, as often you drink it, in remembrance of me" (1 Cor. 11:23–25). Accredited priests then transformed the bread and cup into Jesus' actual flesh and blood, and this transubstantiation was added to the matters for rancor and division. Some Protestants even retreated so far as to commemorate a self-proclaimed eater, drinker, and server entirely without bread or wine.

See also **Christianity: Eastern Orthodox Christianity**; **Christianity: Western Christianity**; **Judaism**.

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LA VARENNE. Little is known about the life of François Pierre (1618–1678), who signed with the name La Varenne. One account states that he was born in the Burgundian town of Chalon-sur-Saône and died in Dijon in 1678, and we know that from approximately 1640 to 1650 he worked in the kitchens of the Marquis d'Uxelles. His fame is due to the publication, in 1651, of *Le Cuisinier françois* (The French cook), the first of a new generation of cookbooks to document the changes that had taken place in French cuisine during the first half of the seventeenth century, and by far the most popular. Cooks were abandoning the use of spices that typified medieval and Renaissance cookery and replacing them with native European herbs: parsley, thyme, bay leaf, basil, etc. Many recipes, which are still popular with French chefs today—*bisque* and various *ragoûts*, for instance—are mentioned for the first time in *Le Cuisinier François*. La Varenne emphasizes the use of the *roux*, almost systematically employs a *bouquet garni* (a bundle of herbs) in stews and soups, and is the first to publish a recipe for *Oeufs à la neige* (snow eggs). His was also the first French cookbook to be translated into English (1653).

Although some have attributed other works to La Varenne, most notably *Le Pâtissier françois* (The French pastry chef) and *Le Confiturier françois* (The French confectioner), recent scholarship has shown that there is little reason to believe that he is the author of these texts.

See also **Chef**; **Cookbooks**; **France**.

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LEAF VEGETABLES. Leaf vegetables are a diverse and eclectic group of plants comprising several different taxonomic plant families: Aizoaceae, Amaranthaceae, Asteraceae (Compositae), Basellaceae, Boraginaceae, Brassicaceae (Cruciferae), Chenopodiaceae, Convolvulaceae, Cucurbitaceae, Euphorbiaceae, Malvaceae, Phytolaccaceae, Polygonaceae, Portulacaceae, and Tetragoniaceae. In the literature, leaf vegetables are commonly known as "greens" and "potherbs." They are grown for their tender, succulent, and normally green leaves, and are usually cooked before eating, thus the name "potherb." Alternatively, the salad greens, for example, lettuce, radicchio, and endive, are usually eaten uncooked. Nevertheless, the leaf vegetables can be added fresh to tossed salads, giving the salad color and novel flavors. Not included in the group are those plants with leaves that serve as an important herb or flavoring ingredient, but do not constitute the main ingredient in the dish, such as cilantro, parsley, rosemary, etc.

Additionally, there are a large number of plants the leaves of which are eaten in certain parts of the world although the leaves are actually a secondary crop. For example, in Southeast Asia, chili pepper (capsicum) leaves are eaten, but it is the fruit that Americans usually consume. Other examples of plants whose fruits or roots are the primary crop but whose leaves are also consumed are peas and beans, plantain, cassava, cucumber, radish, and sweet potato.

Leaf vegetables may be cool-season or warm-season crops and can be grown as annuals or as perennials. In addition, some leaf vegetables are adapted to the tropics, while others are adapted to the temperate climates. Depending on location, leaf vegetables are either a main crop or treated as a minor crop. The more important leaf vegetables, based on dollar value, are spinach, kale, collards, mustard greens, and Swiss chard. Other leaf vegetables such as New Zealand spinach and dandelion are popular with home gardeners and are grown on a limited scale by market gardeners.

Leaf vegetables are among the most nutritious vegetables on a fresh weight basis and are also among the world's most productive plants in terms of nutritional value per unit area, in part because they grow rapidly, allowing several crops or harvests in a season. Although some of the constituents are lost during cooking, they still contribute significant amounts of provitamins A and C and several minerals. Leafy vegetables are also good for the eyes. Age-related macular degeneration is a leading cause of blindness among individuals over the age of 50. A research study in Massachusetts found that people who ate spinach, collards, and other dark green, leafy vegetables five or six times a week had about a 43 percent lower risk of the disease than those who ate it less than once a month. The typical shelf life for most leaf vegetables is ten to fourteen days.

Major Leaf Vegetables

Spinach. Spinach (*Spinacia oleracea* var. *inermis*) is a member of the Chenopodiaceae family, which also includes table beet, Swiss chard, sugar beet, and amaranth. Spinach is native to an area near present-day Iran and was first cultivated by the Persians more than 2,000 years ago. Records of its use are meager, but it is believed that cultivation of the crop developed during the period of the Greek and Roman civilizations. It was introduced to China in 647 C.E. and apparently was transported across North Africa to Spain by the Moors by 1100. Two seed types exist, one having a smooth, round shape and the other an irregular, prickly shape. The crop was known in Germany in the thirteenth century only in the prickly-seeded form. Smooth-seeded spinach, which is used exclusively in today's commercial production, was not described until 1552. The colonists introduced spinach to the Western Hemisphere, and it was listed in American seed catalogs by 1806.

SPINACH

Apparently the time of the introduction of spinach into China is well-recorded in Tang Dynasty history (618–907 C.E.) because it marked the flow of many new food offerings of grain and seed from Tibet. Also, the trade routes to the West went through Tibet, and presumably spinach may have been traded from its origins in Persia. One story is that it was included as a part of the bridal offerings that were carried into China with the marriage of Princess Wencheng to the Tang Emperor Taizong sometime before 641 C.E. This marriage was well recorded in both Han and Tibetan writings and folklore. It is also known that during this same period many other food products flowed (such as pepper and cardamom) into China. This trade resulted from the extensive connections Emperor Taizong had established with the western Asian region. While it is possible that spinach came into China through the marriage, it was also likely that it could have come anytime during the later reign of this emperor after establishing all of these connections. It is also relevant to note that this period (618–641 C.E.) also marks the time when both tea and porcelain were first extensively traded with the west.

Solomon H. Katz

Spinach is the most important leaf vegetable in the United States. The edible portion of the plant is the compact rosette of fleshy leaves attached to a short stem. Leaves vary from ovate or nearly triangular to long and narrow arrowhead shapes; the latter are a characteristic of more primitive types. Leaf margins may be smooth or wavy, and surfaces are smooth, semisavoyed to heavily savoyed (crinkled). The crinkled appearance of the savoy tissue results from differential growth of parenchyma tissues between leaf veins.

When plants have attained marketable size, which, depending on the season, can be 30 to 80 days, and when overwintered as much as 150 days, they are pulled or undercut below the stem. Each plant will have five to eight fully developed leaves. Intact plants are trimmed, and several are tied together in bunches and packaged. Not all hand-cut spinach is bunched. Some are bulked into harvest baskets and sold in that manner. Savoy types are preferred for the fresh market because the leaves are dark green and resist compression during packing, thus allowing for better aeration, cooling, and postharvest life. Most of the commercial frozen spinach is machine-harvested. The machines have cutting blades adjusted to cut four to six inches above ground level to reduce the amount of petioles harvested with the leaves. The smooth or semisavoyed leaf types are generally used for machine harvesting because they yield more and are easier to clean. A limited amount of greenhouse spinach is produced in northern Europe during the winter.

Because spinach has a high leaf-surface area and a high respiration rate, it must be cooled rapidly to prevent weight loss and decay. Overheating will destroy quality. Thus, rapid cooling is essential to reduce wilting and weight loss. Vacuum cooling can give satisfactory cooling within ten minutes, usually applied after bulk packing and washing. Hydrocooling (cold water application) takes longer than vacuum cooling but is more feasible for small market operations. Following hydrocooling, excess water must be removed by centrifuging; otherwise postharvest diseases begin to develop. The product can then be stored under shaved ice to preserve freshness.

A serving (1½ cups) of cooked spinach has forty calories and provides 70 percent of the recommended daily allowance (RDA) for adults of vitamin A, 25 percent of the RDA of vitamin C, and 20 percent of the RDA of iron (see Table 1). Spinach also contains high levels of calcium, phosphorus, and potassium. It has moderate levels of protein. However, not all constituents of spinach are nutritionally beneficial. Oxalic acid in spinach reacts with calcium to form calcium oxalates. Excessive oxalic acid may interfere with calcium absorption in humans, a condition particularly serious for infants. Levels of oxalic acid are substantial in all spinach cultivars, although apparently less in savoy types than in smooth leaf types. Oxalic acid is also found in many of the other leaf vegetables, including chard and, especially, rhubarb. The leaves of rhubarb are toxic and should never be consumed. The stalks should be fresh when eaten.

An additional problem relates to the accumulation of nitrogen in the nitrate form, especially in spinach fertilized heavily with ammonium nitrate and grown under high temperatures and low light intensity. Nitrates convert to nitrites in digestion, and nitrites will oxidize hemoglobin to form methemoglobin. This substance can lead to methemoglobinemia, a disorder of humans and ruminants. Nitrates can also form carcinogenic nitrosamines. These toxic constituents in spinach do not present a risk when the crop is grown with proper fertilization and is consumed as part of a balanced diet.

Swiss Chard. Swiss chard (*Beta vulgaris* var. *cicla*) is a type of beet developed for its large crisp leaves and fleshy leafstalks rather than for its roots. Early civilizations utilized the roots as a medicine. The first records of cultivation indicate that the Eastern Mediterranean region, not Switzerland, was the place of origin. Aristotle wrote of seeing a red chard in 350 B.C.E. From this leaf plant was selected the swollen root form, the table beet. Although large acreages are not common, it is grown widely to supply local markets.

Swiss chard leaves are of best quality just when fully expanded or slightly earlier but remain succulent throughout the season as long as the leaves are harvested at the proper size. The succulent, glossy, dark green leaves are usually slightly crinkled or savoyed. Sometimes the fleshy white leaf midribs are separated from the leaf blade and prepared much like celery or asparagus. The midrib color can be white, red, yellow, pink, or green. Swiss chard is prepared for the market by washing thoroughly, grading, and bunching. Storage is not recommended, but it can be kept for short periods.

A serving of Swiss chard (3½ oz.) provides 130 percent of the adult RDA of vitamin A and 25 percent of the adult RDA of vitamin C (see Table 1). Like spinach, which is related, Swiss chard has high levels of oxalates.

Kale and Collards. Members of the Cruciferae family, kale and collards (both *Brassica oleracea* var. *acephala*) are known as "greens" and "soul food" in the southern United States, where they are most popular. Unlike cabbage (*Brassica oleracea* var. *capitata*), neither kale nor collards forms a head—thus the name "acephala" which means 'forming no head'. Kale and collards are the oldest forms of cabbage and are native to the eastern Mediterranean region of Europe or to Asia Minor. The use of kale as a food dates to 2000 B.C.E. or earlier. The Greek philosopher Theophrastus described a savoyed form of kale in 350 B.C.E. Traders and nomads introduced these leaf vegetables to other parts of the world, and they were introduced to the United States from Europe in the seventeenth century.

Both kale and collards have dark green leaves that form a rosette-like whorl toward the apex of erect unbranched stems. Even though collards and kale belong to the same taxonomic group, they are quite distinct. Collards differ from kale mainly in leaf shape and flavor. Collards have large, broad, flat, smooth leaves with smooth leaf margins; kale has a greater variability of leaf types. Most kales have largely upright heavily curled leaves. The decorative leaves of kale have given rise to its use as an ornamental plant. Flowering kale is very attractive for landscape plantings and is edible though not very palatable. The term "flowering" derives from the shape and coloration of the plant, which resembles a flower, and does not refer to actual flowers.

Kale is also called borecole ("winter cabbage"). The name "collard" is a corruption of *colewort* or *colewyrt*, Anglo-Saxon terms meaning young cabbage plants. Curly leaf forms of kale occur because of disproportionate growth along leaf margins, whereas the savoy (crinkled) appearance is due to nonuniform growth of portions of the leaf laminae. Kales and collards are the hardiest of the cole corps; when properly acclimated, they can tolerate temperatures to 0°F or lower and they are often overwintered. In addition, kale and collards have good tolerance to high temperatures (80° to 85°F), although growth stops at about 85°F. However, the best-quality kale collards are grown in the cooler part of the year. In general, collards are more heat tolerant, while kale is better adapted to cooler weather.

Both kale and collards are biennial, meaning that they will flower after an extended exposure to cold weather. A vigorous collard plant may reach a height of three to four feet. Kale is somewhat smaller. Two general types of kale are grown for the market: curly leaf (the most widely grown) and smooth leaf. Of the curly leaf forms, Scotch kale is rather light green, with very ruffled, finely divided leaves; it may be dwarf or tall, with the dwarf form preferred. Because of the curly leaves, one of the commercial production problems is removing sand from the leaves.

Collards can be harvested by cutting young plants. Large plants can be cut off, or the lower leaves can be removed during the season. Leaves of both crops should be young and tender. The flavor of kale is sweeter after a frost, and many prefer to harvest at that time. After harvest, the leaves or small plants should be washed, graded, and bunched or packed. Shipments are made with an ice covering to preserve freshness. When necessary, kale and collards can be stored for ten to fourteen days at 32°F at 90 to 95 percent relative humidity.

Both kale and collards excel in food value, with kale superior to most vegetables in protein, vitamin, and mineral content. On a fresh weight basis, kale is among our most nutritious vegetables. One serving (3½ oz.) provides 200 percent of the adult RDA of vitamins A and C and 13 percent of the calcium RDA for adults.

Siberian kale (*Brassica napus*) has other common names such as Hanover kale, Hanover salad, spring kale, and Hanover turnip. It is a cool-season crop that belongs to the Brassicaceae family. Siberian kale cultivars vary considerably in appearance. The plant might best be described as resembling the ordinary collard, but it is not as curly as kale. The leaves form a rosette, and are usually smooth like collards rather than hairy like turnip leaves. The petioles vary from purple to white. Although it is sometimes compared to the turnip in growth habits, it does not form a fleshy root like turnips. Young tender leaves are used in cooking.

Amaranth. Within the genus *Amaranthus*, more than fifty species, including both cultivated and weedy species, are eaten as greens. The cultivated species are collectively called "amaranth." Another crop of the amaranth family grown in tropical Asia for its edible leaves is *Celosia argentea.* In Southeast Asia, the many cultivars of this species are usually classified by leaf color and shape. Common names for Amaranthus include bush greens, Chinese spinach, hon-toi-moi, pigweed, and tampala. Because of the large number of species used, there is considerable variability in growth habit, leaf shape, color, inflorescence characteristics, and utilization. Leaf shape and color also vary considerably among the different seed accessions. Some are red, others are green, while others

TABLE 1

Nutritional constituents of leaf vegetables

						Vitamins										
Crop	Water (%)	Energy (cal)	Protein (g)	Fat (g)	Carbo-hydrate (g)	A (IU)	C (mg)	Thiamin (mg)	Ribo-flavin (mg)	Folate (mcg)	Niacin (mg)	Ca (mg)	P (mg)	Fe (mg)	Na (mg)	K (mg)
Amaranth	92	23	2.5	0.3	4.0	2,900	43	0.03	0.16	85	0.7	215	50	2.3	20	611
Broccoli Raab	92	18	1.8	0.2	2.0	2,700	70	0.05	0.07	71	0.5	125	45	1.5	40	250
Chaya	80	64	6.2	0.6	10.7	–	194	0.2	0.20	–	1.6	234	76	2.8	58	270
Collard	91	30	2.5	0.4	5.7	3,800	35	0.05	0.13	166	0.7	145	10	0.2	20	169
Dandelion	86	45	2.7	0.7	9.2	14,000	35	0.19	0.26	27	0.8	187	66	3.1	76	397
Garland Chrys.	93	21	1.6	0.2	4.4	14,675	37	0.03	0.22	77	0.9	56	32	3.1	52	571
Ice Plant	94	05	0.7	0.2	0.3	2,000	23	0.04	0.06	–	0.3	90	26	0.6	–	–
Indian Mustard	91	27	2.7	0.4	4.9	6,000	93	0.11	0.19	187	0.8	181	46	2.0	33	374
Kale	84	50	3.3	0.7	10.0	8,900	120	0.11	0.13	29	1.0	135	56	1.7	43	447
Malabar Spinach	93	19	1.8	0.3	3.4	8,000	102	0.05	0.16	140	0.5	109	52	1.2	24	510
Mustard Greens	91	26	2.7	0.2	4.9	5,300	70	0.08	0.11	159	0.8	103	43	1.5	25	354
N. Zealand Sp.	94	14	1.5	0.2	2.5	4,400	30	0.04	0.13	15	0.5	58	28	0.8	130	130
Pokeweed	92	23	2.6	0.4	3.7	8,700	136	0.08	0.33	–	1.2	53	44	1.7	23	242
Purslane	94	16	1.3	0.1	3.4	1,320	21	0.05	0.11	12	0.5	65	44	2.0	45	494
Sorrel	93	25	0.74	0.1	3.8	010	10	0.03	0.04	–	0.3	130	21	0.9	6	360
Siberian kale	87	42	2.8	0.6	8.3	3,100	130	0.07	0.06	28	1.3	205	62	3.0	70	450
Spinach	92	22	2.7	0.4	3.5	6,700	28	0.08	0.19	194	0.7	99	49	2.7	79	558
Swiss Chard	93	19	1.8	0.2	3.7	3,300	30	0.04	0.09	14	0.4	59	46	1.8	213	379
Turnip Greens	91	27	1.5	0.3	5.7	7,600	60	0.07	0.10	194	0.6	190	42	1.1	40	296
Water Spinach	91	26	3.1	0.4	4.6	4,600	50	0.07	0.17	–	1.1	84	49	2.7	43	385

Data per 100g raw sample. 1 IU = 0.3 µg vitamin A alcohol. Vitamin C = Ascorbic acid

SOURCE: U.S. Department of Agriculture, Agricultural Research Service, 1999. USDA Nutrient Database for Standard Reference, Release 13. Nutrient Data Laboratory. Available at, http://www.nal.usda.gov/fnic/foodcomp; V. Rubatzky, and M. Yamaguchi, *World Vegetables,* 2nd ed., International Thomas Publishing, 1997; H. D. Tindall, *Vegetables in the Tropics,* AVI Publishing, 1978.

may be variegated, usually with purplish patterns on a green background. Major leaf vegetable amaranth species are *Amaranthus tricolor*, *A. lividus*, *A. dubius*, *A. gangeticus*, *A. blitum*, and *A. hybridus*. *A. spinosus*, known as uray, is a vegetable of some importance in the Philippines. Amaranth is grown not only as a leaf vegetable, but as a grain (*A. caudatus*) in subtropical and tropical climates of Africa.

The green-leafed variety of vegetable amaranth (*A. tricolor*) has been offered in the United States as the cultivar tampala. It is as acceptable as spinach when cooked, but not raw. *A. lividus*, known as bondue, is grown for vegetable uses in tropical Africa. Young plants of *A. leucocarpus* are a leaf vegetable in Algeria; in addition, the seed is made into candy. The green form of *A. gangeticus*, Chinese spinach, is most commonly cultivated for use as boiled greens in Asia.

For many of the leaf vegetable *Amaranthus* species, centers of diversity are Central and South America, India, and Southeast Asia, with secondary domestication in western and eastern Africa. The greatest diversity of leaf amaranths is found in India. The leaf amaranths are popular, low-cost, and a good protein source for the populations of many tropical, subtropical, and temperate regions.

Most leaf-type amaranth plants are erect, about one foot to three feet high, and produce numerous small flowers on terminal and axillary spikes. When harvested, plants are pulled with the roots left on to facilitate bunching. In another method, partial leaf removal is made with regrowth permitted for successive harvesting. Frequent harvesting, every seven to ten days, tends to delay flowering and encourage new shoot and leaf growth. Postharvest life is relatively short because of rapid wilting of the tender foliage.

Some general disadvantages of amaranths are the early, short-day flowering response and low-temperature sensitivity of some species and the high calcium oxalate content in leaf tissues. Nevertheless, these plants supply large amounts of provitamin A, vitamin C, protein, and fiber. Amaranth is not as high in vitamin A as spinach, but other constituents are comparable.

Mustard Greens. Mustard is often used in a generic sense to identify somewhat morphologically similar brassicas even though they are different species. All belong to the Crucifer family and are native to Central Asia and the Himalayas. For instance, black mustard (*Brassica nigra*), white mustard (*Sinapis alba)*, and Ethiopian mustard (*B. carinata* and *B. juncea*) are all called mustard greens. However, in the United States "mustard greens" normally refers to *Brassica juncea* var. *crispifolia*. When *Brassica juncea* seeds are ground, they produce the famous Dijon mustard. Mustard greens are strong flavored and pungent although the inner leaves are relatively mild and quite suitable for raw salad use. It is an annual cool-season plant with its early growth in a basal rosette. Leaf form can vary among cultivars. Some cultivars have large leaves while others have leaves that are broad toward the apex. Within both forms are cultivars with curled or smooth leaf margins. The young tender leaves are harvested approximately seven weeks after sowing when they reach six to eight inches in height and before they become tough and woody. Plants are cut by hand, washed, and packed. They are packed for transit in the same way as spinach.

AMARANTH

Amaranth is one of the most ancient crops of the Aztecs of Mexico, who domesticated it about 5000 B.C.E.; it appears to have been independently domesticated also among the Inca of Peru. Among the Aztecs amaranth was cultivated first in the *chinampa* system; fertile algae-rich mud from their garden canals was made into seed beds, and the amaranth was allowed to grow to about eight to ten inches in height and was then transplanted to fields in the higher ground, where it was usually intercropped with maize. After the Spanish conquest, the continued use of amaranth was prohibited because the red color of the seeds reminded the Spanish of blood and its connection to traditional Aztec religious practices.

Solomon H. Katz

Minor Leaf Vegetables

Several leaf vegetables are grown to a very limited extent on commercial acreage to meet a small but steady demand. One may find these leaf vegetables growing more frequently in home gardens. Some of these crops are normally thought of as weeds; however, they are grown because they feature some prominent characteristic that is favored among specific ethnic groups. These crops include broccoli raab, chaya, dandelion, garland chrysanthemum, garden sorrel, ice plant, kangkong, Malabar spinach, New Zealand spinach, orach, pokeweed, and purslane.

Broccoli raab (*Brassica campestris*) is also known by such names as raab, rapa, rapini, broccoli turnip, spring broccoli, cima di rapa, taitcat, Italian turnip, and Italian mustard. It is a highly regarded leaf green in Italy and other Mediterranean countries. The plant resembles turnip tops and sprouting broccoli but develops a much smaller, less compact inflorescence. The leaves are cut with the seed stalks before the flower buds open. There are two forms of broccoli raab: rapine, or spring raab, and rappone, or fall raab. Other than the season of maturity, there is no difference in appearance or flavor.

Leaf vegetables are ideal for greenhouse horticulture since many species can be forced during the winter months for early spring harvest. Angelo Favoretto, a Vineland, New Jersey, wine maker, supplements his income from grapes with an early crop of dandelion greens, a leaf vegetable rich in vitamins and minerals. © BOB KRIST/CORBIS.

Both go to seed very rapidly. In areas with a moderate climate, raab may be planted in the fall and overwintered to produce an early spring crop. Rappone seems superior to rapine for these fall plantings. In most areas, both are spring planted for early or late summer harvest. The harvest system is similar to that used for collards and turnips; the leaves and the flower stalks are tied together and sold as bunches. Raab is very perishable and must be marketed immediately.

Chaya (*Cnidoscolus chayamansa*) is a little-known leaf vegetable of dry regions of the tropics. The leaves are used as a green vegetable in many Latin American countries. The name "chaya" comes from the Mayan word for the plant, *ixchay* or *chay*. Other common names are tree spinach, chaya col, kikilchay, and chaykeken. Chaya is a large leafy shrub reaching a height of about six to eight feet. It somewhat resembles a vigorous hibiscus or cassava plant. The dark green leaves resemble okra leaves. The domesticated cultivars have little to none of the offending features—stem spines and leaf hairs—found in wild chaya. It is reported that "pig chaya" is one of the very best eating varieties. Plants are continuously harvested. Large leaves are cut into manageable pieces before cooking. Chaya is a good source of protein, vitamins, calcium, and iron. However, raw chaya leaves are highly toxic because they contain hydrocyanic glucosides. One minute of boiling destroys most of the glucosides.

Dandelion (*Taraxacum officinale*) has been encountered by almost everyone as a weed in lawns and gardens. However, there are cultivated varieties of dandelion that make excellent cooking greens. The dandelion is a European native with low-spreading deeply notched leaves forming a rosette pattern as they emerge from a central tap root. The varieties used as a leaf vegetable have been selected for their leafiness and freedom from bitterness. The three major cultivars are Thick Leaf, Improved Thick Leaf, and Arlington Thick Leaf. The leaves are an excellent source of provitamin A, vitamin C, calcium, and several other minerals. Given that the plant is a perennial, the leaves are harvested by cutting below the whorl to keep the plant intact. The leaves are then washed, graded, and cooled.

Garland Chrysanthemum (*Chrysanthemum coronarium*) is also called edible chrysanthemum, chop suey greens, *shungiku* in Japan, and *tong hao cai* in China. It looks very much like a leaf version of the flowering ornamental chrysanthemum. A native of the Mediterranean region, it was introduced to Asia via contact with European traders. It is now a popular cooked green in Korea, Japan, and China. Leaf shape varies from lobed to highly indented. Daisy-like flower heads are yellow or yellowish white and are also eaten. All plant parts have aromatic flavor qualities, becoming most pronounced in older foliage.

Garden sorrel (*Rumex acetosa*) is a perennial plant that is closely related to rhubarb and buckwheat and is sometimes referred to as dock. However, the term "dock" has been used in Great Britain to include all members of the family Polygonaceae. Owing to its tart flavor, it is sometimes called sour dock and sour grass. In fact, sorrel derives from the Old French *surele*, meaning 'sour'. Garden sorrel is of Eurasian origin with long, thin light green or reddish green, slightly crinkled, arrow-shaped leaves. Other *Rumex* species similar to garden sorrel are French sorrel (*R. scutatus*), spinach rhubarb (*R. abyssinicus*), patience dock (*R. patientia*), and Indian sorrel (*R. vescarius*). French sorrel differs in being a short plant with branched stems that exhibit a semireclining growth habit. Leaves are arrow- or fiddle-shaped, more succulent, and smaller than garden sorrel. French sorrel is used like garden sorrel but has a milder taste. Spinach rhubarb is eaten like spinach, and the petioles are like rhubarb. Patience dock looks similar to garden sorrel although the plant is stouter and taller and has larger leaves and a noticeably stronger taproot than garden sorrel.

Ice plant (*Mesembryanthemum crystallinum*) is a little-known vegetable of the southern hemisphere. Ice plant is so named because of the shimmering silvery dots that cover the leaves. It has also been called fig marigold, frost plant, diamond plant, midday flower, and dew plant. This is not to be confused with New Zealand spinach, which is sometimes referred to in gardening books as New Zealand ice plants. Ice plant is a perennial that does best in hot, dry climates. It is grown as an annual when used as a green vegetable. The leaves are picked as wanted once the plant has several leaves and is well-established. The slightly acidic, fleshy leaves are boiled and served like spinach.

Malabar spinach (*Basella alba* & *B. rubra*) is also known as Ceylon spinach, climbing spinach, gui, acelga trepadora, bretana, libato, vine spinach, Indian spinach, and Malabar nightshade. The red leaf form belongs to the *rubra* species, while the green form is classified in the *alba* species. *Basella alba* has an African or Southeast Asian origin, while *Basella rubra* is thought to have originated in India or Indonesia. Malabar is not a true spinach, but its leaves, which form on a vine, resemble spinach and are used in the same way. Malabar spinach can be grown from seeds or cuttings. The vine is normally trellised. Two vines are sufficient to supply a small family all summer and fall. The thick, fleshy leaves are cut off together with some length of the stem to keep the plant pruned to a desired shape. When cooked, Malabar spinach is not as slick in texture as many greens such as spinach. The Bengalis cook it with chopped onions, spicy chilis, and a little mustard oil. The mucilaginous texture is especially useful as a thickener in soups and stews.

Mizuna (*Brassica juncea* var. *japonica*) is an Oriental cooking green also known as potherb mustard, kyona, Japanese greens, and sometimes California peppergrass. It is widely grown in Japan but is found only occasionally in gardens in the United States. Mizuna is twelve to eighteen inches tall with yellow-green leaves that are smooth and a bit fuzzy, similar to curly mustard, but with a different leaf shape. Leaves of mizuna are deeply notched, narrow, feathery, and quite attractive. A single plant may have as many as 180 leaves clustered together in a compact, twelve-inch diameter bunch. It withstands frost and light freezes and is not quick to seed even in periods of warm weather that occur during the winter months. Leaves are ready for use any time after three weeks of growth. Leaves are removed as needed, keeping enough young foliage to continue the regrowth.

New Zealand spinach (*Tetragonia expansa*) is indigenous to New Zealand and became widely cultivated after it was introduced to Europe. It was introduced to England by Captain Cook in 1771 and was used on his voyages as a source of vitamin C. Presently, little is grown commercially in the United States, but it is popular with many home gardeners. Not a true spinach, it does somewhat resemble spinach in appearance and is used similarly. The plant is large, growing to a height of two or more feet in a spreading and branching habit of growth, and has thick succulent leaves. The young tops are harvested for boiling, and each harvest encourages new branching. Unlike many of the leaf vegetables, New Zealand spinach is a warm-season crop with very wide adaptation. It is an excellent source of fresh greens throughout the summer and is also frost-sensitive. Its flavor is comparable to that of spinach, but milder and without the astringency. In its early growth, New Zealand spinach is entirely vegetative. As it begins to develop, however, it soon produces flowers from the leaf axils. The flowers are considered undesirable for the market. Like spinach, tissues contain oxalates that render calcium nutritionally unavailable.

Orach (*Atriplex hortensis*) is a hardy branching monoecious annual of the Chenopodiaceae family that is a substitute for spinach. It is also commonly known as mountain spinach, French spinach, and sea purslane. Some variations of the name are orache, arache, and orage. The name derives from the Old French *arrache*, a corruption of the Vulgar Latin *atripica*, from Latin *atriplex*; these in turn were from the Greek word for orach, *atraphaxus*. It is sometimes called salt bush because of its tolerance of alkaline soils. The plants have a tolerance to drought and salinity and are adapted to a broad temperature range. Orach is considered to have originated in northern India and has been used as a medicinal and food plant for more than 2,000 years, making it one of the oldest cultivated plants. It was widely grown until the eighteenth century but is of little commercial importance today although it is returning in popularity as an ingredient in mesclun salads. It is grown as a substitute for spinach in Europe and in the northern plains of the United States. It is seldom seen in the tropics. Its leaves are slightly crimped, soft, and pliable and are shaped like arrows that are four to five inches long and two to three inches wide. Plants can attain a height of five to six feet. A rosette of leaves first develops, followed by a seed stalk that can grow to a height of six to nine feet. There are four common varieties of orach. White orach is most often grown because it is the most tender and best flavored. The leaves are very pale green, almost yellow. Red orach has dark-red stems and leaves. Green orach, also called Lee's Giant orach, is very vigorous, with a stout, angular, branching stem. The leaves are rounder, less toothed, and darker green than those of the other varieties. The fourth is a copper-colored variety that is now much sought after by specialty growers.

Orach is a cool-season vegetable and is grown much like garden spinach. It is quick to bolt in summer. Although stems quickly elongate, flowering is slow, and plants tolerate growing temperatures too high for spinach. Young leaves may be harvested and the plants will continue growing for multiple harvests. Orach has a mild flavor much like that of spinach, but it contains less oxalic acid. Even when the plant goes to seed, young leaves are usable. However, old leaves are not palatable and are not harvested.

Pokeweed (*Phytolacca americana*) is a native plant throughout eastern North America. Other common names are inkberry, pigeon berry, coakun, pocan bush, scoke, garget, and poke salad. The branches bear clusters of flowers and dark red fruits that resemble the berries of a nightshade; pokeweed is therefore sometimes called American nightshade. It is a large-rooted perennial with a strong-growing tip, reaching up to ten or more feet in height. The top dies down in cold weather. There is little cultivation of pokeweed in the United States or elsewhere because it is gathered from the wild. All plant parts are poisonous. The young tender shoots and the older leaves may be eaten if boiled. The bitterness, and by association the poisonous compound, is removed by boiling and pouring off the cooking water until all the bitterness is removed.

PURSLANE

Purslane has very high levels of the linoleic omega 3 fatty acid, which is essential and relatively low in the U.S. diet as compared with the higher levels of the omega 6 fatty acids. This imbalance of the ratio between the two classes of fatty acids may be the basis of an important nutritional imbalance.

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Purslane (*Portulaca oleracea*) is known by various names such as kitchen purslane, garden purslane, and in Spanish, *verdolaga*. One of the more descriptive names for this plant is in Malawi, where it translates to "the buttocks of the wife of a chief," because of the shape of the leaf. The exact origin of purslane is not known, but it is reported to have been used more than 2,000 years ago in Iran or India. Purslane is a popular vegetable in France, several other European countries, and Africa, especially in Egypt and Sudan. It was introduced to the United States from Europe. The name "purslane" derives through Old French *porcelaine* from Pliny's Latin *porcilaca*. The cultivated forms are upright and more vigorous than the weedy form. It is a summer annual with small, oval, juicy leaves clustered at the ends of smooth, purplish-red, prostrate stems that arise from a single taproot. The leaves are usually stripped from the stems and are prepared like spinach. The taste is a cross between watercress and spinach. An undesirable quality of purslane is that its foliage, like that of spinach, contains oxalic acid and tends to accumulate nitrates.

Water spinach (*Ipomoea aquatica*), also known as kangkong, water glorybind, water spinach, water convolvulus, and swamp cabbage, is an important green leaf vegetable in Southeast Asia, Taiwan, Ceylon, and Malaysia. It is speculated to have originated in India but is now widely grown throughout the tropics. Water spinach can become an undesirable weed. The Florida Department of Natural Resources must issue a special permit to anyone wanting to grow it in Florida. There are two major forms (cultivars) that are cultivated in two ways, either upland (dry) or swamp (wet). Ching Quat, an upland variety, has narrow leaves, while Pak Quat, a swamp variety, has arrowhead-shaped leaves. The plants produce a trailing hollow vine that is adapted to floating in aquatic environments. The leaves are light green and look somewhat like sweet potato leaves. The upland types are started from seed or cuttings and are grown on trellises. Plants are often grown in nursery beds for transplanting later to the garden. Taking cuttings from plants in the nursery beds is the usual method. Harvest may start six weeks after planting. The swamp types are usually planted with twelve-inch-long cuttings planted in mud and kept moist. As the vines grow, the area is flooded to a depth of six inches, and a continuous flow of water is maintained through the field, similar to the way watercress is grown. Harvest begins four weeks after planting. When the succulent tips of the vines are removed, lateral and upright branches are encouraged. These branches are harvested every seven to ten days. All parts of the young plants are eaten. The crop is fragile and requires rapid and careful handling to minimize damage and wilting. It is eaten like cooked spinach. A canned product is often available in ethnic markets.

Conclusions

Leafy vegetables are consumed in most cultures and regions of the world. They consist of a wide range of different plants, yet no matter which leaf vegetable is used, it is usually prepared like spinach. The leafy vegetables contribute significantly to a nutritious diet. As a food source, the leafy vegetables are some of the best sources of provitamin A and vitamin C and supply good amounts of iron, folate, and other essential minerals. They are also an excellent source of phytochemicals, which aid in fighting heart disease and cancer.

See also **Cabbage and Crucifer Plants**; **Herbs and Spices**; **Lettuce**; **Vegetables**.

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LEEK. *See* **Onions and Other *Allium* Plants.**

LEGUMES. Legumes are members of a family of flowering plants known as Leguminosae. It is one of the three largest families of flowering plants, with approximately 690 genera and about 18,000 species. Legumes are a significant component of nearly all terrestrial biomes on all continents except Antarctica. Some are fresh water aquatics, but no truly marine species exist. The species within the family range from dwarf herbs among arctic and alpine vegetation to massive trees in tropical forests.

The leaves usually occur alternately on the stem and are compound, meaning each leaf is divided into separate leaflets. Both pinnate and trifoliate leaves exist. Legumes are easily recognized by the structure of the flower. The flowers are hermaphroditic with male (stamens) and female (pistils) parts in the same flower and usually with five sepals and five petals. The ovary has a single carpel, cavity, and style. The principal unifying feature of the family is the fruit, a pod technically known as a legume. The legume pod is modified in many ways, including flat, winged, thick, thin, straight, coiled, short, long, woody, fleshy, splitting open, or indehiscent to facilitate dispersal by animals, wind, and water.

The family is divided into three subfamilies: Papilionoideae, Caesalpinioideae, and Mimosoideae, identified by their flowers. The Papilionoideae is the largest of the three subfamilies and the most widespread, extending farther into temperate regions. This subfamily can be easily recognized by its butterfly-like flowers. Most of the important legume crop species consumed by humans, including soybean, field pea, chickpea, field bean, and peanut, are in this group.

The subfamily Caesalpinioideae is comprised of tropical or subtropical trees and shrubs. The useful products derived from this subfamily include edible fruits *(Tamarindus indica)*, senna medicine (*Senna* spp.), hematoxylon red dye from the logwood tree *(Haematoxylon campechianum)*, and resins used in paints, varnishes, inks, plastics, adhesives, and fireworks derived from the copal (*Copaifera* spp.) tree.

The subfamily Mimosoideae includes species of industrial, forage, browsing, and fodder importance, such as *Acacia* spp. (Bisby et al., 2000). The Australian blackwood *(Acacia melanoxylon)* tree provides useful timber, and gum arabic from the tree of that name *(Acacia senegal)* is used in an array of industrial processes.

Nitrogen Fixation

Most legumes convert atmospheric nitrogen into nitrogenous compounds useful to plants. Root nodules containing *Rhizobium* bacteria fix free nitrogen for the plants. In return, legumes supply the bacteria with carbon produced by photosynthesis. This symbiosis provides the nitrogen needed by the plants for survival. Root nodules form in all subfamilies except in rare cases among the Caesalpinioideae.

The basic process of nitrogen fixation involves penetration by the *Rhizobium* through the root hairs into the cortex, where cell division occurs. These tetraploid cells produce the nodules that appear on the root surface. The nodule growth and efficiency are influenced by the carbon-nitrogen ratio of the plant and by the presence in the soil of phosphate, calcium, magnesium, molybdenum, and boron. If the nodules are ineffective, the bacteria may be parasitic on the host plant. Effective nodules contain red leghemoglobin, which can be seen when the nodules are cut. Ineffective nodules are usually small, hard, spherical, and a greenish color inside. Legumes produce more nodules in the tropics in acid soils and soils deficient in phosphorus, calcium, and other nutrients than in temperate areas. Many strains of *Rhizobium* occur in nature with multiple hosts, and several *Rhizobium* species occur with one host (Purseglove, 1981). Many scientists suggest inoculating legume seeds with the appropriate strain of *Rhizobium* for best agricultural results. This inoculation technique is accomplished by mixing the *Rhizobium* in water to form a slurry and then adding it to the seed.

Origin

The primary temperate legumes used for human food include garden pea *(Pisum sativum)*, field pea *(Pisum arvense)*, winged pea *(Tetragonolobus purpureus)*, green bean *(Phaseolus vulgaris)*, runner bean *(Phaseolus coccineus)*, butter bean *(Phaseolus lunatus)*, lima bean *(Phaseolus limensis)*, soybean *(Glycine max)*, lentil *(Lens culinaris)*, and broad bean *(Vicia faba)*. These legumes originated in humid, subhumid, cool season, subtropical, semiarid, and temperate areas in diverse regions ranging from Southwest Asia and East Asia to the Mediterranean, Peru, Mexico, and Guatemala (Muehlbauer, 1993).

Common tropical legumes consumed by humans include winged bean *(Psophocarpus tetragonolobus)*, jicama *(Pachyrhizus erosus* and *Pachyrhizus tuberosus)*, chickpea *(Cicer arietinum)*, black-eyed pea *(Vigna unguiculata unguiculata)*, and peanut *(Arachis hypogaea)*. These tropical legumes originated in areas characterized by humid, semiarid, cool season, subtropical, and tropical climates, primarily including South America, Southwest Asia, Ethiopia, India, Japan, China, and West Africa (Hymowitz, 1990).

History. Soybean, one of the most popular legumes, is one of the oldest cultivated crops. Cultivated soybeans probably arose from a wild type in Asia and moved to Europe and North America in the eighteenth century. Soybean soon became the third most important agronomic crop in the United States. Cowpeas were introduced to the West Indies and ultimately spread throughout the southern United States after the seventeenth century. Field beans (*Phaseolus* spp.) were cultivated by American Indians at the time of the European discovery of North America and soon were introduced to Europe. The popular peanut, introduced into the United States from Brazil when the colonies were established, was commercially developed in the mid-eighteenth century.

Peas, including garden peas, field peas, broad beans, lentils, and chickpeas, were introduced into the Americas from Europe and the Near East. Jicama is grown in Southeast Asia, Mexico, and Central America. Winged beans were introduced into more than sixty countries, primarily subtropical and tropical, after the mid-1970s.

Primary Food Legumes

***Soybean* (Glycine max).** Soybean is the most important legume produced in the agricultural industry worldwide. It is an annual crop, is easy to grow, and is adapted to a temperate climate. A hot weather crop, soybean requires a minimum of 59ºF (15°C) for seed germination and mean temperatures of 68–77ºF (20°–25°C) for crop growth. Only moderate soil moisture is needed for germination and seedling establishment, but dry weather is essential for dry seed production. Soybeans suffer when the soil is waterlogged, and established plants tolerate drought.

Soybeans should be fertilized with phosphorous, potassium, and micronutrients, and they require typical agricultural field preparation. The important differences among soybean cultivars are day-length response, pest resistance, and production. These varieties are subdivided into groups according to tropical, subtropical, or temperate climate adaptation (Martin, 1988).

Several major obstacles obstruct optimum soybean production. Diseases cause one-eighth of all soybean losses. Noteworthy diseases and their causal agents include bacterial blight *(Pseudomonas glycinea)*, bacterial pustule *(Xanthomonas phaseoli* var. *sojense)*, and wildfire *(Pseudomonas tabaci)*. However, the most devastating diseases are caused by fungi, including brown stem rot *(Cephalosporium gregatum)*, stem canker *(Diaporthe phaseolorum* var. *batatatis)*, pod and stem blight *(Diaporthe phaseolorum* var. *sojae)*, brown spot *(Septoria glycines)*, and sclerotial blight *(Sclerotium rolfsii)*. Mosaic virus disease, root knot nematode (*Meloidogyne* spp.), and cyst nematode *(Heterodera glycines)* also cause significant soybean losses.

The chemical composition of mature soybeans varies with the cultivar plus the soil and climate conditions. Generally, the black-seeded cultivars are protein rich with low oil content, and the yellow-seeded types are oil rich with low protein. The nutritional components of dried seeds are 5.0 percent to 9.4 percent water, 29.6 percent to 50.3 percent protein, 13.5 percent to 24.2 percent fat, 14.0 percent to 23.9 percent carbohydrate, 2.8 percent to 6.3 percent fiber, and a large amount of vitamin B. Soybean seeds contain a higher amount of protein than any other pulse and most other foodstuffs.

Soybean oil is about 51 percent linoleic acid, 30 percent oleic acid, and 6.5 percent linolenic acid and is used as a cooking oil, salad oil, shortening, and margarine. Soybean flour is mixed with wheat flour in baked products, such as bread, cakes, cookies, and crackers, and it is also used in ice cream, candy, and pudding. In Asia soybeans are consumed as soybean milk, soy sauce, soups, drinks, breakfast foods, and vegetables. People in eastern Asia eat unripe seeds and dried seeds, and elsewhere these large seeds are consumed as shelled green beans or as dry beans. Both the Bansei and the Green Giant cultivars are among the more popular soybeans. In the West soybeans are a primary ingredient of Worcestershire sauce, made by mixing boiled beans with wheat flour and salt, then fermenting the mixture with the fungus *Aspergillus oryzae* for up to one week. The fermented beans are submerged in brine and exposed to the sun for several months to extract the flavor. In Indonesia boiled beans are fermented with *Aspergillus* and formed into cakes.

Soybeans are used industrially in paints, linoleum, inks, soaps, insecticides, and disinfectants. Soy meal, the residue of oil extraction, is a healthy livestock feed (Purseglove, 1981). Soybeans are also used in the pharmaceutical and nutraceutical industries. For example, Ensure glucerna, a dietary aid for diabetics, includes soybeans, and Estroven, marketed as a dietary supplement with natural phytoestrogens, contains isoflavones, a group of antioxidants found in both humans and legumes, extracted from soybeans. While isoflavones do not show antioxidant activity in legumes, they serve various roles as protectants, attractants, and repellents. Because of their antioxidant characteristics, it is possible that isoflavones make a healthy contribution to the human diet.

Groceries and other retail stores sell products that contain soybeans in some form, and American and Oriental restaurants offer foods with soybean constituents. In addition, many products sold as dietary supplements or nutraceuticals in health food stores include soybeans.

***Field peas* (Pisum arvense and Pisum sativum).** The green pea type of field pea became a food source in the sixteenth century. Field peas grow during the cool season and develop flowers and seeds as the days become longer. Field peas have a variety of uses, and production has increased worldwide. At the beginning of the twenty-first century, U.S. production was estimated at 200,000 hectares, and Canadian production exceeded that threefold. Major diseases include Ascochyta blight *(Ascochyta*

GLOSSARY

Biome—The world's major communities classified according to the predominant vegetation and characterized by adaptations of organisms to that particular environment

Carpel—A single member of a compound seed-bearing flower organ.

Cortex—The primary plant tissue between the vascular system and the epidermis of the stem and the root.

Cover crop—A crop grown between orchard trees or on fields between cropping seasons to protect the land from leaching of nutrients and erosion.

Diversity—Variety of life on the planet.

Fodder—Coarse plants harvested whole and cured in an erect position.

Forage—Plant matter, fresh or preserved, gathered and fed to animals.

Green manure—Any crop or plant grown and incorporated into the soil.

Hay—Fine-stemmed plants cut and cured for forage.

Heme—Iron-protoporphyrin IX, a ubiquitous prosthetic group structurally associated to many enzymatic, regulatory, transport, and binding proteins.

Herbivorous—Animals that consume only plant material.

Indehiscent—Remaining persistently closed.

Lectin—Proteins or glycoproteins of nonimmune origin that agglutinate cells and precipitate complex carbohydrates. They are valuable for blood grouping and erythrocyte polyagglutination, mitogenic stimulation of lymphocytes, lymphocyte subpopulation studies, fractionation of cells and other particles, and histochemical studies of normal and pathological conditions.

Leghemoglobin—Heme-containing, oxygen-binding protein found in plants.

Ovary—The part of the pistil (the seed-bearing flower organ) that contains the ovules.

Parasitic—An organism living or feeding on another organism to the detriment of the host organism.

Pasture—Land with forage plants used for grazing animals.

Petal—A division of the corolla (the inner floral envelope).

Pinnate leaf—Compound leaf with leaflets arranged on each side of a common axis.

Pulse—Legume plants or seeds used for food.

Sepal—A division of a calyx (the outer floral envelope).

Silage—Forage preserved in a succulent condition by partial fermentation in a tight container.

Style—The portion of the seed-bearing flower organ that connects the stigma and the ovary.

Tetraploid—An organism whose cells contain four haploid (4n) sets of chromosomes or genomes.

Trifoliate—Having three leaflets.

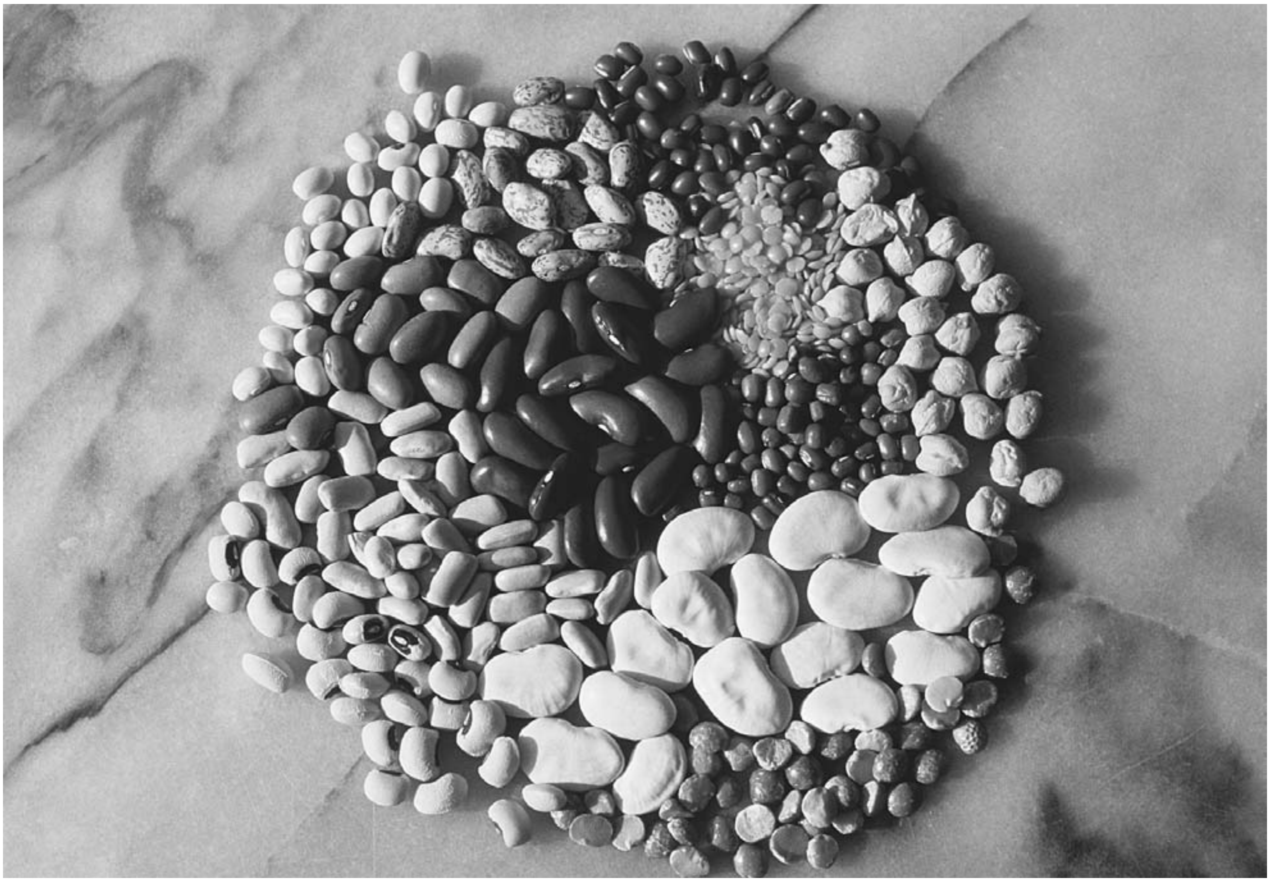
pisi and *Ascochyta pinodella)*, bacterial blight *(Pseudomonas pisi)*, and fusarium wilt *(Fusarium oxysporum* f. *pisi)*. Significant insect pests are the pea weevil *(Bruchus pisorum)*, the pea aphid *(Illinoia pisi)*, and particularly the root knot nematode *(Meloidogyne incognita)*. The wrinkled-seed types of field peas are canned in the immature stage, and the smooth-seed types are eaten as dried peas.

Field peas are usually grown as winter annuals in regions receiving 450 to 500 millimeters of rainfall annually. Generally, field peas perform best on well-drained soils with pH between 6.0 and 7.5. Nitrogen fertilization is not needed, but phosphorus, potassium, and sulfur are required (Muehlbauer, 1993).

The nutritional components of dried seeds are 10.6 percent water, 22.5 percent protein, 1 percent fat, 58.5 percent carbohydrate, and 4.4 percent fiber. Fresh green peas are about 74.3 percent water, 6.7 percent protein, 0.4 percent fat, 15.5 percent carbohydrate, and 2.2 percent fiber. These legumes are a major source of human dietary protein worldwide but are of minor importance in the United States. The seeds are consumed as a fresh vegetable and are canned, frozen, and dried. Field pea pods are also edible. Worldwide field pea plants are used for forage, hay, silage, and green manure (Purseglove, 1981).

***Field beans* (Phaeolus *spp.*).** Brazil, the United States, Mexico, and Italy are the leading producers of field beans. In the United States the common field bean is grown primarily in New York, Michigan, and west of the Mississippi River. Suitable for a variety of soil types, beans are a warm season annual crop. The optimum temperature is 63–77°F (17–25°C), and the beans need 120 to 130 days without frost.

Field bean crops require fertilization with phosphorus and potassium, and zinc is often needed in residual amounts. Because beans are planted in warm soil after all danger of frost is past, planting dates vary from early April to early July according to geographic location. Dry beans are harvested after the pods turn yellow and prior to seed scattering (Martin and Leonard, 1967). Field beans are



Legumes are not only a nutritious addition to the diet, they are also attractive as decorative seeds, as this artistic arrangement of lentils and beans demonstrates. © MICHELLE GARRETT/CORBIS.

subject to a wide array of diseases, including bacterial blight *(Xanthomonas phaseoli)*, anthracnose *(Colletotrichum lindemuthianum)*, and common bean mosaic virus. Insect pests that cause substantial damage and loss are the bean weevil *(Acanthoscelides obtectus)* and the Mexican bean beetle *(Ephilachna varivestris)*.

Rich in the amino acids lysine and tryptophane, field beans are one of the most important sources of human dietary protein. Dried adzuki beans *(Phaseolus angularis)*, consumed in Japan and China in soups and cakes, are about 21 percent to 23 percent protein, 0.3 percent fat, and 65 percent carbohydrate. Mung beans *(Phaseolus aureus)* are about 9.7 percent water, 23.6 percent protein, 1.2 percent fat, 58.2 percent carbohydrate, and 3.3 percent fiber. The green mung bean pods are edible, and the fried seeds are popular in India (Purseglove, 1981). Flour from the seeds is used in Indian and Chinese foods, and in the United States grocery chains and restaurants offer mung bean sprouts. Rice beans *(Phaseolus calcaratus)* are consumed in India, Burma, Malaysia, China, Fiji, and the Philippines. The beans are usually boiled, and the young pods and leaves are also eaten. Rice beans are about 10.5 percent water, 21.7 percent protein, 0.6 percent fat, 58.1 percent carbohydrate, and 5.2 percent fiber.

Central Americans consume the green and dried seeds of the scarlet runner bean *(Phaseolus coccineus)*. Lima or butter beans *(Phaseolus lunatus)* are eaten fresh, canned, or frozen in the United States. Dried lima beans are 12.6 percent water, 20.7 percent protein, 1.3 percent fat, 57.3 percent carbohydrate, and 4.3 percent fiber. However, the green beans contain about 66.5 percent water, 7.5 percent protein, 0.8 percent fat, 22.0 percent carbohydrate, and 1.5 percent fiber. The mature beans contain the glucoside phaseolutanin, which gives them their characteristic taste. Because the seeds contain hydrocyanic acid, the cooking water should be boiled and changed during preparation to dissipate the acid.

Black grams *(Phaseolus mungo)* are highly prized in vegetarian diets in India. They can be boiled or eaten whole, and they are ground into a flour used to make porridge or baked into bread and biscuits. The green pods are also edible. Dried black grams are about 9.7 percent water, 23.4 percent protein, 1.0 percent fat, 57.3 percent carbohydrate, and 3.8 percent fiber (Purseglove, 1981).

The most popular and most widely used beans are known as French beans, kidney beans, runner beans, snap beans, and string beans and are sold throughout the world in grocery stores and restaurants. These are the primary protein food in Latin American and tropical Africa, and in Europe and the United States they are grown for the immature pods, which are consumed fresh, canned, and frozen. The popular baked beans are made with any of these types of whole dried beans cooked with tomato sauce.

***Winged bean* (Psophocarpus tetragonolobus).** The winged bean is a perennial vine that climbs by twining. Usually grown as annuals, the plants flower during short days. Scarifying winged bean seeds induces better germination. Seeds are planted anytime during the year and germinate within five to fifteen days. The plants tolerate various soil types, including heavy, poorly drained, riverbank, sandy, and infertile soils. Organic material in soil promotes successful winged bean growth; otherwise a small amount of mineral fertilizer is generally recommended. While few pests attack winged beans, geese and chickens consume the plants, and damage by cowpea aphids and root knot nematodes has been reported (Martin and Delpin, 1978).

Winged bean leaves, flowers, shoots, immature pods, mature dried seeds, and tubers, which are highly nutritious, are primarily consumed in Papua New Guinea, South Asia, and Southwest Asia. The young, tender pods, sliced or chopped, are eaten raw. The mature dried seeds are especially nutritious because of their high protein content, 30 to 42 percent. These mature seeds can be steamed, boiled, fried, roasted, or made into milk or tofu. The beans contain some antinutritional substances, thus the seeds should always be soaked overnight and then boiled in water until tender. Oil derived from winged beans contains behenic acid, linoleic acid, and tocopherols (vitamin E). Behenic acid reduces the digestibility of winged beans. Tocopherols are antioxidants that improve the utilization of vitamin A in the human body.

Winged bean tubers, which have a protein content of 8 to 20 percent, are eaten boiled, steamed, fried, or baked in Burma and Papua New Guinea. Winged bean sprouts and shoots are consumed raw or cooked. Usually only the top three leaves are eaten. The flowers, steamed or fried, taste similar to mushrooms. The seeds contain several antinutritional phytochemicals, such as trypsin and chymotrypsin inhibitors, amylase inhibitors, phytohemagglutinins, and cyanogenic glycosides. The seed inhibitor activity can be safely eliminated only by moist heat, that is, by soaking the seeds for ten hours and then boiling them for thirty minutes. Both vanilla- and chocolate-flavored milks have been produced from the seeds in Thailand. Scientists have developed snacks of the tubers sliced thin, fried, and salted or softened in sugar syrup. Immature winged bean pods are pickled in southern India (Martin and Delpin, 1978). *Psophocarpus tetragonolobus* lectin is derived from winged bean seeds and is used commercially in medical diagnostics.

Uses for Legumes

Senna occidentalis—Potential bactericidal, pesticidal, and viricidal plant. It also contains tannin, which is an antidiarrhetic, an antioxidant, and an antiviral agent and has cancer preventive potential.

Crotalaria juncea—Sunn hemp, known as a multiple-use small-tree crop. It is used in paper making and as green manure and has bactericidal qualities. Sunn hemp contains pectin, which has antidiabetic, antidiarrhetic, antitumor, antiulcer, and cancer preventive potential. Sunn hemp has been used in Iraq to treat psoriasis.

Mucuna pruriens—Velvet bean, a green manure crop and a nutraceutical in the United States. The seeds contain L-dopa, which is used in the treatment of Parkinson's disease, beta-sitosterol, a potential anti-inflammatory, antileukemic, antitumor, cancer preventive, and estrogenic agent; gallic acid, a potential antioxidant, antiseptic, antiviral agent, and cancer preventive; and lecithin, a potential Alzheimer's preventive. Velvet bean is also used in India, Venezuela, and Mexico to treat asthma, snake bites, cancer, coughs, diarrhea, mumps, ringworm, syphilis, and tumors and as a scorpion antidote.

***Jicama* (Pachyrhizus erosus *and* Pachyrhizus tuberosus).** Jicama is a tuberous legume commonly grown in Mexico on commercial farms and intercropped with maize and beans on smaller farms. It is also monocropped in Thailand, Malaysia, and Hawaii. Jicamas are usually grown from seeds, however, sprouted tubers are occasionally used. In Mexico tuber yields are highest when planted in March and harvested from September to November, and in Hawaii maximum tuber yields occur when planted in September or October and harvested five months later. Thus jicamas require a hot subtropical to tropical climate with moderate rainfall. They tolerate some drought but are sensitive to frost. They attract few pests but occasionally are attacked by the rose beetle *(Adoretus versutus)* and the bean common mosaic virus (Grum, 1990).

The edible portion of jicamas are about 87.1 percent water, 1.2 percent protein, 0.1 percent fat, 10.6 percent carbohydrate, and 0.7 percent fiber. The tubers are eaten raw or cooked. The young pods from *Pachyrhizus erosus* are prepared like French beans, but the mature seeds and roots of that plant contain a toxic substance known as rotenone. Young pods of *Pachyrhizus tuberosus* are avoided because they have irritant hairs (Purseglove, 1981).

***Chickpea* (Cicer arietinum).** Chickpea is the major pulse crop in India, where production reaches 7 million hectares. In the United States, chickpeas are primarily grown in California, Washington, and Idaho. These legumes have a high phosphorus requirement, and both potassium and sulfur should be added if the soil is deficient in either. Chickpeas are adapted to dry conditions and generally flourish on well-drained soils of pH 6.0 to 7.5. The major chickpea pests include gram blight *(Mycosphaerella rabiei)*, rust *(Uromyces ciceris-arietini)*, wilt *(Rhizoctonia bataticola* and *Fusarium orthoceras)*, and gram caterpillar *(Heliothis armigera)*.

Chickpeas are important in India, where the dried seeds are boiled and the green pods and shoots are prepared in a variety of ways. Flour made from chickpeas is used in many Indian confections. The common chickpea, also called garbanzo bean, is used in the United States primarily in salads and as a vegetable side dish. Dried chickpeas are about 9.8 percent water, 17.1 percent protein, 5.3 percent fat, 61.2 percent carbohydrate, and 3.9 percent fiber (Purseglove, 1981).

***Peanut* (Arachis hypogaea).** Peanuts, called groundnuts in other parts of the world, are one of the most important crops in the southern United States, primarily in Georgia, Texas, Oklahoma, North Carolina, Alabama, and Virginia. Other leading production countries include India, China, Nigeria, Senegal, Indonesia, and Brazil. An annual crop with a growing season from 1 May to 1 November in the United States, the peanut prefers sandy loam soils. Adequate soil moisture and high temperatures are necessities for seed germination and plant growth. Peanuts respond best when the pH is above 5. The American peanut is classified into three botanical types based on the shape of the nut and growth characteristics: Virginia (bunch and runner growth types), Spanish (bunch growth type), and Valencia (bunch growth type). Crop rotation is recommended because peanut yields are good following cotton or other nonleguminous crops, and applications of lime and potash usually increase yields. Peanuts suffer from cercospora leaf spots *(Cercospora arachidicola* and *Cercospora personata)*, stem and peg rots *(Sclerotium rolfsii)*, and tomato spotted wilt virus.

Peanuts are consumed by humans throughout the world as peanut butter, in candies, and as cooking oil. Peanut oil is about 53 percent oleic acid and 25 percent linoleic acid. The Virginia peanut is 38 percent to 47 percent oil, and the Spanish peanut is 47 percent to 50 percent oil. Shelled peanuts are about 5.4 percent water, 30.4 percent protein, 47.7 percent fat, 11.7 percent carbohydrate, and 2.5 percent fiber. The primary proteins in peanuts are arachin and conarachin, and peanuts are rich in vitamins B and E (Pattee and Young, 1982). Some people have allergenic reactions to certain types of peanuts. The peanut allergens designated as Ara h 1, Ara h 2, and Ara h 3 are glycoproteins with a molecular mass of 63 kilodaltons and are present in raw and roasted peanuts since they are heat stable and may be found in any peanut type. Peanut proteins, including arachin, conarachin, peanut agglutinin, and peanut phospholipase, can also be allergens. Other important phytochemicals in peanuts are protocatechuic acid, which has shown potential antioxidant and pesticidal qualities, and lecithin, which has shown antioxidant activity (Beckstrom-Sternberg and Duke, 1994). A lectin derived from peanuts is used commercially in medical diagnostics.

***Cowpea* (Vigna *spp.*).** Cowpeas led U.S. legume production until about 1941, when they were replaced by soybeans, clovers, and other special-purpose legumes. Cowpeas are produced in California on a fairly large scale, and they are cultivated in Africa, southern Asia, and the Mediterranean region of Europe. A short-day, warm-weather crop, they should be planted in warm soil after all danger of frost has passed. However, severe drought will prevent seed formation. Cowpeas grow well in sandy or clay soils with good water drainage. The common black-eyed pea *(Vigna unguiculata)* is by far the most important cowpea variety.

Common diseases include cowpea wilt *(Fusarium oxysporum* var. *tracheiphilum)*, cowpea root knot nematode *(Meloidogyne* spp.), charcoal rot *(Macrophomina phaseoli)*, and viral diseases. The chief insect problems are the cowpea weevil *(Callosobruchus maculatus)* and the southern cowpea weevil or four-spotted bean weevil *(Mylabris quadrimaculatus)*.

Legumes Cultivated for Phytochemicals

Jack beans *(Canavalia ensiformis)* are cultivated primarily for their phytochemicals. The ripe, dried seeds are about 11.0 percent water, 23.4 percent protein, 1.2 percent fat, 55.3 percent carbohydrate, and 4.9 percent fiber (Purseglove, 1981). Jack bean seeds are the only source of the lectin known as concanavaline-A, which is used in medical diagnostics. Lectins extracted from several other legumes, including sunn hemp *(Crotalaria juncea)*, red kidney beans *(Phaseolus vulgaris)*, and field peas *(Pisum sativum)*, are used in medical diagnostics also. Guar seeds *(Cyamopsis tetragonolobus)* contain galactomannan gum, which is used in food additives; industrials; pharmaceuticals; confectionaries, including cereal, ice cream, and candy (Whistler and Hymowitz, 1979); and nutraceuticals, such as Ensure glucerna.

Kudzu (*Pueraria* spp.) produces isoflavones used in nutraceuticals for natural estrogen therapy, such as Estroven. A nutraceutical known as kudzu root is sold in powder form. Velvet bean *(Mucuna pruriens)* extract is

TABLE 1

Minor legumes with special-purpose value

Name		Use		
Scientific	**Common**	**Agricultural**	**Bioactive**	**Phytochemical (Pharmacological)**
Canavalia ensiformis (L.) DC.	Jack bean	Forage, green manure, pulse	Pesticide	Concanavalin-A (lectin) Canaline (allelochemic)
Crotalaria juncea (L.)	Sunn hemp	Paper, green manure	Bactericide, pesticide	Pectin (antidiabetic, antidiarrhetic, antitumor, antiulcer, cancer preventive)
Mucuna pruriens (L.) DC.	Velvet bean	Green manure	Bactericide, pesticide, viricide	Beta-sitosterol (anti-inflammatory, antileukemic, antitumor, cancer preventive, estrogenic) Gallic acid (antioxidant, antiseptic, antiviral, cancer preventive) Lecithin (anti-Alzheimeran, hepatoprotective)
Rhynchosia minima (L.) DC.	Snout bean	Forage	Fungicide, pesticide, viricide	Gallic acid (see above) Protocatechuic acid (antiasthmatic, antioxidant)
Senna occidentalis (L.) Link	Coffee senna		Bactericide, pesticide, viricide	Tannin (antidiarrhetic, antioxidant, antiviral, cancer preventive)
Tephrosia purpurea (L.) Pers.			Pesticide	Rutin (antidiabetic, anti-inflammatory, antioxidant, antitumor, antiviral, cancer preventive)

marketed as an antiparkinsonian herbal supplement or nutraceutical. See Table 1 for additional legume phytochemicals.

Legumes Cultivated for Animal Food

Legume species used for forage include *Aeschynomene*, *Desmodium*, *Leucaena*, *Macroptilium*, *Neonotonia*, *Stylosanthes*, *Desmanthus*, *Macrotyloma*, *Sesbania*, and *Trifolium*. Several species, including *Desmanthus virgatus*, *Stylosanthes scabra*, and *Stylosanthes guianensis*, have been tested in the southeastern United States for possible forage production. *Stylosanthes hamata*, *Stylosanthes humilis*, *Macroptilium atropurpureum*, *Macroptilium bracteatum*, *Neonotonia wightii*, and *Lotononis bainesii* are grown successfully as pasture legumes in Australia and show potential for use in the United States (Morris, 1997).

Other Uses for Legumes

Several legumes have multiple uses as human foods, animal feeds, ornamentals, cover crops, green manure, and erosion control plants. Minor legumes used primarily for cover crops, forage, and green manure worldwide include calopo *(Calopogonium mucunoides)*, centro *(Centrosema pubescens)*, and tropical kudzu *(Pueraria phaseoloides)* (Morris, 1997).

Indigofera arrecta was once cultivated in India for indigo dye, but it declined significantly with synthetic dye production. In Central Africa, however, indigo dye derived from the plant is still used. Dhaincha *(Sesbania bispinosa)* produces galactomannan gum and is grown also for soil improvement, fiber for paper pulp, fodder, and its ornamental qualities. Lead trees *(Leucaena leucocephala)*, similar in growth to mimosa trees, are used for paper products and as cover crops, fodder, pastures, green manure, and ornamentals (Morris, 1997). Other legumes are important in reclamation of mined soils, polluted soils, deforested areas, and soils with poor nutritional conditions (Morris, 1997).

Legume Traditions

The expression "blackball" comes from the ancient Greek and Roman practice of using beans for voting. A white bean signifies acceptance, while a black bean means rejection. The black-eyed pea is eaten on New Year's Day in the southern United States to bring good luck for the coming year.

The Navaho-Ramah Indian tribe used an annual clover known as *Trifolium dubium* as a ceremonial medicine. For a dermatological remedy the Iroquois used a wild bean known as *Strophostyles helvola*, and the Pawnees used spider bean *(Desmodium illinoensis)*. Bush clover or rabbit foot *(Lespedeza capitata)* was an antidote in the Fox tribe and an analgesic for the Omahas and Poncas. The Cherokees chewed tickseed or trefoil *(Desmodium*

TABLE 2

Ethnobotanical uses of minor legumes

Scientific name	Common name	Uses	Countries
Canavalia ensiformis (L.) DC.	Jack bean	Kidney and tonic	China
Clitoria ternatea (L.)	Butterfly pea	Arthritis	Philippines
		Scorpion bite	Sudan
		Laxative	Samoa
		Snake bite	Iraq
Crotalaria juncea (L.)	Sunn hemp	Psoriasis	Iraq
Crotalaria retusa (L.)	Rattle box	Fever	Java
Desmodium adscendens (Sw.) DC.	Tick clover	Bronchitis, colic, ringworms, wound	Africa
		Cough	Cameroon
		Laxative	Ghana
Desmodium gangeticum (L.) DC.		Dysentery, fever, tonic	India
Indigofera tinctoria (L.)	Common indigo	Fever, inflammation, laryngitis, mumps, scabies, swelling, dysentery	China
		Antiseptic, fever	Turkey
Leucaena leucocephala (Lam.) de Wit	Lead tree	Fever, typhoid	Bahamas
		Laxative	Dominican Republic
Mucuna pruriens (L.) DC.	Velvet bean	Scorpion antidote, asthma, snake bite, cancer, coffee, cough, diarrhea, mumps, ringworms, syphilis, tumor	India, Venezuela, Mexico
Psophocarpus tetragonolobus (L.) DC.	Wing bean	Boil, tumor	Java
Tephrosia candida DC.	White tephrosia	Insecticide, piscicide	India, Java
Tephrosia cinerea (L.) Pers.		Fever, piscicide, venereal, tumor	Mexico, Guiana, Brazil, Venezuela
Tephrosia purpurea (L.) Pers.		Colic, piscicide	Sudan, Guiana, Mexico
Tephrosia vogelii Hook. f.	Fish poison bean	Insecticide, insect repellant, piscicide	India, Tanzania, Sudan, Africa

perplexum) roots for sore gums and mouths. The Mohegans made a blood purifier from rattle box *(Crotalaria sagittalis)* root, and the Delawares treated venereal disease with rattle box root (Beckstrom-Sternberg, Duke, and Wain, 1994). See Table 2 for additional ethnobotanical and multicultural uses of legumes.

See also **Nuts**; **Peanut Butter**; **Peas**.

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LENT. The word "Lent" is derived from Old English *lencten*, meaning 'spring', the lengthening of days after winter is over. This was a period of spring fasting known in Old English as Lencten-Fasten, or in its abbreviated form, as Lencten or Lent. The ecclesiastical name for this once mandatory period of fasting is the Quadragesimal Fast, or the fast of the Forty Days, in imitation of the forty days of fasting performed by Jesus in the wilderness.

Like other institutions of Christianity, Lent took time to evolve into its full medieval form. Fasting was practiced in the early Christian Church and was viewed as an aid to prayer. Credence was given to the practice by a statement of Jesus: "When the bridegroom shall be taken from them, then shall they fast" (Matthew 9:15). What was called "half-fasting" was practiced very early on Wednesdays and particularly on Fridays to commemorate the passion or crucifixion of Christ. The Friday fast, as well as the Lenten fast, is still practiced by Roman Catholics, Eastern Orthodox Christians, and some Protestants.

Historically, the forty-day fast reaches back to the second century C.E., although forty days were not always required. By the fourth and fifth centuries, the fasting took place on thirty-six days representing the six weeks prior to Easter, minus six Sundays since Sundays were not fast days. Later, four extra days were added to make forty: Ash Wednesday and the three days following it.

The medieval Catholic Church in general took a middle ground on fasting. Those who put too high a value on the merit of fasting were rebuked with the words of St. Paul: "The kingdom of God is not meat and drink, but righteousness, and peace and joy in the Holy Ghost." Some extremist heretical groups, such as the Montanists in the second century, fasted frequently on bread, water, and salt.

Abstinence involves refraining from certain foods, meat in the case of Lent, and indeed, during the Middle Ages, all animal products, including butter, lard for cooking, and eggs. Many cookery books contained special recipes designed to make use of non-animal ingredients, such as olive oil, almond milk, and dried fruit. But fasting also refers to the number and fullness of the meals one partakes of on fast days. Both practices are subsumed under penance or penitence, which involves contrition and reparation for sin in human life. Since Vatican II, the rules of Lenten fasting for Roman Catholics have been modified, but earlier they were quite elaborate and even published in newspapers so that the guidelines would be clearly set forth. The following regulations were in force during the 1950s.

Everyone over the age of seven was to observe the Roman Catholic Lent with complete abstinence on all Fridays, Ash Wednesday, and Holy Saturday Morning. During these times, meat and soup, or gravy made from meat, could not be used. During days of partial abstinence, which included the Saturdays in Lent (except the last one), meat and soup, or gravy made from soup, could be taken only once a day during the main meal. For those over twenty-one and under fifty-nine, only one full meal per day was allowed during the weekdays of Lent. Other meatless meals were allowed only to maintain strength, but could not equal another full meal. Eating between meals was not permitted, except for liquids, but those people whose health or ability to work were seriously affected by fasting could be excused from the regimen. Acts of charity and of self-denial (such as abstaining from alcoholic drinks and amusements) and daily attendance at mass were encouraged.

In 1966, following Vatican II, Pope Paul VI issued his "Apostolic Constitution on Penance" (*Poenitemini*), which gave present shape to the Roman Catholic Church's practice of abstinence. This papal clarification modified the elaborate rules for Lent. Still, all Roman Catholics between the ages of eighteen and fifty-nine were required to fast on Ash Wednesday and Good Friday. Everyone over the age of fourteen had to abstain from meat on Ash Wednesday, Good Friday, and all Fridays during Lent. Fasting was defined as taking only one meal per day, but with smaller meals permitted. Abstinence for Roman Catholics does not now include meat juices, broths, consommés, soups made or flavored with meat, meat-based gravies or sauces, margarine or lard. Even bacon drippings poured over salads and meat byproducts such as gelatin are now allowed. With the permission of the Episcopal Conference, many American Roman Catholics have substituted other forms of penance, such as works of charity or acts of piety, for the other meatless Fridays during the year.

By contrast, Orthodox Christians abstain from all meat products during most days of the Great Lent, and also from fish and animal products—lard, milk, butter, cheese, and eggs—together with wine and oil during Holy Week. The rigor and austerity of Orthodox fasting remains unchanged and follows the proscriptions of the early Church and its ecumenical councils. For the Orthodox, there are four main periods of fasting during the year: the Great Fast (Lent), the Fast of the Apostles (starting eight days after Pentecost), the Assumption Fast (from 1 to 14 August), and the Christmas Fast (from 15 November to 24 December). There are also a number of lesser fasts that fall outside the Lenten period.

Protestant attitudes to Lent range from complete rejection by denominations of Puritan and Pietist origin, to a rather full acceptance by Anglicans and Lutherans, who retain many practices similar to those of Catholicism. Even the Church of the Brethren, which in its sectarian, separatist beginnings opposed any celebration of the liturgical year, in the late twentieth century began, in some of its congregations, to hold special services on Ash Wednesday and the Sundays of Lent. Such services highlight repentance and prayer, but there are no special Lenten restrictions on food. There has been a movement among most of the Protestant churches to find common ground during Lent with such community-wide observances as the World Day of Prayer on the first Friday of Lent, and the One Great Hour of Sharing on the fourth Sunday of Lent with offerings dedicated to relieving world hunger.

In order to relieve the dietary austerity of Lent, and to enrich the formerly meager and restricted meals, special Lenten dishes developed in nearly all branches of Christianity. In the United States, they often appear in ethnic markets or in supermarkets catering to certain ethnic groups. One common theme is desserts, with sweet foods taking the place of meat. Recipes for Lent were once commonly published in the spring issues of women's magazines as well as in the food columns of daily newspapers. Cookbooks such as Florence S. Berger's *Cooking for Christ* (1949) and William I. Kaufman's *The Catholic Cookbook: Traditional Feast and Fast Day Recipes* (1965) generally include sections on Lenten meals and recipes that have been found acceptable under the canon law of the Roman Catholic Church.

See also **Christianity; Easter; Fasting and Abstinence: Christianity; Shrove Tuesday.**

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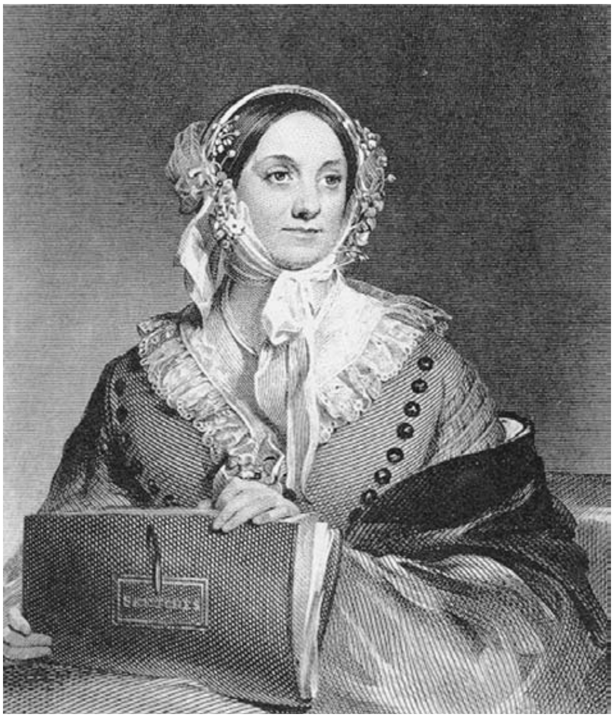
LESLIE, ELIZA. Eliza Leslie (1787–1858) was an American cookbook writer, poet, editor, and author of fiction and nonfiction for children and adults. Although her primary literary activity focused on *belles lettres*, Eliza Leslie is remembered today mainly for the cookery books that launched her career as an author and earned her a national reputation as one of the most popular and influential American food writers prior to the Civil War.

In 1828, Leslie edited and published *Seventy-Five Receipts for Pastry, Cakes and Sweetmeats*, a collection of recipes she had compiled many years earlier while a student at the cooking school of Elizabeth Goodfellow in Philadelphia. The book was an instant success and quickly assumed its place as the first bestselling cookbook in the United States. This was followed by *Domestic French Cookery* (1832), *Directions for Cookery* (1837), *The Lady's House Book* (1840), *The Indian Meal Book* (1846), the first cookbook devoted entirely to corn recipes, *New Receipts for Cooking* (1854), and *The New Cookery Book* (1857), this last title being a massive reworking of her *New Receipts*. Many of these books popularized regional American foods (such as terrapin and okra) at a time when America was searching for a more distinct culinary identity. Of these, *Directions for Cookery* is generally considered Leslie's most influential culinary work, since it remained in print well into the 1880s.



Portrait of Eliza Leslie from a copper engraving originally published in *Godey's Ladies'* Book. The engraving is based on an undated oil portrait by Thomas Sully in the collection of the Pennsylvania Academy of the Fine Arts, Philadelphia. ROUGHWOOD COLLECTION.

Okra Soup

Take a large slice of ham (cold boiled ham is best) and two pounds of lean fresh beef. Cut all the meat into small pieces. Add a quarter of a pound of butter slightly melted, twelve large tomatas pared and cut small, five dozen okras cut into slices not thicker than a cent, and a little cayenne pepper to your taste. Put all these ingredients into a pot, cover them with boiling water, and let them stew slowly for an hour. Then add three quarts of *hot* water, and increase the heat so as to make the soup boil. Skim it well and stir it frequently with a wooden or silver spoon.

Boil it till the tomatas are all to pieces and the okras entirely dissolved. Strain it, and then serve it up with toasted bread cut into dice, put in after it comes out of the pot.

This soup will be improved by a pint of shelled lima beans, boiled by themselves, and put into the tureen just before you send it to table.

FROM: *Directions for Cookery,* 32–33. Philadelphia: Carey and Hart, 1837.

Eliza Leslie's success has been attributed to several factors working in tandem: improved female literacy; a growing urban middle class in need of instruction on points of cookery according to American taste and ingredients; and the proliferation of the cookstove, the technological revolution upon which all of Leslie's recipes are based.

See also **Goodfellow, Elizabeth**; **Maize**.

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William Woys Weaver

LETTUCE. Lettuce has been described as a "weedy Cinderella" by T. W. Whitaker (1974) and as the "queen of the salad plants" by Franklin W. Martin and Ruth M. Ruberté (1975). What is this plant that merits two such disparate descriptions? It is certainly the most commonly used salad vegetable, occurring in or under most salads. Many types exist, varying in size, form, leaf shape, color, and taste. All of these types may have evolved from a weedy form that was used in ancient Egypt as a source of cooking oil from pressed seeds, so both descriptions are probably justified.

Among the several lettuce types, most of which are consumed as raw leaves, one is used for its stem instead of its leaves. This lettuce is depicted on the walls of tombs dating back to about 2500 B.C.E., during the Middle Kingdom of ancient Egypt. Lettuce is shown as a long stem with marks indicating where leaves had been removed. At the top of the stem is a tuft of elongated leaves, bluish green in color. This lettuce may have been the one that first was eaten and may have been derived in turn from the type used for seed oil. The blue color is associated with the process in the growth of lettuce called bolting or stem formation. Leaves that form in the development of the head are green. As the process of bolting begins, the leaves become bluish green, signaling the elongation of the stem, which emerges from the interior of the head and eventually produces many small, yellow flowers that mature into small, narrow fruits. The fruits are less than four millimeters long. They look like seeds and usually go by that name.

Oilseed lettuce is a primitive, wild-looking plant that forms no head or rosette of leaves. It bolts early in its growth cycle, forming a thin stem with elongated, narrow leaves. The seeds produced on this stem are about 50 percent larger than those formed on cultivated lettuce. The seeds are pressed to express an oil used in cooking. This is an ancient custom still practiced in twenty-first century Egypt.

Evolution of Lettuce

One can speculate that somewhere in time ancient Egyptians selected, perhaps from oilseed lettuce, plants that bolted more slowly and formed a thick stem that was less bitter than the more primitive type and therefore edible. This new stem lettuce also had somewhat broader leaves. Later, perhaps many centuries later, further selection may have yielded a newer form with a still shorter stem and broader leaves that were appealing enough to eat, the romaine type. From Egypt, romaine lettuce moved around the Mediterranean Sea and to the Middle East. In these areas it was the most commonly grown lettuce in the twenty-first century. The original stem type traveled eastward, eventually reaching China. Numerous mentions of lettuce in ancient literature, beginning with Herodotus in 550 B.C.E., document its travels into Persia, Greece, Rome, and Sicily and later into France, Germany, and England. Use of descriptive names, such as crispa and purpurea, and place names, such as Cappadocian and Cyprian, indicate further proliferation into various distinctive types differing in color, size, leaf shape, and adaptation to specific environments. The various modern butterhead, leaf, and crisphead forms undoubtedly were selected and developed as lettuce spread through Europe. Lettuce reached the shores of the New World with the second voyage of Christopher Columbus in 1494. Many

Chadwick's Rodan is a variety of lettuce developed in England for small kitchen gardens. It was created by Alan Chadwick, the "father" of organic gardening. PHOTO ROB CARDILLO.

varieties within the different types were brought to the Western Hemisphere in subsequent years.

The scientific name of lettuce is *Lactuca sativa. Lactuca* means 'milk forming', *sativa* means 'common'. It is related to over one hundred wild species of *Lactuca* and also to sunflower, artichoke, aster, and chrysanthemum. Among the modern types of lettuce are two crisphead forms, iceberg, which forms a large, firm head, and Batavia, which is slightly softer and smaller than iceberg and is popular in Europe. Romaine lettuce has long leaves in a loaf-shaped head. Butterhead lettuce is quite small with oily, soft textured leaves. Red and green leaf lettuces form no head and have leaves with a variety of shapes. Less commonly found are the Latin type, which looks like a small romaine, and the aforementioned stem and oilseed lettuces.

Preparing a Salad

Since lettuce is used mainly in salads, preparation methods are simple, rapid, and informal. The ubiquitous tossed salad is made of lettuce leaves cut up into various-sized pieces. To some people the use of a knife is anathema, and they tear the leaves by hand. The salad maker may use one type of lettuce alone or a mixture of two or more kinds. Depending upon the ingenuity of the salad maker and the availability of edibles, any combination of other vegetables, fruits, and even cheeses or meats can be added to the lettuce. A dressing is added, and the ingredients are mixed together. Salads are vital to many slimming diets, the effectiveness of which can be reinforced or negated by the calorie value of the chosen dressing.

In the United States head lettuce was for many years commonly cut and served as a wedge, covered with mayonnaise or another dressing, and eaten with a knife and fork. This simple salad was served less frequently by the beginning of the twenty-first century. The popular Caesar salad is made only with leaves of romaine lettuce tossed with a special dressing, including a raw egg and small pieces of anchovy. A relative newcomer to the salad scene is mesclun, a mixture of baby leaves consisting of several lettuce types and other leafy vegetables, some of which are fairly exotic. These may include arugula or rocket, actually a partially domesticated weed; a fine-leaved endive called *frisée*; mizuna, a small, dark green round leaf from Japan; spinach, beet tops, or chard; red chicory (radicchio); and romaine, butterhead, and red and green leaf lettuces. These leaves are cut in the field by hand, or mowed, when they are no more than ten centimeters long. In parts of the American Southwest wilted lettuce is a favorite salad made by pouring bacon fat over lettuce leaves.

Some salads consist primarily of other vegetables or fruits, such as sliced tomatoes or a scoop of cottage cheese. These are often arranged in a more formal manner than a tossed salad. Lettuce may find its way into these salads as whole or shredded leaves serving as a base for the main constituent.

Lettuce may also be used to make soup, as part of the filling for sandwiches, or as a wrap for holding cooked meat and vegetable mixes. Stem lettuce is consumed raw, like a stalk of celery, in Egypt or as a cooked vegetable in China.

The Biological Human Connection

Lettuce relates to human biology in several ways. The most obvious way is in its role as a food. Some less well-known relationships to human consumption also exist.

As a green vegetable, lettuce contains many of the same nutrients found in other green vegetables, although mostly in lesser amounts. These include vitamins, minerals, water, and fiber but essentially no protein or fat (Table 1). Lettuce is a low to moderate source of vitamins and minerals. Among the various types of lettuce, romaine and leaf varieties exceed crisphead and butterhead varieties for most of the common nutrients. This is directly related to the proportion of dark green leaves in the edible portion. The nutrient contribution of lettuce

TABLE 1

Selected nutritional values per 100 grams for crisp, butter, romaine, and leaf lettuces

	Minerals (g)					Vitamins		Water	Fiber
	Ca	P	Fe	Na	K	A (IU)	C (g)	%	g
Crisp	22	26	1.5	7	166	470	7	95.5	0.5
Butter	35	26	1.8	7	260	1,065	8	95.1	0.5
Romaine	44	35	1.3	9	277	1,925	22	94.9	0.7
Leaf	68	25	1.4	9	264	1,900	18	94.0	0.7

SOURCE: Adapted from Rubatzky and Yamaguchi (1997) as compiled from several original sources.

compared to other vegetables is affected by the amount consumed. For example, a study by M. A. Stevens in 1974 showed that broccoli has considerably more vitamins and minerals than lettuce but that much more lettuce was consumed than broccoli; therefore the total contribution of nutrients to the diet by lettuce was greater than that of broccoli. This relationship may have changed somewhat as consumption habits changed. Nonetheless lettuce is important for its nutrient content, which complements its usefulness as a diet food because of its high water and fiber content.

Prevention of Cancer

Research in recent years has identified a connection between the consumption of vegetables and certain other foods and beverages and anticarcinogenic activity due to the presence of compounds known as antioxidants. These compounds inhibit the formation of carcinogenic substances in the body. Among the antioxidant compounds in lettuce are 0-beta-carotene, a precursor to Vitamin A, and anthocyanin, which gives the red color in certain lettuce varieties.

The oil pressed from large seeds of certain primitive types of lettuce contributes to a minor food use. The oil is used for cooking and is similar to other oils used for the same purpose. This practice is believed to be hundreds, perhaps thousands of years old.

Nonfood Uses of Lettuce

Turning to nonfood uses, the stems and leaves of lettuce and its wild relatives contain a milky liquid called latex. The latex contains two substances called sesquiterpene lactones, which are the active ingredients in preparations used in some western European countries as a sedative and as a sleep inducer. In folk medicine additional uses for lettuce extracts include treatment for coughs, nervousness, tension, pain, rheumatism, and even insanity. The efficacy of these treatments is not well documented, but some of these effects have been shown in mice and toads.

Another minor nonfood use is drying lettuce leaves for the production of cigarettes without tobacco. Actually leaves of a wild relative of lettuce produce a more tobacco-like appearance. These have been manufactured for use in several brands of cigarettes. Effects on health are not known.

Rarely lettuce may impact human biology in a harmful way. Green leafy vegetables are normally the standard for healthful food, providing vitamins and minerals in a fresh, tasty, and light context. Nitrogen is a vital constituent of chlorophyll, the plant substance that gives the green color and controls photosynthesis. However, green leafy vegetables, including lettuce and spinach, when grown under low light and low temperature conditions in greenhouses in the winter, may accumulate high levels of the nitrate form of nitrogen. In the body nitrate may be converted to compounds that may cause the syndrome called blue baby in infants or may be carcinogenic. Fortunately the likelihood of these consequences is remote, since nitrate accumulation in greenhouse-grown lettuce can be prevented by growing the crop with adequate heat and with supplemental light. Lettuce grown outdoors is not subject to this problem.

Symbolism: Fresh, Cool, Green

The obvious symbolism associated with lettuce is three words, “fresh,” “cool,” and “green.” “Fresh” is a word that many think of as important to health. Lettuce is eaten fresh and raw. In the gardening months many can cut it and eat it almost immediately. It is not that fresh in the store bin of course, but it is still only a few days old. Even the leaves in a packaged salad were growing in the soil shortly before they appeared on the shelf. Lettuce is never frozen or canned.

Lettuce is kept cool. After being cut in the field it is transported to a cooler, where the temperature is quickly reduced to just one degree above freezing. It is transported in refrigerated trucks to a market, where it is kept in a cooler before being placed in a refrigerated bin. Finally, it is purchased by the consumer, taken home, and placed in the refrigerator. This sequence is called the cold chain and is designed to maintain the quality of the lettuce at the time of harvest in the field as long as possible.

Finally, lettuce comes in various shades of green. Even red lettuce contains chlorophyll, which confers the green color, though it may be hidden in the red parts of the leaf. Green means vitamins. Green is a cool color. Many also associate greenness with the health of the planet and with personal health. The process of photosynthesis produces oxygen and sugar converted from carbon dioxide and water. The absorption of carbon dioxide by green plants, from lettuce to trees, helps prevent its accumulation in the air, thus mitigating the greenhouse effect and possible global warming.

The symbolism of these words is so strong that they and similar words, such as "ice," "crisp," "winter," and "spring," have been used repeatedly in various combinations in the names of lettuce varieties. Consider the names Green Ice, Iceberg, Crisp as Ice, Coolguard, Green Towers, Valverde, Valspring, and Winterset.

In ancient Egypt lettuce had sexual symbolism. After completing its vegetative development with the formation of a head or a rosette of leaves, the plant goes into its reproductive phase with the formation of an erect seed stalk bearing flowers. The amount of latex in the plant increases and is under pressure, so if the top of the flowering stalk is cut off, the latex spurts out in a manner reminiscent of ejaculation. The same tomb paintings portraying the ancient stem lettuce also picture the god Min with an erect phallus. Consumption of lettuce may therefore have been thought to increase sexual prowess.

Commercial Production and Marketing

Lettuce has become a major player in commercial production and marketing. Total production worldwide does not compare with the major cereal crops, especially rice, corn, and wheat, or with other commodities, such as sugar crops, beans, and potatoes, but among the vegetables it ranks high. In the United States it is in the top three with tomatoes and potatoes. The key word in contemporary use of lettuce is change: in use of the various types, in development of world markets, in methods of marketing, and in methods of production.

The primary markets for lettuce were, until the late twentieth century, in western Europe and North America, the consequence of its first appearance in the Mediterranean basin followed by movement into northern Europe and then to the New World. In the late twentieth century lettuce became important in Japan, China, Hong Kong, Australia, and some countries of South America and Africa. In the different regions where lettuce was consumed, one type was usually more popular than the others. In northern Europe, for example, the butterhead type predominated. Until the 1970s about 80 percent of the lettuce consumed in England was butterhead, and the other 20 percent was divided among the other major types. In the countries surrounding the Mediterranean nearly all the lettuce was romaine. Stem lettuce was the main type in Egypt and China. In the United States, until the early part of the twentieth century, no one type was strongly dominant. At that time crisphead lettuce began to increase in popularity at the expense of the other types. After the modern iceberg lettuce was developed in the 1940s, 95 percent of the production and consumption was of this type. The first modern iceberg variety was created by T. W. Whitaker of the United States Department of Agriculture and was named Great Lakes, although it was actually bred in California.

Changes in Consumption Patterns

In the late 1970s and early 1980s changes in consumption patterns began. In Britain and Scandinavia iceberg lettuce increased in popularity until it became the dominant type. Iceberg lettuce also made inroads into the butterhead and romaine domains in other western European countries. In the United States, where the iceberg type reigned supreme for most of the twentieth century, romaine, butterhead, and leaf lettuces regained popularity and comprised about one-third of the total production at the end of the twentieth century.

The construction of a home-cooked meal has become a casualty of the modern fast-paced lifestyle. People either eat out more frequently or rely on food packages that are partially processed and therefore can be prepared quickly. Salads are included in this drive for efficiency and speed. Modern supermarkets have dedicated extensive shelf space to packaged salads containing what appears to be an infinite number of combinations of leaves (lettuce, cabbage, radicchio, spinach), cut vegetables (carrots, broccoli, cauliflower), dressings, bacon bits, shredded cheeses, croutons, cut fruits, and more.

Changes have also occurred in production methods. Growing, harvesting, and marketing of lettuce is mainly on a large scale, from planting, with significant inputs of water, chemical fertilizers, and appropriate pesticides, to harvesting, cooling, and shipment to market. Production of food with organic methods has become a rapidly growing industry although it is still a small part of the production picture. Lettuce is included in this cultural change. Most of the change has been in the production of nonheading types, such as romaine and leaf lettuce, but some iceberg lettuce is grown in this way. Organic production emphasizes nonuse of chemical fertilizers and pesticides. This type of production began with small-scale growers, but has been included by growers in large-scale production systems.

Where Lettuce is Grown

The need for coolness is a key factor in the location and magnitude of lettuce production areas. In the early twenty-first century the United States was by far the largest producer of lettuce in the world (Table 2). However, few of the fifty states produce lettuce commercially, and of the ones that do California and Arizona are responsible for over 90 percent of the production in the country. California alone accounts for over 70 percent and actually grows lettuce year-round. In the summer let-

TABLE 2

Commercial production of lettuce in the United States and the European Union

Area in hectares (1 hectare = 2.47 acres), production in millions of metric tons.

	Area	Production
United States (1997)	82,150	3,116
California	57,090	2,243
Arizona	21,900	765
European Union (1996)	90,200	2,351
Spain	33,600	925
Italy	21,300	420
France	13,500	366
United Kingdom	7,500	231
Germany	5,900	144
Greece	3,600	70
Belgium	2,500	85
Netherlands	2,300	110

SOURCE: Compiled from U.S. Department of Agriculture and Eurostat statistics for the years shown.

tuce is produced in coastal valleys near the Pacific Ocean, particularly in the Salinas Valley, which is the most important production region in the world. In the winter lettuce is produced in the desert regions of California and Arizona. For short periods in the spring and fall lettuce is grown in the great Central Valley of California. The coolness of the season is the reason for the movement from location to location. Lettuce grows best when the daytime temperature rarely exceeds 70 to 75°F (21 to 24°C). The desert and inland areas are too hot in summer, while the coastal areas are too cold in winter. Those locations and others with similar seasonal climates in other countries, such as eastern portions of England, the Mediterranean Coast, the Negev Desert in Israel, and the southeastern portions of Australia, produce nearly all the commercially grown lettuce in the world.

Lettuce is grown in home gardens worldwide. In warm climates lettuce growing is usually restricted to the spring and fall, when temperatures are more moderate than in summer or winter. Lettuce grows fast and is easy to grow, especially leaf lettuces, which are the ones most commonly found in the backyard garden.

See also **Oil**; **Organic Farming and Gardening**; **Salad**.

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LIPIDS. Lipids (fats and oils) have borne the brunt of the blame for the degenerative diseases (heart disease and cancer) that are the major causes of death in the developed world. The negative view of lipids has obscured their essentiality for human health. If a problem exists, it is one of quantity, in general, and specific lipids in particular.

Lipids are important for maintenance of human health and well-being in a number of ways. Probably the most important function of lipids is provision of an efficient energy source. Fat provides 9 calories of energy per gram or 2.25 times as much as either carbohydrate or protein. Carbohydrate is not stored in the body and protein stores are predominantly muscle, whose breakdown entails serious health consequences. Fat is stored as such and can be easily mobilized if needed. In primitive times survival may have been possible because of energy provided by metabolic use of stored fat (Gurr and Harwood, 1991).

Lipids are a group of substances of diverse structures that share the common trait of being soluble in solvents such as ether or benzene. The major lipids of the body are triglycerides, which comprise a molecule of glycerol to which three fatty acids are bonded. Phospholipids are substances in which glycerol carries only two fatty acids plus phosphoric acid and an organic base such as choline or serine. Cholesterol is a member of the family of large complex molecules generically called steroids. It has the capacity to carry one molecule of fatty acids (cholesteryl ester). Cell membranes are predominantly composed of phospholipids and cholesterol. Cell membranes confer stability to cells and control entry or release of chemicals into or from the cell. Lipids serve as effective insulators and help in maintaining body temperature. Important organs such as the heart, kidneys, and reproductive organs are cushioned by fat. Nerves are protected by a sheath (myelin) that contains cholesterol, phospholipids, and other lipids.The animal organism carries a number of essential substances that catalyze chemical reactions in cells. These are called vitamins and are designated by letters. The B and C vitamins are soluble in water; the others, vitamins A, D, E, and K, are insoluble in water but soluble in fats. They are transported in lipids in the blood and stored in fat in the body.

Chemistry

Cholesterol is a molecule that is found in the membrane of every cell. About 0.2 percent of the average body weight is cholesterol. Most of this cholesterol is present in the muscle (cell membrane) or brain (as insulation against trauma). The functions of cholesterol in the brain are still poorly understood. Most of the cholesterol in the body is manufactured in the liver, and the diet makes a relatively small contribution to this pool. Cholesterol, in turn, is the parent substance of a number of vital compounds. Among these are the bile acids that are necessary for proper absorption and digestion of fat; the corticosteroids such as cortisol and hydrocortisone that are essential to life; progesterone which is required for normal reproduction, and the male and female sex hormones. The involvement of cholesterol in the etiology of coronary heart disease will be discussed below.

Fatty acids are chains of carbon acids that culminate in an acidic group called a carboxyl group. Each carbon atom has the capacity to bind four other atoms. In the fatty acid chain, two of those binding elements are bound to the carbon atoms on either side, and the other two are bound to hydrogen atoms. If the hydrogen atoms on adjacent carbon atoms are missing, the two carbons (which are already bound by one bond) form a second bond, and these are called double bonds. A fatty acid lacking the maximum number of hydrogen atoms is called an unsaturated fatty acid. The most common fatty acid in the human body is palmitic acid (16:0, which designates sixteen carbon atoms and no double bonds). Oleic acid (18:1) is the next common fatty acid. The diet provides linoleic (18:2) and linolenic (18:3) acids, which are called "essential fatty acids," meaning fatty acids that are essential to life and health and cannot be synthesized by the human body. Linoleic acid is converted via arachidonic acid to a series of compounds with hormonal activity called prostaglandins. The prostaglandins are usually made within the tissue in which they act and are involved in diverse functions such as control of inflammation, uterine contraction during labor, and blood platelet aggregation. An important group of long-chain polyunsaturated acids (polyunsaturated fatty acids [PUFAs]) occur in the fats of cold-water fish such as salmon and cod. The two principal PUFAs are eicosapentaenoic acid (20:5) and docosahexaenoic acid (22:6). While these fatty acids do not necessarily affect blood cholesterol levels, their presence in the diet has been associated with a reduced risk of cardiovascular disease.They have been shown to be essential to development of normal vision and also to influence brain development in newborns (Innis, 1991).

Phospholipids are glycerol derivatives in which two of the hydroxyls are esterified to fatty acids and the third to phosphoric acid, which is, in turn, esterified to a base. In lecithin, the most abundant phospholipid, the base is choline. The fatty acid in the 2 position of a phospholipid is usually polyunsaturated. It is often arachidonic acid (20:4), a product of metabolism of essential fatty acid, and a direct precursor of prostaglandins.

Biochemistry

Blood is an aqueous medium that contains an appreciable amount of lipid. Normal blood serum or plasma appears as a pale yellow, clear liquid, because the fat has been emulsified to give water-soluble fat-protein aggregates. These aggregates are designated as lipoproteins and have a lipid core and a protein coat. Fat enters the lymph in the form of chylomicrons, which are large triglyceride-rich particles. In the course of circulation the triglyceride is deposited in or metabolized by cells and the particles become smaller in size. The lipoproteins can be separated physically on the basis of their hydrated density and are designated as very low-density lipoproteins (VLDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL). Although estimations of the lipid composition of the various lipoproteins are available, their size and shape may vary.

The proteins surrounding the lipid core (apoproteins) have been characterized and their biological functions catalogued. Thus, apolipoprotein AI (ApoAI) and apolipoprotein AII (ApoAII) are present only in HDL and are required for metabolism of the lipid portion of HDL. ApoAI activates lecithin-cholesterol acyltransferase, which is active in the synthesis of cholesterol esters, and ApoII is required for breakdown of the triglycerides by lipoprotein lipase.

Apolipoprotein B (ApoB) occurs only in LDL and is required for secretion of the triglyceride-rich lipoproteins. The exclusivity of ApoA and ApoB to HDL and LDL, respectively, is often used for determination of LDL/HDL ratios. Apolipoprotein E (ApoE) is present in both VLDL and HDL. It occurs in several modifications (isoforms), which may determine level of success in treatment of hypercholesterolemia and which have been hypothesized to influence susceptibility to Alzheimer's disease. An LDL variant, Lp(a), appears to confer increased susceptibility to atherosclerosis, and its presence in serum is often used as an additional diagnostic indicator. The principal lipoproteins, LDL and HDL, are known popularly as the "bad" and the "good" cholesterol.

TABLE 1

Functions of human plasma lipoproteins

Lipoprotein class	Origin	Function
Chylomicrons	Intestine	Transport lipids from intestine to liver and tissues
Very low density (VLDL)	Liver	Transport lipid from tissues to liver
Intermediate density (IDL)	VLDL	Precursor of LDL
High density (HDL 2 and 3)	Intestine	Remove cholesterol from tissues

Elevated levels of LDL are a risk factor for heart disease, hence LDL is considered to be a "bad" lipoprotein. Elevated HDL levels lower the risk of heart disease, hence the designation '"good" cholesterol. LDL is rich in cholesterol and delivers cholesterol into cells, whereas HDL, which is about 50 percent protein, aids in cholesterol egress from cells.

Heart Disease

There is a roster of risk factors that are associated with an increased chance of succumbing to heart disease, but none of these factors is an unequivocal risk. Risk in places like Las Vegas is called "odds." There are a number of well-documented risk factors for development of coronary heart disease. Heredity and age are beyond control. The others are elevated blood pressure, elevated blood cholesterol, smoking, obesity, diabetes, physical inactivity, and stress. Each factor exerts its effects differently in each individual. These factors may also interact. It is now becoming accepted that the initial injury in atherosclerosis may be inflammation, which complicates the risk picture (Ross, 1993). There are suggestions that infection in some way prepares the arterial tissue for the subsequent metabolic events. At present we must monitor the various controllable risk factors, bearing in mind the possibility that a prior event may determine the extent to which the risk factors affect risk. In the United States, deaths from heart disease (cases per 100,000, adjusted for age) peaked in 1968 and have been falling since then. Between 1960 and 1998 mortality from all causes in men fell by 33.8 percent and coronary heart disease mortality by 51.0 percent. In women the reductions were 33.7 and 50.1 percent, respectively. Incidence of the disease may be rising as population increases and other modes of demise diminish or disappear. A century ago the major causes of death were related to infection, while a half-century ago the average age of victims of coronary disease was considerably below what it is today. This is a public health triumph due to improved diagnosis and treatment. The aim now should be to achieve productive and healthy aging.

Of the risk factors cited above none has received more attention than blood cholesterol. Dietary studies related to atherogenesis were conducted early in the twentieth century; they usually involved a combination of dietary alterations plus physical stress. The earliest purely nutritional study was carried out by Ignatowski in 1909. He observed aortic atherosclerosis when weanling rabbits were fed milk and egg yolk or when adult rabbits were fed meat. A few years later Anitschkow (1913) fed rabbits cholesterol and reported atherosclerotic lesions and fat deposition. Anitschkow's work established dietary cholesterol as the modality for establishment of atherosclerotic-like lesions, and this was carried over to human nutrition; consequently dietary cholesterol was presumed to be the principal contributor to cardiovascular disease. Relatively mild interest in cholesterol and atherosclerosis was evinced in the research and medical communities for the few decades after Anitschkow's publications. In the late 1940s and early 1950s interest in cholesterol intensified. The reasons for this renewed interest were an increase in death from coronary disease, as death from infectious causes waned and new research findings, especially Gofman's demonstration of the separation of different lipoprotein classes, which differed in their chemistry (Gofman et al., 1950). The cholesterol-rich lipoproteins were associated with greater susceptibility to heart disease. Subsequently the research area developed the concept of risk factors, of which elevated blood cholesterol was the first clearly defined one. At about the same time epidemiological studies, many conducted by Ancel Keys, began to show that populations whose diets were rich in cholesterol and fat demonstrated high death rates from heart disease.

At this point it might be important to distinguish between the effects of dietary cholesterol and dietary fat. While there is no argument that blood cholesterol is a risk factor for coronary disease, the connection with dietary cholesterol is not strong.The connection between dietary cholesterol and blood cholesterol is controversial. The data show that the amount of dietary cholesterol plays a lesser role in affecting blood cholesterol than does the type of dietary fat. Dietary cholesterol plus saturated fat is much more cholesterolemic than the same amount of cholesterol plus unsaturated fat (McNamara, 1987). Since dietary cholesterol is often accompanied by saturated fat, it is considered prudent to limit its intake. Gertler et al. (1950) reported a study in which they had segregated from a large cohort of coronary patients and controls four groups of ten men each, those who ate the most cholesterol and those who ate the least, and those with highest or lowest plasma cholesterol levels. In every subgroup the coronary patients exhibited significantly higher plasma cholesterol levels than did the controls—thus confirming the role of cholesterol as a risk factor. However, in no group did the investigators find any correlation between dietary cholesterol intake and blood cholesterol level. Thirty years later an attempt was made to correlate diet with coronary disease in three large populations under continuous study. The populations were in Framingham, Massachusetts; Puerto Rico; and Hawaii. Diets of men who had had a coronary event and those who had not differed significantly in total calories (lower in cases), complex carbohydrate (lower in cases), and alcohol intake (lower in cases). Intake of fat or cholesterol was the same in cases and controls (Gordon et al., 1981).

Type of dietary fat affects atherogenesis in rabbits and cholesterolemia in humans. Keys (1965) and Hegsted (1965) and their colleagues showed that fats rich in saturated fatty acids promoted cholesterolemia. They developed formulas to predict changes in blood cholesterol based on dietary saturated and/or unsaturated fatty acids. Since the publication of the original formulas many revised and refined versions have appeared. The new formulas provide coefficients for specific fatty acids, but none has proved to be more serviceable or useful than the originals. It should be pointed out that even the most saturated dietary fat, coconut oil, contains oleic (about 7 percent) and linoleic (about 2 percent) acids, and that one of the most unsaturated fats, safflower oil, contains about 7 percent palmitic acid and 2 percent stearic acid. In the Keys and Hegsted formulas stearic acid is viewed as "neutral" because it has no effect on blood cholesterol.

An issue that has been debated for several decades is the role of trans-fatty acids. In most naturally occurring unsaturated fatty acids the hydrogen atoms attached to the carbons that constitute the double bond are spatially on the same side of the molecule (*cis*); when they are on opposite sides, they are designated as "trans." There are many trans fats in nature but not many in our usual diet. However, trans double bonds may be formed during hydrogenation of fat used for margarines. The major source of trans fat in the diet is margarine and baked goods made with margarines or margarine stock. Concerns over diets high in trans fats were aired in the 1940s and 1950s. It was found then that in rabbits fed atherogenic diets trans fat elevated cholesterol levels but did not increase severity of atherosclerosis (McMillan et al., 1963). The question of trans fat effects is complicated because hydrogenation may provide fats with double bonds anywhere from carbon 4 to carbon 14 of the fatty acid. Recent research shows that trans fat lowers levels of HDL-cholesterol in humans. It has also been demonstrated that trans fats have little effect in diets containing high levels of polyunsaturated fat. Because of health concerns margarine manufacturers have begun to produce products containing little or no trans-unsaturated fat (Kritchevsky, 1999b).

Ingestion of cholesterol per se appears to have little effect on cholesterolemia. Numerous studies have shown that eggs, the richest source of cholesterol, have little effect on blood cholesterol (McNamara, 2000). However, most cholesterol in the diet is associated with animal fats, which are more saturated than plant fats. Hence the admonition to exercise prudence in ingestion of cholesterol.

The field of fat and cholesterol is still active and as new fats and new facts emerge dietary suggestions will be modified. At one time we were admonished to eat a virtually fat-free diet, but fat is a necessary nutrient. Very low-fat diets present their own problems, since diets too high in carbohydrate may affect insulin metabolism and can lead to triglyceridemia (Lichtenstein and Van Horn, 1998). In the 1950s high plasma triglyceride levels were considered to be an independent risk factor for coronary disease. For a long while triglyceride levels were virtually ignored, but they are beginning to reassume importance as new clinical and epidemiological data appear. Similarly, the appreciation of specific aspects of fatty acid effects has led to changes in recommendations regarding their intake. At one time the entire emphasis was on polyunsaturated fat, but it was shown that this type of fat lowered both LDL and HDL cholesterol whereas monounsaturated fat (olive oil, for instance) reduced only the "bad" lipoprotein (LDL), leading to a more acceptable LDL-cholesterol/HDL-cholesterol ratio (Mattson and Grundy, 1985). These observations have led to support of the "Mediterranean diet," which is rich in monounsaturated fat but also contains more vegetables and fruit than does the present American diet.

In general terms, current recommendations suggest a diet containing 30 to 35 percent calories from fat with no more than 7 to 10 percent being saturated fat and about 30 to 40 percent carbohydrate, with adequate levels of dietary fiber. Liberal intakes of vegetables and fruit (five to seven servings per day) are also recommended as we begin to find that various plant constituents (carotenoids, flavonoids, phytosterols) may contribute to cardiovascular health. The role of caloric intake is not always addressed directly, but obesity is looked upon as a risk, and daily physical activity is encouraged (Krauss et al., 1996, 2001).

Our view of coronary disease keeps changing with new research findings. Whereas it was originally thought to be simply fat deposition, we now view it as an inflammatory process that can be stimulated by oxidized cholesterol and specific growth factors (Ross, 1993). The initial inflammation may be caused by viral or bacterial infection. The size of the LDL particle may be important; thus small, dense LDL particles may indicate increased risk even in the face of normal lipid levels (Krauss and Burke, 1982). Lipoprotein (a), a slightly altered LDL, affects blood clotting and may be an independent risk factor (Loscalzo, 1990).

The question of established and emerging risk factors has been addressed. The well-established, major risk factors continue to be cigarette smoking, hypertension, elevated serum cholesterol, elevated LDL cholesterol, low-HDL cholesterol, diabetes, and aging. Additional factors that predispose to coronary disease are family history of premature coronary disease (genetics), obesity, physical inactivity, and psychosocial factors (stress, for instance). Other risk factors are also beginning to appear—some are general and the causative actions of some are not clear. Among these are elevated serum homocysteine levels, first suggested over thirty years ago and possibly connected with metabolism of folic acid and vitamins B_6 and B_{12} (Malinow et al., 1999). C-reactive protein (CRP) is a general marker of inflammation produced in the liver in response to bacterial infection or physical trauma. The risk of coronary events is elevated in subjects with elevated levels of cholesterol and CRP (Ridker et al., 1999).Coronary heart disease is related to elevated serum lipids, diabetes, and obesity. All may be influenced by diet but the view of diet becomes more sophisticated and goes beyond dietary fat, although fat still plays a significant role. There is a plethora of risk factors of varying significance, and we still have no unequivocal indication of which subject's risk is affected by which particular factor.

Cancer

The role of fat in cancer has also been the subject of much research inquiry. In a classic study, Armstrong and Doll (1975) investigated the effects of diet on a number of cancers. Positive associations were found between total fat consumption and colorectal or breast tumors. Animal studies showed that a high-fat diet was more co-carcinogenic than a low-fat diet and that unsaturated fat was more co-carcinogenic than saturated fat. The latter result were due to the fact that linoleic acid is a growth factor for tumors (Carroll and Khor, 1971).

The data concerning fat and cancer risk are inconsistent. High intake of fat is a marker for a high-calorie diet and it is possible that it is the caloric contribution of fat rather than fat itself that is the culprit. Hoffman (1913) suggested that "erroneous diet" was a factor in the etiology of cancer. Excess body weight has been correlated with cancer mortality (Garfinkel, 1985). Animal studies dating to 1909 show that caloric restriction leads to reduced tumor growth. Lavik and Baumann (1943) showed that the incidence of methylcholanthrene-induced skin tumors in mice fed a diet high in fat but low in calories was 52 percent lower than that seen in mice fed a diet high in calories but low in fat. It has also been shown that incidence of dimethylbenz(a)anthracene induced mammary tumors in rats fed 5 percent fat ad libitum is lower than in rats fed a diet containing 20 percent fat but whose energy intake is restricted by 20 percent (Klurfeld et al., 1989).

Epidemiological studies have shown a positive correlation between energy intake and breast or colon cancer risk. The factors underlying the cancer-inhibiting effects of energy restriction are under study. Energy restriction leads to reduction in circulating insulin, and insulin is a growth factor for tumors. Energy restriction also reduced oncogene expression and leads to enhanced DNA repair (Kritchevsky, 1999a).

Diet

When all of the above has been said, the question each of us must answer remains, "What should I eat?" Dietary suggestions have ranged from the four food groups (meat, carbohydrates, dairy, and fruits and vegetables) to the United States Department of Agriculture (USDA) pyramid. The USDA pyramid is an attempt to illustrate which foods should be eaten in which amounts. The broad base of the pyramid represents large quantitites of grains and starches, and the narrow peak represents small quantities of fats and oils. Other dietary components are displayed between the peak and the base and their position in the pyramid represents the relative suggested levels of intake. The idea is to incorporate the best dietary information of the day into a healthful eating pattern. The "Dietary Guidelines for Americans" are written by select committees appointed by the United States Departments of Agriculture and Health and Human Services, and the publication is disseminated under their joint sponsorship. The guideline recommendations have changed relatively little in the past few decades, but the changes that appear reflect current findings and opinion. We are told to maintain ideal weight, although nobody is certain what that means. Originally we were advised to eat a diet that would provide protection against the ravages of infection, but now we are intent on protection against degenerative diseases, heart disease, and cancer, for which we have developed a catalog of risk factors but have no unequivocal diagnoses. Another general factor that we did not have to deal with in the past is the rise in obesity.

Vegetables and fruits provide chemicals that, in the laboratory, protect against cancer and heart disease and provide little or no fat. Grains are part of a healthful diet because they provide complex carbohydrate and fiber. Meat provides high-grade protein, necessary trace minerals (zinc, manganese, iron) and vitamin B_{12}, but fear of its fat content is reflected in advice to limit its consumption. Dietary fats are limited because of their caloric content, but they contain the essential fatty acids. Advice about dietary components is presented with the implied view that they are metabolized in a similar manner despite their quantity or presence of other nutrients in the diet. There is virtually no information concerning interaction of individual nutrients.

Fat is feared because of its caloric density and its connection with the risk of heart disease or cancer. The food industry is capable of producing foods that address current concerns. We have available a host of fat-free snacks, but their caloric content is rarely different from the fat-rich food they are replacing. Thus, influence on a risk may be diminished but there is no effect on body weight. Very low-fat diets are criticized as unhealthy. Diets high in carbohydrate may affect insulin metabolism, and there are some investigators who believe that insulin resistance may underlie both cancer and coronary disease.

General dietary advice—enough essential nutrients to maintain health—is constant but the specifics are distributed on an ad hoc basis depending on current knowledge. A case in point is the avocado. Thirty or so years ago this fruit was not recommended because of its fat content. Today we know the fat is monounsaturated ("good") and the avocado also contains generous quantities of various carotenoids. The avocado is now recommended by nutritionists everywhere. Fat content?—well, just don't eat too much of it. Carotenoids are a family of chemicals that occur in highly colored fruits and vegetables. Some may be precursors of vitamin A. The most common carotenoid is lycopene, which occurs in tomatoes.

To return to the specifics—namely, what we should eat—we still mean a "well-rounded" diet, to be taken in quantities that do not influence body weight. Suggestions to exercise regularly are also becoming part of dietary advice, again for purposes of weight control. Sugary snacks and sugar-rich beverages should be kept to a minimum. The ideal diet, in addition to its content, requires input from the consumer—namely, a measure of discipline.

Healthful diets go beyond "one size fits all." Growing children have different requirements than adults. The elderly may require different levels of various nutrients, and the active elderly have different needs than do the infirm elderly.

So we come down to the general advice of a little of everything but not too much of anything. The advice has to consider age, activity, and health status. Eating should be a pleasurable, social activity and not feared as the specific arbiter of life and death. The best advice for the average healthy person is variety, balance, and moderation. The watchword should be: Moderation, not Martyrdom.

See also **Assessment of Nutritional Status**; **Dietary Assessment**; **Dietary Guidelines**; **Disease: Metabolic Diseases**; **Fats**; **Intake**; **Mediterranean Diet**; **Nutrition**; **Vitamins**.

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David Kritchevsky

LIQUOR. *See* **Alcohol; Cocktails; Spirits.**

LIVESTOCK PRODUCTION. Domesticated livestock have played a pivotal role in the development of human civilizations around the world and continues to be an integral part of human culture, society, and the local and global economy. Domestic livestock has contributed to the rise of human societies and civilizations by increasing the amount of food and nutrition available to people in four ways: by providing sources of meat, milk, and fertilizer, and by pulling plows. Throughout history livestock have also provided leather, wool, other raw materials, and transport.

Livestock furnish high quality protein and energy foods, and function as part of integrated, renewable systems of plant and animal agriculture. The digestive systems of ruminant animals such as cattle, sheep, goats, llamas, and camels are specially adapted to convert plant materials that humans cannot utilize into proteins of high biological availability to humans.

Livestock and the Origins of Civilization

In his Pulitzer-prize winning book *Guns, Germs, and Steel*, Jared Diamond describes how the availability and husbandry of domesticated plants and animals enabled prehistoric peoples to produce and store sufficient food supplies to develop large, dense societies that did not have to wander in search of food. Agriculture generated the ample, dependable food supply needed to develop specialized, stratified societies, political organization, writing, and technology. Diamond argues that through close coexistence with domestic animals, people in these societies acquired some immunity to epidemic diseases that devastated other populations. His examples include the Spanish conquest of the Inca and other Native American populations, and the near extermination of the Aboriginal peoples of Australia and other regions by British and other European settlers.

DEFINITION OF DOMESTICATED ANIMALS

Domesticated animals have been modified from their wild ancestors through being kept and selectively bred for use by humans who control the animals' breeding and feeding.

Just five major species of large, plant-eating mammals have been widely domesticated by people for use around the world: sheep, goat, cattle, pig, and horse. Another nine minor species have been domesticated for use in smaller numbers or in restricted geographical areas. These minor species include the Arabian and Bactrian camels, llama, alpaca, donkey, reindeer, water buffalo, yak, Bali cattle of Southeast Asia, and mithan (another bovine descended from the wild gaur) of India and Burma. Under domestication cows, sheep, and pigs have become smaller in size than their wild ancestors. Sheep and alpacas have been selectively bred for fleece characteristics, while cows have been bred to increase milk production. Pigs, cattle, and some sheep have been bred for meat quantity and characteristics. Horses have been bred for specialized purposes including work, war, speed, and riding. Breeds or strains of all the major species have been developed and adapted for specific climatic, physical, and cultural conditions and needs.

Many questions remain about the origins of agriculture, but in most regions archaeologists have found evidence that domestication of plants preceded that of animals by several hundred years. Yet the herding of sheep and goats had become integral to the local economy in areas of the central Levant between eight and nine thousand years ago.

The pastoral societies of Central Asia and reindeer-herding Lapps and Samoyeds of the Arctic are examples of cultures that domesticated livestock, but engaged in little or no cultivation of plants. Augustin Holl, a specialist on western Africa and the advent of food economies, believes pastoralism—herding of animals for food without cultivating plants—was the first form of food production developed by post-Paleolithic groups in regions of the Sahara. Cattle may have been domesticated around ten thousand years ago in Northern Africa.

Evolution of Domestic Livestock through Animal Husbandry

The ancient Romans developed sophisticated agricultural systems that integrated livestock and crop production, with particular attention to use of animal manures and

Did an Early Symbiosis of Cows and People Lead to the Civilization of Ancient Egypt?

Anthropologists Angela Close and Fred Wendorf (in *Transitions to Agriculture in Prehistory*) have uncovered a story—of humans and cattle surviving together where neither could likely have survived alone, in the harsh conditions of early Holocene Southeastern Sahara—that illustrates mutually beneficial relationships between humans and cattle. The cattle needed people to find and dig water sources in a region with no standing water. The humans could not have survived without the protein provided by the cattle. Archaeological evidence suggests the cattle were not kept for meat. The authors point out that wild or tame, animals do not have to cooperate with their slaughter for meat, but animals must cooperate for humans to collect animal milk or blood.

People and cattle were able to migrate together to a new area with more resources. Close and University of Rome anthropologist Barbara Barich maintain, as outlined in the January 2000 issue of *Discover*, that these Neolithic Saharans fleeing the desert brought the rudiments of agriculture and of organized, hierarchical society to the Nile Valley, giving rise to one of the earliest great world civilizations. This theory challenges old assumptions about the source of Ancient Egyptian culture and development, and has sparked considerable discussion among scholars in the field.

composts. They developed the art of animal husbandry and selectively bred well-determined breeds of livestock. Their capacity for food production enabled the building of the Roman Empire. Cattle were a significant source of wealth and prestige to the early Romans and to early Germanic peoples. *Pecunia*, the Latin word for money, comes from *pecus*, the word for cattle. The English word "fief" derives from the Old High German word for cattle, *fehu*, denoting the value of cattle for medieval noblemen. Life in the Middle Ages revolved around farming, as the majority of people lived off the land. When hunting became a privilege reserved for the nobility in medieval Europe, livestock became even more important as food sources. But compared to Roman practices, animal husbandry suffered decline during the fifth through the thirteenth centuries. Animals became smaller and less productive with the loss of Roman breeds and selective breeding techniques. Still, the lasting effects of Roman breeding kept medieval stock in the areas of the former Roman Empire superior to those in neighboring regions.

Bökönyi suggests deteriorating climate and crop conditions, changing lifestyles, and devastation of cattle populations by frequent wars as likely causes for the widespread dwarfing of livestock, most pronounced in cattle, which lost 20 centimeters in height at the withers. Beef was the primary meat consumed by the armies of Europe—the origin of the name Beefeaters for the king's guard. Soldiers drove off any cattle they did not eat.

Bökönyi notes that cattle typical of the early medieval era—small, slender, long-legged, and short-horned—are still found in areas of the Balkans, Anatolia, and the Near and Middle East where animal husbandry largely remains at a medieval level. Early medieval pigs were small, long-legged, and primitive, with skulls similar to the wild boar, with which they could interbreed since domestic pigs roamed freely, foraging in the forests. This approach to pig husbandry continued for centuries, and was common practice in colonial North America. Early medieval horses were more variable, with descendants of Roman horses mixed with large numbers of horses from the East. Horses were similar to modern Asian horses, with slender legs and light trunks. The first coldblood (heavy) horses were selectively bred in Central Europe to carry the weight of a knight in heavy armor.

The Renaissance of Animal Husbandry

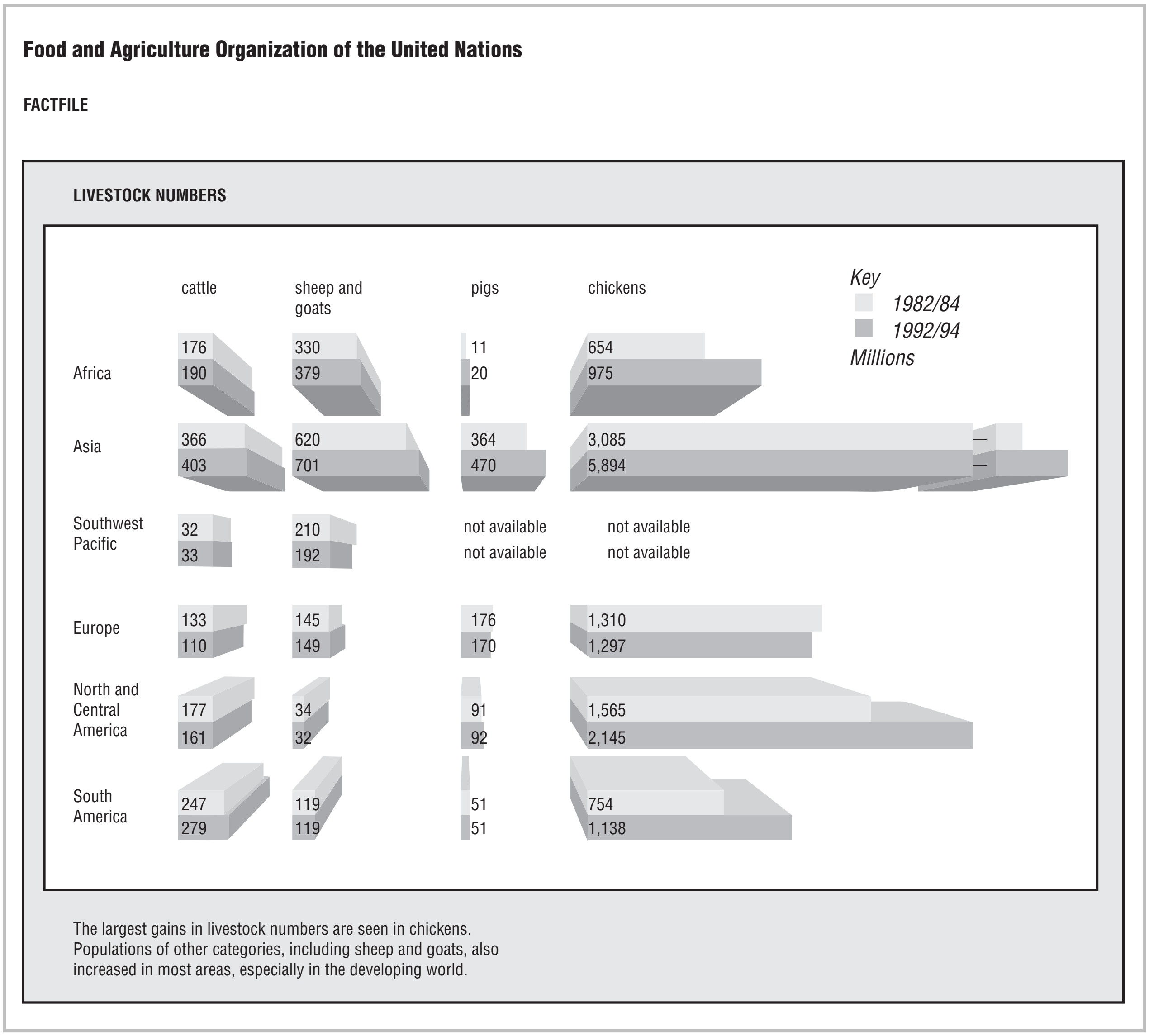
The demographic expansion and rise of urban centers in the Middle Ages could not have happened without an increasingly productive agricultural base, Sweeney argues in his introduction to *Agriculture in the Middle Ages*. The Renaissance in Europe brought the reintroduction of intentional, conscious animal husbandry and breeding, based on classical sources. Farmers and scholars also began to rediscover the value of manure—well documented and practiced by the classical Romans—in fertilizing and rebuilding soils.

Livestock animals grew in size, and increased in productivity, efficiency, and quality. From the fourteenth century to the early modern era (later in Eastern Europe) cattle regained the twenty centimeters in height lost in the early Middle Ages. New breeds of lasting economic consequence were developed, and growth in trade, migration, and exploration brought new domestic species and breeds to various regions around the world. Improved breeds of sheep and cattle yielded higher quality wool and more milk. The excellent meat and stamina for long drives of Hungarian gray steppe cattle, the standard breed in Hungary and neighboring territories by the fourteenth and fifteenth centuries, gained the breed quick popularity through Central and Western Europe, Bökönyi reports.

Livestock and the Agricultural Revolution 1750–1880

The growth of animal husbandry—including greater use of manure from livestock as fertilizer, was the first of four factors contributing to the Agricultural Revolution that

TABLE 1



The largest gains in livestock numbers are seen in chickens. Populations of other categories, including sheep and goats, also increased in most areas, especially in the developing world.

ended the cycles of dearth and hunger that had afflicted Europe for centuries (Chambers and Mingay, *The Agricultural Revolution*, p. 4). The Renaissance openness to scientific discoveries, new crops, improved animals, and the resulting productivity gains in agriculture, set the stage for the Agricultural and Industrial Revolutions and the rise of the great cities.

The spread of Merino sheep from Spain is an example. Before the end of the 1700s, Merinos were found throughout the sheep-breeding centers of Western and Central Europe. The first Merinos were brought to New England in 1811. Within two decades the Merino and related Saxony imports, prized for their long-fiber wool, dominated the rising New England woolen industry. Howard S. Russell describes how skilled breeders increased fleeces from only 6 percent of a sheep's live weight in 1812, to 21 percent by 1865 (*A Long Deep Furrow*, p. 352). Prize breeding stock from Vermont sold for prices in the thousands of dollars. Russell describes how the kinds and populations of domestic animals changed over time in response to market, economic, technological, and social trends and needs in a specific geographical region.

New fodder crops—legumes such as clover, and root vegetables such as turnips—greatly increased the supply and nutritive value of livestock feed. Improved feeding and selective breeding accelerated gains in meat, milk, and wool production. As late as the early 1700s, cattle and sheep—even castrated steers and wethers—took four to five years to fatten, or put meat on their bones. Improved feeding and breeding cut fattening time in half, and by 1800 progressive farmers recognized the value of quality breeding in livestock.

TWENTIETH CENTURY BRINGS BONANZA IN PRODUCTIVITY GAINS

The twentieth century brought stunning productivity gains, perhaps best illustrated by dairy farming. In 1905 New England was a center of dairy farming, with nearly one million dairy cows on farms throughout the six-state region (Russell, p. 496). In that era, cows produced an average 5,354 pounds of milk in a year. By 2001, the New England milk cow population had declined to 265,800 cows, just 3.1 percent of total U.S. dairy herd. But at over 17,500 pounds of milk per cow per year, the modern cows averaged more than three times the production of their ancestors a century earlier. In the 10 years from 1992 to 2001, milk per cow increased 16 percent in the U.S., while cow numbers declined 6 percent, resulting in a ten-percent increase in total milk production. Over this same ten-year period, the number of dairy farms in the United States decreased by 43 percent, from over 170,000 to fewer than 100,000 dairy farms. (See USDA graphics)

Progress in knowledge and husbandry skills led to specialization in livestock types and breeds, crops, and products. In the 1720s Daniel Defoe described in his *Tour of England and Wales* how farmers in different locales specialized in particular crops such as cereal grains, fruit or hops, on fattening livestock, or dairying. He reported on how the cow-herders of the village of Cheddar cooperated in making their already famous Cheddar cheese.

By 1800 agriculture had become specialized in areas of the United States. Southern New England and eastern New York were already dedicated to dairying, and Connecticut was a center of butter and cheese production and export. Progressive farmers and their associations began importing prize breeding stock from Europe in the early 1800s. Feeding and shelter for livestock improved, especially for milk cows.

Livestock in the Modern Era

Trends established by the late 1880s continue into the twenty-first century. Lower-priced imports of grain, dairy products, and meat kept prices low, even in times of crop failure, as in 1870s Britain. Yet escalating demand for meat, cheese, and other dairy products encouraged investment and expansion in livestock enterprises. Progress in the art and science of breeding, feeding, health, and care of livestock continues to bring gains in livestock productivity and efficiency. Transportation improvements allow the raising of food-producing animals at greater distances from population centers. Sheep, cattle, and hog numbers have fluctuated in response to market demand changes and regional comparative advantages.

Government Protection of Animal and Human Health

To combat severe outbreaks of sheep-rot and of cattle plague (rinderpest) brought by infected cattle imported from Europe in the 1860s and 1870s, the British government restricted the movement of animals and compensated owners for animals slaughtered to control the spread of the diseases, programs first tried in the mid 1700s. In the first half of the 1900s the United States intervened to eradicate livestock diseases such as hog cholera, tuberculosis, and brucellosis in cattle that were transmissible to humans. These tactics remain mainstays of animal disease control efforts.

Commercial pasteurization, introduced in 1895, greatly increased the safety of milk. Improvements in refrigeration and containers further enhanced milk's safety and shelf-life. The serial publication in 1905 of *The Jungle*, Upton Sinclair's muckraking novel about the meatpacking industry, helped lead to government regulation of the food industry. The U.S. Congress passed both the Pure Food and Drug Act and the Meat Inspection Act in 1906, the beginning of federal food safety inspection and regulatory programs.

Modern Agricultural Trends and the Environment

In response to market demands for lower-cost production, livestock agriculture continues the trend to fewer and larger operations. The U.S. poultry industry became highly intensive and vertically integrated in the last quarter of the twentieth century, with a handful of companies dominating the industry and contracting with growers to raise flocks owned by the companies. The swine industry is experiencing similar restructuring and vertical integration. Intensification and specialization has separated crop production from livestock-raising in many regions, resulting in heightened concerns about environmental impacts, primarily related to manure runoff into water bodies in some areas of Europe and North America. Soil fertility, health, and structure have deteriorated in some crop-intensive areas from lack of livestock manure.

The United States and Europe have increased technical assistance and environmental regulation of livestock operations in response to these concerns. The Clean Water Act legislation of 1972 and 1977 set higher standards of water quality. Less-developed countries have not evolved regulatory or technical assistance programs to address livestock-related pollution.

Sustainable agriculture advocates have sought ways to reintegrate and balance animals and crops to promote soil health and protect natural resources, and have promoted the environmental benefits of practices such as intensively managed grazing. Some dairy, beef, sheep, and other livestock producers have adopted these scientific grazing systems in major livestock-producing regions including North America, Europe, Australia, and New Zealand. Government farm programs and subsidies have been increasingly linked to plans and practices to protect soil, water, and wetlands.

Global Livestock Expansion and Trade

World meat production including poultry totaled 236,991,142 metric tons in 2001, according to the Food and Agriculture Organization of the United Nations. The United States produced 16 percent of the world supply, and the European Union produced 15 percent, while the nations of the Far East produced 35 percent. World milk production in 2001 was 584,651,111 metric tons. The European Union produced over one-fifth, and the United States produced one-eighth of the world milk supply.

China is one of the world's top producers of hogs, beef, poultry, corn, and soybeans. The U.S. Department of Agriculture's February 2002 Agricultural Baseline Projections projected strong growth for the next decade in world beef production, especially in China, Mexico, Canada, and the countries of the former Soviet Union. Brazil, Mexico, China, and Canada are expected to expand pork production. In 2001 Russia was the world's top volume importer of poultry meat, second-highest of pork, and third-highest importer of beef. But Russia, Ukraine, and Kazakhstan have the resource potential to develop into agricultural powerhouses once they establish market economies.

Australia's small population offers a limited market, but its low-cost production capacity limited only by water gives it a competitive advantage in export markets. Australia's herds and flocks fluctuate dramatically in response to world markets.

Brazil and Argentina are major livestock and feed producers. Argentina's exports were temporarily set back by a foot and mouth disease outbreak in 2001. Brazil is expanding livestock production capacity and adopting new technology to increase yields.

Saudi Arabia, Egypt, and Iran import grain to support expanding livestock production. Most Moslem countries prefer meat from home-grown livestock to ensure animals are slaughtered in accordance with Islamic rites.

The U.S. Department of Agriculture expects global trade in livestock products will continue to expand, based on ample global supplies and steady growth in demand. Livestock production is expanding globally to meet demand for meat and dairy products in the growing economies of Asia and Latin America. Livestock development will continue to be a part of economic progress in the developing world.

See also **Cattle**; **Goat**; **Mammals**; **Meat**; **Pig**; **Sheep**.

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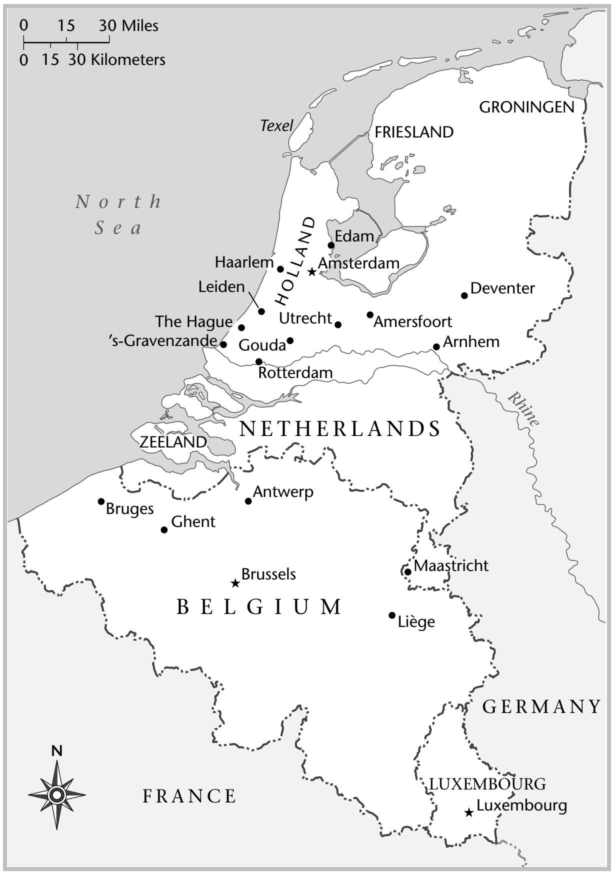
Lorraine Stuart Merrill

LOW COUNTRIES, THE. At the beginning of the twenty-first century, twelve Belgian restaurants operated in New York City, but only one Dutch restaurant planned an opening. Historically tied together, Belgium and the Netherlands nevertheless developed dissimilar cuisines. During the fifteenth century the area subsequently divided between the two countries became part of the holdings of the powerful duke of Burgundy. With the death of Charles V in 1555, Belgium became a possession of the Spanish Crown. It was part of the Habsburg Empire from the beginning of the seventeenth century until the Napoleonic age. After the revolution of 1578 the Netherlands was an independent republic, confirmed as such in 1648 by the Treaty of Westphalia. In 1813 the two countries were united under King Willem I, which lasted until 1831, when the Netherlands and Belgium, where Flemish, a Dutch dialect, and French are spoken, became separate monarchies. Although the two countries share the Dutch language, they have made different culinary contributions. Belgium's kitchen, akin to the French, is known for its exuberant bistro-style foods that became popular in the United States. The Netherlands' cuisine is more staid, but the country exports fine food products, such as vegetables and cheeses, sought all over the world.



The Middle Ages and the Renaissance

The first printed cookbook in the Dutch language was *Een Notabel Boecxken van Cokeryen* (A notable little book of cookery). It was published circa 1514, during the time the Low Countries were part of the Burgundian Empire under the reign of Maximilian of Habsburg. The presumed author and publisher is Thomas van der Noot, who belonged to one of the prominent Brussels families.

The book was meant for the well-to-do, the nobility and the high-placed clergy, who could afford the expensive foodstuffs called for in the recipes. As was common for cookbooks at that time, many of the 170 or so recipes were copied from other authors. In this case they were copied especially from the famous French cookbook of the period, Taillevent's *Le Viandier*. The Dutch book includes sauces; fish dishes; ways to prepare meat, poultry, and game, including peacock and pheasant; raised pies; tarts; sweets; and eggs. The recipes are clearly divided into dishes for everyday and those for the church-ordained days of fasting and abstinence, when meat, dairy products, and eggs were forbidden. This prohibition encompassed altogether about 150 days in a year, when only fish, vegetables, and bread were permitted.

Eggs were particularly popular. Said to be the poor person's supper, they often were barely cooked and were slurped from the shell. Milk was cooked in porridges or custards, some of which were given a pastry base. Milk was preserved as cheese and butter. Unlike in southern Europe, in the Low Countries butter rather than oil was used as a cooking medium.

Several kinds of cheese made of cow's and sheep's milk were marketed in the fourteenth and fifteenth centuries. Cheeses were usually named for the places they came from. The Netherlands is known for its cheeses from the cities of Gouda and Edam. Gouda cheese is made from milk with cream, while Edam-style cheeses are made from skimmed milk and are sometimes flavored with cumin, as in Leyden cheese. By the end of the eighteenth century cumin was replaced in the north by cloves to create Frisian *nagelkaas.* Sheep cheeses were popular early on. Often colored green with sheep feces, these cheeses came from the island of Texel or from 's-Gravenzande. As breeding improved and cows produced more milk, more recipes called for milk products, including homemade ricottalike cheeses.

Pork, particularly the fatty parts, was the favorite meat of all classes. Pigs were kept everywhere and generally roamed free. In the fall families who could afford it would purchase a cow that was slaughtered and preserved for winter through salting and smoking.

Cattle, particularly oxen, were imported from Denmark and Schleswig-Holstein in northern Germany. They were herded or transported by ship to Holland for grazing and fattening for slaughter in the grassy meadows of that province. Chickens, ducks, and geese were the common poultry, although songbirds were eaten as well. Deer, goats, and wild boars were among the large game animals hunted, whereas rabbits, pheasants, bitterns, cranes, swans, herons, and ducks were considered small game. The hunt was the privilege of nobility. Falcons and sparrow hawks were trained to catch partridge, geese, ducks, kites, doves, or any other fowl. By the fifteenth century game was reserved more for special occasions than for the daily table of the nobility.

It is often implied that medieval people strongly seasoned their foods because the meats were generally spoiled. That is an unlikely premise. People knew how to preserve foods by drying, smoking, and salting and many regulations concerned the sale of meat. Seasoning was instead more a matter of taste. Spices from the Orient, such as pepper, nutmeg, cloves, and cinnamon, were introduced by way of Venice and became a status symbol for the well-to-do. These spices were mixed with sour verjuice (juice from unripe grapes) or apple juice and some locally grown herbs such as parsley, sage, or savory. They gave the dishes a sharply spiced and sour taste that was popular.

Little is known about the food of the masses. Much of what is known about the food of the period comes from records of the elaborate banquets of the nobility on the occasions of weddings, victories, or coronations. These extravagant medieval feasts consisted of several courses, each with ten or more dishes, and were known for their between-course happenings. For example, at one of Philips of Burgundy's banquets, an entire orchestra stepped out of a raised pie and started to play.

Fishery was as important to the food supply as to the economy. In the fifteenth century, when the schools of herring moved from the Sont, the strait between Denmark and Sweden, to near the English coast, the Dutch herring fishery bloomed. The development of cleaning and salting herring onboard ship made the fish less perishable. Consequently herring became not only a folk food but also another major trade good for the Low Countries. The salt, which was needed in large quantities not only for preserving herring but also for preserving meat, was imported from France and Portugal. Dried cod, imported from Bergen, Norway, was the main fish eaten by all classes and an important food for the days of fasting and abstinence.

From the rivers the abundant eel were harvested, as were carp, pike, and bream. These were the fish for the more affluent, while the poor and the working classes ate dried plaice, flounder, or whiting. Among its forty or so fish recipes, *Een Notabel Boecxken* describes how to make a brown sauce for a freshly boiled carp. The cooking liquid is mixed with *lebkuchen* (a chewy honey cake), vinegar, and wine and seasoned with ginger, cinnamon, rosemary, quite a bit of sugar, and a little salt.

Castles and cloisters were the centers of horticulture during the Middle Ages. Their gardens provided vegetables, herbs, fruits, and nuts. When, in the second half of the fifteenth century, the sand dunes near Haarlem were removed, fertile grounds became available for horticulture. Through the increased mercantile influence of the large towns, such as Antwerp and Amsterdam, with their expanding markets, horticulture started to flourish beyond castles and cloisters, and by the sixteenth century the Netherlands was known all over Europe for its vegetables. Seeds were cultivated under glass to extend the growth period. Gheeraert Vorselman's *Eenen Nyeuwen Coock Boeck* (A new cookbook) of 1560 was the first to publish salad and vegetable recipes in the Low Countries.

In the Middle Ages, wheat, rye, barley, oats, peas, and beans were grown, but even in the beginning of the period the Netherlands did not grow enough grain to supply its inhabitants. The grain trade developed early on, and by the fifteenth century it was concentrated in Amsterdam. Bread was the mainstay of the diet. It was prepared by bakers, who were organized in powerful guilds. As early as 1341 the government set regulations on bread content, weight, and price. The more expensive wheat bread (called white bread) was eaten by the affluent. Rye bread (called black bread) was the common food for the poor until the second half of the nineteenth century, when through improved transportation methods American wheat, cheaper than the local rye, was imported. At that time wheat bread became the common bread for all.

Beer was the common drink, wine was for the well-to-do, and buttermilk was popular on farms. Beer was brewed at home, but by the fourteenth century the cities of Haarlem and Amersfoort had famous breweries. Cloisters were often known for their brews, and some of the famous Belgian beers hail back to that tradition. The sweeter and less-perishable wines from the Mediterranean countries were popular with the upper classes. The mostly young and white wines, imported from France and Germany, were at that time sour, so they were mixed with honey and spices, such as cloves, coriander, cinnamon, and ginger, to make a drink like hippocras that was enjoyed at the end of a large meal.

Abundant feasts at times of plenty contrasted with the famines of the Middle Ages that wiped out large parts of the population. The Dutch were true trencherpeople who ate and drank immoderately at parties and banquets for guild celebrations; weddings; births, where they would "drown the child"; or funerals, called in jest "grave weddings." Paintings by Brueghel and others depict such events. But the regular meal pattern consisted at most of two meals a day. The main meal, two dishes, was served around eleven in the morning, and the evening meal was one dish. Bread; cheese; root vegetables, like parsnips, carrots, and turnips; cabbage; garlic; onions; peas and beans; fruit in season; porridge; eggs; and a little meat or fish when available were the main foodstuffs.

Mealtimes shifted toward the end of the Middle Ages, when increasingly people ate breakfast. Before meals a water pitcher, a bowl, and a towel or napkin were provided for washing the hands. The plates were first made of bread, then wood, and later tin. The table was covered with a cloth, and bread and salt were placed upon it. The fingers, spoons, or knives were used for eating as the fork was not yet in fashion.

A major change in eating habits came after the Protestant Reformation in the middle of the sixteenth century, when the northern Netherlands largely embraced the Protestant faith as preached by John Calvin and the southern Netherlands remained Catholic. It may be assumed that the Calvinists stopped the days of abstinence immediately, though they continued to eat fish on Friday. Meeting the obligation not to eat meat and dairy products on many days of the year was difficult and expensive. Some medievalists hold that this might be one of the contributing causes of the Reformation's success.

The Seventeenth Century

The seventeenth century brought prosperity. Both the East India and the West India Companies were founded in its first quarter. Dutch ships brought spices from the Dutch East Indies (now Indonesia) and sugar first from Brazil and then from plantations in the West Indies. Exotic plants, like the pineapple, arrived from every port where Dutch ships docked. With more food available, consumption increased, and the common meal pattern grew to four meals a day. Breakfast consisted of bread and butter or cheese. The noon meal became a stew of meat and vegetables or fish with a dish of fruit, cooked vegetables, honey cake, or raised pie. The afternoon meal of bread and butter or cheese was served a few hours later. Just before people went to bed they ate leftovers from noon, bread and butter or cheese, or a porridge. The poor had a more meager diet.

With the fortunes made in the overseas trade, well-to-do families built country houses away from their city houses, which were usually their places of business also. Country houses had gardens with fruits and vegetables for home consumption and plants from far-away lands. For example, corn was grown as an ornamental and was used in flower bouquets, as still lifes testify. The defini-

New Netherland

The history of the colony New Netherland begins in 1609. In that year Henry Hudson explored the river that bears his name on behalf of the Dutch East India Company with the aim of finding a northern passage to the Orient. Hudson's explorations established the Dutch claim to a vast area from the Connecticut River to the Delaware Bay. In 1621 the Dutch States General granted a charter with exclusive trading rights in the Western Hemisphere to the Dutch West India Company. In 1626 the island of Manhattan was purchased and settlement began. In 1664 the English took over New Netherland, and with the exception of a brief interlude in 1673–1674, the area remained in British hands until the American Revolution. Yet in only seven brief decades the persistent Dutch settlers entrenched their culture in the country.

Americans eat dishes that can be traced back to the foodways brought by early Dutch settlers. The practical merchants who formed the West India Company intended that the colony should be not only self-sufficient but also able to provision the company's officials and ships engaged in the fur trade and in trade with the West Indies. The settlers brought fruit trees, such as apples, pears, and peaches; vegetables, such as lettuces, cabbages, parsnips, carrots, and beets; and herbs, such as parsley, rosemary, chives, and tarragon. In addition they brought farm animals, such as horses, pigs, and cows. Aboard ship the animals had their own stalls, and often each had an attendant, who would get a bonus when the animal arrived safely.

The new land was fertile. Jacob Steendam, one of the three major Dutch-American poets of New Netherland, called the colony "a land of milk and honey." Adriaen van der Donck, who wrote *A Description of the New Netherlands* (1655) to entice his fellow citizens to settle in the new colony, also was impressed with its fertility. He reports that by the middle of the seventeenth century all sorts of European fruits and vegetables "thrive well" and marvels at the native fish, fowl, and other wildlife available in great abundance.

Trade with the Indians was an important aspect of life in New Netherland. The Dutch traded cloth, beads, and ironware, such as axes and cooking kettles, for beaver skins. The Dutch also used their baking skills to produce breads, sweet breads, and cookies to trade with the Native Americans. The Indians valued the wheat bread of the Dutch, which previously had been unknown to them. Harmen Meyndertsz van den Bogaert relates in his diary of 1634–1635 that, when he was more than a day's walk away from Fort Orange, a Mohawk Indian who had just come from the fort offered him a piece of wheat bread. An ordinance for Fort Orange and the village of Beverwijck (now Albany) forbade further baking of bread and cookies for the Indians. Evidently the bakers were using so much flour for this Indian trade that not enough was left to bake bread for the Dutch community. A record survives of a court case in which a baker was fined because "a certain savage" was seen coming out of his house "carrying an oblong sugar bun."

In their new country the colonists continued to prepare the dishes they were used to. Ship records confirm that the West India Company ships brought them kitchen tools, such as frying pans for pancakes or irons for hard and soft waffles. The settlers tried to duplicate life in the Netherlands in New Netherland. However, while they continued their own foodways, they incorporated native foods into their daily diets but in ways that were familiar to them. For instance, they made pumpkin cornmeal pancakes, made pumpkin sweetmeat, or put cranberries instead of the usual raisins and apples in their favorite *oliekoecken.* For lovers of porridge, it was easy to get used to *sappaen,* Indian cornmeal mush, but the Dutch added milk to it. This dish became such an integral part of the Dutch-American diet that it is mentioned on an 1830 menu for the Saint Nicholas Society at the American Hotel in Albany under the heading of "National Dishes." Although many descendants forgot the native tongue, they did not forget the foods of their forebears, and they continued to enjoy the pastries and other dishes connected with feasts and holidays into the twenty-first century. Cookies; pancakes; waffles; *oliekoecken*, a forerunner of doughnuts; pretzels; and coleslaw are among the items the Dutch colonists imported into to America. Vestiges from those original foodways remained in the American kitchen.

tive cookbook of the seventeenth century, *De Verstandige Kock* (The sensible cook), published by an anonymous author in 1667, gives recipes for the homegrown bounty. The book starts with recipes for salads, which were eaten before the meal "to open the stomach." It gives a full range of recipes for greens; meat; game; poultry; salted, smoked, and dried fish; fresh saltwater and freshwater fish; baked goods; raised pies; and tarts. Separate chapters on preserving meat and fruits end the volume. This was a cookbook for the rapidly developing, affluent burgher class, which, since the nobility had comparatively little influence, was the leading segment of Dutch society. While the peasant diet consisted mostly of bread, milk dishes, vegetables, and meat, the middle classes ate a plentiful diet of varied foods.

The people of the Low Countries were known for their love of sweets. Such treats as sweet breads, like honey cake or gingerbread; or confections, like marzipan, candied almonds, or cinnamon bark, were consumed in addition to the daily fare. Like cheese, Dutch *koek* (*Kuchen* in German) or honey cake was named for its city of origin. By the fourteenth and fifteenth centuries Deventer *koek* from the town of Deventer in the eastern part of the country was famous all over the Netherlands. An important component of the Saint Nicholas celebration on 6 December was another special kind of *koek* named for its chewy texture, *taai taai* or tough dough. All of these cakes were made by professional bakers, who protected their recipes and were united in guilds. Waffles, wafers, and *olie-koecken*, deep-fried balls of dough with raisins, apples, and almonds, were some of the celebratory foods prepared at home, but they were also sold on the streets, as the contemporary artists portrayed.

In the second half of the seventeenth century tea and coffee were introduced, and they had a significant impact on meal patterns and social customs. The East India Company brought tea to the Netherlands first from Japan, then from China through Chinese merchants situated in Batavia. An early shipment in 1610 was considered a curiosity, but as shipments gradually increased, domestic markets developed. Preparing tea required its own paraphernalia, such as small porcelain teacups and small teapots, which were also imported from the Orient. Using a small teapot, an extract of tea was brewed that was diluted with boiling water when served. The small teapots remained in fashion until the nineteenth century, when, according to the English custom, tea was brewed at the required strength directly in a large teapot. Teacups did not have handles until the eighteenth century. Many humorous tales relate the enormous number of cups drunk at the popular late-century tea parties. One woman, admonished by her husband that it was time to go home, told him she could not leave yet because she had only had twenty cups. Tea was served with sweets, like hard candies, marzipan, cookies, and particularly an Utrecht specialty called *theerandjes* (tea cookies), which were strongly spiced small gingerbread slices. The third meal of the day, which earlier in the century had consisted of bread and butter, was incorporated into the tea ritual and was moved to a later time in the afternoon.

While tea drinking, for which women would gather in the afternoon, had a certain air of high society and snob appeal, coffee was the more public drink. Coffee was consumed in coffeehouses, where men stopped in to have a cup, smoke a pipe, and read the paper. Stefanus Blankaert, an Amsterdam physician and author of a 1686 book on diet, commented on the crowds visiting the coffeehouses in his city. At the end of the century it became the custom of the wealthy to furnish their guests with eating implements, not only a knife and spoon but also a fork. However, it took several decades for the fork to be accepted generally. As late as 1733 a leading journalist argued against its use because, according to a contemporary saying, "God has given us fingers."

The Eighteenth Century

The eighteenth century marked greater sophistication in recipes and more variety in dishes offered at one meal. *De Volmaakte Hollandse Keuken Meid* (The perfect Dutch kitchen maid) of 1761 describes in detail how to serve the customary succession of three courses, each consisting of at least ten dishes, and how to place each dish on the table. It was so popular that in 1838 it was reprinted as *De Volmaakte Belgische Keuken Meid* (The perfect Belgian kitchen maid), an updated version that included a section on potato recipes. With some twenty editions spanning the second half of the century, *La Cuisine bourgeoise* (1753) by Menon is an important part of Belgian culinary history.

Fish rather than meat was an important food for the common folk, but oysters and mussels were foods of the rich except in those areas with ready access, such as the Belgian provinces and Zeeland. Game was still the food for nobility, but rabbits became more commonly available.

The more affluent kitchens increased their use of vegetables, including nettles and watercress, abundantly available in rivers and streams. The Italian broccoli was cultivated and was preferred over white cauliflower. Although Carolus Clusius, the founder of the extant botanical garden of Leiden, mentioned the potato plant as early as 1601, potatoes did not enter the popular cuisine until the second half of the eighteenth century. At that time crop failures had made grain expensive and scarce, and cattle diseases had created a lack of milk products. The potato took up the slack and became the most important foodstuff of the poor person's diet. Not until the Napoleonic age, when the economy was failing, did the upper classes include potatoes in their main meals. That was also when the custom developed of not eating bread when potatoes were served. In Dutch restaurants the bread is removed when the main course is served.

Market stall selling traditional Dutch cheeses in Gouda, the Netherlands. © OWEN FRANKEN/CORBIS.

Desserts and treats were presented in even greater variety in the eighteenth century. *De Volmaakte Hollandse Keuken Meid* offers a recipe for a luxurious double-crust pie filled with sliced oranges, sprinkled with sugar and cinnamon, and topped with a layer of chopped pistachio nuts. The same volume includes a vast assortment of cookies and sweets, presumably served with tea. The first famous version of the centuries-old *koek* was a simple mixture of rye, honey, spices, and the secret addition of leavening potash made from wood ash imported from the Baltic to make the heavy dough rise. By the seventeenth century *koek* was made all over the Netherlands. The northern parts of Groningen and Friesland were known particularly for their spiced honey cakes with candied citrus fruit peel. But in 1751 the first pastry book, Gerrit van den Brenk's *T'Zaamenspraaken Tusschen een Mevrouw, Banket-bakker en Confiturier* (A dialogue between a lady, a pastry baker, and a confectioner), finally revealed a professional baker's secrets and gave helpful insights into its preparation. By 1750 sugar had overtaken honey as the general sweetener. By that time chocolate had become a popular drink at home, especially on Saturday and Sunday evenings. Fruit, though seasonal, was eaten by all classes.

The Nineteenth Century

An even wider difference between the diets of the middle classes and the poor is evident in the nineteenth century. By the end of the century the well-to-do ate meat once or twice a week; only rarely did the worker have meat or, for that matter, fish. An 1869 peat worker's family ate mainly potatoes, rye bread, buckwheat flour, barley, rice, some melted fat, oil, and butter and went without wheat bread, meat, eggs, cheese, or vegetables. They drank a little milk and some coffee. Such unhealthy conditions raised enough concern by midcentury that charitable groups began to establish soup kitchens to provide food for the poor.

The nineteenth century also produced mechanical inventions and a wider selection of cookbooks. Cheese and butter making had been the province of women, but in the 1860s machines took over the work. A machine was invented for kneading rye bread, which up to then, because of its heavy structure, had been kneaded with the feet. While Belgium's most important cookbook of the time, *L'économie culinaire*, written by a Ghent caterer in 1861, enjoyed multiple editions, the main cookbook in the Netherlands, Philippe-Édouard Cauderlier's *Aaltje, de Volmaakte en Zuinige Keukenmeid* (Aaltje, the perfect and frugal kitchen maid), spanned the entire nineteenth century. First published in 1803, it was reissued in 1893. This book presented for the first time the mashed one-pot dishes and the typically Dutch menus of meat, vegetable, and potatoes followed by a dessert made with milk.

Until the nineteenth century the sugar beet was used as cattle feed. But during the Napoleonic age, when the supply of sugar cane was interrupted, the emperor encouraged the fabrication of sugar from sugar beets. By 1812 fourteen such factories operated, but after Napoleon's defeat they disappeared until later in the century.

Changes occurred as well in the general use of beverages. Beer lost its popularity and was replaced with coffee, particularly in the eastern and southern provinces. Tea was more popular in the west, where both beverages were served. The use of *jenever* (juniper-flavored gin) increased dramatically among the working classes, and even hospital personnel received a daily ration of *jenever.* The affluent still drank wine.

The Twentieth Century

After the industrial revolution and two world wars, the customary meal pattern changed to three meals a day, including breakfast and lunch, of which bread was the major component, and one hot meal in the evening. Coffee breaks in the morning and tea breaks in the afternoon became the common interruptions of the workday. Snack foods, especially French fries and soda, readily available from corner snack shops or street carts, were consumed anytime. Holiday foods still included *taai taai* and *oliekoecken* (*oliebollen* in modern Dutch). Indonesian restaurants, serving the well-known *rijsttafel* (rice table), became especially popular after World War II. In the year 2000 cosmopolitan restaurants, including America's McDonald's and Pizza Hut, reflected the Dutch trade interests in most countries in the world.

At the end of the nineteenth century and the beginning of the twentieth century, the interest in wholesome foods and the plight of the masses prompted the founding of so-called household schools in both the Netherlands and Belgium. Household schools were intended to instruct working-class housewives in a proper family diet. A better-fed worker could produce more work. But because working-class women had to work, daughters of the middle classes, who were expected to stay home and tend their families as adults, attended these institutions. The teachers did not adjust their curricula or their recipes to the new, higher-class audience. With the goal to simplify and improve, they took away much of the charm, the joy, and some say the taste of the good, centuries-old Dutch burgher kitchen described above. The aim was to create recipes that were considered nutritious and healthful with the right combination of protein, fat, and carbohydrates. Martine Wittop Koning's *Eenvoudige Berekende Recepten* (Simple calculated recipes, 1901), which went through sixty-two editions, is a prime example. In addition, rather than instructing their students in home cooking from scratch, the teachers encouraged and popularized time-saving, factory-made products in both their classrooms and their cookbooks. The influence of the household schools lasted through several generations, until at least the 1960s. These developments coupled with ever increasing agricultural mechanization and industrialization of food production might explain the demise of the Dutch burgher kitchen. The Netherlands' renowned and outspoken food writer Johannes van Dam also cited them as the explanation for the Netherlands' lesser status as a culinary power. Others look to the lingering trend to think that "one eats to live" coupled with the Calvinist spirit, which frowns on earthly pleasures. Yet others indicate the Dutch commercial inclinations to sell the best products and keep the lesser quality for use at home. The fact remains that, while Dutch foodstuffs are highly sought after and are sold all over the world, its restaurants are not well known.

In contrast, the Belgian kitchen remained true to its French-inspired original. Belgian restaurants have achieved the coveted three-star Michelin status on more than one occasion. Nika Hazelton in *The Belgian Cookbook* (1970) lauds home cooking from scratch. She savors the fish soup from Ghent called waterzooi and marvels at mussels *marinière* with white wine, butter, lemon, and parsley. She cannot stop talking about the *friture* or deep-fried foods, particularly French fries, and she toasts the cuisine with a smooth Bruges wheat beer or a Brussels *geuze lambiek*.

The generous custom of treating friends on a person's own birthday rather than being treated is the origin of the expression "Dutch treat." Both countries, Belgium with its restaurants, artisan-made beers, and melt-in-the-mouth chocolates, and the Netherlands with its horticultural products, beers, cocoa, and cheeses, bring the world a true Dutch treat.

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Peter G. Rose

LUNCH. Lunch, the most informal and unassuming of meals, defies easy definition. A relatively late entry into the cycle of dining, it is replete with socioeconomic forms and meanings. Though the notion of the lunch or luncheon is most often attributed to nineteenth-century Britain, the terms had long been in use in England, albeit in slightly different form. Descended from the Spanish *lonja*, referring to a slice of ham, as the *Oxford English Dictionary* notes, the term has been in use since the Middle Ages as a word for a small snack, often eaten in the fields during the workday and sometimes called *nunchin*. Dr. Johnson's 1755 *Dictionary* defines "luncheon" as "as much food as one's hand can hold." For many centuries, lunch or luncheon was precisely this: a hunk of food, a few hurried bites of sustenance, a snack.

The Evolution of Meals

The reason for this minor version of the contemporary lunch was simple: For many centuries, the cycle of meals in England was considerably foreshortened. Breakfast was taken when one rose with the dawn to begin work in an economy that remained largely agrarian and rural. The day's first meal, however, was not originally the elaborate affair that we now identify as the classic British breakfast, and by midday, the medievals were ready for a more substantial repast. This was dinner, the most serious meal of the day for rich and poor alike, involving as much elaboration as one's pocket could afford. For the worker, dinner was meant to help the body recover from the exertions of the morning and to power it through the afternoon's remaining labors. For the rich landowner, it was a marker of ease and privilege and often occupied quite a large portion of the afternoon.

Dinner was generally taken between 11 A.M. and 1 P.M. Dining hours in the medieval period were proscribed both by science and religion. Doctors determined when food might be taken, in what manner and quantity, and in what form. The church also played a role in determining dining hours. In the monasteries of the age, as in contemporary contemplative communities, the hours of the day were divided up according to cycles of prayer; and the monks restricted their dining to the period after prayers at the hour of none, nine hours after dawn. The dining hour in the monasteries moved about, depending on the hour of dawn across the year's cycle. It is from this habit of taking the meal at the ninth hour that the term "noon" is derived, and, thus, the concept of "nooning." Noun or verb, nooning was not unlike *nuncheon*: Though the meaning of the term shifted about, it referred to a small meal taken at or around the noon hour and was in use in this sense, according to the *Oxford English Dictionary*, as early as 1652.

Not everyone in medieval society adhered to the edicts of doctors or priests, however, and the earliest manifestations of the meal we now call lunch seem to have appeared among the rich and idle. Erasmus's *In Praise of Folly* (published in 1511) describes hard-partying courtiers who slept late but observed the religious forms of the day by having "a wretched little hired priest waiting at their bedside [who] runs quickly through the mass before they're hardly out of bed. Then they go to breakfast, which is scarcely over before there's a summons for lunch." The accumulation of meals is telling: The notion of eating while one was still full from the meal before was thought to be particularly unhealthy, and meals were few and far between in part because the pleasures of dining were, in proper thinking, subordinate to the real occupation of the day—that is, work. By noting that his courtier eats a full meal for this snack, and eats it directly after breakfast, Erasmus emphasizes the morally and physiologically uncertain nature of the lives of the idle rich—and their distance from the strictures of the working world.

Urbanization and Industrialization

Over time, the hours of dining became increasingly flexible. Urbanization, industrialization, and technology all played roles in changing the dinner hour. Like much related to the English Industrial Revolution, the transformation of the noon-hour meal progressed at a glacial pace through the eighteenth century and then abruptly picked up speed at the turn of the nineteenth century. In the mid-eighteenth century, dinner was still eaten in the middle of the day. As Horace Walpole wrote in a letter to Richard Bentley in 1753, "[a]ll I will tell you more of Oxford is, that Fashion has so far prevailed over her collegiate sister Custom, that they have altered the hour of dinner from twelve to one. Does it not put one in mind of religion? One don't abolish Mahommedanism; one only brings it back to where the imposter left it." But after James Watt's invention of the steam engine, in 1765, life in England picked up speed in every possible way, and gastronomy was hardly excepted.

One of the most apparent—and arguably most abrupt—of many changes in the socioeconomic landscape of the nation was urbanization. As northern rural land rented for centuries by tenant-farmers was transformed into factories and mines, as families of farmers who had worked common land for generations found themselves without means of support, and as the factory towns offered ever-growing possibilities for employment, a wholesale and unprecedented move to the cities took place across the nation. The mass migration affected every aspect of life, and meals were no exception. Men and women who had lived their lives according to the rhythms of the fields and livestock—rising early to feed animals and work the land before the heat of the afternoon set in, dining heartily in the middle of the day, and taking a small supper (often indistinguishable from breakfast) in the early evening before retiring—found themselves faced with the artificial hours of the factory. In this age before any meaningful regulation of labor, men, women, and children commonly worked twelve- to fifteen-hour shifts on the great factory floors and in smaller, artisanal assembly works. Working days began and ended in darkness, and regularly scheduled breaks were unimaginable. Instead, workers took their food when they could—buying breakfast from a cart on the way to work to maximize their sleeping time (and thus marking the dawn of fast-food culture), and eating a snack—a nuncheon or luncheon—brought from home or bought on the street, in the brief breaks between stretches of work. The abbreviated meal might consist of bread and cheese, boiled bacon, or a bit of pie or oatcake. Like the monks of old, the workers often took this break during the none or noon hour, in the middle of their extended workday.

Urbanization, of course, was not limited to the poor, and the middle class, too, found its meal schedules profoundly affected by the rhythms of the city. The growth of middle management through industrialization brought legions of men into the factory towns of the north as well as into London: men of the newly reimagined middle classes, strivers seeking to better themselves and climb the social ladder by dint of hard work of the mind. Such men were also deeply involved in the labor of buying, selling, and transport. Britain's seemingly ever-expanding empire, Parliament's simultaneous embrace of laissez-faire capitalism and tariff laws, and such new technologies as canning created possibilities for widespread international import and export, so that London's docks teemed with firms promoting the buying, selling, and shipping of wholesale goods. In these firms, middle-class men sat on upper floors with ink and paper, working columns of figures and making deals in a new kind of labor of the mind, while working-class men dirtied their hands with the work of moving actual product around. Similarly, the eighteenth and nineteenth centuries saw the rise to new prominence of "Change Alley," home of the stock exchange—the near mythic locus where, then as now, where fortunes might be made or lost in an instant, and place of irresistible temptation for men of little fortune and much ambition. These, then, were the new proving grounds of the middle class: the spaces where strivers might push themselves into the upper echelons, by dint of hard work, good luck, and vast infusions of filthy lucre. The laborers were driven by coffee, often consumed in the coffeehouses of the city: Once the bases for political radicals of the Reformation, these purveyors of speediness and drive were the meeting grounds for movers and shakers. Coffee helped to distance the worker from his body: Divorced from physical fatigue, the entrepreneur and the city man were able to work efficiently and quickly, laboring entirely with the head, not the hand.

The world of the middle-class striver, then, was utterly distanced from the sun-dictated realm of the rural worker: Dawn and dusk became nothing more than markers for those who could work as easily by candlelight as they could by daylight. And as the striver rushed through his businesslike day, urgently buying and selling in the fast-paced world of commerce, he was increasingly unwilling to stop work for a heavy, mind-dulling dinner; nor was he willing to afford his clerks, rising young men themselves, the opportunity to eat and drink themselves into uselessness. Accordingly, the striver began to take his dinner after the workday was done, when the markets were closed and nothing more could be earned. Since coffee alone often proved insufficient fuel for the workday, he grew accustomed to taking a bite of something: a small meal at the coffeehouse or cookshop, a snack from a food vendor in the street, or a bite of bread and cheese, brought from home and eaten at his desk—a luncheon, or, as it was vulgarly known, a lunch.

Urbanization, industrialism, and class mobility, then, all played central roles in the development of a small, relatively casual noontime meal, taken at the once accustomed hour for dining, yet distinct from the more formal and substantial dinner. But the nineteenth-century trend toward lunching was not limited to the laboring classes, and the changing habits of the workingman, ironically, were the driving force behind the changing habits of the man and woman of leisure. In the country manors and fine town houses, too, the dining hour moved further and further up the clock, creating a substantial alimentary gap in the middle of the day. In some great families, of course, this move reflected the changing working hours of their own city men, lawyers and legislators (and, as the middle classes moved into the realm of the upper crust, the waiting of dinner for the arrival of the great man became increasingly common—hence the late and formal dinners held in the home of Charles Dickens's businessman Mr. Merdle in his 1854 *Little Dorrit*). For others, however, the late dinner hour was a marker not of labor but of excessive leisure—and, thus, of privilege.

City men, after all, dined late because they came home late from work; they swallowed their dinners and retired to bed soon afterward, ready to do it all again the next day. The elder sons of aristocracy and moneyed gentry, on the other hand, had no such demands on their time, and their schedules, like the fare on their tables, reflected this. For the rich, coffee was consumed at breakfast as an aid to recover from the depredations of the night before; similarly, it was swallowed after a period of after-dinner drinking, with only men present, so that card-playing, dancing, and other entertainments might go on until the wee hours. Dinner, a leisurely meal involving many dishes and, later in the century, many courses, was held late as a marker of sophistication and of wealth. An extensive dinner consumed in the hours of darkness, illuminated by expensive wax candles, was an occasion of glamour for those whose bodies were not bound by the demands of the clock. Let the ordinary working folk dine in full daylight and retire to bed early; those who need not work might gossip and intrigue round the table in the intimacy of candlelight, sup at midnight, and retire to bed in the wee hours—practices that were especially prized during the Regency period, from 1811 to 1820. Technology played a role here as well: While candlelight was certainly adequate for dining, it was hardly ideal for the labor of cooking and cleaning, and so dining at night was difficult for those not equipped with a large staff to deal with the work effectively and the means to light a kitchen well with many candles (or, later in the century, with gaslight). Dining late, then, was in and of itself a marker of means.

Because dinners were relatively public events, at which the rich (nouveau and old alike) displayed their wealth with quantities of heavy, preferably imported food and drink, they were, like every public display of wealth, competitive. The constantly shifting markers of true class necessitated ever-increasing demonstrations of deep pockets and cultural currency, one sign of which was the lateness of the hour. Accordingly, "half-gentlemen," as Jane Austen terms strivers, with pretensions to true gentility, held their dinners late as a means of classing themselves with the sophisticates of the upper echelons, and every time the hour of dining for such ordinary folk moved up, the sophisticates themselves, feeling the competition close in, felt the need to assert their class distinction by pushing their dinner hour later still.

The result of all this, of course, was a need for more meals to fill in the stomach-rumbling spaces between breakfast and dinner—often a gap of some twelve hours or more. The English afternoon or "high" tea evolved around the middle of the nineteenth century, as a genteel late-afternoon sop to the appetite (and, probably, a much-needed dose of restorative caffeine). In the noontime hour or a little afterward, the gentle classes began to take a refreshment that was more formal and more substantial than a tea, but considerably less extensive than a dinner. In the kitchens and servants' halls, this meal was referred to as lunch, and was taken as a snack, as it was in the factories. In the dining room, the repast was luncheon.

The French Influence on Lunch

The prestige of this upper-crust version of the British luncheon was helped along by French cachet. Though gentle Britain was extremely uneasy about the revolutionary developments across the channel, where the aristocracy had been jailed or beheaded, fashionable moneyed Britons nevertheless coveted all things French, and particularly all things French and gastronomic. Gallic chefs, sauces, and dishes were all perceived as both foreign and dangerous, and, thus, as the crucial markers of chic, up-to-the-minute elegance. Luncheon was no exception. Prosper Montagné's bible of all things gastronomic and French, *Larousse gastronomique*, attributes the development of *dejeuner*, the French precursor to the genteel English luncheon, to the Revolution itself, claiming that the long hours of the new Constituent Assembly, which sat from noon to six, brought about a particular alimentary transformation. According to Montagné, the members of the Assembly obligingly moved their dinner hour (*diner* in French) from one o'clock or so to six o'clock or later, but they soon found that they were unable to work effectively without food from breakfast (*dejeuner*), eaten first thing in the morning, to dinner. To stave off hunger, the members made it a practice to eat a "second breakfast" before their sessions began, around 11:00 A.M. "This second dejeuner," Montagné notes, "was more substantial than the first and included eggs and cold meat." The practice caught on, and the first *dejeuner* (a meal of soup or coffee with milk) was soon relegated to the status of *petit dejeuner*. The term "lunch" or "luncheon" was introduced into France in the nineteenth century, generally referring to a cold buffet for a large group of people, eaten standing up.

While the French *dejeuner* was driven by the lofty labor of hard-thinking men, the genteel English version was originally a ladies' amusement: The twentieth-century "lady who lunches" had her cultural birth in nineteenth-century England. Women of fashion and leisure, left at home while their husbands tended to business or pleasure, soon found that delaying their dinner to eight o'clock or later left them hungry in the afternoons; they began taking a midday repast, generally at the same time that the servants and children had their dinner. This small luncheon soon turned into an occasion for entertaining, reserved nearly exclusively for women. Arnold Palmer in *Moveable Feasts* cites such luncheons, served at one o'clock in the afternoon, occurring as early as 1818, but notes that this is an aberration. By the 1830s, however, luncheons were increasingly common. The meal was dainty. By the 1850s the practice had spread to the relatively financially stable members of the striving classes, as women who were freed from the real labor of the home by servants filled their afternoons with visiting and eating. The middle-class meal was not always as elaborate as the luncheon of the rich, however: Frugal housewives might make a lunch of leftovers from the last night's dinner or the children's meals, though only when no company was expected. When guests were present, luncheon foods were lighter than the fare of other meals, and because visitors generally retained their bonnets and shawls throughout the meal, the food could not be cumbersome or messy. It was served elegantly but simply. Sara Paston-Williams writes in *The Art of Dining* that by the close of the century, the fashionable table was quite bare: All food except fruit was served from the sideboard by the butler, so that the meal was at the crossroads between utter formality of service and utter informality of appearance. Less dressed-up luncheons featured hot meats on the sideboard, cold sweets in a row in the middle of the table, and other dishes served by the hostess. By the late 1800s, formal luncheons as celebrations and special occasion meals were not uncommon.

As Palmer makes clear, this form of luncheon was generally shunned by men, viewed as a despicable product of daintiness, trendiness, and boredom, a bastion of gossip and irrelevancy. While women's luncheons developed into a full-fledged meal, men tenaciously clung to the original sense of the term, downing a bite or two of wine and a swallow of biscuit, with or without a bit of meat, in a chophouse, at a club, at work, or on the street. For city men in particular, luncheon was public, and thus associated with business; there was nothing of indulgence or leisure about it. As the middle class grew more stable toward the end of the century, however, the practice of the lengthy business lunch, generally held at gentlemen's clubs, gradually caught on.

Gentlemen of leisure, on the other hand, incorporated luncheon into their days in more relaxed ways. They may well, for instance, have taken their cues from French epicureans. Jean-Anthelme Brillat-Savarin, in *The Physiology of Taste*, describes the great pleasures of the "hunting-luncheon," a snack of bread and cheese, chicken, and wine taken beneath the trees, as the epitome of leisure, and thus brings the notion of the courtier's lunch back to the leisured classes, while retaining its implications as a light, unmeal-like meal.

LUNCH MENUS

Arnold Palmer quotes Edgeworth's satisfying luncheon of 1823 thusly:

> "First course, cold; two roast chickens, better never were; a ham, finer never seen, even at my mother'[s] luncheons; pickled salmon, and cold boiled round. Second course, hot; a large dish of little trout from the river; new potatoes and . . . a dish of mashed potatoes for me; fresh greens, with toast over, and poached eggs. Then, a custard pudding, a gooseberry tart, and plenty of Highland cream—highly superior to lowland—and butter, ditto." He adds, "[f]or this, she was charged six shillings." (Quoted in Allen, p. 180)

Edward and Lorna Bunyard's *The Epicure's Companion* cites a day of ladies' meals in a great house, recorded in the 1857 *Country Hospitality*, or *Lord and Lady Harcourt,* thusly:

> Lady Axminster and Lady Rachel had that morning breakfasted on a first course of fish-curry, followed by meat pies, preserves, eggs, chocolate, tea, coffee, and muffins. At luncheon they had reveled on hashed venison, stewed mushrooms, an immeasurable apricot tart drenched in cream, and a bottle of soda water with sherry, but both ladies now declared they felt "quite faint"—a mountain of bread and butter now vanished rapidly, and numberless cups of tea were drained off (p. 422).

A luncheon (probably catered) held by Theodore Mander, a self-made industrialist, to celebrate the opening of the Higher Grade School in Wolverhampton, included the following (Paston-Williams):

Consommé
Saumon et mayonnaise
Soufflés de homard à la Montglas
Dindonneau froid à la Grande Duchesse
Soufflé à la Marguérite
Aloyau de boeuf rôti
Cotelettes de mouton en aspic
Galantine de volaille
Pâté de gibier
Jambon glacé, Langues
Dindon rôti
Pièce de boeuf braisée à la Napolitaine
Faisans, perdreaux
Gâteau d'abricots
Gelée à la Russe, gelée à la Française
Charlotte à l'Alexandra
Pommes à la Princesse Maud
Créme à la Munich
Fruits

The Acceptance of Lunch

By the middle of the nineteenth century, the regular luncheon meal had become, if not commonplace, at least commonly accepted among the fashionable. But the trajectory of the meal was by no means clear. Benjamin Disraeli, in his collected *Letters*, refers to luncheon as "my principal meal," at once marking his own sense of distinction by referring to luncheon and demonstrating his old-fashioned bent, by turning his luncheon, as it were, into dinner. Palmer describes writer Maria Edgeworth's oscillation between meal cycles as she moves from country house to country house, enjoying a full-fledged lunch of two courses and dessert one day, and reverting to the old-fashioned habit of midday dinner on the next. Lunch was sometimes amalgamated with tea, and taken in the middle of the afternoon. Sarah Freeman declares in *Mutton and Oysters* that "[l]unch as an occasion for entertaining was introduced in the late 1850s," but the first edition of Isabella Beeton's *Book of Household Management*, published in 1861, wastes little time on the meal. In her all-purpose guide for the up-to-date housewife, she makes mention of a light, sweet dessert known as a "luncheon cake" but declares it "seasonable at any time." And though she refers to luncheons in her survey of the well-bred lady's day as "a very necessary meal between an early breakfast and a late dinner, as a healthy person, with good exercise, should have a fresh supply of food once in four hours," she devotes scant space to its forms. In a brief section at the end of the book, she advises women to take

> [t]he remains of cold joints, nicely garnished, a few sweets, or a little hashed meat, poultry or game . . . with bread and cheese, biscuits, butter, &c. If a substantial meal is desired, rump-steaks or mutton chops may be served, as also veal cutlets, kidneys, or any dish of that kind. In families where there is a nursery, the mistress of the house often partakes of the meal with the children, and makes it her luncheon. In the summer, a few dishes of fresh fruit should be added to the luncheon, or, instead of this, a compote of fruit or fruit tart, or pudding.

For Beeton, in other words, luncheon remained a meal for fuel, rather than an occasion for entertaining and social niceties, and leftovers or nursery food were more than sufficient. This easy dismissal of luncheon may be due, in part, to her focus on helping women become useful helpmates and mothers, rather than fashionable figures: Since luncheon was patently a women's meal in the home, it could occupy little space in the husband-centered Beetonian oeuvre. Breakfast, on the other hand, warranted a great deal of ink in Beeton's work, since this was a meal over which men did business, and at which the men and women of the household ate together. And it was substantial: It is easy to imagine that anyone who ate a breakfast of cold meats, broiled fish, chops or sausage, kidneys, eggs, fruit in season, and toast might find themselves not exactly hungry when the luncheon hour came around. Indeed, it is not unthinkable that the ladies' luncheon evolved in tandem with the lady of genteel appetites. As women's eating habits came under increasing scrutiny in tandem with the development of the medicalized and rigorously controlled female body of the nineteenth century (the precursor to our own cultural preoccupation with women's bodily shapes), any self-respecting lady would restrain her appetites, particularly for strong meats and organ foods, at a meal at which men were present. Thus, it is conceivable that the woman who ate breakfast with becoming propriety would find herself hungry by noon, while her husband, free to eat whatever was before him, could not conceive of such alimentary weakness.

However, Beeton's neglect of the meal also signals its still-precarious position in the pantheon of meals at midcentury. In mealtimes, as in the realms of work and fashion, nineteenth-century England seemed to exist in several periods at once: The old-fashioned dinner sat alongside the newfangled luncheon, and the two meals were sometimes taken, as Beeton notes, at the same moment by members of various echelons of the household (servants and children dined while ladies lunched). Participation in one regime or the other marked the eater: The luncher was urban or, at least, in touch with the latest London fashions; female; young or progressive in her style; and wealthy, or hoping to be taken as such.

By the end of the nineteenth century, the luncheon was well-established in English society; the 1899 edition of Beeton's *Book*, for example, gives a full seven pages to luncheon forms, etiquette, and menus. Even at this late date, however, confusion remained. Beeton introduces her section on luncheon by remarking that "[u]nder the above name come a very great variety of meals; for we have no other name for the one that comes between breakfast and dinner. It may be a crust of bread and butter or cheese, or an elaborate meal of four or five courses; it is still 'luncheon.' Also it may take place at any time. The lower classes lunch between 10 and 11; the upper, some three or four hours later." Everyone, it seems, found a lunch of some sort necessary by the close of the century: the chasms between rich and poor, man and woman, urban and rural had more or less closed on this point. And despite the confusion over the hour and contents of luncheon, the meal remained an informal one, generally lighter than either breakfast or dinner. Through the Edwardian period, lunch became a lighter meal, similar to contemporary imaginings of the repast, and more generally indulged in by both men and women.

The end of the century also saw the advent of brunch, a meal closely associated with the Oscar Wilde-esque dandies of the period. The *Oxford English Dictionary* notes that the word was originally university slang; *Punch* magazine attributes the term to Guy Beringer, writing in *Hunter's Weekly* about a meal that combined breakfast and lunch—and was presumably indulged in by university rakes and other men about town who slept through breakfast, exhausted by the exertions of the night

MRS. BEETON'S INSTRUCTIONS FOR A PROPER LUNCHEON

The 1899 edition of Mrs. Beeton's *Book of Household Management* includes instructions for laying a proper luncheon table, guidelines for menu construction, and a warning to avoid extravagance at this most informal of meals. The book offers a number of menus for luncheons with guests, picnic luncheons, and "family luncheons."

On a Monday in summer, a family might lunch on "[m]utton cutlets and peas, cold chicken, ham, salad.—Gooseberry fool, cold milk pudding.—Bread, cheese, butter, biscuits." On a Saturday, the menu might include "Minced beef or any other cold meat, Russian salad.—Macaroni cheese.—Cake, fruit, bread, butter, biscuits." A winter family menu might consist of "Curried cold fish, steak fried, mashed potatoes.—Tinned pine.—Custard.—Bread, butter, cheese, biscuits." (Note the marks of technology and of Empire: curries from India, generally stripped of much of their spiciness, became standard fare on British tables during the nineteenth century, and canned goods were at once economical and alluring in their factory-stamped newness.) A Thursday winter family lunch, on the other hand, might be based around a "[j]oint from servants' table with vegetables"—incorporating both economy and good old English style, as the plain joint—a well-cooked piece of meat without fancy foreign sauces—was the epitome of old-fashioned English fare. It could be accompanied by "[a]ny cold pudding.—Cake, preserve.—Bread, butter, cheese, biscuits." (p. 246)

An "economical luncheon" was much more limited, incorporating one main course, one simple dessert, and bread with butter, cheese, or marmalade; the main course might consist of "rissoles of cold meat" or "potato pie made from remains of cold meat" (p. 247). The inclusion of such recipes demonstrates the reach of luncheon through every class.

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A luncheon for guests was somewhat more elaborate. The 1899 edition of Beeton lists the following menu for a summer repast for ten:

Cold salmon, tartar sauce, cucumber
Roast chicken, potatoes, green peas
Cold lamb, salad
Raspberry and current tart (cold), custard
Maraschino jelly
Strawberries and cream
Bread, butter, cheese, biscuits, &c. (p. 245)

In winter, Beeton's *Guide* suggests the following:

Clear soup
Fried soles, caper sauce
Hashed turkey, cold roast beef, beetroot, mashed potatoes
Pheasants
Sweet Omelette, stewed prunes and rice (cold), cheese, celery
Pears, oranges
Bread, butter, &c. (p. 245)

In 1934 Florence B. Jack's *Cookery for Every Household* offered a series of seasonal menus for "the luncheon proper, which resembles the French déjeuner in style" (p. 674). While noting that dishes might be added or subtracted depending on appetite and occasion, she generally proposes menus of four courses, including the following:

For spring: spring soup, mayonnaise of halibut, stewed pigeons, and French pancakes or eggs on spinach, cold beef with mixed salad, orange soufflé, and cheese cakes. For summer, fish salad, French beans à la maitre d'hotel, roast lab, and compote of cherries with custard sauce; for fall, grilled mackerel, minced chicken with spinach, bread-crumb pudding, and stewed prunes; and for winter, stuffed fillets of fish, Russian steaks, apple charlotte, and coffee eclairs.

before. In this, the brunchers improved on the medieval courtiers who ran from one meal to the next. A meal of absolute leisure, brunch obliterated the need for form and attention to hours, trumpeting the freedom of the brunchers from the tyrannies of the workday. It was an excellent means of marking the dandy as a creature entirely divorced from the middle class, and only when it was taken up as a weekend form, largely in the United States in the 1930s and 1940s, did it transform itself into the respite from the workweek that we know it as today.

Lunch in America

Though the process through which lunch developed in America closely mirrored that of England, the timetable was much slower, as the country moved more gradually from rural to urban economies. The working classes began eating a quick meal known as lunch—usually a brown-bag affair brought from home—in the nineteenth century, but the practice of referring to the midday meal as dinner persisted in many rural areas through the 1940s. The development of the upper-class lunch also occurred much later. Harvey A. Levenstein in *Revolution at the Table* places that transition in the 1880s and attributes the later dinner hour not only to fashion, but also to the American work ethic. Even men who did not work, he claims, liked to be seen as busy during working hours, and so were loathe to sit down to dinner in daylight. Particularly, but not exclusively, among the privileged, "nooning" persisted in America through the nineteenth century as a term referring to a light midday meal taken at leisure, often in less than formal circumstances.

By the early years of the new century, the ladies' luncheon was common, and home-based luncheon clubs for ladies were proliferating. But since many men of the middle and upper classes ate their midday meal at home, luncheon in America had much less of a gendered character than the British variety. Through the twentieth century, as children came home from school to eat lunch, the meal was made to bear the weight of America's great nutritional edicts, so that homemade meals and the women who cooked them shouldered the responsibility for the emotional, physical, and intellectual well-being of the nation's children. Women of leisure took their midday sustenance in public restaurants, marking their distance from the labor of the home by combining lunching or luncheon, as they termed it, with shopping and other wealth-driven pursuits of pleasure.

In the public world of work, lunch in America was driven by the nation's speedy, progress-obsessed business culture. As Daniel Boorstin notes in *The Americans*, soon after the Civil War, the notion of the lunch counter evolved, modeled on the horrible "refreshment rooms" in railroad stations, where commuters in a hurry downed worse than mediocre food at top speed. The lunch counter, like the refreshment room, was based on the premise of moving patrons in and out quickly; the setting and the seating were less than luxurious, and the food was served up extremely quickly, encouraging rapid turnover (a business practice that Ray Kroc, the entrepreneur behind McDonald's, elevated to an American art form). Unsurprisingly, innovation- and efficiency-driven Americans also developed the concept of the lunch box, complete with divisions for various types of food and eating implements, for which patents were applied in 1864.

In its contemporary American incarnation, lunch continues to incorporate many of the class- and gender-driven connotations of its nineteenth-century manifestations. Office workers may eat a quick lunch—brought from home or ordered from a take-out or delivery restaurant, contemporary versions of nineteenth-century food carts and chophouses—at their desks, or they may use their lunch hour, a sacred American twentieth-century institution, for leisure activities, shopping, exercising, or eating out at restaurants that devote themselves in some way to fast noontime service. People of real leisure and means eat lunches in restaurants, and the notion of the salad-eating "lady who lunches" still holds considerable currency. Though the notion of the business lunch, another midcentury American institution, has declined somewhat (and the legendary three-martini lunch has more or less disappeared, as a faster, meaner working world has evolved), lunch remains an important public meal for executives, who often use it as an opportunity for doing business, just as eighteenth- and nineteenth-century "Change Alley" businessmen once made deals in the coffeehouses of London. Business luncheons are more formal affairs, held for a larger number of people, and often involving a speaker. The term "luncheon" in general now refers, in the United States, to a formal affair involving a substantial number of participants, though in Britain it may also refer to a relatively formal repast for one person or a small group of people. For children, lunch is still seen as a particularly important source of nutrition, as the hot lunch programs in the schools attest, but as women have moved out of the home and into the workplace, the responsibility for this all-important feeding now rests with the schools and the public domain. Perhaps most tellingly, in the go-go American business environment of the early twenty-first century, the most important lunch is the one that is not eaten: As businesspeople seek to mark themselves as serious, driven, busy, they have come to see lunch as a sign of indulgence, even of weakness. Like their nineteenth-century London counterparts, ambitious workers often scorn lunch as a meal reserved for the weak, the slow, the unambitious, and the overly leisured. The best kind of lunch for the upwardly mobile entrepreneur is the one he or she has forgotten to eat.

See also **Art, Food in: Literature; Beeton, Isabella Mary; Breakfast; Brillat-Savarin, Anthelme; Dinner; England; Etiquette and Eating Habits; Fast Food; Gender and Food; Household; *Larousse gastronomique*; Places of Consumption; Restaurants**.

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Gwen Hyman

LUTEIN AND LYCOPENE. *See* **Antioxidants.**

LUXURY. Luxury means spending more than one needs to, and, in the view of some who concern themselves with the matter, more than one ought to, on comforts and pleasures. Since eating and drinking are (to most people) pleasures, luxury may take the form of lavish spending on eating and drinking, which is the form relevant to this encyclopedia.

Consider the possibilities. You can eat more than would be necessary to stay alive and healthy. You can drink more wine than is consistent with sobriety. You can choose foods and drinks for their flavor, their appearance, their rarity, their cost, their reputation, or their brand name, rather than because they are handy and nourishing. You can also make choices of dining companions and of ambience that others consider luxurious. If you entertain friends in a Michelin three-star restaurant, you and your guests are probably doing all these things. With a focus on different individual aspects of your pursuit of pleasure, you may thus earn specialized epithets such as glutton, gourmand, gastronome, connoisseur of fine wine, bon vivant. All of these, along with the nonfood pleasures that you enjoy before and after your visit to the restaurant, are subsumed in the general term "luxury."

Can we manage without it? *Le superflu, chose si nécessaire*: "The superfluous, a very necessary thing" is the paradoxical definition with which Voltaire approaches the topic of luxury in *Le Mondain*, a poem published in 1736. Whether or not luxury is necessary to individuals, we may still see it as playing a crucial role in human society, making the distinction between haves and have nots, identifying social classes, setting targets for the upwardly mobile.

At any rate, luxury exists in most cultures in which some people have superfluous wealth, power, or leisure to expend on its pursuit. In ancient Greece, even the Spartans (who were proverbial for their frugal way of life) found that some fellow citizens brought better game and finer delicacies to the communal meal than others. In the twentieth century, even among the Russian Communists there was a distinction between the Nomenklatura, who could afford—and were authorized—to buy luxury imported produce, and the others, who could not. It seems that to bring full satisfaction to those who practice it, luxury must not be shared too widely. Thus the list of luxuries changes continually. In the early twentieth century, fresh fruits that were not in season locally, hothouse peaches, for example, were costly luxuries, available to few. Thanks to refrigeration, air freight, and cheap gasoline, fresh exotic fruit is now no luxury—but the number of food luxuries, costly products that only some people can afford, is somehow no smaller than it was before.

The practices of luxury extend worldwide. In China, there have been costly, exotic luxury foods for more than two millennia. Beginning with the Emperor and the Court, there have been people who have spent lavishly on fine foods, enjoying banquets that might number hundreds of dishes. In India and Southeast Asia, too, it is possible to read descriptions of luxury feasts and entertainments dating back nearly two thousand years. In all these countries, there have been many people who could afford none of this. Thus the necessary contrast has existed between those who want and those who command luxury. Throughout the world, there have been philosophers and hermits who have consciously renounced the pursuit of luxury in favor of meditation; among them was the Buddha, who lived in India in the 6th century B.C.E. and whose life and teaching have influenced the whole region deeply. However, Buddhism and the other ascetic traditions stopped short of criticizing those who chose to live a life of luxury. To the Buddha himself this statement is attributed: "I do not despise sensuality: I know that is what this world is. I also know it to be transitory; therefore it does not seduce my mind" (Aśvaghoṣa, *Buddhacarita* 4.85). Thus his renunciation of luxury was a personal matter; it was not enjoined on all. In this sense, in traditional southern and eastern Asia, the pleasures of luxury were not a problem: simply, some people abstained.

The great Near Eastern civilizations, Sumerian, Babylonian, Assyrian, Egyptian (fourth to first millennia B.C.E.), as they grew in wealth, grew also in their appetite for luxury. Of the Persian Empire (sixth to fourth centuries B.C.E.), which swallowed up all of these, it was said that the best foods and luxuries, and even the best drinking water, were brought from every province to the Persian king's table. Classical Greek travelers and historians reported with awe on the vast quantities of fine produce (four hundred fatted geese and thirty pounds of anise are just two items in a very long list) that were supplied every day to the Persian court for the so-called "King's Dinner." At the courts of the Hellenistic kingdoms of the Near East, ruled by Greek monarchs in the third to first centuries B.C.E., lavish and costly banquets followed the patterns already established by the Persians. The biblical legends of King Solomon's wealthy court and of Belshazzar's feast are inspired by Persian and Hellenistic royal feasting.

Rome's conquests in the East, particularly in Anatolia (modern Turkey) in the second and first centuries B.C.E., brought the wealth and skills that enabled Rome to enjoy luxury on an imperial scale. The Roman general Lucullus, who served in Anatolia, is proverbial for his luxurious lifestyle: one may speak still of a "Lucullan" feast that offers the finest food and entertainment at astronomical cost. Several of the Roman emperors (first to fifth centuries C.E.), unmatched in wealth and power, fully demonstrated a capacity for luxury and gluttony. Among these emperors, Claudius (ruled 41–54 C.E.) is famous for his practice of vomiting after a big dinner to make room for another. Arabs and Byzantines continued these Roman traditions. At the marriage of the emperor Maurice, in 582, "the city celebrated for seven days and was garlanded with silver: deep platters, basins, goblets, bowls, plates and baskets. Roman wealth was spent; a luxury of golden display, the secret riches of the imperial household, formed a theatre for all who wished to feast upon visions" (Theophylact Simocatta, *History*, Book 1, section 10). There are equally breathtaking anecdotes of luxury from late medieval, Renaissance, and modern European royal courts.

The Western literary tradition of sensuous description and lavish praise for the pleasures of gastronomy and luxury has been paralleled, for more than two thousand years, by an opposing tradition urging renunciation of luxury and of the wealth that pays for it. This tradition may be traced to Greek philosophers, including Plato (c. 428–348 B.C.E.) and his contemporary Diogenes the Cynic. The pronouncement of Jesus, "It is easier for a camel to go through the eye of a needle, than for a rich man to enter into the kingdom of God" (Matthew 19:24.10) foreshadows the early Christian thinkers' fierce criticism of the usages of luxury. Such philosophers and religious teachers were reflecting popular views and also helping to shape them. Many people, ancient and modern, have believed that overspending on food, wine, entertainment, and other luxuries is morally wrong. These views have influenced government policies. Some Greek and Roman governments imposed direct restrictions on luxury spending or legislated to cap the prices charged for fashionable products. For example, in 89 B.C.E. the Censors at Rome decreed that Greek wine should not be sold at more than one copper per gallon; a few years later, Julius Caesar (it was said) authorized officials to enter private dining rooms to confiscate dishes whose ingredients contravened the antiluxury laws. Many modern govern-

A luxurious dinner was used as tool for teaching humility and tolerance in the 1987 movie *Babette's Feast.* The story on which this film was based was a critical attack on a puritanical religious movement in Denmark called the Holy Danes. © THE KOBAL COLLECTION/BETZER-PANORAMA FILM/DANISH FILM INSTITUTE.

ments impose differential taxes on luxury purchases. In France, for example, sales tax on fast food is levied at the reduced rate for "essentials" of 5.5 percent while on restaurant meals it is levied at the standard 19.6 percent.

Those who oppose luxury tend to complain that the businesslike satisfaction of hunger, which ought to be the purpose of food and drink, is progressively overshadowed by the pleasurable satisfaction of the senses. To satisfy the sense of taste is natural enough, but it is wrong to put flavor above nourishment in one's selection of food. The same applies to the sense of smell, and are we distracted from the proper business of the meal by scents and perfumes around us? As for the sense of sound, serious conversation is quite appropriate, if only conversation were always serious and never seductive. And must the senses of sound and sight be distracted by artists employed to dance and make music at a meal? Finally, the sense of touch: must these entertainers also mix with the guests and seduce them to promiscuous sexual pleasures? Thus, at some times and in some places, luxurious meals have turned into orgies. All of this comprises "luxury," a term that in Christian moral thinking came to be characterized as a sin. In the canonical list of mortal sins as catalogued by Pope Gregory in the sixth century, five sins are subsumed under Pride, leaving two, gluttony and lust, to belong to the classification of Luxuria, or sins of the flesh. These Seven Deadly Sins have been a recurrent theme of art and literature ever since, woven in the mid-twentieth century into Anthony Powell's novel sequence *A Dance to the Music of Time* (*A Buyer's Market* [1952] and *The Kindly Ones* [1962]).

Examples in this article are taken from many cultures at many periods, to show how widespread is the appreciation of luxury in food and dining. In each case, therefore, the date and place are specified.

Luxury in Detail

The simplest characterizations of gastronomic luxury are those that focus on the quantity of food and wine and on the convivial pleasures that surround them. In the *Odyssey*, one of the two early Greek epics (c. 700 B.C.E.), the hero Odysseus, addressing his host Alcinous on the magical island of Scherie, sets out what later Greek readers considered to be the quintessence of ancient *tryphe* (Greek for luxury): "I believe there is no more delightful pleasure than when there is happiness among all the people;

when feasters in the house, sitting in rows, can listen to a singer, while beside them tables are full of bread and meat, and a waiter brings wine from brimming bowls and fills their cups: this seems to me in my heart to be the best of all." Such descriptions can be found in oral literature of other times and places. Modern Americans, if recommending a barbecue, are likely to paint a similar picture, and to emphasize, like Odysseus, the quantity of meat available.

If tastes become more sophisticated, one will find that emphasis is placed on the quality rather than the quantity of food. This leaves room either for encyclopedic listing or for mouth-watering details.

The wine will perhaps be of varied kinds; Julius Caesar (100–44 B.C.E.) made his gastronomic mark by being the first politician in Rome to serve four wines in sequence at his public banquets. Or it will be from a good vineyard: the vogue of Chateau Haut-Brion, still a noted name among the Bordeaux vineyards, can be dated from the April 1663 dinner at which the London diarist Samuel Pepys "drank a sort of French wine called Ho Bryen that hath a good and most particular taste I never met with." Or it will be from a renowned region: the luxury banquet laid out in the famous tomb of King Tutankhamen of Egypt (died 1352 B.C.E.), intended for the monarch to enjoy in the afterlife, included a gourmet selection of wines inscribed with names of wine districts—appellations, one may call them—in the Nile Valley, the Nile Delta, and the Oases. Or it will be a well-aged vintage wine: in the fictional Dinner of Trimalchio, an episode in Petronius's novel *Satyricon* (Italy, first century C.E.), the boastful host presents a wine labeled with a truly great vintage, the consulship of Opimius in 121 B.C.E., and spoils the effect by adding, "I didn't serve such good stuff yesterday, and my guests then were much better class." Or it will be of a special style, like the so-called East Indian Madeira favored in eighteenth-century England: loaded in casks at the Portuguese island of Madeira, this wine took the long sea journey to the East Indies (modern Indonesia) and back again to Europe, crossing the equator ten times, rapidly developing a toasty maturity, and just as rapidly increasing its price. Or, if nothing else, it will be expensive: witness the strange early-twenty-first century vogue for Beaujolais Nouveau, harvested, vinified, and bottled in indecent haste. Wines and liqueurs that claim to belong to the luxury class may sometimes be as boastful as Trimalchio. The sweet wine of Tokay, in Hungary, is labeled in Latin *Vinum regum—rex vinorum* (the wine of kings—the king of wines). Bénédictine, a commercial liqueur from Fécamp in northern France, carries the dedication *D.O.M.* (to God, best and greatest) on every bottle.

The food will be notable in various similar ways. The meat may perhaps be that of a suckling animal, sucking-pig or baby lamb or kid; these are always expensive, because economic sense dictates slaughtering animals when full-grown. Or it may be game, from wild hare to wild boar to grouse. In many cultures, game reflects glamour on a male host by implying that he is the huntsman; in others, including the modern West, serving boar or venison is simply a sign that serious money has been spent. As far back as the Assyrian and Persian empires, the wealthy have kept private hunting parks stocked with "wild" animals such as boar and deer; for example, thirty gazelles were supplied each day to the Persian King's Dinner mentioned above. Or the food may be taken at the precise time of year when it is known to be at its best, its tenderest, or its most flavorsome; Archestratus, Europe's first gastronomic writer, insists on this point continually in his instructions for selecting Mediterranean fish. Like an appellation wine, the food may come from the very region where it is said to reach its peak of quality or from the producer who has the best reputation; this emphasis found fashion in restaurant menus in the United States in the early twenty-first century. It may be of very distant origin—which in earlier times would mean that it had necessarily made a slow voyage across dangerous seas, had passed through the hands of many traders, and would fetch a vast price at journey's end. This helps to explain certain strange and lavish uses of spices: true camphor (from Borneo) in medieval Chinese tea, nutmeg and cloves (from eastern Indonesia) in modern European cakes and puddings, myrrh (from southern Arabia) in classical Roman spiced wine, cinnamon in medieval Byzantine porridge. Cinnamon, which came to early Europe from Southeast Asia across the stormy Indian Ocean, fetched three times the price of gold.

Above such tastes as these lie the higher levels of luxury, those at which a host will pay fabulous prices to make the desired statement. Notice in the examples that follow, and in some of those already given, that the high price and reputation of the food and wine matter more than their effect on the taste buds. The visual effect of the display of wealth in tableware, decoration, service, and entertainment matters more than the (often minimal) contribution of these things to the participants' pleasure.

At these levels the wine will be of the highest reputation and of the most expensive vintage. "What kind of champagne is it?" "I'm afraid to look." "Suffering Pete—Bollinger 1911," said Guy Bolton to P. G. Wodehouse (New York, 1920s) in awed contemplation of a luxury buffet, ordered in their name, that they could not pay for (Bolton and Wodehouse, *Bring on the Girls*, chapter 5, section 6). The food must also be at the top of its class. It may be perennially rare, as is caviar (it will become rarer each year). It may be costly to produce, as hothouse peaches used to be and as foie gras still is. Foie gras and caviar are not bad, but are they really a hundred times as good as pork liver and cod roe? It is easy to name other foods that are neither as tasty nor as nourishing as their price might lead one to suppose. The ordinary eater can do little with truffles, yet their rarity and reputation ensure that the price fetched by the truffles of Périgord and

Tuscany remains extremely high. Bird's nest soup is said to be almost tasteless, yet the difficulty of obtaining it and its reputation ensure that its price is still fabulously high in China. There have through the centuries been many delicacies whose price owed more to fashion than to flavor and food value. Rome's second emperor, Tiberius (ruled 14–37 C.E.), considered legislating when the market price of red mullet, in response to fashion, rose to ten thousand sestertii each. (Note that it was Tiberius on one occasion who demanded luxury of a nongastronomic kind by insisting, when accepting an invitation to dinner, that the waitresses be nude.) Three of this emperor's successors—Caligula (37–41), Vitellius (69), and Elagabalus (218–222)—were famed for their use of ridiculously costly ingredients. Vitellius's triumph (shortly before his assassination) was the recipe "Shield of Minerva," his personal invention. It included parrotwrasse livers, pheasant and peacock brains, flamingoes' tongues, and the milt of moray eels, all these supplies specially fetched for him by Roman naval commanders from both ends of the Mediterranean and even beyond.

Once-exotic foods are available across the world; spices that were once fabulously costly are ridiculously cheap; philosophers and religious thinkers have ceased to decry luxury. Luxury has a past; the difficult question is whether luxury has a future.

See also **Art, Food in: Literature; Class, Social; Feasts, Festivals, and Fasts**; **Greece, Ancient; Medieval Banquet; Pleasure and Food; Renaissance Banquet; Rome and the Roman Empire.**

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MACROBIOTIC FOOD. Macrobiotics is a way of eating and living in accordance with the natural order of the universe. This simple way of life has been practiced for thousands of years, originating with the ancient Far Eastern theory of yin and yang energies, a never-ending continuum where opposites change into one another to complement, balance, and form a union; for example, the sun (yang) and moon (yin), night (yin) and day (yang); summer and spring (yang), winter and fall (yin). All things on earth are created and held in balance by these two complementary forces, a fundamental understanding that governs the whole universe. The human body is included in the universal cycle of the endless harmonious motion of change. All the major organs and functions within the body have a cycle of yin and yang movement. For example, when we inhale (yin), we must also exhale (yang); the body needs both rest (yin) and activity (yang). Foods and liquids restore and maintain the body. Therefore, the macrobiotic way of living and eating is about understanding how to live simply and choose and prepare food in conjunction with the natural order of the universe, creating physical, mental, and spiritual well-being. The sidebar at right lists yin and yang characteristics.

The History and Development of Macrobiotics

The word "macrobiotics" comes from the Greek *makros* meaning 'large', 'a great' and *bios* meaning 'life'. Hippocrates first used the term in the fifth century B.C.E. in his essay "Air, Water, Places," about a group of people who lived long and healthy lives. Even to this day, his famous quote, "Let food be thy medicine and medicine thy food," continues to be acknowledged and respected. Hippocrates emphasized that life itself depends upon what foods are consumed and how they are prepared. He suggested that healing takes place when foods are eaten in their most natural form.

While Hippocrates coined the term, macrobiotics was practiced hundreds of years earlier in the Far East. Around 500 B.C.E. one of the world's oldest medical books was written, *The Yellow Emperor's Classic of Internal Medicine*, a compilation of the medical wisdom of ancient China. The book states that people who lived in harmony according to the laws of nature, balancing yin and yang energies, lived long and healthy lives. This wisdom is believed to go back even several thousand years earlier. "Macrobiotics" became a common term used in early Western literature, including the Bible, to describe patriarchs such as Abraham as "Macrobiotic people." In 1797 Dr. Christopher W. Hufeland, a German philosopher and physician, challenged medical practices by becoming a macrobiotic spokesman in Europe. His publication of *Macrobiotics or the Art of Prolonging Life* warned against popular foods like meat as well as foods containing refined sugars in favor of a simple vegetable and grain diet.

The development of macrobiotics as it is known today is credited to George Ohsawa (1893–1966; formerly Yukikazu Sakurazawa), who overcame tuberculosis in 1909 by rejecting Western medical treatment in favor of a simple diet of whole cooked grains such as brown rice, earth and sea vegetables, beans, seeds and nuts, and miso soup. The source of the information that relieved his illness was *A Method for Nourishing Life Through Food: A Unique Chemical Food-Nourishment Theory of Body and Mind*, written by Japan's Sagen Ishizuka in 1897. Ishizuka's vision consisted of eliminating a diet of meat, dairy products, potatoes, eggs, white bread, simple sugars, and the other highly refined foods of modern civilization. He contended that eating this way goes against the natural order of the universe and humans' immediate environment, thus causing people to lose their physical, psychological, and spiritual

CHARACTERISTICS OF YIN AND YANG

Yin	*Yang*
Colder	Hotter
Darker	Brighter
Longer	Shorter
Larger	Smaller
Softer	Harder
More inactive, slower	More active, faster
More expansive, hollow	More contractive, solid

Food Classification According to Yin and Yang

Extreme Yang Foods	Moderate Foods							Extreme Yin Foods	
Some Chemicals, Drugs, and Roots	**Fish and Seafood**	**Whole Grains and Grain Products**	**Beans and Bean Products**	**Sea Vegetables**	**Vegetables**	**Fruits**	**Beverages**	**Tropical Foods**	**Stimulants**
Refined salt	Carp	Brown rice	Azuki beans	Agar-agar	*Root:*	*Fresh and Dried:*	*Reguals use:*	Asparagus	Black tea
Iodized salt	Clams	Millet	Black-eyed peas	Alaria	Beets	Apricots	Bancha twig tea	Avocado	Green tea
Crude gray sea salt	Crab	Barley	Black soybeans	Arame	Burdock	Blackberries	Bancha stem tea	Bananas	Mint tea
Ginseng	Cod	Whole wheat	Black turtle beans	Dulse	Carrots	Blueberries	Roasted rice tea	Brazil nuts	Other stimulating
Insulin	Flounder	Oats	Broad beans	Hijiki	Daikon	Cantaloupe	Roasted barley tea	Cashews	aromatic teas
Thyroxin	Haddock	Rye	Chickpeas	Irish moss	Dandelion roots	Grapes	Roasted grain tea	Coconut	Coffee
Various others	Herring	Buckwheat	Great Northern	Kelp	Jinenjo	Honeydew melon	Kombu tea	Coconut oil	Decaffeinated coffee
	Iriko	Corn	beans	Kombu	Jerusalem artichoke	Lemon	Spring water	Dates	Cola
Eggs	Lobster	Sorghum	Kidney beans	Mekabu	Lotus root	Mulberries	Well water	Eggplant	Soft drinks
Chicken eggs	Octopus	Wild rice	Lentils	Nekabu	Parsnip	Nectarines		Figs	Chocolate
Duck eggs	Oysters	Amaranth	Lima beans	Nori	Radish	Olives	*Occasional Use:*	Grapefruit	Cinnamon
Caviar	Red Snapper	Quinoa	Mung beans	Wakame	Rutabaga	Oranges	100% grain coffee	Green peppers	Curry
Other eggs from	Scallops	Other cereal grains	Navy beans	Others	Taro	Peaches	Amazake	Kiwi fruit	Nutmeg
poultry or fish	Scrod	Sweet rice	Pinto beans		Turnip	Pears	Dandelion tea	Mango	Other spices
	Shrimp	Mochi	Soybeans	**Seasonings**	Others	Plums	Lotus root tea	Palm oil	
Meat	Smelt	Bread	Split peas	Unrefined sea salt		Raisins	Burdock root tea	Papaya	**Processed Foods**
Beef	Sole	Chapatis	Whole dried peas	Tamari soy sauce	**Round/Ground:**	Raspberries	Other traditional,	Plantain	White rice
Lamb	Trout	Tortillas	Other beans	Real tamari	Acorn squash	Strawberries	nonstimulant,	Potato	White flour
Port	Other white-meat	Soba	Miso	Miso	Broccoli	Tangerines	nonaromatic	Red peppers	Refined grains
Ham	fish and seafood	Udon	Natto	Rice vinegar	Brussels sprouts	Watermelon	natural herbal	Spinach	Instant foods
Sausage		Somen	Okara	Brown rice vinegar	Buttercup squash	Wild berries	teas	Sweet potato	Canned Foods
Bacon	**Condiments**	Noodles and	Tamari soy sauce	Umeboshi vinegar	Butternut squash	Othertemperate-		Tomato	Frozen foods
foodsVeal	Gomashio	pasta	Tempeh	Sauerkraut brine	Cabbage	climate varieties	*Infrequent Use:*	Yams	Sprayed foods
Wild game	See vegetable	Couscous	Tofu	Mirin	Cauliflower		Fruit juice		Dyed Foods
	powders	Bulghur	Other bean	Amazake	Cucumber	**Garnishes**	Cider	**Dairy Foods**[1]	Irradiated foods
Poultry	Tekka	Fu	products	Barley malt	Green beans	Grated daikon	Dyed foods	Butter	Foods produced with
Chicken	Umeboshi plum	Seitan		Rice malt	Green peas	Grated radish	Soy milk	Cheese	chemicals, additives,
Duck	Shio kombu	Oatmeal	**Pickles**	Grated gingerroot	Hubbard squash	Grated horseradish	Vegetable juice	Cream	artificial coloring,
Goose	Shiso leaves	Corn grits	Bran	Grated gingerroot	Hokkaido pumpkin	Chopped scallions	Barley green juice	Ice cream	flavoring, emulsifiers,
Pheasant	Green nori	Cornmeal	Brine	Grated daikon	Mushrooms	Grated ginger	Sake	Kefir	preservatives, stabilizer
Turkey	Yellow mustard	Arepas	Miso	Grated horseradish	Onions	Red pepper	Beer, natural	Milk	Vitamin pills
	Green mustard	Popcorn	Pressed				Fermented		
			Rice flour						

[CONTINUED]

Food Classification According to Yin and Yang

Extreme Yang Foods	Moderate Foods							Extreme Yin Foods	
Some Chemicals, Drugs, and Roots	**Fish and Seafood**	**Whole Grains and Grain Products**	**Beans and Bean Products**	**Sea Vegetables**	**Vegetables**	**Fruits**	**Beverages**	**Tropical Foods**	**Stimulants**
Fish and Seafood Bluefish Salmon Swordfish Tuna Other red-meat and blue-skinned varieties	Cooked nori Roasted sesame seeds Other traditional condiments	Other grain products **Seeds and Nuts** Almonds Chestnuts Filberts Peanuts Pecans Pinenuts Pistachios Poppy seeds Pumpkin seeds Sesame seeds Squash seeds Sunflower seeds Walnuts Other temperate-climate varieties	Salt Salt and water Sauerkraut Takuan Tamari soy sauce Umeboshi Other traditional types	Horseradish Umeboshi plum Umeboshi paste Lemon juice Tangerine juice Orange juice Fresh black pepper Red pepper Green mustard Yellow mustard Sesame oil Corn oil Safflower Oil Mustard seed oil Olive oil Sake Sake lees Other natural seasonings	Patty pan squash Pumpkin Red cabbage Shiitake mushrooms Snap beans Summer squash Swiss chard Wax beans Zucchini Others **White/Green Leafy:** Bok choy Carrot tops Celery Chinese cabbage Chives Daikon greens Dandelion greens Endive Escarole Kale Leeks Lettuce Mustard Seeds Scallians Sprouts Turnip Greens Watercress Wild Grasses Others	Other traditional garnishes	Wine, natural Fermented Other grain- and fruit-based mild alcoholic beverages of natural quality **Sweeteners** Amazake Barley malt Rice syrup Maple syrup Fruit juice Cooked fruit Dried fruit	Sour cream Whipped cream Yogurt **Sweeteners**[2] Aspartame Blond sugar Brown sugar Cane sugar Carob Corn syrup Chocolate Dextrose Fructose Glucose Honey Molasses Nutra-Sweet Raw sugar Saccharin Sorbitol Turbinado sugar White sugar Xylitol	Mineral supplements Other food capsules, tablets, and similar products **Some Chemicals and drugs** Amphetamines Antibiotics Aspirin Cortisone Cocaine LSD Marijuana Others **Seasonings** Margarine Soy margarine Lard Shortening Animal fats Refined vegetable oils Herbs Spices Wine Vinegar Mayonnaise Hot Pepper

[1] Brie, Roquefort, and several other salted cheeses that have aged for a long time are classified as yang rather than yin.
[2] Soft drinks, candy, pastries, desserts, and other items containing these sweeteners should also be avoided.

vitality and harmony. According to Ishizuka, the ability to experience the highest levels of spirituality is controlled by food. He emphasized that the great sages and saints all lived on whole cooked grains and vegetables cooked with salt. Ishizuka was also concerned with the way eating patterns determined how families and societies functioned. His philosophy and scientific studies echo the macrobiotic way of living and eating in the early twenty-first century. He emphasized balancing Na-dominance (sodium) and K-dominance (potassium) in foods, which is also known as the acid-alkaline balance. Ohsawa amended Iskizuka's theory by imposing yin and yang forces onto the acid-alkaline balance, contending that these energies make up the mystery of life. Iskizuka's work sparked Ohsawa's passion to study, write, and extend his own version of macrobiotic practice and teachings to American, Asia, and Europe.

Macrobiotic Foods

A macrobiotic diet is defined as eating in balance between extreme yin and yang energies. For example, animal meat is considered an extreme yang food and creates natural strong cravings for extreme yin foods, such as refined sugar in cookies and cakes. Extreme foods create sickness and are the body's warning that there is an imbalance. The imbalance causes the blood to become too acidic, creating an environment in which diseases can thrive. Human organs, especially the kidneys, need to work harder to buffer the acids and maintain a normal pH alkaline blood condition of 7.35–7.45. Scientific studies have shown how a sustained acidic condition can cause normal cells to change to cancer cells. (The sidebar below illustrates foods in relation to acid and alkaline.) If extreme foods continue to be consumed, the body starts accumulating and storing toxins in the form of mucus, fats, cysts, and tumors.

To avoid these undesirable conditions, the consumption of whole, unprocessed foods grown without pesticides and other chemicals is recommended. These consist of earth and sea vegetables, whole cooked grains such as brown rice and millet, bean products, seitan (a wheat-based food), nuts, seeds, and occasionally fish. Seasonings and condiments are used to add nutritional value and to enhance flavor. These include miso, made from soybeans and sea salt commonly flavored with fermented barley or brown rice, which strengthens the blood; *umeboshi*, a salty plum that neutralizes extreme foods and conditions; sea vegetable flakes, which are high in minerals such as *dulse* and nori; tekka, a powder made from *hatcho* miso, sesame oil, burdock, lotus root, carrots, and gingerroot that is simmered for several hours and gives strength; *gomoshio*, a mixture of sesame seeds and sea salt high in calcium; and shoyu soy sauce to help with digestion. *Kuzu*, a white starch made from the deep root of a wild vine that helps digestion, thickens sauces. These condiments and seasonings have a variety of medicinal uses and can also maintain normal levels of blood alkaline. Eating these foods, seasonings, and condiments balances the body without causing cravings for extreme foods; thus, the transition of foods from yin to yang and vice versa is smoother, thereby creating internal balance and promoting health.

ACID AND ALKALINE IN FOODS

Too much alkaline	***Too much acid***
Refined salt	Meat, eggs, fruits, sugars

Lower alkaline	***More Balanced***	***Lower acid***
Miso/shoyu soy sauce	Sea/land vegetables	Grains, beans

In a temperate climate, macrobiotic foods do not include nightshade vegetables such as tomatoes, potatoes, peppers, and eggplant. These foods are high in alkaloid content and contrary to the healing process. By eating nonpollutant food, the body has a chance to clean out stored chemicals, increase nutrient absorption, and improved health.

Cooking Techniques

Cooking processes also have a yin and yang quality. For example, cooking meals, such as beans, longer involves more heat, which indicates yang energy, and this way of cooking complements cooler seasons such as winter, which is yin. In contrast, lighter meals, such as salads, and quicker cooking methods are yin, which complements warmer seasons such as summer, which is yang. This style of cooking and eating promotes remaining in balance with the changing seasons, supporting the natural order of the universe.

A gas stove is recommended for cooking macrobiotic foods because the heat comes from natural energy. Also urged are cooking with natural spring water when needed and using stainless steel, glass, cast iron, and porcelain cookware to keep the food away from possible contamination that may occur with aluminum and synthetic coatings. Ideally, foods are locally grown in season to promote internal balance and harmony with the environment.

Food and Behavior

There is also a cause and effect relationship between food and behavior. For example, eating mostly extreme yang foods usually leads to irritability and anger, while eating mostly extreme yin foods usually leads to depression and reduced energy; however, soon after eating extreme yin foods, such behavior as explosive anger has been noted.

Eating foods that are balanced with yin and yang energies without extremes maintains a normal alkaline blood level and leads to vitality and a peaceful, more comfortable state of mind. Table 1 illustrates foods associated with certain behaviors and moods.

TABLE 1

Yin and Yang foods associated with behaviors

	Foods	Behaviors
Extreme Yang	Refined salt	Aggressive
	Meats	Overactive
	Poultry	Angry, irritable
	Fish (blue and red skin)	Attacking, intolerant
	Hard salty cheese	Self pride
		Voice too loud, tense
		Tense muscles
		Dry skin
Balanced	Grains	Assertive
	Vegetables	Active
	Sea vegetables	Content, patient
	Miso	Positive outlook
	Beans	Satisfied with life
	Seeds	Voice pleasant
	Nuts	Relaxed muscles
		Smooth, clear skin
Extreme Yin	Sugar	Passive
	Honey	Overly relaxed
	Molasses	Depressed, sad
	Coffee, caffeine	Negative, retreating
	Milk	Self-pity
	Ice cream	Voice too soft, timid
	Yogurt	Loose muscles
		Moist skin

The standard macrobiotic diet consists of 30 to 50 percent whole cooked grains and whole grain products, such as sourdough bread and pasta (including *udon* noodles made with wheat flour, brown rice, and sea salt and *soba* noodles made from buckwheat flour); 20 to 30 percent locally grown organic vegetables; 5 to 10 percent beans such as adzuki and lentil (including tofu made from soybeans, *nigari*, and water and tempeh made from split soybeans, vinegar, and water); 5 to 10 percent soups, including miso and vegetable; and 5 percent condiments, such as *umeboshi* plum, *gomashio*, and sea vegetables, including *wakame* and *kombu*. Macrobiotic foods are high in complex carbohydrates, fiber, vitamins, and minerals that provide the balance of proper nutrition that the body needs.

A very basic balanced macrobiotic meal may consist of: one cup of miso soup made with onions, carrots, and sea vegetables such as *wakame;* one cup of whole cooked grains, such as brown rice seasoned with a pinch of sea salt; one-quarter cup of cooked beans, such as adzuki mixed with a small amount of the sea vegetable *kombu* and a sweet vegetable such as butternut squash seasoned with shoyu soy sauce; one cup of cooked green and yellow root and leafy vegetables; a pickled vegetable; and a garden salad. Fish can be eaten occasionally along with soy products such as tofu and tempeh to substitute for beans to provide protein. For dessert, a recommended dish may be couscous cooked with apple juice and apples. Also used for sweeteners are barley malt and brown rice syrup. In addition, *kukicha bancha* tea, which has a pleasing taste, is used as a daily beverage that has virtually no caffeine, alkalizes the blood, has a beneficial effect on digestion, and relieves fatigue.

Recommended macrobiotic foods and their portions vary according to a person's physical and mental condition, climate, and age. For example, someone with a slower metabolism may benefit from eating fewer grains and more vegetables. Macrobiotic counselors throughout the United States help people adjust the diet to their specific needs.

The Spread of Macrobiotics

Macrobiotics owes much of its contemporary popularity to George Ohsawa and his wife, Lima. His students Aveline and Michio Kushi developed the Kushi Institute in Brookline, Massachusetts, which helped spread macrobiotic teachings and practices in the eastern United States. Cornelia and Herman Aihara, also Ohsawa's students, developed the study and practice of macrobiotics in the western United States. Macrobiotic food may be found in health-food stores, and macrobiotic cookbooks are available there and in major bookstores throughout the United States. In the early twenty-first century, there are over five hundred macrobiotic centers throughout the United States whose advocates stress the advantages of this way of eating and living. The more common benefits experienced are increased vitality, better sleep, a stronger immune system, reduced fatigue, and improved memory. There are also scientific and medical studies which indicate that following a macrobiotic diet can prevent or relieve cancer and other terminal illnesses. These benefits are said to result from a body cleared of chemicals and toxins. Practicing the macrobiotic way of life moves beyond physical health to also revitalize the true nature of mental and spiritual well-being.

See also **Eating: Anatomy and Physiology of Eating**; **Health and Disease**; **Health Foods**; **Natural Foods**; **Organic Food**; **Preparation of Food**; **Soy**.

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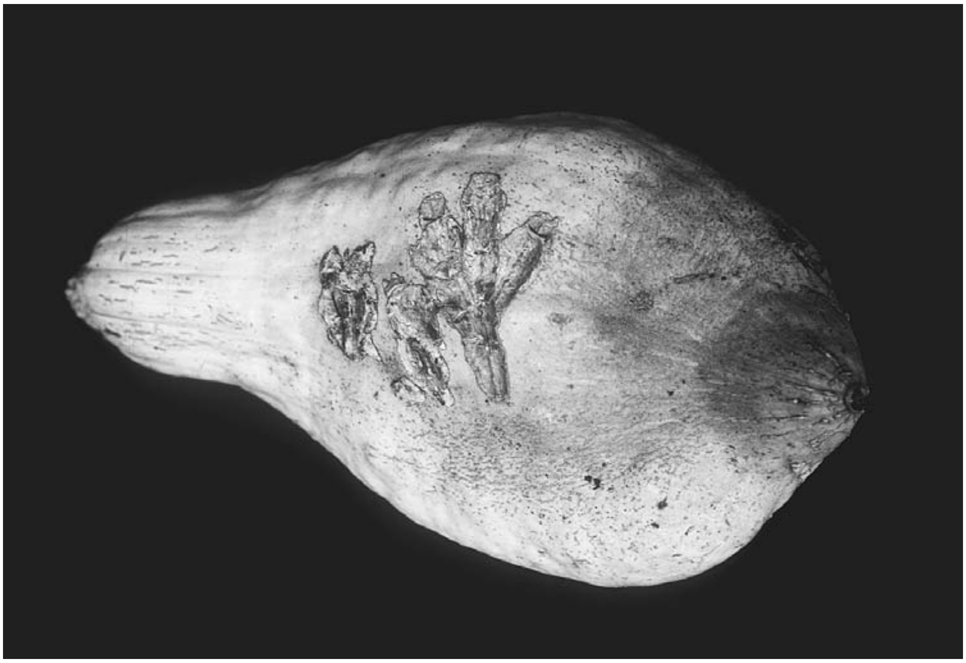
Roberta Bloom

MAGIC. The English term "magic" (*magie* in French, *Magie* in German, and *magija* in Russian) comes from the Greek *magikos*, a term that referred to a class of priests in ancient Persia and Greece. Later the word was taken over by Christianity and applied to the kings ("magi") who traveled to pay their respects to the infant Jesus. It was not until the Middle Ages that the word "magic" took on negative connotations. In modern times, magic refers to witchcraft, sorcery, and the casting of spells. Magic is also part of rites and ceremonies that are connected with the belief in a supernatural influence on nature, animals, and human beings. The field of ethnology uses the term "magic" very widely, but the meaning of the term is not always clear. Witchcraft was opposed by official religions from ancient times, as, for example, the Indian "Laws of Manu" (sixth to fifth centuries B.C.E.) and the Roman "Laws of 12 Tables" (mid-fifth century B.C.E.). The position of Christianity was shown in the Codex of the Emperor Justinian (529). Among the East Slavs, witchcraft was considered a superstition and a relic of paganism and therefore a sin. There is a tradition of identifying magic with witchcraft and distinguishing "white magic" from "black magic." Around the turn of the twentieth century, A. Lemann and others associated magic with sorcery. Lemann formulated the most popular definition of magic: "Magic or witchcraft is every action provoked by superstitions." B. Malinovsky wrote that magic was from ancient times the province of specialists and that witchcraft or healing was the first profession.

The connection of magic with religion and religious rites has also been interpreted in many ways. Sir James George Frazer thought that magic was founded on men and women's belief in their own potential to influence nature; this stands in contrast to the concept of religion, which is built on a belief in supernatural beings (gods, spirits, ghosts) that control natural phenomena. Other theories assert that religion is inseparably linked with magic. S. A. Tokarev gave a description of religious rites that can be classified as magic rites, depending on their form and function. The division of magic by form proceeds from the psychological mechanism behind the use of magic forces, including establishing contact, initial (beginning), imitative magic, apotropaic magic (to avert evil), cleansing, and verbal magic. The division of magic according to function is linked to real-world or practical roots of magical beliefs: for example, medical magic is connected with folk medicine, love magic is connected with courting, trade magic is associated with hunting techniques, and agrarian magic is linked to primitive agronomics.

Food is associated with almost every kind of magic. Magic rites connected with food production, processing, and presentation reflected ancient beliefs and motifs that had lost their primary mythological meanings over time and had become inalienable elements of different religions. For example, it is no coincidence that figures from Slavic mythology were identified with Christian saints, such as Peroun, the god of rain, or in India Pardjanja, Pirva (Hettish), Perkons (Lettish), with St. Eliash; Veles, the god of cattle and wealth, with St. Vlasij; and Yarila, the god of fertility, with St. George. The roles of these figures are reflected in folklore, and especially in demonology. Traces of this type of folklore can still be found in modern times. For example, the Orthodox Church does not deny the presence of evil and other evil spirits in everyday life, but it does not support the spreading of superstitions among its followers. Nevertheless, such beliefs still exist and are reflected in ceremonies surrounding food production.

Beyond its main role of satisfying one of the vital requirements of the human organism, food plays a large symbolic role in every culture. Group meals and specific types of food are obligatory components of any festivity or event in most cultures. Depending on the societal and cultural context, food can be viewed as ritualistic, festive, sacred, funereal, prestigious, and non-prestigious. For example, many sacred rites are connected with the production of bread. It was common in many cultures to bless and to pray during bread baking and to put a cross on the bread before it was eaten. In Georgian beliefs, bread protected a child from evil spirits. Depending on the situation, a different number of loaves (accounts tell of anywhere from three to twenty-nine) could be used during magic actions. In Armenia, in order to protect her child from evil, a mother collected flour from seven families, baked bread (*lavash* in Armenian) in the shape of human being, put it under the pillow of the child, and on a certain day buried the bread. If a child became ill during the first forty days of life, he or she was passed through the hole made in a large loaf of bread. In Armenia bread was also seen as a form of sustenance in the afterlife: this belief was observed in a ceremony where fresh bread was offered for the deceased. The Udmurts often used similar magic. To return her child to health a mother baked bread three times in a day: the first time



Hexefuss (witch track) on a Hubbard squash. The mark, which resembles a goosefoot, was viewed as an omen of bad luck or impending disaster among the Pennsylvania Dutch. It appears on both fruit and vegetables and is thought to be caused by a fungus, although folk belief explains it otherwise. PHOTO BY WILLIAM WOYS WEAVER.

she baked five small loaves; the second time she baked seven loaves; and the third time, nine loaves. To strengthen the magic influence she formed dough on a kneading trough and hid herself from the daylight under a shawl.

In some rituals, bread was used to protect the human world from another one. Among eastern Slavs it was a custom to keep bread on the table that was in the "red" corner (red in Russia means beautiful) or iconostasis, a shelf on which icons were kept, regarded as a sacred place. Bread has upper and bottom sections; thus, turning bread over was forbidden, as it was believed that the bread could be "offended" by that act. Bread and salt were the obligatory foodstuffs involved in the Russian ritual of entering a new house. Among Russians, Ukrainians, and Belorussians (White Russians), only men could first enter a new house, with icons and bread in their arms as the main symbols of a new living space. They might also carry a pot of porridge or kneading trough with dough, which symbolized prosperity, abundance, and fertility. Over time these items were supplemented with such cultural symbols as poppy seeds, thistle, burdock, garlic, and religious texts, which were supposed to protect a house from evil spirits and witches. In northern Russia, peasants invited friends and neighbors to enter a new home and treated them to a good meal to protect the house from undesirable people.

Magic and magical acts, such as the casting of spells, have traditionally been connected with health. Thus, many rites included actions and language that were supposed to help maintain or attain a state of good health. Rites such as these stood in opposition to illness, death, and misfortune. The main elements of water, fire, earth, plants, and animals were considered symbols of health and played a prominent role in different magical ceremonies.

World folklore provides evidence of a close correlation between the universe and human beings. According to the the cosmological beliefs of the people of the Caucasian region, there is a Tree of Life at the back of beyond that connects with three vertical levels: a sky (the upper world), Earth (the middle world), and an underground kingdom (the lower world). The upper world is populated with gods, deities, birds, and fantastic beings. Earth is populated with people, animals, and plants, and the underground kingdom is a world of the dead, as well as devils, dragons, and deep waters. Fantastic horses, eagles, devils, dragons, animals, birds, and others beings were seen as means of communication among different levels or worlds. For example, in Caucasian-Iberian mythology there is an image of a deer with a large antler that holds up or supports the upper world.

Baking rituals in different countries reflected some of the beliefs about communication between the lower world, the human (middle) world, and the upper world. In one ritual, the Belorussians baked three pies as symbols of the three parts of the structure of the world; in modern times, these pies have taken on different religious significance. These pies can be either round, three-cornered, or oval in shape. One never cuts three-cornered and oval pies with a knife; rather, one divides them by hand into arbitrarily sized parts. Only the round pie, which in more recent times is dedicated to the Christian savior, is cut into sections with a knife in accordance with ancient rules. The final form or figure of the sliced pie is a circle divided into an eight-segment circle or *mandala*—a cosmological symbol of the universe. Thus, these three pies reflect in a symbolic form the vertical structure of mythological space.

Religious symbolism very often stems from magic practice, which supposed a transfer of symbolic qualities from one object to another. For example, eggs, rice, and pomegranates are traditional symbols of fertility and prosperity. An egg, as a symbol of life, was used for Easter festivities and also for many other ceremonies connected with food production. Russians, Ukrainians, and Belorussians prepared special pies or chicken with an egg inside for weddings. In Daghestan, women always baked fancy cakes with eggs inside in the springtime as a symbol of the revival of life. There is a tradition among the Crimean Karaims (Karais) of putting magic patterns of sun, moon, stars, and fish on Easter bread, which is made in the form of a sun.

Magic stemming from the upper world was thought to provide a possibility of survival in difficult situations, such as finding food when one is faced with starvation. An example is the fairy tale "Jack and the Beanstalk," which tells a story of the magical properties of three fava beans (*Vicia faba*). A. C. Andrews pointed out an abundance of bean stories and superstitions and attempted to explain these as being an adjunct of an original Indo-European totemism. He drew almost exclusively on classical sources from the Greeks, Romans, and other closely related Mediterranean peoples.

The earliest and most abundant mentions of bean superstitions came from Greek city-states. Literature from ancient Rome contains similar references. R. Rowlett and J. Mori analyzed the work of their predecessors, including A. C. Andrews, and discovered that "favistic" folktales about beans were not always connected with favism (1971, pp. 98–100).

The motif of communication with the upper world can be seen in the calendar ceremonies of eastern Slavs, who bake special bread with forty stripes, which recall Jesus's footsteps on the Day of Ascension (forty days after Easter). The eastern Slavs bake another type of bread—*onoochkee*—that represents the cloth wrapped around Jesus' feet. Russian peasants put such bread in the rye field, believing that grain would provide strength. People in southern Russia baked similar bread on the fortieth day after an individual's death. Mourners put bread on the bench by the gate of the house, and people later ate it with honey. On that day some people ate pancakes at the nearest crossroads to prevent the deceased from returning home.

Magical food has been involved in many burial customs and rites that confirm a constant link between the living and the dead. For example, in many cultures magic rituals involved feeding deceased people, or more specifically, feeding their souls. Such symbolic actions were often performed on the stove in the home. Food was thrown about the house near the body of the deceased. Sometimes people placed food in the deceased's mouth, such as in the traditions of the Nganasans of Taymyr, Russia. Closely associated with these rites are the ceremonies that occurred after burial, because they include the same feeding of the souls. In addition to traditional funereal meals, many religions have ceremonies on special days that involve food and the deceased. Such celebrations are popular in Latin America. Mexicans have celebrations in August and November that involve the notion of spirits enjoying the smell of food. Persians put food on houses and roofs in the middle of March to encourage prosperity in the next year. B. Propp retraced the great role of the cult of ancestors in Russian agrarian festivals. Eastern Slavs celebrate "Parents' Saturdays" in accordance with the Orthodox calendar (*Dzjady* in White Russia) and the Japanese celebrate a Bon' Day. Russians always put out a glass of spirits with a piece of bread on the day of a funeral and on subsequent anniversaries. It is still a rule in Ukraine to have breakfast together with the deceased at the cemetery on the next morning after the funeral and to eat bread, sweets, and cakes and drink spirits. In Russia, visiting the cemetery on the second day after Easter (*radunitsa*) and sharing a meal with the deceased also became a custom: the meal was a painted Easter egg and sweet bread that were placed in the tomb.

Eastern Slav celebrations at Shrovetide and at Christmas were both devoted to the memory of the deceased. These days were observed by the preparation of such obligatory ritual dishes as bliny (pancakes) and *kissel*, made from oat, fruits, or berries. This tradition still exists among Russians. Ukrainians have a custom of preparing compote and small sweet pies with jam at funerals.

An example of using verbal cliché with magic purpose can be found in the texts of the Apocrypha, biblical books of dubious authenticity that are excluded from the Jewish and Protestant versions of the Old Testament. Nevertheless, apart from the fasts on Fridays established by the Orthodox Church, there was a tradition of fasting on the twelve "Temporary" Fridays, or "Vow" or "Big" Fridays, that were very popular among Orthodox adherents. Fasting on Fridays was a well-known practice of the use of the apocryphal texts as amulets, which was widespread in many cultures. The main role of the Apocrypha was to protect people from different troubles but only under the condition of fasting. Orthodox Christians kept fasts on these days to prevent unexpected misfortunes such as drought, bad harvests, infestations, and diseases.

The apocryphal Twelve Fridays were widespread in Russia in the guise of legends, spiritual verses, and tales dating from the eleventh century. Wandering (usually blind) minstrels sang the verses and advised followers to respect Fridays by "saint fasting and praying, faith and love, gentleness and humility." The verses warned that anybody who committed a breach of Fridays would be punished for generations to come.

In Russia the texts about the Twelve Fridays (as the texts "Dream of Our Lady") were also used for magical purposes and were worn on the body and used as amulets. However, such texts were not just magical; they were manifestations of piety in many provinces where they were distributed in the form of manuscript copies, apocryphas, and spiritual songs.

In the nineteenth and twentieth centuries, the texts of the Twelve Fridays could be found in many Russian provinces. They were dedicated to the main feasts of the Church calendar, and people fasted on Fridays before these holidays. Every Friday had a special grace and promised special preferences. The Twelve Fridays manuscript is still popular. People still believe that keeping fasts on these Fridays protects them against diseases and disasters.

See also **Feasts, Festivals, and Fasts; Folklore, Food in; Religion and Food; Russia.**

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MAGNESIUM. *See* **Minerals.**

MAIZE.

This entry includes two subentries:
The Natural History of Maize
Maize as a Food

THE NATURAL HISTORY OF MAIZE

Maize, also referred to as corn or Indian corn in the United States and Great Britain, respectively, is a cereal plant of the Gramineae family of grasses that today constitutes the most widely distributed food plant in the world. Accordingly, maize—from the Arawak *mahiz*—is grown in diverse regions and climates, from 58 degrees north latitude in Canada and Russia to 40 degrees south latitude in South America. Maize cultivation and processing are driven by the production of food and livestock feed, fermentation, and raw materials for industry.

Chestnut dibble or planting peg from Maryland, circa 1850. The top of the dibble is cut to fit the thumb. Farmers planted maize by stabbing the plowed ground with the dibble and dropping a seed into each hole. Beside the dibble are seeds of King Philip Flint Corn, a variety that emerged in New Hampshire during the 1830s. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Given its many uses, maize is likely to be found in over 1,000 products in a well-stocked U.S. supermarket. The specifics of maize production, reproduction, cultivation, processing, and consumption—its resiliency, mutability, as well as the intractability of cultural and botanical constraints—continue to provide science with insights into the past and possible future of the species. Not surprisingly, maize is the most studied plant species on the planet.

The Ethnobotany of Maize

Ethnobotany, the study of symbiotic relationships between human cultures and the plants on which they rely, is one of the many fields of study fueling investigations into the earliest domesticated maize and its subsequent global diffusion. Ethnobotanists, archaeologists, anthropologists, taxonomists, food and horticultural scientists, nutritionists, geneticists, biotechnicians, art historians, and many others are all trying to find answers to the numerous questions posed by the evolution and proliferation of maize. This diverse body of scientific sources provides information about the natural and cultural history of maize.

The Quintessential Maize Plant

Experts have established that modern maize evolved from *teosinte* (God's corn), or *Zea mays* ssp. *Mexicana*, although some botanists continue to argue that it evolved from an early Mesoamerican maize variety called *Chapalote*. Even the timing of maize origins has been questioned. A review of the botanical characteristics of both maize and *teosinte* will distinguish them and provide some idea of how maize developed into the fully domesticated cultigen it is today.

According to plant geneticist John Doebley, maize (*Zea mays L.* ssp. *mays*) and the teosintes (*Zea* spp.) differ profoundly in terms of vegetative characteristics and "inflorescence architecture" (1996, p. 66). That is, differences are specific to the form of the plant and its reproductive architecture, including variation in the mode of development and arrangement of the flowers or blooms along the axis of the plant.

In this instance, the distinctions are most notable in the forms of the male tassel, or spikelet, that sprouts at the summit of the maize or teosinte stalk, as well as in the form and development of the female inflorescence or maize ear. Despite these distinctions, Doebley acknowledges that maize and the Mexican teosintes are essentially variants of the same biological species. As such, they form fully fertile hybrids and cross-pollinate; the inherent differences in chromosome structure and other genetic aspects between teosinte and maize are no greater than those observed among the diverse races of maize (p. 66). Experiments distinguishing genes of teosinte from maize have been replicated in recent years through the use of molecular analysis.

The characteristic reproductive pattern of maize is a very ancient and primitive one. Maize includes both male and female reproductive characteristics and constitutes an Andropogonoid grass that bears a spike-like axis or tassel on which flowers or blooms are attached and from which pollen is dispersed; it is a self-pollinating plant that disperses pollen from the tassels to the "style" or "silk" of the maize ears (female inflorescences), where it is absorbed in the reproductive process. Whereas each tassel contains some 25 million pollen grains, each female inflorescence or maize ear contains upwards of 1,000 ovules or potential kernels. Each pollinated silk is thereby transformed into an individual kernel of maize that grows to contain a single ovule necessary for the reproduction of the plant itself. Maize leaves track the sun's light and absorb its energy; a field of maize is optimally designed for producing high yields from solar energy.

Maize Variation and Race

There are some twenty-five "primary" races of maize found in Mesoamerica, and none of these is pure. The proliferation of hybrid variants and recent advances in bioengineered or genetically modified varieties of maize has seemingly sealed the fate of this most ancient foodstuff. In fact, the global proliferation of genetically engineered foods is poised to completely displace or replace existing strains of the primary grain crops with biologically engineered substitutes.

The evolutionary history and inherent mutability of maize are so complex that scientists continue to debate and question the taxonomic identification of all the extant races of maize in both wild and domestic contexts.

There is no agreement about the taxonomic names or numbers of races that may exist in any single world region. Since maize is so easily hybridized, the number of varieties far exceeds any other crop species on record. Botanical taxonomists have loosely grouped these varieties into some 300 races for the Western Hemisphere alone. Early textbook taxonomies, on the other hand, once identified only six races, including dent, flint, flour, sweet, pop, and waxy varieties. Of these, two dominate American commercial agriculture and include the Flint (*Zea indurata*) and Dent (*Zea indentata*) varieties. The nine major types cultivated in the United States include the Southwestern Semidents, Southwestern twelve-row, Pima-Papago, Great Plains Flints and Flours, Corn Belt Dents, Southeastern Flints, Southern Dents, Derived Southern Dents, and Northern Flints.

Of those races of maize indigenous to Mesoamerica, four main groups of maize have been identified. Their respective taxonomic classifications are based on the vegetative characteristics of the plant, characteristics of the spike or spikelet, characteristics of the cob, and the physiological, genetic, and cytological characteristics of the plants studied. These primary maize groups are (1) antique indigenous, (2) exotic pre-Columbian, (3) prehistorical mestiza, and the (4) not well-defined or modern races. To this latter category may be added the proliferation of genetically engineered strains.

The antique indigenous group consists of those races that originated in Mesoamerica with the primitive earliest races of maize. Variations within this group are thought to be evidence of multiple independent origins in diverse areas of Mesoamerica. The races specifically identified with this group include Palomero Toluqueño, Arrociclo Amarillo, Chapolote, and Nal-Tel.

Maize in the New World

The history of maize and its domestication may be traced back some 8,000 years. Maize spread across the length and breadth of the Americas, and subsequently to Europe, Africa, and Asia. Teosinte (*Zea mexicana*) has been linked with the earliest maize in Mesoamerica and was first harvested as early as 10,000 years ago.

The origins of maize begin on the Pacific slope of the modern Mexican states of Oaxaca, Tehuacán, and the Valley of Mexico. The earliest primitive corncobs discovered in Mesoamerica were obtained from specimens recovered within a cave near Oaxaca. From there maize diffused rapidly into Central America and then into South America by way of the eastern slopes of the Andes approximately 4,000 years ago. Guatemala may have served as the source or conduit for the adoption of the earliest strains of maize in Andean South America and Peru. In fact, the initial appearance of maize in Peru has been dated to 6070 B.C.E. Ecuador, Chile, and Argentina, with Andean Peru, form a likely corridor for the transmission of maize from Guatemalan sources into coastal valleys. Some nineteen races of maize from ten Latin American countries have been identified with the Classic period of 300 to 900 C.E. Six of these evidenced interactions between Mesoamerican and Peruvian societies from the most remote periods of pre-Columbian cultural development.

New World dispersals. Walton C. Galinat has traced the diffusion of maize into North America to a Northern Flint Pathway established by 700 C.E. in the Rio Grande valley. From there maize spread northward along both the eastern and western flanks of the Rocky Mountains, and eastward along major river courses—including those of the Arkansas, Mississippi, Platte, and Ohio Rivers—permitting its continued cultivation and dispersal eastward. By 1200 C.E., maize cultivation was established in upstate New York and New England. While the eight-rowed variety of maize was cultivated in the southeastern United States in pre-Columbian times, the Southern Dent Pathway accounts for the distributions of other varieties of maize after 1500 C.E., subsequent to Spanish contact in those regions. Ultimately, the hybrid vigor identified with the larger and more robust forms of maize can be traced back to the merging of the Northern Flint varieties with the Southern Dent varieties by U.S. farmers of the Midwest in the mid-nineteenth century. According to Galinat, this hybrid fusion can be characterized as having resulted in an “inadvertent evolutionary explosion” that ultimately transformed maize into a highly productive and important foodstuff.

Maize in the Old World

Even before the Wampanoag Indians presented the early Plymouth colonists with maize at the first Thanksgiving celebration in 1621, enabling this early English colony in present-day Massachusetts to survive, maize had already made its way back to the Old World and was rapidly being incorporated into the agricultural economies of sixteenth- and seventeenth-century Europe and the Middle East, the Balkans, Africa, India, and Asia. In fact, according to Sylvia Johnson, as early as the mid-sixteenth century, maize had been introduced to Europe, western Asia, Africa, and China. These early Old World encounters with maize were ambivalent toward the exotic grain then known as Turkish wheat, Turkish grain, Spanish wheat, or Indian corn. In fact, negative reactions to maize in the Old World largely focused on the belief that maize was less nourishing than extant European grain products such as the wheat, barley, or oat cereals used in the production of bread and related by-products.

Despite its considerable productivity in comparison with wheat, its shorter growing season, and its considerable adaptive potential to marginal environments, maize was initially seen as a foodstuff fit only for animals or the poorest of the peasantry, who ground it up with water and ate it as a finely ground mush or porridge. This came to be known as “polenta” to the peoples of northern Italy, which has since been incorporated into European and American cuisines. Beginning in Italy, a variety of toppings and additives, including cheese and pasta, have diversified the ingredients of this poor persons' food and transformed it into an international favorite.

In China and Southeast Asia, maize is cultivated in rotation with other, more traditional crops like rice or millet, and sequential cropping (relay cropping) strategies permit a form of multiple-cropping that overlaps the life cycles of two or more crops. These methods made possible the generation of crop surpluses in Asia beyond those originally identified with the exclusive or traditional reliance on rice as a primary cultigen. In fact, maize is being used throughout Asia to supplement more traditional crops by extending the growing season and expanding production potentials throughout the year. In addition, the production of maize fodder and feed for livestock has fueled the adoption of maize agriculture throughout the developing countries of Asia and Africa. Maize provides the world's most cost-effective and highest yield plant resource currently available for the production of livestock forage, fodder, and feed (Dowswell et al., 1996, pp. 27–28).

Old World dispersals. The cultural, economic, and political impacts of the European discovery of maize were evident in the ensuing population boom that followed its introduction into the Old World. After 1492, maize rapidly diffused into Europe, Africa, and Asia and was successful in large part because it did not directly compete with existing grain crops such as rice, wheat, oats, millet, and barley. Maize was also suited to cultivation in otherwise poor growing conditions related to topography, soils, climates, aridity, and elevation. Significantly, maize also prospers in exceptionally wet climates unsuited to wheat or relatively arid regions unsuited to rice cultivation. Moreover, maize has the additional advantage of rapid returns and twice the productive yield per unit of land of wheat.

The adoption of maize in Africa and China heralded a dramatic social and cultural transformation. Maize provided a level of food surplus that permitted the exponential growth of populations. Whereas in Europe maize was seen as a substandard cereal grain, fit only for feeding the poor and hungry and livestock, in many areas of Africa and Asia maize came to dominate the agricultural economies of many nation-states. The productivity and efficiency of maize horticulture and its low production and transportation costs made it a cheap food for slaves captured and held by European and Arabic slave traders. Maize made possible the efficient and economical transport and exchange of horrific numbers of sub-Saharan Africans destined for the markets of Europe, the Middle East, and the Americas.

The African Connection

Although it remains unclear who first introduced maize to Europe, Africa, and the Old World more generally, a number of scholars now argue that the Portuguese colonies of Africa served as the initial conduit to the diffusion of maize in that hemisphere. Jean Andrews claims that maize, beans, peppers, squash, and turkeys diffused into the Balkans, or southeastern Europe, by way of Portuguese Africa, India, and the Ottoman Empire in the period following the voyages of Columbus (1993, pp. 194–204). So profound was the impact of maize on the African economy that, like Mesoamerica, culture and society, subsistence and settlement, political economy and gender relations, and the respective cuisines and culinary technologies of each of these vast regions were rapidly transformed to accommodate the adoption of maize and those human diasporas with which it was associated. The unique maize-based cultural complex of agricultural practices, extensive settlement patterns, and storage, distribution, and food processing technologies identified with maize cultivation in fact fueled much of the transformation in question. In *Africa's Emerging Maize Revolution*, Derek Byerlee and Carl Eicher acknowledge that the adoption of maize has been the primary engine driving the transformation of the African social, political, and economic landscape for the many societies that have been swept up in this new agricultural revolution.

More specifically, it is becoming increasingly evident that those agricultural practices identified with maize, such as swidden cultivation, extensive or shifting settlement patterns that are, in turn, identified with swidden systems, the processing of maize with basalt grinding slabs, the female domination of these labor-intensive food processing and storage traditions, and the emerging role of women in the maize-dominated marketplace have all played significant roles in the transformation of the African political economy. Moreover, given the fact that in many areas of Africa, much of the traditional African agricultural complex—centered on such crops as millet—has been displaced by maize has much to do with the changing face of African cuisine at the most fundamental level of analysis, and more generally, at the interface of cultural change and transformation.

Africans prepare a maize porridge—called *kpekple* in Ghana, *bidia* in Zaire, *sadza* in Zimbabwe, *putu* in Zululand, *mealie* in South Africa, and *posho* or *ugali* in East Africa—consumed by millions. Virtually no African country has remained untouched by the diffusion and exchange of maize, and the agricultural practices on the African continent range from the simple sowing of maize kernels along rivers and streams to the cultivation of maize in household gardens. While widespread, these traditional practices are primitive compared to the magnitude and intensity of agribusiness development and investment in commercially viable maize agricultural field systems.

Maize Procurement and Processing

Maize is seldom described outside of the so-called Mesoamerican triumvirate of maize, beans, and squash. Early Mesoamerican peoples planted these food crops together, often planting beans and squash adjacent to maize so as to provide the former plants stalks on which to ex-

MAIZE-TORTILLA TECHNOLOGIES

Neolithic maize-tortilla technology persisted well into the late nineteenth and early twentieth centuries throughout Mesoamerica, and the Americas more generally. It did so in large part due to the unique lime processing of the soaked and softened maize kernels for *nixtamal* used in Mesoamerica. This maize dough by-product was then washed so as to remove the pericarp, or outer skin of the individual kernels, and was ground on metate grinding platforms. Apparently, the resulting mix of moist flour (*masa*) was then processed into tortillas.

The use of metate grinding slabs and the pestle (*metlapilli* or *tejolote*) provided a range of nutritive and socioeconomic benefits: (1) reduction, fractionation, and mineral supplementation of maize kernels, (2) lime treatment, (3) the shearing stroke used to process maize kernels, (4) craft specialization and the appearance of markets oriented to the production and exchange of maize-tortilla technologies, (5) nutritional and subsistence economics of maize preparation, (6) the social and economic reorganization of maize preparation, including cooperative production among households and the appearance of specialists such as tortilla vendors, and (7) the emergence of maize-tortilla technology and equipment—including *comalli* or *comal* ceramic griddles—that were indicators of social or economic status.

As for the persistence of maize-tortilla technologies specific to the metate and *tejolote*, because tortillas require a very finely ground *masa*, the adoption of power milling (*molinos de nixtamal*) of maize flour for the production of tortillas was not generally adopted until the improvement of power milling technologies in the 1940s and 1950s. Male heads of household resisted the adoption of power milling technologies because the thirty-five to forty hours per week required to hand mill *masa* on the traditional metate grinding slab was construed as women's work. Women, however, generally favored the adoption of the new *molinos de nixtamal*, and between the years of 1935 and 1940 the number of *molinos* (power mills) in Mexico increased from 927 to almost 6,000. The efficiency of the power mills freed women for other household tasks, including those pertaining to their newfound roles, industries traditionally reserved for males, in the marketplace and arts and crafts. Similar patterns affecting the displacement of men and or the relegation of women to maize-processing industries have been identified with the adoption of maize agriculture in Africa, Europe, and other regions of the Old World. In fact, the metate identified with Mesoamerica is now a familiar feature of that material culture associated with both women's daily activities and the African kitchen more generally.

tend their vines. Mesoamerican cuisine similarly combined the products of these plants in a culinary mix that reinforced and supplemented the otherwise niacin-poor composition of maize-dominant dietary practices. Without these supplements, or the lime processing inherent in the production of *masa* (maize flour) used in the production of tortillas and related foodstuffs, maize-dominant diets have the potential to result in the spread of the skin disease pellagra. Pellagra spread rapidly and in epidemic proportions throughout all the European and African countries that first adopted maize consumption without similarly adopting the critically important *nixtamalización* process necessary for the production of *nixtamal* or lime-treated *masa*. The source of the disease remained a medical mystery until it was studied in the context of maize consumption in the southern United States. It was ultimately determined that the niacin-deficient nature of maize-dominant diets played a key nutritional role in the onset of those symptoms identified with pellagra.

Traditional Maize Agricultural Systems

In Latin America, maize is the central foodstuff of the hearth and household. Because of the broad range of climates, soils, and topographic and hydrological conditions under which maize may be cultivated, diverse agricultural methods have evolved to accommodate its cultivation and processing. Maize environments in the Third World have been classified into four major types: tropical, subtropical, temperate, and highlands. As of 1996, tropical environments accounted for 90.6 million acres, or 45 percent of the total area under maize cultivation in developing countries; temperate environments accounted for 55.1 million acres, or 27 percent of the total; subtropical environments accounted for 42 million acres, or 21 percent of the total; and highland environments constituted 15.3 million acres, or 8 percent of the total area under maize cultivation in the developing world (Dowswell, Paliwal, and Cantrell, pp. 38–46).

In the tropical forests of Mexico and Central America, maize agriculture is predominantly associated with swidden (slash-and-burn or shifting) agricultural systems and the development of *milpas* (maize fields). Swidden cultivation entails the scoring or felling of trees and the subsequent torching of dry foliage and timber left in the wake of the clearance operation. Once the forest parcel has been cleared, dibble sticks are used to pierce the soil

Cuitlacoche: aka “Corn Smut”

Of the many ancient and traditional food by-products of maize, “corn smut” (*Ustilago maydis*), a fungus called *huitlacoche* or *cuitlacoche* by the Mexican Aztecs, continues to hold its own as one of the more popular delicacies of Mexican cuisine on the U.S market. *Huitlacoche*, comparable to the Portobello mushroom in some respects, is a soil-borne fungal growth that affects the internodes, the base and midrib of leaves, and immature ears of maize. This fungus is but one more in a constellation of foodstuffs not previously considered for the modern marketplace. In fact, it has been surmised that corn smut may soon become a part of the nouvelle cuisine in the United States. Like the skepticism that greeted the initial introduction of maize in Europe, it may take time before corn smut becomes popular with consumers.

Corn smut accounts for some 3 to 5 percent of maize crop losses or damage in the United States alone. As such, it will likely provide a continuing source of economic incentives to U.S. farmers prepared to define a market niche for the maize-based fungal growth.

for the sowing of maize kernels in the charred timbers of the *milpa*. In contrast, in highland Guatemala maize is cultivated on the steepest of mountain slopes and under the most challenging topographical and hydrological conditions. In highland central Mexico, on the other hand, maize cultivation took the form of *chinampas* (floating gardens)—perhaps the most unique agricultural system devoted to maize—that rapidly evolved and proliferated in the Basin of Mexico in pre-Columbian times. In fact, *chinampas* were a fundamentally important aspect of agricultural development in the highly populated Basin in the precontact period from the thirteenth to sixteenth centuries C.E. Earlier forms of agricultural intensification associated with both *chinampas* and maize cultivation have similarly been identified with the ancient metropolis of Teotihuacan, Mexico. This ancient city, which contained a population of some 150,000 people within an area of just under 8.5 square miles, was sustained through such productive systems of agricultural intensification during the period from 100 to 650 C.E. The only remaining Mesoamerican examples of this form of agricultural intensification are found in Xochimilco, Mexico.

In essence, *chinampas* entailed the creation of new agricultural parcels of land built atop floating islands or enclosures created within the shallow margins of Lake Texcoco. *Chinampas* plantations were framed within long, narrow rectangular enclosures formed from willow branches staked into the depths of the shallow lake bed—part of a system of lakes identified with Lake Texcoco—that once dominated the Basin of Mexico. Earth and mud gathered from the shallow lake bottom were dumped into these enclosures and used to form the agriculturally viable portion of those *chinampas* that were eventually anchored to the shallow lake bottom through the growth of those willow shoots and branches used to stake the plots. The recurring introduction of nutrients for maize grown atop *chinampa* parcels entailed the use of lake bottom mud, silt, vegetation, and excrement in an otherwise effective and ecologically sound practice. In this way, the Mexican Aztecs and their predecessors increased their ability to feed a rapidly growing Basin population by expanding the amount of cultivable lands devoted to maize and related crop systems. The area identified with the lakeside community of Xochimilco in the southern Basin of Mexico continues the practice of *chinampa* cultivation and floating gardens, and such parcels enable Mexican farmers to excel at the production of maize, beans, squash, flowers, and a variety of other Mesoamerican crops.

In the Maya lowlands and along the coastal margins of the Yucatan peninsula, the ancient Maya devoted considerable resources to the production of maize and related crops in raised or ridged field systems. These massive ridged field systems are among the largest and most extensive earthworks ever produced by the Maya or other societies of ancient America. Created within swamps, flooded *bajos*, or water-filled shallow limestone sinks or coastal estuaries, raised fields (or ridged islands or embankments) were formed into elongated, roughly rectangular agricultural parcels by piling soils or upcast scooped from drained areas immediately adjacent to the embankment or island. The overall appearance of such fields resembles massive waffle-like garden grids. These individual islands, however, were broad enough to accommodate the passage of a tractor-trailer rig. Pollen studies from these large earthen constructions have determined that, while maize was the major product of these systems, a variety of other Mesoamerican foodstuffs were also cultivated. In fact, the quantity of foods produced by such systems far exceeded the amount projected for swidden agricultural systems (once thought to be the predominant means by which food was grown in the tropical landscapes of the Maya heartland).

Whether produced by the indigenous systems of *milpa* or *chinampa* agriculture, maize cultivation in much of the Third World, and in more traditional contexts, has been dominated by the use of the “dibble stick” since pre-Columbian times. Consisting of a shaft of wood with a pointed tip used to pierce the soil for the sowing of maize kernels, the dibble stick has persisted for thousands of years and has been adopted by subsistence farmers throughout developing countries that have adopted maize agriculture. Nineteenth-century American maize farmers adopted both the cylindrical silo or "corn crib" and the "dibble stick" from American Indian prototypes (Fussell, p. 152). Improvements on the dibble stick developed in the 1850s ranged from the Randall and Jones Double Hand Planter to the long-lived "Stabber" or "Jobber." Both of these variations "stab" the soil and simultaneously dispense maize kernels into the holes (Fussell, pp. 144–146). Such early efforts ultimately led to the evolution of the automated maize planters of today. Unlike commercial systems of mass production identified with the technology of maize planting and cultivation, the dibble stick has weathered the introduction of new techniques and continues to dominate more traditional, nontechnological farming practices around the world.

The Maize Harvest of the Machine Age

One need only travel to places like the state of Nebraska to realize that maize agriculture dominates the agricultural traditions of some societies. In fact, a drive through Nebraska during the growing season might leave some outsiders with the impression that it consists of a seamless, seemingly endless, and very dense field of maize. For the past two hundred years, farmers and agricultural scientists in such areas have developed a variety of means, technologies, and hybrids suitable for the continuing propagation of maize. In *The Story of Corn* (1992), Fussell summarizes the many agricultural technologies, cropping and harvesting methods, hybrids, commercial products, and cultural and religious values identified with maize agriculture in the Americas and other parts of the world.

Methods of harvesting of maize range from the hand culling of hybrid maize cobs from home gardens to towering high-tech combines or harvesting machines and tractors rigged—in the largest combines—to cull maize ears or cobs at the rate of twelve rows at a time and thousands of bushels per day. Even an older combine or harvester can harvest some 10,000 bushels of maize per day, yielding 150 to 200 bushels per acre. On the other hand, the maintenance and upkeep of such machines easily runs into the thousands of dollars per year, an amount likely to double or triple in the Third World. A new combine harvester can cost from $100,000 to $200,000 or more in the United States. Whereas subsistence farmers throughout much of the Third World continue to thresh maize by hand without specialized equipment or resources, this task is left to agribusiness giants and commercial agricultural concerns in industrialized nations.

Maize has become an important agricultural crop throughout Africa. These farm workers in Zimbabwe are harvesting maize on a cooperative. © Hulton-Deutsch Collection/CORBIS.

An array of farm machinery patents for the harvesting and processing of maize appeared shortly after the industrialization of farms. The U.S. Patent Office Report of 1860 lists hundreds of patents for corn planters, cultivators, harvesters, cornhuskers, corn shellers, cornstalk cutters, corn-shock binders, cornstalk shocking machines, corn cleaners, seed drills, rotary harrows, smut machines, corn and cob crushers and mills, and seed drills (Fussell, p. 144). The advent of the canning industry in 1862 and the proliferation of new land-grant colleges devoted to science, agriculture, and industry helped fuel the industrialization and modernization of maize procurement, processing, storage, distribution, and hybridization. In time, the industrialized farming operations and agricultural cooperatives of the Corn Belt adopted many mechanized methods for harvesting and threshing maize. Soon thereafter the towering grain silos and high-rise grain elevators of the Midwest replaced the humble corncribs adopted from the North American Indians. Despite this, traditional household corncribs survived the onslaught of the Industrial Age, and survivals include the Mesoamerican *cuezcomatl* (thatch-roofed adobe brick granary), the crib-logged granaries of the Sierra Tarahumara Indians of northern Mexico, and the clay-lined maize grain silos of Africa. In each instance, subsistence farmers and agribusiness giants alike must take into account the difficulties of storing maize at optimal conditions and balance humidity, the moisture content of the kernels, and the potential for pest infestations.

The Future of Maize

Maize is processed into a dizzying array of consumer products ranging from corn on the cob and popcorn to cornstarch, corn oils, automotive fuels, such as ethanol and gasohol, and alcoholic beverages, including corn beer (*chichi*) and whiskey. In addition to the more than 1,000 maize-based products that one is likely to find in the local supermarket, the genetically modified by-products of maize are creating their own culinary diversity and potentials, pitfalls, controversies, and complications for the world of food production and biotech industries. Beyond the diversity inherent in the production and distribution of maize in the marketplace, the reality is that maize remains the most important agricultural crop for over 70 million farm families worldwide. Eighty percent of the world's farmers who cultivate maize are in developing nations of the Third World. This reality, coupled with the "genetic erosion" of the crop, has prompted some to ask whether maize can be bred so as to assure the sustainable evolution of the crop (Sevilla, p. 221). If the lawsuits for patent infringements against farmers by agribusiness corporations and biotechnology firms for the unlicensed use of their patented hybrids are any indication, the potentials of genetic diversity and hybrid vigor once identified with maize may be constrained to ever fewer and increasingly more vulnerable hybrid offspring.

See also **Africa; Central America; Columbian Exchange; Mexico; Mexico and Central America, Pre-Columbian; Niacin Deficiency (Pellagra); Swidden.**

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Ruben G. Mendoza

MAIZE AS A FOOD

The evolution, dispersal, and consumption of maize span the better part of the past eight thousand years of human cultural development. Until European exploration in the Americas began in 1492, maize was a New World domesticate with an exclusively American distribution and consumption. After 1492, maize rapidly diffused throughout the Old World of Europe by way of ships returning from the New World. In fact, by 1498 cultivation of maize had begun in Seville, Spain. With its subsequent adoption in Africa for the purpose of feeding the growing numbers of African slaves destined for southwest Asia and the Americas, consumers throughout Africa, Europe, and Asia began to use maize as food and as fodder. According to Sophie D. Coe's review of America's first cuisines, maize constitutes the third most important food crop in the world, following on the heels of wheat and rice (p. 10). It is no accident, therefore, that maize constitutes a fundamental ingredient in many of the world's cuisines, ranging from Mexican enchiladas and Chinese baby-corn, to African-American grits, corn flakes, popcorn, Italian polenta or gruel, corn meal, maize-based alcoholic beverages (such as whiskey and bourbon), mayonnaise, and corn oil. Thus, maize has more than demonstrated its cross-cultural adaptability, gastronomic significance, and culinary versatility.

Maize Preparation and Consumption

The preparation of maize into food and beverages subsumes a world of food and beverage variations. Maize-based foods and beverages in Mesoamerica—the place where maize originated—are many and diverse, and many of these are quite old. In Mexico alone, food and beverage varieties range from those by-products of maize that derive from the food process known as *nixtamalización* (or nixtamalization) to the fermentation of processed maize into alcoholic beverages and the creation of a very broad variety of foods. The oldest and most enduring method for processing cereal grains is one that originated in ancient Mesoamerica long before the Common Era.

Nixtamal Production

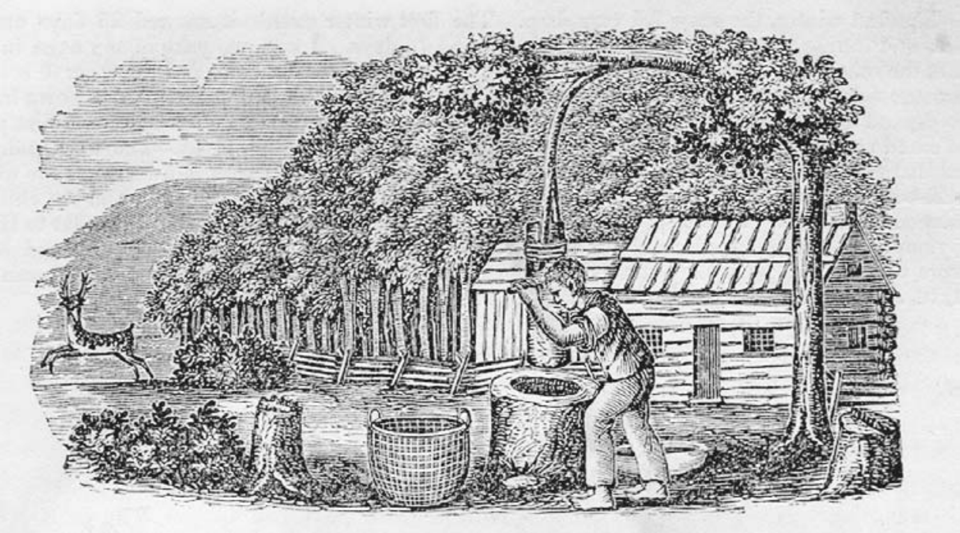
In order to produce any one or more of the aforementioned maize-based foods or beverages, maize must be reduced to a paste or flour. The resulting by-product was known to the Mexica-Aztecs as *nixtamal*, and the process for rendering the maize kernels into a paste has since come to be known as *nixtamalización*. According to Sebastián Verdi, *nixtamalización* entails the fundamental process of rendering maize kernels into a paste that is treated with lime and heat in order to incorporate calcium and digestible iron into the *masa*, or maize dough. Ultimately, *nixtamalización* enhances the nutrient content of tortillas and related maize food by-products in such a way that maize is rendered superior in nutrient value to other grain-based foods such as white bread (p. 9).

In their study of the physiochemical, structural, and textural properties of tortillas and the *nixtamal* process, G. Arámbula-Villa and colleagues provide a detailed overview of the distinctions inherent in the methods and mechanics of the *nixtamalización* process. In comparing the efficacy and mechanics of traditional methods of dry-*masa* flour production versus modern methods of instant-*masa* flour production, these researchers present two detailed diagrams (p. 246). The traditional dry-*masa* production method entails several distinct steps, including cooking, steeping, *nixtamalización*, washing, *nixtamal*, milling with a hammer mill, drying, re-milling with the hammer mill, classification, and product collection. The modern production of instant masa entails dry milling, the mixing of water and lime with ground maize, extrusion or *nixtamalización*, fresh *masa*, drying, milling with a hammer mill, and product collection.

TARAHUMARA INDIAN *TESGÜINO* PRODUCTION

Anthropologist Bernard Fontana has documented the process identified with the production and fermentation of the maize beverage known as *tesgüino* to the Tarahumara Indians of Chihuahua, Mexico. This fermented maize drink may be processed from newly sprouted maize or malt, even though other variants of *tesgüino* may be processed from roasting maize ears or the fruit of the nopal cactus, shrubs, and selected fruit trees. The Tarahumara recipe for *tesgüino* is as follows: Maize kernels are distributed along the bottom of shallow baskets. The baskets are then covered with grasses and placed in a darkened location where they are sprinkled with water daily for four or five days, so as to stimulate the sprouting of the maize kernels contained therein. When the maize sprouts are approximately one inch in height, they are ground on a ground stone slab or metate and placed into pottery jars or metal bowls containing water. These are set to boil for approximately eight hours. Once the liquid acquires a yellowish hue, it is left to cool. The liquid is then strained into another bowl and mixed with other herbs to produce a paste into which more water is added. The mixture is then placed into specialized fermenting vessels that are stored in a warm location for the evening. The watery paste is then mixed with the strained maize broth and allowed to ferment for three to four days. Ultimately, *tesgüino* is intended for festive occasions such as the *rarajipari* kick-ball game and related rituals, and it should be consumed immediately since it begins to spoil within twelve hours of completing the recipe (p. 54).

Nixtamalización often involves the use of a lime or alkaline bath or pre-soak that results in the softening and "shelling" of maize kernels. Once softened, the maize kernels are rendered or ground by way of basalt-stone grinding technologies, such as the ancient metate grinding slab or the modern automated *molinos*, or maize grinding mills, that pulverize maize for preparation into such by-products as *masa* or maize dough. *Masa* is used predominantly in the production of the pancake-like maize cakes or flat breads known as tortillas. *Masa* is also used in the production of a broad variety of foods and beverages, including the ever-popular corn-husk encased Mexican *tamale*, *totopos*, or *tostaditas*. *Masa* is also used in the Mexica-Aztec ground maize drink or gruel known as *atolli*



A frontier settler in Potter County, Pennsylvania, is shown using a hominy block for crushing corn to make grits. The pestle is attached to a sapling, which allows for easier pounding. Woodcut, circa 1840. ROUGHWOOD COLLECTION.

or *atole*, in *champurrado*, which consists of a rich broth of *atole* mixed with chocolate, and in the alcoholic beverage known to the Tarahumara Indians of northern Mexico as *tesguino*. Many of these indigenous Mexican foods and beverages have been adopted or reinterpreted by agribusiness, nutritional scientists, the general public, and the food industry. Such foods are distributed internationally under such brand and trade names as Quaker *masa harina* (dough flour), Fritos, Taco Bell, Corn Chex, Kellogg's Corn Flakes, Doritos, and many others.

Maize Nutritional Composition

Scientists from several disciplines have studied the tortilla and its counterpart the tamale as examples of the nutritional value or mineral composition of processed maize products. In one such study conducted in 1988 and 1989, nutritional scientist Charles Weber and colleagues studied commercially produced tortillas and tamales from food chain stores. The tamales in this study included both green corn and stuffed beef and pork varieties. The researchers contrasted those tortillas and tamales with others produced in neighborhood factories or outlets and homes in the Mexican-American barrio communities of Tucson, Arizona. Thus, the results of these studies provided one basis for understanding the nutritive values of processed maize as represented by both commercial and domestic by-products. The study demonstrated that there was little variation in the size, composition, and mineral content in the commercially milled tortillas obtained from different commercial outlets.

The findings also demonstrated that the average size and weight of the maize or corn tortilla were 5.7 inches and 0.71 ounces, respectively. Average moisture content was 42.9 percent; protein content was 5.9 percent; lipid values were 2.3 percent; and acid detergent fiber and ash values were 1.8 percent and 1.3 percent, respectively. Carbohydrate content averaged 49 percent, while energy values averaged 240 kcal/100 grams (pp. 326–327). In contrast, tamales averaged 4 ounces in weight; moisture content averaged 59 percent; protein values averaged 5.4 percent; and lipid concentrations varied considerably but averaged 11 percent. This latter variation was thought to be the result of the wide variety of recipes used to produce tamales, and the variable use of fat sources such as lard versus hydrogenated vegetable oil. Also, it should be noted that whereas beef tamales averaged 4.2 ounces in weight, green corn tamales averaged 3.5 ounces in weight (pp. 330–331). Finally, in regard to mineral content, Charles Weber and his colleagues found that maize or corn tortillas contain calcium, phosphorous, iron, zinc, copper, and magnesium in variable amounts. Their study also noted that the calcium content of tortillas produced from lime-processed *nixtamal* was ten to twenty times higher than that of the original grain source (pp. 331–332). These studies demonstrate that the dry milling and lime processing of maize at the most fundamental level have a profound effect on the inherent nutritive values of maize.

Pellagra and the Indian Triad

Because of the inherent nutritional values and mineral composition of maize grain, the lime processing of *nixtamal* and the evolution of the so-called "Indian triad" or "Mesoamerican triumvirate" were critical innovations that were directly attributable to the ancient Native Americans who nurtured maize through much of its evolutionary history. The triad or triumvirate in this instance refers to the American Indian horticultural heritage and/or tendency to cultivate maize, beans, and squash together in the same agricultural plots and, subsequently, to mix these ingredients into their culinary repertoire in a nutritionally balanced and sophisticated way. The combination of maize with both beans and squash is culturally and biologically critical in that the nutritional value of maize is significantly enhanced by the addition of these two fundamental foods. While maize lacks the amino acid niacin, common beans (*Phaseolus vulgaris*) are a significant source of amino acids, including niacin, tryptophan, and lysine. In her account of the *nixtamalización* or lime processing of maize developed in ancient Native America, Betty Fussell documents the means by which this process transforms maize's inherent protein structures (mainly albumins, globulins, glutelin, and zein) into the metabolically and nutritionally critical amino acids niacin, tryptophan, and lysine (pp. 203–204).

The maize-dominant diets of some European, Egyptian, and other African peoples at the end of the nineteenth century lacked the aforementioned essential amino acids. This lack resulted in the spread of pellagra in epidemic proportions. Kwashiorkor—a severe form of malnutrition identified with infants and children dependent on high-carbohydrate and low-protein diets—also appeared among African and other peoples whose diets were maize-dominant. In her book on the culture and agriculture of tomatoes, potatoes, corn, and beans, Sylvia Johnson notes that those afflicted with pellagra suffered skin rashes, dizziness, sore muscles, and in the worse-case scenario, insanity and death (pp. 24–25). According to Betty Fussell, to Europeans pellagra was widely known as "corn sickness" until it was renamed pellagra by an Italian in 1771 (p. 202). Even so, the specific causes of pellagra remained a mystery until after 1915, when the U.S. National Institute of Health commissioned a pellagra investigation headed by Dr. Joseph Goldberger, whose findings ultimately led to the effective treatment of the disease in the United States by the 1930s. These deficiencies and the epidemics with which they were associated might have been averted with the adoption of the "Indian triad" and the alkaline or lime processing of maize into *nixtamal*. According to Betty Fussell, this variety of maize processing can be documented to as early as 100 B.C.E. through the discovery of lime-soaking pots at the ancient site of Teotihuacan. She concludes that such discoveries have led many to believe that "corn is the oldest chemically processed grain in the world" (p. 176).

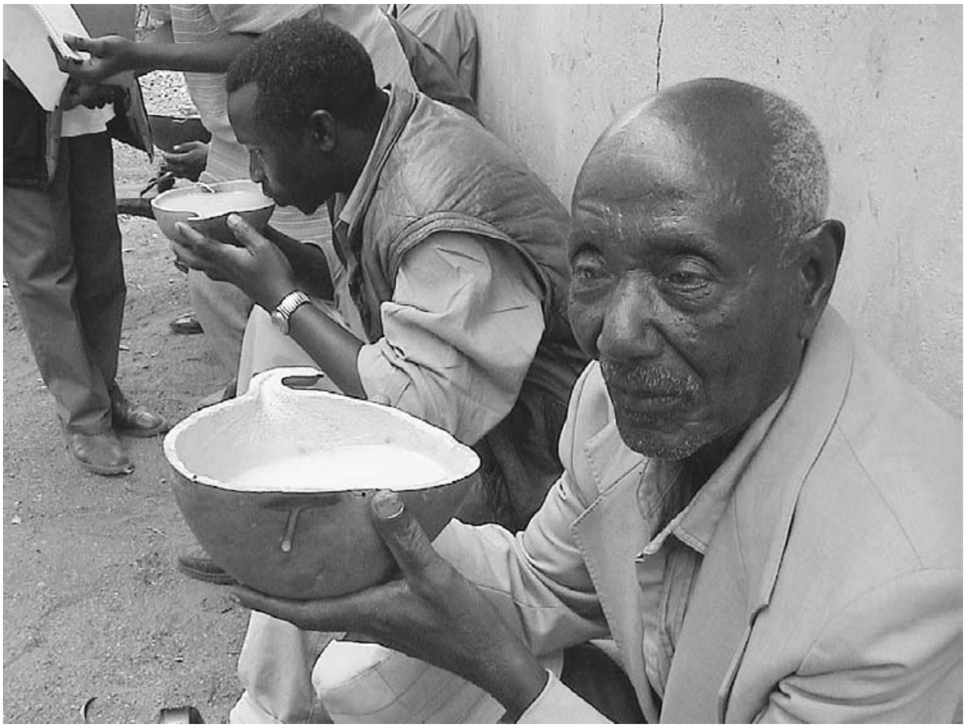
FROM *AREPAS* TO BLUE CORN *PIKI*

Arepas are to Venezuelans, Colombians, and Peruvians what tortillas are to the Mexican people. In order to prepare *arepas*, dry white maize kernels are ground into flour, which is then mixed with water, oil, and salt, and then prepared in much the same way that tortillas are formed, except in this instance, the flat breads are smaller but much thicker in shape than tortillas. The larger and thicker tortillas, which characterize the maize flat breads of the Nicaraguans, allow for larger servings of beef or other ingredients to be placed in the tortilla-like container. The *pupusas* of El Salvador, prepared from lime-treated maize with the addition of cheese, are essentially smaller tortillas that are used primarily for burritos or taco-like containers of beef or chicken and legumes and vegetables. The *humitas* of Bolivia and Chile are yet another form of tamale consumed in South America. Invariably, precooked maize flour similar to lime-treated *masa* is mixed with other regional ingredients to produce *humitas*.

The Hopi Indians of Northern Arizona have processed maize into a particularly unique food known as *piki* bread for the past eleven centuries. *Piki* bread consists of a very thin, gray, and ashy maize tortilla or wafer created from blue corn meal by way of hand-coating a very hot and finely polished stone griddle with a watery maize dough paste. In *The Story of Corn*, Betty Fussell cites Hopi matriarch Helen Sekaquaptewa's acknowledgement that "*Piki* are the original cornflakes," thereby noting that these otherwise paper-thin, flaky, and quite tasty *piki* blue-corn wafers inspired the subsequent development of flaked corn (pp. 167–168).

The Primordial Maize Tortilla

The maize flat breads or tortillas of Mexico are ancient and ubiquitous in the Americas. These breads are a fundamental staple of Mexican and other Latin American cuisine and have inspired the creation of a wealth of pre-Columbian or indigenous American foods, including enchiladas, tacos, tostadas, *sopes*, *flautas*, *chilaquiles*, and *sopa de tortilla*. The principal distinctions in these foods evolve from the treatment of the tortilla. In these Mexican food examples, tortillas are rolled, folded, flattened, thickened, and or fried. In the case of *chilaquiles* and *sopa de tortilla*, old, hardened, or otherwise stale tortillas are broken up or cut into strips and used in the preparation of casseroles and soups. In most of the aforementioned examples, the tortilla serves as the container, packet, or flat bread into or upon which varying types and quantities of meats and vegetables are placed. Alternately, the tortilla becomes but one additional, albeit important, ingredient in the preparation of casseroles and soups. Sophie D. Coe acknowledges that late-fifteenth and early-sixteenth-century Mexica-Aztec peoples of the Valley of Mexico



Men of the Kamba tribe in Kenya drink maize beer from gourds. It was common in earlier times for the men to drink the beer with straws from a common gourd. PHOTO BY Y. MORIMOTO.

used tortillas and steamed maize-dough tamales as containers or packets for an incredible variety of foodstuffs, including beans, squash, tomatoes, mushrooms, avocados, worms, rabbit, deer, turkey, and many other items (pp. 112–119). Heriberto García Rivas has also investigated the extraordinary wealth and variety inherent in the maize-based pre-Columbian cuisines of Mexico.

In addition to its status as the premier Mexican foodstuff, the tortilla is also part of indigenous and Catholic religious traditions and rituals in Mesoamerica and beyond. Aside from their status as the gastronomic and culinary archetype of maize-based foods, tortillas also serve a practical need in their role as edible utensils (spoons or spatulas) used for scooping up beans, rice, and meats served in Mexican cuisine. In fact, legend has it that Motecuhzoma Ilhuicamina—the illustrious penultimate emperor of the Mexica Aztec—never used the same eating utensils more than once. This was due in large part to the fact that the emperor used tortillas in the same way that the Spanish used spoons and other utensils in the Old World. In many areas outside of Mexico (including the southwestern United States) tortillas have taken on a culinary predominance: they are regularly substituted for breads and other carbohydrates. This phenomenon was unheard of in colonial times. For example, in New Spain or Spanish colonial Mexico (c. 1521–1821), those who believed maize to be an inferior food fit only for the feeding of swine often substituted wheat for maize in the production of tortillas. From that point forward, wheat or flour tortillas took on a status as the flat bread food of choice for Spanish colonials in Mexico, whereas tortillas prepared from maize continued to be perceived as the primary foodstuff of Mexican Indians and the poor. Ironically, what were once called *totopos* or *tostaditas* in Mexico are today called “corn chips,” such as Doritos, Fritos, and nachos, which are a widely consumed snack food in the United States and elsewhere.

Other Traditional Maize Foods

Once maize was introduced into the Old World of Europe, foods containing maize as a main ingredient were created for a variety of distinctive dishes and regional palettes across that vast cultural region. Italians adopted maize into a dish today known as polenta, which consists of a finely ground maize mixed with water in order to produce a porridge or mush. Sylvia Johnson describes polenta as a maize mush cooked in a pot, poured onto a wooden board, and allowed to cool for a few minutes until ready to consume. Eventually, polenta was mixed with other ingredients typical of Italian cuisine including grated cheese, mushrooms, tomatoes, and peppers, or it was served with pasta. When mixed with sugar or honey, polenta took on one other food use: as breakfast porridge (p. 21). In Rumania, *mamaliga* is prepared from sweet cornmeal and consists of a food akin to polenta that is sometimes referred to as “cornmeal mush.” Cornmeal remains a primary staple of Rumanians and Hungarians alike, with *puliszka* being the staple food of Hungarians. *Puliszka* is prepared in much the same way as either polenta or *mamaliga*; however, it is often topped with feta cheese, butter, and other ingredients lightly blended into the cornmeal mush before the meal has been thoroughly cooked. Also popular in Romania and Hungary is *malderash*, which consists of maize cakes seasoned with cumin and coriander.

African Maize Cuisine

In the sixteenth century, maize rapidly diffused across the African continent as a result of the slave trade. By the end of the nineteenth century, a maize meal called *posho* was among the most popular foods of eastern Africa. Sylvia Johnson notes that the primary African use of maize as a food is in mush or porridge. Africans grind and boil maize in water in much the same way Europeans and Americans have done for many years (pp. 236–237). Maize porridge is known as *kpekple* in Ghana and *bidia* in Zaire. In Zimbabwe, people consume *sadza*, whereas East Africans eat *posho* or *ugali*. Zulu-speaking people consume *putu* as a primary source of nutrition. One African dish called *coo-coo* contains maize mush with okra, an African vegetable that slaves introduced in the Caribbean as fungi (pp. 22–23). In Nigeria, maize is boiled and roasted in different forms. For example, *adalu* consists of maize kernels or cornmeal boiled with beans, while *ogi* and *tuwo* consist of ground and boiled maize flour. *Ogi* is a breakfast dish prepared from maize flour that is boiled until it attains a smooth consistency. *Tuwo* also consists of maize flour that is boiled until it acquires a thick consistency. Nigerians generally consume *tuwo* with soup dishes. Similarly, *kokoro* is a Nigerian snack food comprised of ground maize dough rolled together with other ingredients and then fried in vegetable oil. Finally, *aadun* consists of a cooked or baked snack prepared from ground maize, red pepper, and oil. Invariably, many of those maize foods developed in Africa found their way back to the New World by way of the Caribbean and have lasted in the African-American culinary tradition. Grits can also be added to this list of African maize culinary concoctions. Grits consists of coarsely ground dried corn and is used as an ingredient in any number of other maize-based recipes, ranging from cracklin' cornbread to corn chowder, fried catfish basted with yellow corn meal, and a host of cornbread stuffings and hominy-based recipes.

Maize as a Fermented Beverage

According to a Food and Agriculture Organization report, the fermentation of maize by indigenous Latin American peoples provides the basis for virtually all indigenously produced alcoholic beverages in the Americas. *Chicha de jora*, or maize beer, is perhaps the most important and popular beverage produced in South America, including the countries of Argentina, Bolivia, Brazil, Colombia, Ecuador, and Peru. In fact, according to Betty Fussell, *chicha* was the critically important nutritional counterpart to the *nixtamalización* and ash-and lime-processed maize products used in other areas of the Americas (but unknown in Andean South America) in pre-Columbian times (p. 249). Other alcoholic beverages

Maize: Myth and Symbol

The *Popol Vuh*, the sacred book of the ancient Quiche Maya, relates an origin myth that illustrates the role of maize as the hearth and source of Mayan culture and civilization itself. According to the Maya, the ancestors were fashioned from maize and bitter water. Thus depictions of maize plants and foods in the form of human–maize anthropomorphs in Mesoamerican ceremonial and ritual contexts are common. The seventh-century polychrome murals of Cacaxtla, Mexico, present depictions of maize stalks with cobs in the form of human heads bearing Maya-like features and hair consisting of maize silks. Dennis Tedlock's translation of the *Popol Vuh* notes that in order to create the first human ancestors, it was necessary for the female deity and midwife Xmucane—"the Bearer, Begetter, Sovereign Plumed Serpent"—to grind the yellow and white maize nine times in order to render whole the flesh of the earliest ancestors (pp. 145–146). Through this most ancient of legends and cultural lenses, the Maya continue to interpret their world, and in turn, be interpreted by the world about them. According to anthropologist Evon Z. Vogt, the Zinacanteco Indian healers and shaman of Chiapas, Mexico, conduct ancient and traditional rituals that make use of maize kernels, which are still viewed as a model for the structure of the human soul (pp. 94–95). In addition to the spiritual and divinatory place of maize in both ancient and modern Maya cosmology and worldview, Zinacanteco and other Mayan healers prescribe maize in a variety of forms as a remedy for any and all spiritual and physical conflicts.

According to the Food and Agriculture Organization, the Lacandon Maya used *pozol* with water and honey to reduce fevers. At the same time, *pozol* was used as cataplasm to heal minor wounds and to counter the effects of diarrhea. According to Jorge Fernandez Chiti, a tea was blended from *barbas de elote* (corn silk or maize tassels) and this concoction remains a popular Latin American diuretic used in natural healing and medicine in this day and age. *Barbas de elote* continues to be used by Latin American *curanderos* or "curers" for the treatment of kidney and bladder problems, as well as a remedy for hepatitis and edema (p. 59).

Atole: An Aztec Brew

According to Heriberto García Rivas, *atole*, from the Aztec term *atolli*, signifies watery or watered-down liquid or beverage. *Atole* is one of the preferred maize-based drinks of the indigenous peoples of Mesoamerica. Since remote antiquity, atole has been prepared from boiled fresh maize ground into *nixtamal*. Once rendered into *nixtamal*, this by-product is boiled with a variety of ingredients including sugar, milk, and water to produce *atole*. In Mexico, when *atole* is mixed with chocolate it is called *champurrado*. The sixteenth-century Franciscan chronicler Bernardino de Sahagún documented information from his Mexican Aztec informants regarding the different kinds of atoles available in New Spain since pre-Columbian times. Heriberto García Rivas adds that beverages identified by Aztec-era chronicler Sahagún included *totonquiatulli* or hot *atole*, *necuatolli* or *atole* with syrup or honey, *chinecuahtolli* or atole with syrup and yellow chili, *guanexatolli* or *atole* processed from a thick or pasty *nixtamal* mix (p. 46). *Atole* is available from street-based food vendors and Mexican restaurants that serve traditional specialty food items in Mexico, Central America, and in many areas of the southwestern United States.

fermented from maize dough or flour include *abati*, consumed primarily in Paraguay and Argentina; and *chica*, *charagua*, *ostoche*, *sendechó*, *zambumbia*, and *tesgüino*, all consumed in Mexico. *Sora*, or maize beer, is also consumed primarily in Peru. For Latin America, maize-based non-alcoholic beverages and porridges include *acupe* from Venezuela; *cachiri* and *fubá* from Brazil; *champuz* and *napú* from Colombia and Peru; and *pozol*, *sendechó*, and *atole* from Mexico. When producing *pozol*, a mixture of water and lime is mixed in a suitable container and maize is added to the aforementioned mixture and boiled. Once *nixtamal* has been prepared, the by-product is washed and ground into maize dough, which is then shaped into small balls and covered with banana leaves. The fermentation of *nixtamal* is necessary for the production of *pozol*, which ultimately requires one to fourteen days to produce.

Whereas maize is a primary staple of American Indian maize-beer production, in North America its use is best known from the Prohibition-period exploits of "bootleggers" who produced moonshine or corn liquor, or whiskey, and the like. Both Kentucky bourbon and Tennessee whiskey variously make use of no less than 51 percent cornmeal mash. The primary distinction between mash and malt liquors is that mash is derived from corn-

Fermented maize-based cereal products eaten in Latin America

Name	Description	Country
Abati	Alcoholic beverage produced from maize	Paraguay, Argentina
Acupe	Beverage produced from germinated maize that has been both fermented and sweetened	Venezuela
Agua-agria	Non-alcoholic beverage produced from ground maize and water.	Mexico
Atole	Non-alcoholic porridge produced from maize dough	Mexico
Atole agrio	Non-alcoholic porridge produced from black maize dough fermented 4 to 5 days	Mexico
Cachiri	Fermented beverage produced in clay pots from maize and manihot or fruit	Brazil
Champuz	Fermented beverage produced from maize or rice	Colombia, Peru
Charagua	Alcoholic beverage produced from pulque syrup, chili, and toasted maize leaves heated slowly and fermented.	Mexico
Chica	Alcoholic beverage produced from pineapple, barley steep liquor, and black maize dough. Beverage is fermented for 4 days, after which brown sugar, cinnamon, and cloves are added	Mexico
Fubá	Germinated maize grains fermented in water	Brazil
Jamin-bang	Bread produced from maize fermented for 3 to 6 days and cooked as a cake.	Brazil
Napú	Beverage consisting of germinated, ground, and fermented maize.	Peru
Ostoche	Alcoholic beverage concocted from maize juice and pulque or brown sugar	Mexico
Pozol	Non-alcoholic, albeit acidic, beverage produced as maize liquor. Balls of dough prepared from fermented masa are enveloped in banana leaves	Mexico
Quebranta huesos	Alcoholic beverage consisting of maize juice, toasted maize, and pirú fruits (*Schinus molle*)	Mexico
Sendechó	Alcoholic beverage fermented from germinated maize and red chili. Maize dough is resuspended in water, boiled, bestowed, cooled, and inoculated with *Sendechó*	Mexico
Sora	Alcoholic beverage produced from germinated, ground, cooked and fermented maize	Peru
Tepache	Alcoholic beverage fermented from maize grains, brown sugar, and water.	Mexico
Tesgüino	Alcoholic beverage produced from germinated maize, both ground and cooked with fragments of plants that serve as enzyme sources	Mexico
Tocos	Dessert produced from maize fermented for 2 to 3 months and then cooked.	Peru
Zarzaparrilla bark wine	Alcoholic beverage consisting of maize beer and zarzaparrilla bark	Mexico

SOURCE: Argelia Lorence-Quiñones, Carmen Wacher-Rodarte, and Rodolfo Quintero-Ramírez, 1999, with modifications and deletions).

meal made from ground and unsprouted maize kernels, whereas the malt liquors make use of cornmeal ground from sprouted and dried maize kernels. Betty Fussell provides a detailed overview of the history and culture of moonshine, as well as first-hand accounts concerning the methods, ingredients, participants, and paraphernalia involved in bootlegging (pp. 252–264).

The Globalization of Maize

Although the United States is the leading maize producer in the world, maize remains the primary staple for much of Latin America, which is why that region is the leading consumer of maize as a food for humans (as opposed to its consumption as a fodder for livestock and poultry). Since the days of its earliest evolution and domestication in Mexico, maize has been adopted as a primary staple or supplement in virtually every world region. Thus it has become the stuff of cross-cultural traditions and, more often than not, has taken center stage as the primordial embodiment of myth, ritual, legend, folklore, and ultimately multinational commerce and globalization. Apart from its many traditional uses and its consumption as whole maize kernels or as corn-on-the-cob, maize is key to an incredible variety of foods and products. One need only review Diane Kennedy's *The Cuisines of Mexico* to recognize the totality and dominance of maize and its by-products in the whole of Mexican cuisine. Similarly, any superficial review of Julia Child's recipes in her book *The Way to Cook* will provide an encyclopedic retrospective on the place of maize as culinary ingredient and staple foodstuff in the most popular and trendy of American and international favorites.

See also **Africa; Agriculture, Origins of; Combination of Proteins; Mexico and Central America, Pre-Columbian.**

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MALNUTRITION.

Malnutrition results from the chronic dietary intake of nutrients or energy that provides considerably less or more than is required to be considered adequate or appropriate to support the everyday needs of the human body. Such adverse nutrient intakes are detrimental to human health and may lead to a state of deficiency, dependency, toxicity, or obesity. Malnutrition includes undernutrition, which means the body is not receiving nearly enough nutrients, and overnutrition, which means the intake of nutrients is grossly excessive.

Undernutrition

Undernutrition continues to be a significant cause of malnutrition in developing countries, although it is relatively rare in developed countries. Poverty in developing countries contributes more to undernutrition than a lack of global food production and is considered the chief cause of malnutrition. Families that are poor do not have the economic, social, or environmental resources to purchase or produce enough food. Poor soil conditions may also contribute to a family's inability to grow enough food to prevent malnutrition and the accompanying complications to health. Additionally, for the urban poor, low wages, underemployment, and food prices beyond the reach of families also contribute to undernutrition.

Prolonged dietary intakes deficient in energy or calories, protein, fat, vitamins, and minerals lead to illness and eventually death if not corrected. Undernutrition may also be the result of psychological disorders, such as anorexia nervosa, which manifests as an unwillingness to eat enough food to sustain life. Elderly adults often have a decrease both in appetite and intestinal function and are at an increased risk for undernutrition. Children, particularly infants and those under five years of age are also at an increased risk for undernutrition due to a greater need for energy and nutrients during periods of rapid growth and development. Infants born to undernourished mothers are more likely to be low birth weight infants. Addiction to alcohol or drugs may also lead to undernutrition when the addicted individuals favor alcohol and/or drug intake over adequate food intake. Severe, prolonged diarrhea, renal failure, infection, or diseases that cause the malabsorption of nutrients in the small intestine also may cause undernutrition even if dietary intake is adequate. It is obvious that the causes of undernutrition are varied and complex, requiring solutions that may also be complex.

Nutrients Required to Prevent Undernutrition

The nutrients required in adequate amounts by the body to prevent undernutrition are carbohydrates, fat or lipids, protein, vitamins, minerals, and water. Carbohydrates provide the body with energy (about 4 kilocalories per gram of carbohydrate consumed). Carbohydrates also protect protein stores in the body. A minimal intake of 50 to 100 grams (1.8 to 3.5 oz.) of carbohydrates is required to prevent the development of ketones that the brain can use somewhat inefficiently for energy. The brain optimally uses carbohydrate for energy, but when carbohydrate intake is inadequate for several weeks, the body does not metabolize fatty acids completely in order to produce ketones for energy. In addition to ketone formation resulting from insufficient carbohydrate consumption, body protein will also be lost, and the body will generally become weakened.

Fats or lipids provide essential fatty acids upon metabolism following consumption. Essential fatty acids are obtained from dietary lipids and are termed essential because the human body cannot synthesize them. Essential fatty acids are important for human health because they participate in immune processes, vision, are an integral part of cell structures, and participate in hormone-like compound production. If an inadequate intake of lipids is routinely consumed, the body becomes deficient in essential fatty acids. This results in skin problems, diarrhea, and an increase in infections with a corresponding decrease in the ability of the body to heal wounds. Lipids also provide energy for the body (about 9 kilocalories per gram (28 kilocalories per ounce of fat consumed), can be stored for future use as energy, insulate the body and protect body organs, and aid in the absorption and transport of fat-soluble vitamins (vitamins A, D, E, and K) throughout the body. The fat-soluble vitamins are important for vision (vitamin A), bone metabolism (vitamin D), providing antioxidant protection from free radicals (vitamin E), and blood coagulation (vitamin K), among other functions.

Protein is a very important nutrient because so many substances in the body are made from it. Proteins are made when amino acids are combined in specific sequences to form specific proteins. The sequence of the amino acids determines the shape of the protein, and the shape of the protein, in turn, determines the function of the protein. Amino acids can be obtained from plant or animal sources. There are nine essential amino acids: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. The human body is not able to synthesize these amino acids, so they must be derived from the foods we eat. There are eleven nonessential amino acids that the human body is able to make: alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine. As stated previously, amino acids are necessary for protein synthesis, but they are also important because they provide the body with a special form of nitrogen that the body cannot get from carbohydrates or lipids. Protein, like carbohydrate, provides approximately 4 kilocalories per gram of protein consumed, but requires much more metabolizing and processing by the liver and kidneys to put the energy from protein to use. Protein is a part of every cell in the human body. Blood proteins enable the body to maintain the right balance of fluid inside and outside of cells. When adequate protein is not consumed, there is a lower concentration of blood proteins in the bloodstream, which causes the balance of fluids inside and outside of cells in tissues to be thrown off, resulting in swelling of tissues or edema, which can lead to serious medical problems. Proteins also help regulate the pH, or acid-base balance, in the blood, are necessary for the synthesis of many hormones and enzymes, and participate in important cell formation for cells vital for the immune system. Amino acids from protein can also be used to produce glucose, which is a positive thing for providing glucose after an overnight fast. But in the case of starvation, excessive muscle tissue is wasted and results in diminished health. Protein-energy malnutrition results from near starvation and may be seen in the body tissues in either a wet, dry, or combined form. The dry form, marasmus, is caused by deficiency of protein and nonprotein nutrients, with the individual being very thin from the loss of muscle and body fat. The wet form, kwashiorkor, is caused primarily by protein deficiency, with energy deficiency being secondary, and is accompanied by edema. The combined form, marasmic kwashiorkor, results from protein and energy deficiency with edema and more body fat than is seen in marasmus.

There are also water-soluble vitamins in addition to the fat-soluble vitamins. Because water-soluble vitamins are not stored in any appreciable amounts in the body, but are excreted readily in urine, it is relatively easy to become depleted of them. Fat-soluble, in contrast, are stored in adipose tissue and the liver, and consequently it is more difficult to become deficient of them. The water-soluble vitamins are the B vitamins and vitamin C. The B vitamins are thiamin, riboflavin, niacin, pantothenic acid, biotin, pyridoxine, folate, and vitamin B_{12}. All of the water-soluble vitamins except vitamin C have coenzyme functions and are involved in a variety of reactions including energy metabolism, DNA synthesis, nerve function, protein and carbohydrate metabolism, and fat synthesis. Vitamin C is involved in protecting the body from oxidative damage caused by substances called free radicals. It also functions in connective tissue synthesis, hormone synthesis, and neurotransmitter synthesis. Physiological consequences of deficiency include inflammation of the mouth and tongue (riboflavin deficiency); diarrhea, dermatitis (niacin deficiency); edema, weakness (thiamin deficiency); tongue soreness, anemia (biotin deficiency); fatigue, tingling in hands (pantothenic acid deficiency); poor growth, inflammation of the tongue (folate deficiency); poor nerve function, macrocytic anemia (vitamin B_{12} deficiency); and poor wound healing, bleeding gums (vitamin C deficiency).

Minerals are important nutrients that must be obtained from foods consumed, as the human body is unable to synthesize them. Some factors that influence mineral bioavailability (the extent to which minerals in food consumed is available for the body to put to use) are the amount of mineral content in the soil in which the food providing the mineral was grown; dietary fiber consumed in the same meal as a food containing the minerals; mineral-mineral interactions; and vitamin-mineral interactions. Sodium, potassium, chloride, calcium, phosphorus, magnesium, and sulfur are the major minerals. Deficiencies of these minerals lead to such symptoms as muscle cramps (sodium), irregular heartbeat (potassium), convulsions in infants (chloride), an increased risk for osteoporosis (calcium), diminished bone support (phosphorus), and poor heart function (magnesium). There are also so-called trace minerals that are only required in very small amounts to contribute to optimal health. These trace minerals are iron, zinc, selenium, iodide, copper, fluoride, chromium, manganese, and molybdenum. When inadequate amounts of foods containing the trace minerals are consumed, symptoms begin to appear. These symptoms include low blood iron (iron), skin rash/poor growth and development (zinc), muscle weakness (selenium), goiter (iodide), anemia/poor growth (copper), increased risk for dental cavities (fluoride), and high blood glucose after eating (chromium).

Developed countries typically have water supplies that are monitored for safety by government agencies and are provided in large enough quantities that a lack of drinking water is not the norm. Developing countries, however, may not have water that is free from contamination, or because of drought or other natural disasters do not have a large enough water supply for human consumption or to provide water for livestock or crops. Water is vital for life and, without it, an adult can survive only a few days because the human body does not have the ability to store water. Water is found inside of cells as intracellular fluid and outside of cells as extracellular fluid. A proper balance between intracellular and extracellular water is necessary to prevent complications such as edema. Water also is responsible for regulating body temperature, most notably through the cooling-off process accomplished by perspiration. Water is necessary to provide lubrication for joints such as the knees. Without adequate water in the form of amniotic fluid in the womb of a pregnant woman, the growing fetus does not have sufficient support to prevent injury should the mother fall or be otherwise jarred abruptly. Water is also the primary avenue utilized by the body to rid itself of waste products. While water does not supply energy as carbohydrates, protein, and fats are able to do, it is still a very important nutrient necessary to prevent malnutrition.

Overnutrition

Overnutrition results when energy expenditure is grossly exceeded by energy intake and leads to overweight and obesity. Developed countries, with their abundant food supplies and processed foods, are most afflicted with overnutrition and the medical complications associated with it. Due to the excessive intake of food products, the amount of fat-soluble vitamins and minerals in the body can rise to toxic levels because they are stored in the body. Developed countries have greater incidences of cardiovascular disease, blood lipids, diabetes mellitus, hypertension, respiratory problems, gallbladder disease, arthritis, and cancer, all of which are connected to complications stemming directly from overnutrition.

Methods of Evaluating Malnutrition

Malnutrition is diagnosed based on the findings of a medical and diet history, physical examination, and laboratory tests. The results are then compared with norms of weight for height, body mass index (body weight in kilograms divided by height in meters squared), dietary intake, physical findings, and plasma levels of nutrients and nutrient-dependent substances such as hemoglobin. The physical examination would necessarily include anthropometric measurements, as well as close examination of the skin, hair, and mouth for symptoms of malnutrition.

For example, depigmentation of the hair is indicative of undernutrition, and a body weight that is 20 percent above the average desirable body weight as determined by insurance company standardized charts would indicate overnutrition. A triceps skinfold test may be utilized to determine the body's energy stores. Laboratory tests are used to reveal the extent to which amino acid nutrition is meeting the body's needs to determine undernutrition, or plasma lipids in the diagnosis of overnutrition. In the field when assessing nutritional status, the medical and diet history and physical examination may be the only tools accessible to the physician or nurse, particularly in developing countries.

Who is at Increased Risk for Malnutrition?

The risk for malnutrition is increased for a variety of reasons. Increased nutritional needs during growth, pregnancy, lactation, old age, infection, certain cancer therapies, or immune deficiency disorders increase the risk of malnutrition. Diets that focus on a narrow range of foods may not provide the variety of nutrients required and lead to deficiencies. Those experiencing famine, with the accompanying reduction in available food, are at great risk for malnutrition in the form of undernutrition. Lack of money to purchase an adequate diet or cultural practices that dictate which members in the family get a large or small amount of food may also lead to malnutrition. Any medical condition that effects the absorption of nutrients from foods, or requires medication that has adverse consequences on appetite, may cause malnutrition if the condition is long term. Taking megadoses of vitamin/mineral supplements may result in toxic levels of the substances taken in the body with the outcome being a state of overnutrition.

Correcting Malnutrition in the United States

Since the Great Depression of the 1930s, the federal government of the United States has undertaken the task of alleviating and/or preventing malnutrition. In the 1960s, President John F. Kennedy reestablished the federal government's efforts to end debilitating hunger. Individuals and families who have low incomes may take advantage of several federally sponsored programs to ensure a better quality of nutrient intake. Food stamps are available to those who are usually employed but having difficulty purchasing an adequate food supply by using coupons to purchase food from grocery stores. The Commodity Supplemental Food Program distributes U. S. Department of Agriculture surplus foods through county agencies to such low-income populations as pregnant women and families with young children. The School Lunch and Breakfast Programs offer free or reduced-priced meals based on the Food Guide Pyramid to children of low-income families, with the cost of the reduced-priced meals being based on family income. The Summer Food Service Program offers free, nutritious meals and snacks to low-income children and distributes the meals from a central location during lower and secondary school vacations. There are also programs targeted specifically at different age groups. Preschool children enrolled in organized child-care programs receive meals at no cost, and the child-care program receives reimbursement for the meals through participation in the Child-Care Food Program. For individuals 60 years or older, a free noon meal is provided at centralized sites as part of the Congregate Meals for the Elderly Program. Homebound individuals over 60 years of age can take advantage of home-delivered meals at no cost or for a fee, depending on income, at least five days per week.

World Hunger: Addressing a Global Problem

In 1798 the English clergyman and political economist Thomas Malthus suggested that the world's population was growing at a rate faster than the food supply. The year 2002 finds world population growth exceeding economic growth, and poverty on the rise. Globally less than one-half of 1 percent of the world's yearly production of goods and services goes exclusively to economic development assistance, yet 6 percent goes to support the world's military operations. Civil wars in some countries have substantially retarded progress of the poor and continue to contribute to massive undernutrition. Environmental factors such as soil erosion or lack of fresh water for irrigation of crops exacerbate the problem of providing sufficient quantities of foods for many countries. What is being done to overcome all of these detriments to feeding the world's hungry? Since the 1960s, an American program, the Peace Corps, has been instrumental in providing education, distributing food and medical supplies, and building structures for locals to use in developing nations. National surveys such as the National Family Health Survey conducted in India are valuable tools in the determination of whether any progress is being made to improve the nutritional status of the nation. Advances in biotechnology to genetically alter plants and animals to improve the nutritive quality of the foods produced from them may help to meet increasing food needs both now and in the future. The United Nations and the World Health Organization cry out for governments in developed countries to facilitate greater strides in improvements in malnutrition in undeveloped countries by financial, educational, and scientific interventions. What will be required to eradicate malnutrition in this world is a coming together of the leaders of rich and poor nations to the same degree. Globally, there is an adequate food supply and the technical expertise necessary to address the problems and complications of malnutrition. All that is lacking is the political cooperation to address this devastating situation.

See also **Anorexia, Bulimia; Aversion to Food; Body Composition; Caloric Intake; Disease: Metabolic Diseases; Eating: Anatomy and Physiology of Eating; Fasting and Abstinence; Fluoride; Food Politics: United States; Hunger, Physiology of.**

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MALNUTRITION: PROTEIN-ENERGY MALNUTRITION. Protein-energy malnutrition (PEM) may be present at any time during the life cycle, but it is more common in the extreme ages, that is, during infancy/childhood and in the elderly. The present review will be restricted mostly to the condition present during infancy and childhood.

Protein-energy malnutrition is a syndrome characterized by its progressive onset and a series of symptoms and signs that encompass a continuum, ranging from clinically undetected manifestations to the full-blown clinical picture of marasmus or kwashiorkor. A syndrome is defined in clinical practice as a set of symptoms and signs that may be caused by different etiologies.

In the case of PEM, the earliest symptoms include subtle changes in the mood of the child, which may be described by the mother as saying that the child is not as playful as he/she used to be. Further changes include a loss of appetite and a loss of interest in the surroundings, which lead to decreased social interaction with peers or siblings and adults (parents or other caregivers). When PEM becomes more severe, there are adverse effects on the child's cognitive and behavioral development, evident in both the short and the long term.

In relation to signs, the earliest clinical sign of PEM is the lack of adequate weight gain. Also common in the early stages are mild episodes of common acute infectious diseases, such as acute diarrhea or acute respiratory infections. As the condition advances, the child will show signs of body wasting, progressing to an extreme thinness. If the syndrome becomes chronic, there are small or no increases in length. When the condition becomes more severe, the child may show the clinical pictures of marasmus or kwashiorkor, which will be defined later in this article.

The etiology of protein-energy malnutrition as a syndrome may be classified as primary or secondary. Although in practice most cases of PEM are caused by a combination of both, the concept may be useful for targeting interventions. Primary PEM refers to a deficit of available food. This, in turn, may be because of biological conditions, such as maternal malnutrition prior to or during pregnancy and lactation, or to social conditions, such as poverty; to a limited or selective unavailability of food; to war; to ecological disasters leading to famine, or, more often, as a result of profound social inequalities, either at the individual level (discrimination, refugees, prisoners) or at the community or country level. The largest prevalences of protein-energy malnutrition are found in socioeconomically deprived areas of the world, as will be reviewed further on in this article. Secondary causes of PEM include several conditions that impair food intake, absorption, or utilization, or that increase energy and/or protein requirements or losses. Secondary causes of PEM may be biological or social conditions.

Biological conditions may interfere with food intake, such as congenital anomalies (for example, harelip); with absorption, such as any of several malabsorption syndromes (for example, tropical sprue); or with utilization, such as inherited metabolic diseases (for example, phenylketonuria). Biological conditions that increase the need for energy include all infectious diseases accompanied by fever, and other diseases that increase catabolism, such as tuberculosis, or that are accompanied by an increased nutrient loss, such as intestinal parasitism.

On the other hand, social causes that affect food intake, whether it be in quantity or quality (protein-energy or micronutrient content), include several conditions associated with poverty, such as ignorance, inadequate weaning practices, child abuse, alcoholism or other drug addictions, and others.

Different conceptual frameworks for the study of malnutrition have been proposed and adopted throughout the years; one of the most widely accepted ones was developed during the WHO/UNICEF Joint Nutrition Programme in Iringe, Tanzania (B. Jonsson et al., 1993) (UNICEF 1990), from where it has been extended to many parts of the world. An appealing feature of this conceptual framework is that it may be adapted to describe causes of the major nutritional deficiencies present in the world, including vitamin A, iron, and iodine deficiency.

Clinical Picture of Marasmus and Kwashiorkor

Marasmus is characterized by a chronic and severe restriction of both energy and protein to the body. Marasmus is more frequently found at a younger age than kwashiorkor, usually in children under one year of age. A marasmic child presents severe wasting, with a very low weight-for-age and reduced length-for-age, often below −3 standard deviation of the reference population values. The clinical history of a marasmic child may reveal poverty or famine affecting the family; inadequate child-rearing practices, like starvation wrongly prescribed as part of the management of diarrhea; an early stopping of breast-feeding; over-dilution of formula; a history of repeated and/or chronic infections, such as diarrhea or tuberculosis; or some physical condition that affected the child's growth and development, such as prematurity, mental defects, or a malabsorption syndrome. The mother or caregiver will often report that the child is hungry. On a first appreciation, the child may be interested in the environment, with an active cry and reaching for food if offered, or else he/she may be depressed to the point of coma. The typical clinical picture is that of a striking loss of subcutaneous fat and muscle wasting, observed as markedly thin limbs, an evident rib cage, sunken cheeks and eyes that give the child a "monkey-like" or gaunt appearance, a prominent abdomen (although with no evidence of an enlarged liver), and a relatively big head. The hair is often thin and dry, and comes off easily. However, skin rashes or dermatosis are not usually present. Common micronutrient deficiencies include vitamins A and D, zinc, and iron, although anemia is less common in marasmus than in kwashiorkor.

The clinical picture of kwashiorkor is not as striking in appearance, as this syndrome often affects slightly older children, i.e., between one and three years of age. The clinical onset of kwashiorkor usually takes place in a shorter period of time as compared to marasmus, and is characterized by a relative, though severe, limitation in protein intake, with a lesser involvement of energy deficit. A child affected with kwashiorkor is often apathetic to external stimuli, is irritable, and gives the impression of misery, rejecting or crying when cared for. The most salient clinical characteristic of this syndrome is the presence of edema, which may mask the evidence of body weight loss and reduced length in relation to age. It is also common to find skin lesions that range from a flaky, pink dermatosis with skin dryness and depigmentation to deep ulcerations. Also common are petechiae and ecchymoses, as well as clinical signs of anemia. The hair presents discoloration with bands of dark and light hair (described by clinicians as the "flag sign"). An enlarged, fatty liver is also characteristic of kwashiorkor, palpable as a soft mass under the right rib cage. Co-occurring micronutrient deficiencies are common, so clinical signs of deficiencies of specific vitamins, including A, B, C, D, iron, or others, also may be present.

Classification of Protein-Energy Malnutrition

The clinical signs of severe PEM are so impressive that, for several years, they drew the attention of pediatricians and other physicians interested in furthering the understanding of the clinical syndromes and their treatment. Therefore, the study of PEM was long confined to the hospital setting. Actually, the first classification of PEM came from Mexican observers, who ranked the severity of malnutrition based on the risk of death for children with a clinical diagnosis of PEM. This group, led by Gomez, proposed that children with a weight-for-age deficit greater than 40 percent in relation to a reference population were in the greatest risk of dying, and thus labeled them as having third-degree malnutrition. Further, children with 25–40 percent weight-for-age deficit were labeled as having second degree malnutrition, and children with 10–25 percent weight-for-age deficit were classified as having first degree malnutrition (Gómez-Santos, 1946).

This classification had a high predictive value for the risk of death, and therefore had important implications for clinical practice. It was further abused, however, when its use was extended to the classification of malnutrition at a population level. In other words, children with no evidence of clinical malnutrition who have low weight-for-age should not be classified as malnourished; doing so may not only misdiagnose an individual, but may overestimate the prevalence of malnutrition in a population. Also, the Gomez classification has been criticized because a single measure of a child's weight referred to age gives no idea about the nutritional history of the child. That is, an underweight child may be growing according to his/her normal growth channel, may be recovering from a recent episode of weight loss ("catch-up growth"), or may be deteriorating in relation to the recent past.

In order to overcome these caveats, Waterlow proposed combining weight-for-height, as an indicator of an acute episode of malnutrition, with height-for-age, as an indicator of chronic nutritional deficits that would be reflected in growth stunting (Waterlow, 1972).

Although these classifications have been used for several years, they have two important disadvantages that often are overlooked. To illustrate the first disadvantage, it is important to highlight the concept of Z-scores as a means of describing an individual child's anthropometric indicators in a normal distribution. The normal distribution of a reference population has been published by the World Health Organization (WHO) and is most often accepted worldwide as the standard for comparison. Eighty percent of the median weight-for-age might be above or below −2 Z-scores, depending on the child's age. The second disadvantage is that, to approximate a fixed point in the normal distribution, say, −2 Z-score, different percents of median have to be used depending on the anthropometric index used—for example, 90 percent for low height-for-age, or 80 percent of low weight-for-height.

In consequence, the World Health Organization Expert Committee on Physical Status has recommended the use of Z-scores to express weight-for-age, weight-for-height, or height-for-age relative to values reported in a reference population (WHO Expert Committee on Physical Status, 1995). The use of this system has several advantages; i.e., when applied at a population level, it allows the mean and standard deviation to be calculated for a group of Z-scores, and it allows the use of fixed cut-off points (i.e., −1, −2, or −3 Z-scores) to classify mild, moderate, or severe deficits for any anthropometric indicator. Although the use of Z-scores may be difficult to grasp for those who have been accustomed to classifying nutritional deficits based on the percent of median, the advantages of Z-scores outweigh their disadvantages.

Global Prevalence of Protein-Energy Malnutrition

The most recent estimates about the distribution of PEM at a worldwide level were compiled by the World Health Organization (WHO) Programme of Nutrition, available in its Global Database on Child Growth and Malnutrition (de Onis and Blössner, 1997). This database covered 95 percent of the total population of children under 5 years of age who lived in 103 developing nations in 1995, as was reported in nationally representative surveys available at the time. According to these data, an estimated 206.2 million children, who represent 38 percent of all children under 5 years old, were stunted (low height-for-age); 167.3 million children (31 percent) were underweight (low weight-for-age), and 48.8 million children (9 percent) were wasted (low weight-for-height). PEM is most often found in the poor regions known as the "developing world." The largest number of affected children were found in Asia, where 41 percent of all under 5 years old were stunted, 35 percent were underweight, and 10.3 percent were wasted. Africa had 38.6 percent stunted, 28.4 percent underweight, and 8 percent wasted children of all those under 5 years old; Latin America and the Caribbean showed 17.9 percent stunted, 9.5 percent underweight, and 3 percent wasted children of all those under 5 years old. The proportion of children under 5 years of age affected in Oceania was 31.4 percent, 22.8 percent, and 5 percent, respectively, but the total number of children living in this region is much lower, so in reality, these percentages translate into many fewer children affected than in the other regions.

Since the mid-1980s, the Administrative Committee on Coordination/Sub-Committee on Nutrition (ACC/SCN) of the United Nations periodically has examined the trends of malnutrition in the world's children. In its Third Report on the World Nutrition Situation (ACC/SCN, 1997), this Committee (from data from 61 countries) estimated the trends in stunting with two or more nationally representative surveys. In the period from 1980 to 1995, stunting declined globally at a rate of 0.54 percentage points per year. Sub-Saharan Africa had an increase of 0.130 percentage points per year in the average prevalence of stunting; the remaining regions of the world showed statistically significant decreases that ranged from −0.26 in Middle-America and the Caribbean to −0.90 in Southeast Asia (Table 1).

The same Committee was able to use data from 95 countries that had data from at least one national survey to estimate the prevalence of undernutrition; underweight and stunting showed a consistent 11.5 percentage point difference. The higher prevalence was for the underweight classification. During the 1980–1995 period studied, only sub-Saharan Africa had an increase in the prevalences of both stunting and underweight; all the other regions showed decreasing trends in these two indicators (Table 1).

Acute and Long-Term Consequences of Protein-Energy Malnutrition

PEM results from a relative deficiency of protein (essential amino acids and/or total nitrogen) and energy substrates (carbohydrates, fats, or proteins). However, these deficiencies are almost always accompanied by micronutrient (minerals and vitamins) deficits. Manifestations of PEM differ depending on the duration, the severity, and the combination of these deficiencies. In the early stages,

TABLE 1

Estimated prevalence of stunting (%) and numbers of children affected for 1980, 1985, 1990, and 1995 and by region

Region	Prevalence stunting				Numbers stunted (in millions)				% Increase/ decrease in numbers from 1980 to 1985
	1980	1985	1990	1995	1980	1985	1990	1995	
Sub-Saharan Africa	37.4	38.1	38.7	39.4	26.255	30.832	36.248	42.590	+62
Near East/North Africa	30.8	25.9	23.0	22.2	11.397	10.991	10.865	10.913	-4
South Asia	66.1	61.9	57.7	53.5	88.873	93.237	91.520	89.877	+1
South East Asia	51.9	47.3	42.8	38.3	35.581	32.862	30.119	30.206	-15
Middle America/Caribbean	31.6	30.4	29.1	27.8	5.398	5.467	5.631	5.626	+4
South America	25.0	21.0	16.9	12.9	8.285	7.309	5.965	4.644	-44
China(1982)			31.4				36.068		
Across all regions (excluding China)	48.8	45.6	42.5	39.9	175.789	180.698	180.348	183.856	+5

Note: These estimates were derived assuming a linear relationship between stunting and year. The only region for which there was evidence of a nonlinear relationship was Near East/North Africa. For this region, a quadratic model was used to approximate the nonlinear relationship . The estimated prevalence values for this region were from this model.

there are functional impairments, which are later followed by biochemical and physical damage.

The identification, understanding, and treatment of the full-blown clinical syndromes characteristic of severe PEM began in the mid-1930s with the description of kwashiorkor (Williams, 1933). On the other hand, the identification and understanding of the functional manifestations of malnutrition have only come about during the last three decades of the twentieth century, with the launching of two large-scale, community-based research projects: the first one, known as the INCAP Longitudinal Study, was based in Guatemala (Habicht and Martorell, 1992). The second took place simultaneously in three countries—Egypt, Kenya, and Mexico—and was known as the CRSP study (Calloway, Murphy, et al., 1988).

Functional consequences of protein-energy malnutrition. As described earlier, the functional consequences of PEM were recognized and studied only relatively recently (Allen, 1993). Among the most well documented functional consequences of PEM are growth impairment, a reduced immune response, and a disruption in cognitive ability.

Growth impairment. Growth failure because of PEM usually starts to manifest very early in life. Information from the INCAP longitudinal study, as well as from the CRSP studies, coincides in showing that growth stunting begins at about 3 to 4 months of age and is complete before 18 months (Allen, 1995). A further contribution from the INCAP study was provided by a long-term follow-up of the same populations that showed not only that growth stunting present during infancy carried on until adolescence, but also that length at 3 years of age was a strong predictor of adolescent size (Martorell, Schroeder, et al., 1995). It also seems as if stunting in early life is correlated significantly with reduced physical performance (Haas, Martinez, et al., 1995) and reduced psychomotor and mental performance, both during late childhood (Mendez and Adair, 1999) and even until adolescence (Grantham-McGregor, 1995; Pollit, Gorman, et al., 1995).

Two more relevant issues related to growth failure are that there is a window of opportunity for intervention from the ages of 3 to 6 months, when response to the intervention may be greatest (Lutter, Mora, et al., 1990), and that most of the growth deficit found at later ages accumulated during the first months of life (Rivera, Cortes, et al., 1998).

Immune response. It has been recognized that malnutrition is the most common cause of immunodeficiency worldwide (Chandra, 1991). Actually, malnutrition and infection interact in a vicious cycle: the presence of one more easily leads to the development of the other (Scrimshaw, Taylor, et al., 1968). There are several mechanisms involved in this relationship. PEM impairs cell-mediated immunity, phagocitic function, and the complement system. It also diminishes immunoglobulin (IgA, IgM, and IgG) concentrations, and cytokine production (Chandra, 1991). Micronutrient deficiencies associated with PEM also adversely effect the immune response. For example, iron plays an important role in several metabolic functions, including both the host and invasive bacteria. Several microorganisms that infect the human body only achieve their full infectious activity in the presence of iron. Such is the case of bacteria that cause diarrheal disease, such as *Escherichia coli*, *Yersinia septica*, *Salmonella sp.*, and *Vibrio cholerae*; and others responsible for lower respiratory infections, such as *Mycobacterium tuberculosis*, *Klebsiella pneumoniae*, *Pseudomona aeruginosa*, and *Listeria monocytogenes*. These microorganisms actively seek iron in their host during infection, uptaking it from destroyed

THE IMPORTANCE OF MARGINAL MALNUTRITION

The borderline between normal nutrition and malnutrition is so thin that, in clinical practice, there is no foolproof way to distinguish them. This is at least one of the reasons why so little attention was given to marginal malnutrition (i.e., malnutrition that borders normal limits). A further reason, though, obeyed a misconstruct that prevailed for a long time; that is, that only children with severe malnutrition had an increased risk of dying. This concept was probably triggered by the initial clinical observations on the increased risk of death in hospitalized children with third degree malnutrition (Gomez, Ramos-Galvan, et al., 1956), and was reinforced further by epidemiological observations in the field.

In a classic study, Chen and colleagues reported their findings on 2,019 Bangladeshi children between the ages of 13 and 23 months, who were followed for a period of 24 months, assessing death rate (Chen, Chowdhury, et al., 1980). The study team had precise information on the age of these children and had performed a cross-sectional nutritional assessment at baseline. Further, a demographic surveillance team identified all deaths occurring during the study period, recording age and probable cause of death. Child mortality rates were analyzed stratifying by percentage weight-for-age, weight-for-height, and height-for-age. The authors found that severely malnourished children experienced about a twofold higher mortality risk over the first twelve months of the study, and fourfold during the second twelve months of the study, as compared to normally nourished and mildly and moderately malnourished children, who shared the same level of mortality risk. The nutritional index with the strongest discriminative power to identify risk of death was weight-for-age.

This article, and others that followed in the literature (Trowbridge and Sommer, 1981; Heywood, 1982; Bairagi, Chowdhury, et al., 1985), seemed to find a threshold effect for mortality at the cutoff corresponding to third-degree malnutrition, below which the risk of death increased sharply. It was not until 1993 that Pelletier, Frongillo, and Habicht questioned this model (Pelletier, Frongillo, et al., 1993). Following their reasoning, the threshold effect reflects a model in which a population's mortality rate increases as a linear function of malnutrition.

An alternative model is a quadratic one that accounts for the sharp increase in mortality found beyond the threshold. Pelletier et al., however, sustained that a synergistic or multiplicative model, in accordance with the clinical observations that child mortality is a function of the adverse synergism between malnutrition and morbidity (Scrimshaw 1970), provides a much better explanation of the relationship. When testing their multiplicative (i.e., synergistic or exponential) model on a set of available data from several large-scale population studies, they found that an exponential model fit the available data best. Based on the best fit of the exponential model, they calculated that the odds of dying increased at a compound rate of 7.3 percent for each percentage point deterioration in weight-for-age.

In summary, these authors provided strong evidence that a threshold effect does not exist. Their model is consistent with the view that because of the greater number of affected children, mild to moderate malnutrition is associated with a greater absolute risk of dying. The policy implications of this conclusion are striking. Considering that the majority of malnourished children fall in the mild to moderate category, and that their risk of dying is higher than that of non-malnourished children, the attention of health-care programs should be immediately drawn to this population.

Certainly, a larger number of childhood deaths would be prevented if efforts were directed to improve the nutritional status of this group and to lower morbidity burden of all malnourished children, and not just for the ones who are in the worst condition. Therefore, the authors estimate that 45 percent to 83 percent of all malnutrition-related deaths occur in children who present mild to moderate malnutrition, a group that is usually excluded from direct interventions based on the impression that their risk of dying is small. Also, it highlights that either reducing morbidity or reducing malnutrition would reduce child mortality, but a much larger effect (actually, a synergistic effect) would be achieved if both conditions were addressed simultaneously (Pelletier, 1994).

red cells (erythrocytes) and body stores (liver). On the other hand, the host tries to make iron less available to invasive microorganisms, sequestering it through different mechanisms—referred to as nutritional immunity—that include the binding of iron to transferrin and lactoferrin, and the increase in ferritin saturation in the liver (Kochan, 1976). Other micronutrients that play active roles in modulating immunity include zinc, selenium, copper, vitamins A, C, E, B_6, and folic acid (Nezu and Nakahara, 1994).

Conversely, infectious diseases lead to malnutrition by several mechanisms that often interact with each other. Almost every malnourished child will sooner or later present with diarrhea. Many of the interactions between malnutrition and infection are understood because of studies of diarrheal disease (Chen, 1983); hence the illustration of the mechanisms by which these two morbid conditions interact is particularly useful. One of the first symptoms of diarrheal disease is anorexia, as a result of vomiting and abdominal discomfort. Also, fever, dehydration, and electrolyte imbalances contribute to it (Martorell, Yarbrough, et al., 1980). Anorexia leads to a restricted intake, which is often reinforced by erroneous caregiver practices. In part, it is culturally engrained in different societies to withhold food from a diarrhea-affected child (Bentley, 1988), and it is also quite common to find physicians who still think that it is necessary to "put the bowel to rest" during the acute stage of the illness (Brown and MacLean, 1984). The deleterious effect of decreased food intake is worsened by increased catabolic losses of nitrogen that occur as a result of increased metabolic rates and structural damage to the intestine (Powanda, 1977). Another consequence of intestinal damage is the transient loss of absorptive surface and absorptive function as a result of villous atrophy (Davidson and Barnes, 1979). This condition leads to a decreased absorption of macronutrients (fat and carbohydrates) and micronutrients (particularly fat-soluble vitamins). The presence of unabsorbed carbohydrates in the intestinal lumen increases the osmolarity of the intestinal content, thus causing an hyperosmolar diarrhea (Wapnir, 1982). It also subjects these substrates to bacterial fermentation, which produces gas and intestinal bloating, worsening gastrointestinal symptoms. Catabolic losses also are increased by the presence of fever. In cases of parasitic infestations, the child's nutritional status is impaired by blood losses that are secondary to colitis or direct intestinal mucosal damage (common in cases of roundworm [*Ascaris lulmbricoides*], hookworm [*Ancylostoma duodenale* and *Necator americanus*], or whipworm [*Trichuris trichiura*]). Parasitic infestations also are associated with respiratory symptoms (particularly in case of *Ascaris* infestations) and anorexia (Lunn and Northrop-Clewes, 1993).

Disrupted cognition. PEM can disrupt cognition in several ways. Following the lessons learned from the effect of PEM on the body during infections, the classic explanation was that malnutrition caused physical damage to the brain, particularly during sensitive periods of development, namely, during the first two years of life, when about 80 percent of the brain's growth is achieved (Guilarte, 1993; Levitsky and Strupp, 1995). At present, however, it is clear that there are several other mechanisms, aside from organic damage, by which malnutrition can impair intellectual development. There is also evidence that at least part of this damage may be reversible, even in the presence of structural damage to the brain (Levitsky and Strupp, 1995).

Malnutrition may affect brain growth and development, which will be reflected in cognitive disabilities, motor impairment, or lower intelligent quotient (IQ), by means of micronutrient deficiencies such as vitamin B_6 or iron, both of which are vital for normal brain function (Guilarte, 1993; Pollitt, 1997). Malnutrition also may affect these functions because of energy deficiency, which limits activity and social interaction with peers and caregivers. This mechanism was explored first in the early 1970s by Levitsky and coworkers in a rat model. They showed that energy-deprived rats scored lower on such tests as maze running—a proxy for mental ability—because they were so feeble that they withdrew from contact with their peers and the objects in their surroundings (Levitsky and Strupp, 1995). Similar findings were shown to be present in children living in deprived third-world communities (Chávez and Martínez, 1982).

The extent to which PEM affects intellectual potential has been explored by studying the effect of protein-energy supplementation on behavioral development. In spite of different study designs that focused on prenatal supplementation (Rush, Stein, et al., 1980), on postnatal supplementation (Grantham-McGregor, Meeks Gardner, et al., 1990; Husaini, Karyadi, et al., 1991), or in both (Waber, Vuori-Chirstiansen, et al., 1981; Chávez and Martínez, 1982), results from these studies are consistent in showing that a significant proportion of the variability in mental and motor developmental scales during the first two years of life may be accounted for by nutritional supplementation.

The extent to which the differences in intellectual performance found at early ages in children affected by PEM carries on to later stages in life has been addressed by Pollitt et al. in a long-term follow-up study of Guatemalan children, who received supplements during the prenatal period and the first 2 years of life and were later followed up between the ages of 13 and 19 years old (Pollitt, Gorman, et al., 1995). This study found that children who had received a protein-energy supplement had significantly higher scores on tests of knowledge, numeracy, reading, and vocabulary, as well as a faster reaction time in information-processing tasks compared with children who had received only an energy supplement. This effect was particularly strong for protein-energy supplemented children at the lowest end of the socioeconomic distribution, an interesting finding when compared to only energy supplemented children, in whom the higher cognition test scores varied as a positive function of socioeconomic status, as expected. The authors interpretation is that the protein-energy supplement acted as a social equalizer in relation to the differences in performance usually found in populations as a function of differences in socioeconomic status.

Another long-term supplementation study was carried out in a Mexican village, where women received nutritional supplements during pregnancy and their offspring continued to receive micronutrient supplements from 12 weeks until 10 years of age. Compared to a control group (mothers and children from the same village, recruited two years before supplementation began), children who received supplements showed significantly better IQs, school performance, and behavior (Chávez, Martínez, et al., 1995).

The studies of the effects of iron deficiency on intellectual and motor abilities were addressed specifically during the 1980s and 1990s. Several well-designed intervention-control studies have shown that, before treatment, average mental scores on the Bayley Scales of Infant Development of infants with anemia were 6 to 14 points lower than the scores of non-anemic controls (Lozoff, Brittenham, et al., 1982; Grindulis, Scott, et al., 1986; Lozoff, Brittenham, et al., 1988; Walter, De Andraca, et al., 1989), and average motor development scores were 9 to 11 points lower, differences of statistical and clinical significance. No significant improvement on the test scores of initially iron-deficient children were noted following iron supplements for two to three months (Aukett, Parks, et al., 1986; Lozoff, Brittenham, et al., 1988; Walter, De Andraca, et al., 1989). Fewer studies have addressed whether these deficits prevail in later ages. In a long-term follow-up study of Costa Rican children at age 5 years whose iron status had been documented and consequently treated in infancy under careful supervision, Lozoff et al. found that at five years of age, all children had excellent iron status. However, those children who had been severely iron deficient during infancy (hemoglobin ≥100 g per liter) showed lower mental and motor functioning scores at school entry than did the rest of the children, even after controlling for background factors that were potential confounders (Lozoff, Jimenez, et al., 1991). Further, even anemic children with hemoglobin levels > 100 g per liter before and after treatment also had poorer outcomes at five years of age, compared to non-anemic children. Strong as this evidence may be, it is relevant to point out that, to date, there is no definite proof that iron deficiency is the cause of children's lower test scores. For obvious ethical reasons, the gold standard of experimental designs, the double-blind placebo-control study, has not been carried out.

Protein-energy malnutrition also may affect children's performance on cognitive tests by other, indirect mechanisms (often conceptualized as confounding variables in studies that attempt to establish links between PEM and impaired cognition).These include social and economical disadvantages (Johnston, Low, et al., 1987), differences in parental education (LeVine, LeVine, et al., 1991), years of schooling (Ceci, 1991), inadequate attention or affection from caregivers (Engle and Ricciuti, 1995), and other environmental factors, which may include peer interaction, parental presence in the home, etc. (Engle and Lhotska, 1999).

Recent research has addressed the role of breast-feeding (the gold-standard of good nutrition during the first months of life) on cognitive development, adjusting for the aforementioned variables. The results of a meta-analysis that included 11 studies that controlled for ≥ 5 covariates on the effect of breast-feeding on cognitive function, a statistically significant increment in cognitive function of 3.16 points was seen in breast-fed infants, consistent through all the studies, at 6 to 23 months of age. This study found a greater benefit of breast-feeding for cognitive development of premature babies (an adjusted benefit of 5.18 points), and a larger benefit in relation to duration of breast-feeding (an increase of the weighted mean benefit of 1.68 points with 8–11 weeks of breast-feeding to 2.91 points with ≥28 weeks) (Anderson, Johnstone, et al., 1999).

Concluding Remarks

Over the years, much has been learned about protein-energy malnutrition, its causes, and its effects. Without pretending that all is known, available knowledge can alleviate this burden on human development and social inequalities. Although the treatment of malnourished children all over the world is a clear imperative, the key to solving the problem is to focus on prevention. Preventive actions should be interdisciplinary. These actions should encompass a broad focus on education, particularly directed to women; they should include actions to improve sanitary conditions, schooling opportunities, employment, agricultural produce, and access to diverse food sources, particularly those rich in micronutrients. All sectors of society, including government and non-government organizations, should work together toward a common end. The opportunities to make a substantial improvement in the nutritional status of children all over the world are here, as never before in history. We have studied the causes of malnutrition, its mechanisms, and its consequences. It is now time to study the impact of specific interventions tailored to solve persistent problems.

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Homero Martínez

MAMMALS. Mammals—warm-blooded, milk-producing animals—have provided meat protein, milk protein, collagen, hides for leather and shelter, and bones and sinew for various tools since humans began to hunt. Mammals also have provided the power for transportation (still called horsepower) and for heavy lifting or pulling. They have often been regarded as companion animals. Indeed, the existence and progress of humanity have depended heavily on mammals. As human societies became more complex and some took up the settled practices of farming and animal husbandry, certain mammalian species were selected to provide sustainable supplies of meat protein. Bovine (cattle), porcine (swine), ovine (sheep), and caprine (goat) species became valued livestock. Domestic animals, whether raised for food, work, or companionship, were selectively bred by controlling the animals' breeding and food supply to ensure desired traits in the next generation.

Types of Mammals

The three main classes of mammals, based on food preference, are herbivores, omnivores, and carnivores. Herbivores are strict plant eaters (sheep, goats); omnivores are opportunistic meat and plant eaters (humans, pigs); carnivores are almost exclusively meat eaters (wolves, cats). Mammals, thus, are both prey and predator in any food chain, depending on their size and aggressive behavior.

Herbivores. Plant-eating mammals provide most of the world's protein. Virtually every culture around the world tends one of the grazing (herbivorous) species of mammals as a protein source. Dairy cattle, water buffalo, sheep and goats, camels, yaks, reindeer, and llamas and alpacas all provide dairy products such as yogurt, cheese, butter, and milk in various societies.

Cattle originated in northern Europe and were domesticated by the northern Germanic and Celtic tribes in approximately 4000 B.C.E. Romans then brought them into southern Europe in the first century B.C.E. From the upper reaches of the Nile to the plains of southern and eastern Africa, cattle herding was common. Cattle became the basis of wealth for warrior-dominated societies in southern Africa. During the Middle Ages in Europe, cattle represented real wealth as milk providers and as work animals, not as meat animals. Cattle were slaughtered only when they could no longer work. Beef was not widely eaten, as cattle and oxen (castrated dairy bulls) had tough, dry flesh.

Water buffalo, valuable for hauling, transportation, and other work, were also used for milk, and buffalo milk mozzarella is still enjoyed as a table cheese in Italy.

Sheep and goats, small ruminants, are kept for their fleece, hides, meat, and milk. Both are docile and socially inclined mammals, and were herded beginning in 8000 B.C.E. in southwest Asia. Camel, yak, and reindeer are herding animals that provide meat, milk, and hides for the nomadic tribes of Asia and the Arctic Circle, respectively. Reindeer herding developed in the northern latitudes even before herds were kept on the Eurasian steppes. Camel herding became common in Arabia and the Sudan of Africa, and camels were critical to the maintenance of trade routes that crossed the great deserts of Africa and Asia. The yak, a large, long-haired ox with a bushy tail, is native to the Tibetan plateau. It provides dairy products and is used for transport. Llamas and alpacas have provided the peoples of Peru and Bolivia with hides, fleece, meat, and milk since at least 3500 B.C.E.

The American bison, the largest land mammal of North America, is believed to have migrated from the steppes of Central Asia into what is now Alaska by crossing the narrow strip of land (Beringia) that existed during the last Ice Age. Native Americans revered bison for the wealth it provided in clothing, food, and tools made from sinew and bone.

Deer, along with their cousins—elk, moose, and caribou—are antlered, hoofed ruminants. These grazing animals supplied food and clothing to both Native Americans and, later, the European invaders of the North American continent. Antelope are the surviving members of an ancient family of grazing animals native to North America. Lewis and Clark, on their long exploratory trip across the continental United States, found large herds of antelope on the Great Plains. Gazelles and other wild grazing animals of Central Africa and Central Asia are hunted by native peoples for their meat.

Many species of small game have provided meat and fur when large game was not available. Wild hares and some rabbits, both native to Europe and the Americas,

Traditional bowl made of grass fibers for milking camels. Oman, twentieth century. The handle and exterior covering are goat hide. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

are hunted, while other breeds of rabbit are reared specifically for consumption. Muskrats, sometimes called "marsh rabbits," and squirrels are rodents found throughout North America; both have supplemented the human diet. Squirrels are still hunted today in many parts of the United States and are usually served in a stew. Guinea pigs are popular in many Peruvian dishes, especially in the Andes, where these herbivorous rodents (much larger than the guinea pigs kept as pets or laboratory animals) are raised in many households, like rabbits elsewhere. Rats and mice are rarely eaten, though both have provided meat for people in times of famine.

The beauty of its fur led to the beaver's being overhunted by British, French, and Russian trappers in the northern territories of the North American continent in the sixteenth and seventeenth centuries. Beaver pelts were in great demand in Europe, especially for men's top hats. The fatty tail of the beaver was also prized for food. In the Middle Ages, the tail was declared "fish" by the Catholic Church, since the animal lived in water, making it acceptable as a meal on meatless days. Because its meat is very strong, only farm-raised beavers are recommended for cooking.

Kangaroos and opossums, both marsupials, are not consumed widely, though in Australia a cottage industry has developed around the production of kangaroo meat. Opossums, though not farm-raised, are hunted in the southern states of the United States for their meat.

Omnivores. Pigs are descended from a distant ancestor in southern Asia. Domesticated pigs brought to North America by the Spanish occasionally escaped captivity and multiplied, increasing the populations of wild pigs in the southeastern United States. Other breeds subsequently brought to the United States also occasionally escaped and bred with feral pigs, further mongrelizing the pig population.

Peccaries, known also as javelinas, North America's native wild pig, are not related to domesticated pigs and wild boars. Peccaries belong to a separate genus indigenous only to North America. They favor a warm climate and are hunted in New Mexico, Arizona, and Texas.

Raccoons range widely throughout the United States. Although valued primarily for their fur, their meat was commonly eaten during colonial times, and raccoons are still hunted for their fur and meat in the southern states of the United States.

Archeological evidence suggests that bear meat was consumed by native peoples in North America following ritual hunts. Bear meat was prized by European colonists and Native Americans, mainly for its fat for cooking. Though not a widely popular meat, bear are culled from game reserves and the meat is sometimes available frozen.

Carnivores. The small Asiatic wolf, a social animal and meat eater—the ancestor of our canine companions—was reportedly domesticated as early as 11,000 B.C.E., probably because it was more useful for herding and hunting than as a source of food. This is not to say that the dog was not a source of meat. Dog meat has been eaten and enjoyed in Asian cultures, and is still commonly consumed in both China and Korea.

Domestication

Although the history of domestication of mammals by humans is not recorded, archeological evidence suggests that it occurred on all continents between 7000 and 10,000 B.C.E. Each human group chose local migrating herbivores for domestication on the basis of their availability and docility. The first mammals to live with people were likely wolves and small ruminants such as sheep and goats. By the end of the second millennium B.C.E., civilizations based on livestock domestication and agriculture had emerged in Asia, Europe, and Africa. Small grazing animals like deer and sheep, which could provide meat, milk, and fiber, were probably herded by humans as they roamed the broad landscapes of western Asia. No evidence exists that early humans domesticated the numerous grazing animals of Africa.

Goats and sheep. Besides being docile and adaptable, goats and sheep breed successfully in the company of humans, and in time each generation gradually lost more of its feral nature. It is widely believed that the goat was the first herding animal to be domesticated, due to its gregarious nature. As the Romans moved north through Europe during the first century B.C.E., sheep and goats accompanied them, becoming sources for the wool industry, and mutton became a readily available meat. Sheep store fat well and so are efficient animals to maintain.

Goats are browsers, able to digest not only grasses but also woody shrubs and less desirable plants. Goats are even more adaptive and less choosy about their diet than sheep and can graze in arid climates. Goats continue to be prized for their milk and the resulting fermented dairy products. Goat meat, particularly the tender and milder flavor of kid, was enjoyed throughout the Mediterranean and the Asian continent and is also eaten in some regions of the Americas.

Cattle. The ancestor of today's domestic cattle, the aurochs (*Bos primigenius*), is extinct. Members of the bovine genus inhabited most of the world's continents and were introduced into the Western Hemisphere during the European conquests of the late fifteenth and early sixteenth centuries.

Asian cattle, also known as humped back cattle (*Bos indicus*), have provided meat and motive power on the Asian subcontinent. Religious and cultural beliefs in India prevent cattle from being consumed as food, although the milk can be used. In Africa, cattle are probably descended from European and Indian breeds introduced by traders, probably in the first millennium B.C.E.

Veal, meat from castrated young dairy bulls, was a choice dish even in ancient times. Just-weaned calves produce veal, which still brings a handsome price, more per pound than beef. Veal is a light-colored meat because the animals are fed milk or milk-replacer diets and are never permitted to graze.

The distinction between beef and dairy cattle breeds began in eighteenth-century Europe. Breeds that were best for beef and those best for milk production were identified and cultivated. Among the dairy-consuming peoples of northern Europe, the dairy breeds of cattle were selected for the high butterfat content of their milk.

It is generally believed that cattle first came to the North American continent with the Spanish. Columbus carried cattle to Santo Domingo in 1493, and in 1519 Cortés brought long-horned Andalusian cattle to Mexico. In the early seventeenth century, Spanish missionaries were raising cattle throughout the southwest United States.

Pigs. The ancestors of domestic swine were dispersed throughout Europe, Asia, and North Africa. The nomadic lifestyle of early peoples precluded their domestication. They were probably first encountered as pillagers of crops and therefore hunted, but young pigs might have been taken into early settlements and raised for meat. The omnivorous habits of the pig meant that it could thrive on the scraps from humans combined with its own rooting and foraging.

Pigs have evolved gradually over a period of ten million years with a few minor variations. Early pigs were taller than six feet, with an elongated wedge-shaped head, lacking a modern pig's snout, and a body shape similar to that of the European boar. This ancestor of the pig ranged from Europe to Asia and became the ancestor of the European wild boar.

Columbus is credited with bringing the pig to the Americas in 1493. These hogs ran wild throughout the Spanish West Indies, and were later joined by a load of pigs that arrived in Mexico with Cortés in 1521. On his trek west to the Mississippi Delta in 1539, Hernando de Soto brought pigs from the West Indies to Florida.

Dogs. Evidence suggests that early canine-human interactions may have occurred over the kills of larger wild herbivores, leading dogs and humans to be wary competitors at first but ultimately to become allies. Bones of dogs are common in campsites of the late Stone Age from around 7000 to 6000 B.C.E. The Asian wolf was probably the first wild animal domesticated by humans, and it is believed to be the ancestor of all domestic dogs. Until the eighteenth or nineteenth centuries, most of the breeds of dog were described by their purpose (wolfhound, sheepdog), and it was not until the nineteenth century that many breeds were developed.

Horses. The earliest fossil examples, Eohippus, are found in northwestern North America. This wild ancestor of the horse was not much larger than a cat and had four toes on its forefeet and three on its hind feet. It was probably very widely distributed across the globe. Around 4000 B.C.E. the horse was domesticated in eastern Europe, and played a significant role in transportation, draft power, and warfare. Mounted soldiers were important military weapons until the twentieth century. Modern horses were reintroduced to the Americas by the Spanish conquistadors and were quickly adopted by native peoples for transport.

Game mammals and hunting. Those mammals not domesticated were hunted. Hunting animals for food or sport, or to rid a locale of animals that are seen as pests, is a human activity that spans the centuries and the globe. As early as the Late Paleolithic period, successful hunts required methods to preserve meat after slaughter. Meat was dried, smoked, or frozen in pits dug in the earth, or carcasses were weighted down with stones and sunk in cold lakes that froze during the winter. Meat stored was eaten dry, boiled, or grilled.

Hunting still provides some animal protein for the human diet; amounts vary depending upon the culture and region. In developed countries, hunting is largely a sport, while in less developed countries it remains, with fishing, an important source of dietary protein.

Nutrition

Meat. Meat is a popular high-quality protein food that satisfies the appetite and taste of people around the world. With the exception of organ meats, which tend to have concentrated nutrients, all of the cuts of meat from an animal are equally nutritious, providing roughly equivalent amounts of protein, minerals, and vitamins. Nutrition experts recognize meat as a food that also contributes varying amounts of fat to the diet. Meat supplies complete protein (all essential amino acids), essential minerals such as iron and phosphorus, significant B-complex vitamins (for example, thiamin), and trace minerals such as zinc. The protein of meat is comparable to that of fish, poultry, eggs, and milk.

The consumption of organ meats is sometimes encouraged because of the extremely rich vitamin and mineral content contained in edible glands and organs, including the liver, heart, kidneys, brain, sweetbread (thymus gland), tongue, tripe (stomach), and testicles, as well as the lungs and spleen in some cultures.

Dairy. Dishes prepared with milk or cheese are sometimes called "meat alternates" because of the similarity of the nutrient profiles, particularly when it comes to complete protein. The most significant milk products are:

- Yogurt: A fermented milk product made from whole, low-fat, or skim milk, providing all the food value of the milk from which it was made.
- Cultured cream: A product similar to yogurt but made with cream and so higher in butterfat. Sour cream is used widely in eastern European cooking; crème fraîche is more popular in France.
- Butter: A concentrated milk fat that provides fat in the diet and fat-soluble vitamin A.
- Cheese: A concentrated form of milk, fermented and often aged, that loses some of its protein in the cheese-making process but remains a high-protein food.

Mammals and Human Societies

Mammals have long played an important role in human mythology, religion, and social customs. As an act of reverence, humans have sacrificed animals, drunk their blood, and eaten their flesh. There are also taboos against certain relationships between humans and some animals, from the kosher prohibitions on eating pork and certain cuts of other animals to sexual taboos concerning congress between man and beast. Animals have been believed to be the habitat of both evil spirits and the souls of deceased human beings. Superstitions abound about animals, from bad luck brought by a black cat crossing one's path to good luck brought by carrying a rabbit's foot.

Culture, religion, symbolism, tradition, and taboos. Animal worship figures in many cultures and religions, including the cow among Hindus and the cat in ancient Egypt, and involves the role of reincarnation in some Asian religions. In many cultures, the spirits of important food animals were appeased to ensure their continued fertility, or ceremonies were performed to propitiate predators that threatened human survival. Stone Age art, cave drawings dating from 20,000 to 40,000 B.C.E., shows the animals and activities most important to the peoples of those cultures. The archeological evidence strongly suggests that these early people hunted and killed wild animals. Anthropologists believe the caves in which these drawings are found were not dwellings but served a religious or ritual function because food animals and hunting scenes predominate.

The earliest records of meat consumption indicate that animals were ritually slaughtered and the meat distributed to members of the community on the basis of an individual's place in the social hierarchy. Such practices required settled groups engaged in crop and pasture production. With farming and the formation of population clusters came the division of labor necessary to support specific food practices—grain milling, baking, meat processing, leather tanning, and so on. In some societies, meat processing emerged as part of sacrificial offerings to the deities for atonement, appeasement, supplication, or thanksgiving.

Meat eating and religious practices. In ancient times, sacrifices to the gods and goddesses often consisted of roasted sheep, goats, and lambs. Homer, Virgil, and the authors of the Old Testament all give accounts of roasted meat being offered to please the gods or the Lord. The biblical Book of Leviticus stipulates that the sacrificial animal be perfect, without any physical flaws; thus, a castrated animal was forbidden as a sacrifice.

The story of Adam and Eve in the Book of Genesis suggests that humans were created essentially vegetarian. Meat eating followed Eve's transgression. Under the laws of Kashrut, which govern kosher practices, Jews are forbidden to eat pork and shellfish ("tref"). In addition, certain parts of an animal, such as the hindquarters (unless butchered in a special fashion) as well as some organ meats, are forbidden. Another dietary restriction is that meat and milk may not be eaten together. These limits have resulted in fewer choices when it comes to meat for Jews than for others.

Muslims also do not eat pork, and, like Jews, they slaughter their meat according to religious guidelines. Such meat is called *halal*, or lawful. The month-long fast of Ramadan, while strict, is more of a joyful occasion than the Christian Lent, a forty-day period of abstinence and penitence.

The Roman Catholic Church established many restrictions on eating meat on certain days during the year, particularly during Lent and on specified fast days. Until the reforms of Vatican II (1962), meat eating was traditionally forbidden on Fridays. For generations, fish on Fridays was the rule in Roman Catholic communities. Meat, broth, and fat from warm-blooded animals were forbidden, while meat from waterfowl and from cold-water fish was considered acceptable.

Given the Church calendar—abstaining from meat on Fridays, on the eve of certain feast days, and on other days as well—meat eating was forbidden almost every other day: 180 days a year. The Orthodox Church was even stricter. This refusal to eat meat and fat (including butter in some times and places) had an ascetic aspect as well as a penitential one in its denial of human desire. In

India cattle are not consumed because of the religious proscriptions of the Hindu faith. Since pigs, goats, and sheep are raised for meat and milk, however, India is not entirely vegetarian. Butter from the milk of sacred Indian cows was made for religious ceremonies, and ghee, a kind of clarified butter, is used for cooking.

Meat eating and vegetarianism. Meat, whether from mammals, poultry, or fish, provides a concentrated, easily digestible source of protein and fat. Ruminants in particular are able to convert herbaceous material into muscle more efficiently than monogastric animals, such as pigs or poultry, and are therefore better suited as sources of meat protein.

A vegetarian diet—eschewing meat or any animal food products—is undertaken by individuals for many reasons: health reasons and concern for the environment, ecology, and world hunger issues. Vegetarians often also cite economic reasons and ethical considerations as reasons. For some, religious beliefs dictate following a diet that avoids animal products. In India, for example, many are vegetarians because they find the taking of life abhorrent; in addition, many believe in reincarnation and fear that a living soul could be inhabiting a living creature.

Significant scientific data suggest links between a vegetarian diet and reduced risk of developing several chronic degenerative diseases and conditions, including heart disease, high blood pressure, diabetes, obesity, and some types of cancer.

The eating patterns of vegetarians vary considerably. The lacto-ovo-vegetarian diet is based on grains, vegetables, fruits, legumes, seeds, nuts, dairy products, and eggs, and excludes meat, fish, and fowl. The vegan, or total vegetarian, eating pattern is similar with the additional exclusion of eggs, dairy, and other animal products, even honey. Even within these patterns, considerable variation exists in the extent to which animal products are avoided.

Human beings, however, have been omnivorous since before recorded history. It seems unlikely that they will turn en masse to vegetarianism. In fact, arguments from the 1968 Rome conferences of the Food and Agriculture Organization of the United Nations suggest that humans could not abandon the consumption of meat in favor of a solely vegetarian diet. There was not, nor is there now, sufficient arable land to produce adequate protein or calories for the world's population.

Global Issues

While some of the problems discussed here primarily reflect events and situations in Europe and the United States, their repercussions will almost certainly have global consequences as impoverished regions of the world struggle to provide a nutritious diet for their increasing populations. What began as animal husbandry in prehistory threatens worldwide disaster. As the human population has increased beyond the capacity of the planet to feed its numbers, the practice of high-intensity animal production has caused numerous environmental problems that endanger humans as well as the animals bred for food.

ANIMAL RIGHTS

The animal rights movement is a loose-knit coalition of groups who oppose abusing, mutilating, or killing animals to serve human purposes, including inhumane "farming" methods to raise animals for high-status luxury items like fur and leather. Most visible in North America and Europe, the movement includes benign meat eaters and farmers who want to ensure that livestock are treated humanely to vegetarians to activists who smear blood on fur coats and urge supermarkets to remove their lobster tanks. The politically and ideologically motivated efforts have had an impact on mainstream economics, although those with a financial interest dismiss their efforts as romantic or as malicious and dangerous, especially if they still believe that humans are superior to other animals and, therefore, that they have the "right" to do whatever they wish to them in the name of some "grander" (human) purpose. Research has demonstrated that the humane treatment of animals actually improves production and meat quality. Some of the results of that research have been incorporated into animal raising practices. In addition, some major food companies have adopted policies for their meat suppliers that stipulate humane handling practices, and some retail food packages—for example, chicken sausage—bear labels declaring such policies. As people grasp the "radical" idea that animals feel pain and, like humans, have the right not to suffer, whatever the rationale, the animal rights movement grows.

The risks and costs of high-intensity animal production. Since World War II, agricultural production has striven to produce more from less without, some critics say, thought of the consequences. With high-intensity animal production, because animals are kept in close quarters they are more susceptible to the various diseases and parasites afflicting livestock. To counter disease and parasitism, scientists developed inexpensive pharmaceuticals to protect and treat animals. Surprisingly, many of these drugs actually improved livestock feed conversion performance faster than breeding and breed selection. As a consequence, livestock producers adopted these products widely, and meat production operations grew and consolidated in rural areas near feed grain sources.

Feedlots and large poultry operations, however, though extraordinarily efficient, are smelly and environmentally risky as well. Also, starting in the early 1970s, mounting public concern about the residues of pharmaceutical products in meat used for human consumption entered the debate about the wisdom of intensive livestock production. The food supply seemed to be contaminated with unnecessary, and perhaps toxic, chemical substances, and the methods of raising animals that required their use became targets of public protests. One result of these concerns has been the increase in sustainable livestock production, sometimes called "natural" or "organic" production. In natural production the animals are raised without performance-enhancing chemicals or feed additives. Livestock living in herds are as susceptible to disease as those raised in close quarters, and the effects of disease are devastating to herds. However, ranchers claim that it is more expensive to raise pigs or cattle without the aid of drugs or additives and so justify the higher prices charged for such meat.

Organic livestock production is stricter still, involving the feeding of grains and oil seeds produced under National Organic Standards. As adopted by the U.S. Department of Agriculture (USDA), the National Organic Standards specify that livestock and poultry may not be treated with antibiotics or any medicine and must be fed grains and rations that derive from organic crop production.

Intensive livestock production systems are based on concentrating large numbers of animals (housed or not) on small parcels of land and feeding them high-energy diets that guarantee the fastest weight gain in the least time. While feed efficiency (pounds of gain per pounds of feed) is important to the owners of such systems, intensified livestock production also results in large-scale animal waste. The concentration of live animals in a total confinement unit rivals a small city in terms of the annual waste output. Cities of such size are required by law to maintain tertiary water treatment facilities to handle their wastewater outfall. No such provision has yet forced pig or cattle feeders to treat their production wastes in a similar manner.

Among mammals, pigs represent the biggest waste threat to the environment because of the very large confinement units used to raise them. The most efficient pig will convert two pounds of feed into one pound of additional body mass, not all of which is edible protein. In order to acquire that pound, the animal produces one pound of feces and urine. Cattle are even less efficient, converting twelve to eighteen pounds of feed to one pound of body weight during the last weeks of feeding. This waste presents a considerable disposal problem.

With the animals living in such limited space, the waste must be stored for later treatment or use. In the past, this meant applying the manure as fertilizer to agricultural land, but this method of handling manure is no longer sound. Lagoons that hold animal waste often leak or break, with disastrous consequences for local streams and lakes. The open pools of raw waste also fill the surrounding countryside with a prevailing stench. The recent history of such environmental disasters and resulting legal battles is a complex story about shifting the costs of production to others, including future generations. Moreover, the available solutions cost money, so are unacceptable to those watching the bottom line. Steel holding tanks or glass-lined tanks, for example, clearly better containment choices, are prohibitively expensive, usually more than the average pork or beef production operation can, or is willing to, pay. With the infusion of new capital into pork production in the late 1980s, more attention was given to waste management, but the disposal problem has not yet been solved.

Intensive livestock production poses other risks to the environment and human health, for example, pollution of surface and ground water by animal waste. Such spills contaminate water, cause loss of property values for residential land, and harm recreational areas. The frequent and periodic contamination of ground and surface water from manure spills has become a familiar headline, reminding the public that profit-driven production methods endanger their health and the welfare of future generations.

With the appearance in the 1990s of bovine spongiform encephalopathy (BSE; more familiar to the public as "mad cow disease") in England and France, and the deaths caused by its spread to humans who ate meat from diseased cows, vigilance with respect to safe meat production became even more critical. In spite of research demonstrating that the disease had been spread in herds that had eaten feed that contained meat products, some feed suppliers in the United States were found continuing the practice in 2001, and, without enough USDA inspectors to monitor meat production from start to finish, the public cannot be sure that the meat they eat does not come from cows infected with BSE.

Facing continual pressure from environmentalists, real estate developers, and non-farm landowners, livestock producers struggle with presenting a responsible image. This reality applies both to producers managing large, intensified operations and to those who pasture their livestock. In terms of the stocking capacity of open land, whether for cattle, pigs, or small ruminants, it is now being argued that small ruminants (sheep and goats) can provide as much meat per acre as cattle or pigs without the subsequent environmental risks. Raising dual-purpose sheep or goats (those that provide both food and fiber) can be a more efficient use of limited land resources than the typical practices of cattle ranching.

This issue will become more pressing in the future as residential suburbs push into traditionally rural areas. The resolution will need to be political because of the constituencies involved. Technological advances have made the cost of farming too expensive for family farmers. As they are forced to sell their land to the giants of agribusiness or go into bankruptcy, farmers are becoming a smaller and smaller percentage of the population, and their real voice in legislatures will continue to diminish. City dwellers will demand that a fairer burden of the cost of farming be placed on those who profit from it than has been the practice since the New Deal under Franklin D. Roosevelt's administration in 1932–1940.

Another aspect of the urban-rural confrontation involves the cropping practices needed to support the intensified meat-production industry. Of the more than 70 million acres of corn grown annually in the United States, more than 65 percent is used for animal feed, and the price of corn drives all other commodity prices. Federal farm policies during the twentieth century resulted in overproduction of corn and soy relative to world market demands, depressed world prices, and significant loss of farm income. Add to this the loss of agricultural diversity and soil productivity caused by producing the same crop or the same rotation of crops on the same land year in and year out. Such farming practices had forced farmers to use more and more chemical pesticides and fertilizers in order to achieve uniform yields. Biotech crops may be a solution, because they permit more intensified cultivation and higher yields. However, controversy remains within the scientific community about the sustainability of high yields from biotech seed crops. This concern is added to the ongoing problems of groundwater contaminated with fertilizer runoff and pesticides.

Bioengineering. Unlike plant biotechnology, which has quickly introduced numerous varieties of common plants genetically reengineered to include certain traits, such as resistance to common pests for corn, animal biotechnology has had little success in changing the basic properties of livestock or poultry. A few applications of genetic manipulation may eventually prove useful in producing meat protein for human consumption. Of these, cloning is the most obvious and most likely to succeed, if public opposition fails to halt such research. Cloning livestock requires the nuclear transfer from an animal with the most desired traits (for example, efficient feed conversion, muscling, and tenderness) to eggs from the same species. One application would be the cloning of highly desirable boar and sow lines to be used in creating market pigs with specific, repeatable characteristics.

The technology for cloning livestock at this time is prohibitively expensive compared to conventional breeding or artificial insemination. For this reason, cloning is not expected to make a significant contribution to meat production for years. Such genetic manipulation also arouses considerable controversy in public and scientific discourse regarding the ultimate safety of food derived from such genetically modified organisms.

As populations continue to expand and the food crisis intensifies, the twenty-first century will witness societies worldwide struggling with the multitude of social, environmental, economic, and health issues that surround the production of livestock.

See also **Aversion to Food; Cattle; Christianity; Dairy Products; Disgust; FAO (Food and Agriculture Organization); Food Safety; Goat; Government Agencies; High-Technology Farming; Horse; Hunting and Gathering; Inspection; Judaism; Mammals, Sea; Meat; Organic Agriculture; Pig; Prehistoric Societies; Sheep; Vegetarianism.**

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Robin Kline

MAMMALS, SEA. Sea mammals provide meat and fat in the diet of cold-climate–dwelling hunters living primarily in the Northern, but also the Southern, Hemisphere. The skins and fur from sea mammals provide clothing and shelter, while the bones and ivory tusks are carved for tools, talismans, and objects to be sold as art. The fat may be processed for oil to eat or to be used for heat and light. Offal, fat, and less desirable meat products are often fed to dogs.

The most common sea mammals in the human diet are the many species of *Phocidae*, seals. Other sea mammals commonly eaten include walrus, *Odobenus rosmarus*; whales, *Cetacea*; polar bears, *Ursus maritimus*; the bearded seal, *Ergnathus barbatus*; porpoises, *Phocena*; narwhals, *Monodon nanuk*; sea lions, *Eumentiapias jubata* and *Otaria jubata*; and fur seals, *Callorhinus ursinus alsacensis* and *Arctocephalus australis*. Seals, walrus, polar bears, bearded seals, sea lions, fur seals, and porpoise feed on fish, but seals also eat krill. The most commonly hunted and consumed whale is the baleen whale, which filter-feeds on plankton. Polar bears, considered by Arctic native people to be a sea mammal, eat seal, fish, and other land mammals, but are known to be omnivorous. The livers of the meat-eating sea mammals are never eaten.

Arctic coastal-dwelling Canadian Inuit, Alaskan Aleut and Yu'pik, and Siberian Eskimos are best known for hunting seals. Northern Alaskan Inuit, for example, who live on the North Slope and Point Hope, are famous for hunting whales. All Sikumiut (sea-ice–dwelling) peoples share histories of hunting all sea mammals. North Baffin Inuit, for example, begin the spring with hunting seals through breathing holes; infant seals are stomped in their mother's dens in late spring; juvenile ring seals, prized for their silver coats and tender meat, are hunted in late spring, while the adults are hunted as they bask near open water leads. Dangerous trips are taken to the pack ice to hunt migrating narwhals, and summer brings open-water seal hunting from cargo canoes. Freeze-up in the fall brings the return of breathing-hole seal hunting, which extends through the winter months. Polar bear season begins in the late fall and continues through the winter months. Summer bear hunting is not possible due to Canadian conservation laws. The large baleen whale species in the eastern Arctic were overhunted by European whalers in the nineteenth and early twentieth centuries. Since then, eastern Arctic Inuit rarely have hunted whales.

A complex set of skills is required to hunt sea mammals. Cooperative hunting requires an adaptive social organization specific to each sea mammal species. Cultural rules and rituals ensure that the values of sharing, patience, cooperation, stoicism, and emotional containment prevail among Arctic social groups. The social organization used by peoples in northern Alaska for hunting large whales surpasses the complexity of all Arctic groups, but does not need to be maintained intensely for subsistence hunting of other sea mammals. Lone hunters can hunt polar bears and seals, but it is difficult. Breathing-hole hunting is better done with at least two hunters and/or families, and polar bears are less dangerous to hunt with a group. Bear are pursued with a .306 rifle, but have been harpooned or shot with bow and arrow. Walrus, because they are dangerous, are hunted by groups armed with harpoons or large-caliber rifles. In general, the larger or more dangerous the sea mammal, the greater the need for a complex social organization when hunting.

In the Subarctic, seacoast-dwelling native people depend on sea mammals, with those closest to the Arctic being most dependent on them for food, clothing, and shelter. The Tlingit, who live in southeastern Alaska and northwestern coastal Canada, follow an annual cycle of hunting that includes summer sealing camps when harbor seals, fur seals, and sea lions are hunted. There are two sea otter hunts in the fall, another sea otter hunt in the early spring, and late spring concludes with both seal and sea otter hunting. The Tlingit use bows and arrows to hunt small sea mammals and harpoons for open sea hunting, while the Quinault, who live in the state of Washington, use bows and arrows to hunt sea lions and hair seals, which they dry and boil, during the summer. Both of these societies have developed social structures that make cooperative hunting and food sharing possible.

The Eastern Woodland seacoast-dwelling Micmac occasionally hunt seals, but focus primarily on land mammals. At the other end of the earth, the Selk'nam of Tierra del Fuego feast on the flesh of beached whales and seals, but do not actively hunt them because they lack the kind of social organization necessary for actively hunting sea mammals.

The meat, skin, fat, bones, and specific organs of sea mammals are consumed both cooked and raw. Uncooked seal, bearded seal, walrus, whale, and polar bear are relished by Inuit from Siberia across the circumpolar region to Greenland. Inuit also prepare the flesh of sea mammals by boiling, frying fresh meat slices, freezing, aging it in caches, freeze-drying, and cooking it over a heather fire. Although the Inuit once ate polar bear and walrus meat raw, they no longer do because of the risk of Arctic trichinosis, which can survive freezing conditions and infect human hosts. Other meats are safe to eat raw due to the low temperatures and the lack of food-borne pathogens when meat is traditionally processed. The introduction and use of airtight plastic bags for meat storage in the second half of the twentieth century caused deaths from botulism. For this reason, traditional food storage and handling methods are recommended for people who live on the ice.

Subarctic populations cook meat in stews and soups or bake, roast, or fry it. Mixed meat and vegetable dishes are also prepared. Meat strips are dried or smoked and stored. Sea mammal meat was not as important among the Subarctic populations as in the Arctic because of the abundance of other food resources.

Seal and whale oil are significant in the diet of both Arctic and Subarctic hunters. The oil, which provides an excellent source of energy during periods of hunger, such as at break-up and freeze-up, is rendered by pounding fat on a hard surface. Plants and raw or dried fish, meat, or skin are dipped in either fresh or aged oil. Both Arctic and Subarctic peoples will whip seal or whale blubber and add bits of meat and/or plants for flavor.

Seal blood is consumed by Inuit and considered a powerful tonic that improves their mental and physical health. Strong beliefs are held among Inuit concerning the need to eat traditional foods, especially seal, to maintain the health of individuals as well as that of their communities.

The meat of whales, seals, bearded seals, walrus, narwhals, and polar bears is divided and shared according to cultural rules at the end of the hunt among both Arctic and Subarctic groups. Meat and all the edible parts of killed animals is distributed at feasts after large organized hunts. Furs are usually retained as the property of the hunter but can be shared as needed in the community. Families meet at the feast to collect their share but return home to further distribute and consume the food.

Cooperative hunting and food sharing define Arctic and Subarctic hunting populations socially. Sea mammals have an essential role in the diet of all circumpolar and some Subarctic groups. Human exploitation of sea mammals has allowed hunters to flourish in regions under frigid environmental conditions.

See also **Arctic**; **Canada: Native Peoples**; **Fish**; **Fishing**; **Hunting and Gathering**; **Inuit**; **Lapps**; **Mammals**; **Siberia**.

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MANNERS. *See* **Etiquette and Eating Habits; Table Talk.**

MARDI GRAS. *See* **Shrove Tuesday.**

MARGARINE. Margarine was invented by Hippolyte Megè-Mouriès in 1869 in response to an order from Napoleon III to produce a cheap and stable substitute for butter. The product had a pearly luster, and Megè-Mouriès named it margarine after the Greek word meaning 'pearl-like'. The process of manufacture entailed churning oleo oil (obtained from beef tallow) at 77 to 86°F (25 to 30°C) with water or milk. The product was flavored with salt. Over time margarine has been used in baked goods, to improve the palatability and quality of butter, to improve heat transfer during frying, and to add to the flavor of foods. Margarines may contain about 80 percent fat (animal or vegetable), milk solids, emulsifying agents, and salt.

The U.S. Food and Drug Administration (FDA) established a standard of identity for margarine. It must contain not less than 80 percent edible fat of animal or vegetable origin; water, milk, or milk products; suitable edible protein, and vitamin A. Optional ingredients include vitamin D, salt or potassium chloride, nutritive carbohydrate sweeteners, emulsifiers, preservatives, colorants, flavorants, acidulants, and alkalizers. Fat-free and low-fat spreads are available commercially. While it is convenient to describe them as margarines, they do not conform to the FDA standard of identity. Early in the twentieth century the texture of margarine was improved by replacing animal fat with coconut oil. In the 1930s hydrogenated vegetable oils became available, and these became the basic ingredient of margarine. Hydrogenated vegetable fat provided a uniform base for margarine, and control of the extent of hydrogenation gave a series of fats of varying hardness that could be used for specific products.

The hydrogenation process causes migration of the double bonds of vegetable oils and provides both cis and trans double bonds, whereas the double bonds in most vegetable oils are in the cis configuration. A cis double bond is one in which the hydrogen atoms attached to the carbons that form the double bond are on the same side of the carbon chain, and the molecule "bends" at the site of the double bond. In trans double bonds the hydrogen atoms are on opposite sides of the carbon chain, and the molecule has a more linear configuration, similar to that of a saturated fatty acid. Trans double bonds are not unknown in nature, occurring in many plant fats and some animal fats. Where most of the vegetable fats contain eighteen carbon atoms or more, the trans animal fats are generally shorter than eighteen carbon atoms.

Concern regarding the biological effects of trans double bonds was voiced in the 1940s. Studies of effects of trans fats on growth and reproduction in rats show that they have no untoward effects when the diet is replete in essential fatty acids, but when fed as the sole source of fat, they exaggerate symptoms of essential fatty acid deficiency. In this they resemble saturated fatty acids, as they do in many other biological processes.

The effects of trans fats in experimental atherosclerosis were first examined in the 1950s by Gardner McMillan and his colleagues. They found that, while trans fats raised blood cholesterol levels in cholesterol-fed rabbits, their presence in the diet did not lead to more severe atherosclerosis. Studies of rabbits fed cholesterol-free diets, of pigs, and of vervet monkeys have yielded similar results. One six-year study of the effects of partially hydrogenated soybean oil yielded atherosclerosis at a level of severity seen in rabbits fed coconut oil and less than that seen in rabbits fed soybean oil.

In humans the effects of trans fats on cardiovascular disease can only be assessed by effects on risk factors. Early studies yielded variable results of trans fat–rich diets on serum cholesterol. It was observed that the level of hypercholesterolemia varied inversely with the amount of linoleic acid in the diet. Trans fat was not hypercholesterolemic in diets that were also rich in linoleic acid. No differences were found when tissue levels of trans fats in human subjects who had died of cardiovascular disease were compared with that in human controls.

Analysis of human studies in which energy from carbohydrates was replaced by trans–18:1 fat shows that this exchange leads to increases in levels of LDL cholesterol and decreases in levels of HDL cholesterol, which increases the risk of cardiovascular disease. Serum levels of lipoprotein(a), another risk factor, are also increased.

Epidemiological studies of the effects of dietary trans fat on coronary heart disease yield variable results. One study (239 cases and 282 controls) shows a positive association between high intake of trans fat and coronary heart disease (CHD) risk but an inverse association at moderate intake, whereas another study carried out in nine European countries (671 cases and 717 controls) found no association between intake of trans fat and CHD risk. Cohort studies found positive associations between intake and risk only at the highest level of intake. Two studies found the lowest risk at the third quintile of intake. The Seven Countries Study revealed a significant positive association between 18:1 trans fatty acid intake and twenty-five-year CHD mortality rates.

The overall findings concerning intake of trans fat and risk of CHD are not consistent. These disparities are complicated because the data regarding effects of specific trans fatty acids are sparse and differences between populations and interactions with other dietary ingredients are not considered. The trend to consider dietary patterns rather than individual dietary ingredients may help organize the findings. Nevertheless the sum of the experimental data suggests that high intake of fats containing trans fatty acids may pose an increased risk of CHD. The industry response to these findings has been a major effort to produce margarines that are either low in trans-unsaturated fat or devoid of it.

Much is unknown about the balance of dietary fats–trans fat, saturated fat, and polyunsaturated fat and their interactions with other components of the diet. The attitude should be one of prudence, not panic.

See also **Baking**; **Butter**; **Cholesterol**; **Fats**.

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MARINATING AND MARINADES. Marinades are used to enhance the flavors of grilled meats, seafood, and fruits and vegetables. Seemingly simple concoctions of acids, fats, and aromatics, marinades are used around the world; for example, Jamaican jerk, Indian *tandoor*, and Texas barbecue are marinades that form the basis of particular cuisines.

Simply put, tradition or a creative chef dictates the combination of flavors that compose the marinade, in which selected meats, seafood, or fruits are macerated for a period of time. This technique allows the marinade to transfer some of its flavors to the outer layers of the food. When the food is grilled, the marinade blend imparts a new flavor to the food being cooked.

For delicate seafood, such as a teriyaki-glazed grilled salmon, marinades baste the outer surfaces with a soy-sweet flavor. The taste of briefly marinated fruits and vegetables (i.e., pineapple briefly soaked in light vegetable oil, rum, and brown sugar) improves greatly.

More practically, marinades tenderize the tougher fibers of inexpensive cuts of meat. Acid causes the denaturation of the long proteins in meat, rendering the meat tender as well.

Cooking and Safety Precautions

Any excess marinade must be first boiled or reduced before being used as a side sauce, to completely kill any bacteria associated with the raw meat or seafood. Never reuse marinades unless they are cooked first.

Marinades should be mixed in a nonreactive container, such as stainless steel, porcelain, clay, or plastic—cast iron and aluminum are not acceptable choices. Plastic containers may pick up residual flavors of the marinade, and should be reserved only for the making of marinade in the future. Although food does not need to be completely submerged in the marinade, it needs to be turned often so its surface area comes into contact with the marinade. Food may be marinated far in advance, but after three to six hours there is no perceivable difference in penetration of the marinade into the food. Generally, marinades coat only the outer few layers of the meat. Immersion of foods for an overly long period results in an overly broken down piece of meat, cooked seafood, or macerated fermenting fruit.

Components of Marinades

Marinades have three main components, acids, aromatics, and fats. The combination of the three can show a distinct ethnic profile.

Acids. Acids include all types of vinegar, fruit juices, and cultured milk products, such as yogurt. Flavored vinegars such as balsamic from Italy are used sparingly, adding top notes of flavor, while a hearty apple cider vinegar will add a robust flavor to a pork roast marinade. Wine and wine vinegar are common for European marinades, while rice vinegar is common in Asia for simple fish marinades. Citrus juices shine in marinades; the souring agents of lemon juice or pomegranate juice are common in the Middle East. Lime juice in Latin America is the base for *seviche.* In this case, the marinade actually "cooks" the fish or scallops, transforming the proteins in the fish to a cooked state while still retaining the texture of uncooked fish. Orange or grapefruit juice may be used for variation. Dairy-based marinades include well-known yogurt and spice mixtures for lamb in the Middle East, yogurt and cayenne for India's *tandoor*, and buttermilk for catfish in the American South. Even Coca-Cola is a common marinade base for some barbeque sauces.

Aromatics. Aromatics add a distinctive character, with spicy, hot, sour, or sweet flavors. Chopped ginger will dominate in an Asian-influenced teriyaki marinade, along with lemongrass and soy sauce. Chinese-style marinades use ginger, green onion, and garlic. A *mirepoix* (finely minced onions, carrots, celery, and leeks in red wine vinegar) flavors French-style marinades. Herbs may be fresh or dried, such as parsley, bay leaf, oregano, allspice, and peppercorns; juniper berries are typical ingredients for game marinades. Strongly flavored condiments such as Tabasco, Dijon mustard, fish sauces, or Worcestershire sauces add intense bursts of flavor to the marinade. Chilies are the foundation for many Latin marinades, including ground chili powder, or the smoky *ancho adobo* chile. Latin marinades also feature large proportions of garlic, cumin, and lime juice.

Fats. The fats in a marinade seal in flavor and help to keep foods moist during grilling. Olive oil or oils with mono- and diglycerides penetrate deeper and faster. As with other recipes, the oils provide a clue to the regional and ethnic profile for the recipe. Olive oil is preferred in the Mediterranean and in the western United States. Heavy fruity olive oils are best. Flavored nut oils such as hazelnut or sesame oil provide a balance to the acids and aromatics.

Yogurt, which has an acid component, also provides fat; it is one of the simplest marinades to create and use. More complex marinades will consider the balance between the right acid, aromatic, and fat. A heavy fruity olive oil will not balance light rice vinegar. Nor should the cook use strongly flavored oil such as sesame oil in large quantities. Sesame oil, like balsamic vinegar, is used lightly.

Since marinated foods are grilled over heat, the combination of fat and acid is needed when grilling to prevent the food from burning off the marinade combination before the food is properly cooked. During grilling, a chef will often use a basting brush to continue to coat the grilled food with reserved marinade as it cooks. Even the brush can be part of the art of marinade; rosemary sprigs can become a basting brush while adding additional flavor. As the marinades cook on the surface of the meats, carmelization and a slight glazing of flavors is produced on the surface as well.

Consistency of Marinade

Marinades may be quite liquid, as in the classic red wine, olive oil, and rosemary-garlic marinade. They may also be thick and viscous, as in spiced cumin yogurt. Drier pastes are also marinades, and somewhat easier to spread over large pieces of meat. Jamaican jerk seasoning is thick, textured, and often features the intense heat of a scotch bonnet pepper. Blended with allspice, cinnamon, nutmeg, brown sugar, and vinegar, jerk is a memorable marinade now used by gourmets. *Chimichurri* is a famous thick sauce-paste from Argentina, using cayenne, parsley, sherry vinegar, and lemon. Indonesian *sambals* grill strips of meat covered in a thick peanut and chili marinade. North Africans are familiar with Berber spice paste, with top notes of cumin, cinnamon, lemon, and olive oil.

Dry rubs are another marinade version. Rubs are a combination of spices, sugars, and salts spread onto the meat. The meat then basted with oil before grilling.

As long as the three components of marinades are kept in mind, many marinades are possible. A simple marinated chicken breast can transport the diner's palate to desert India with the use of *tandoor* marinade; to sultry Jamaica with Caribbean jerk; to sunny and sophisticated Provence, with garlic and rosemary; or to a down-home Texas barbecue, with chilies. Marinades can enhance the simplest ingredients, elevating them to a novel dining experience.

See also **Barbecue**; **Caramelization**; **Caribbean**; **France**; **Fruit: Citrus Fruit**; **Grilling**; **Herbs and Spices**; **India**; **Italy**; **Meat**; **Mexico**; **Middle East**; **Oil**; **Proteins and Amino Acids**; **Sauces**; **South America**.

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MARKETING OF FOOD. In order to understand how food is marketed in grocery stores or in restaurants or other food outlets, it is important to understand how consumers make choices among food options. It is generally believed that, although consumers sometimes have strong, stable preferences for some foods—for example, one may have a clear, unambiguous preference for sardines over and above any other food—more often than not, consumers' preferences are constructed on the spot and are contingent on a variety of factors, such as the social context, the other choices available, or the decision-maker's consumption goals. Therefore consumers do not always choose the same brands, or the same products, each time they go to the store. In this kind of decision context, marketing stimuli can be very effective at persuading consumers to buy one brand over another. In particular, the packaging and the branding of foods can be influential in how consumers choose among food items.

Packaging Strategies

There has been a great deal of research done on how packaging influences consumers' perceptions of products. The first research in packaging was done in the 1930s when self-service supermarkets were becoming more popular. At this time, marketers placed *identical* detergents in two different packages: one had circles on the outside and the other had triangles. The marketers asked consumers which product they preferred and why. Eighty percent of the consumers preferred the product in the box with circles because they believed it had "higher quality." Even when the consumers took the two boxes of detergent home and used both products, the belief that the one in the box with circles was of higher quality persisted. This example points out an important aspect of the marketing of food: it is the perception of quality, not the actual quality, that influences consumers' decision making.

The packaging can influence a consumer's decision about what foods to choose even more than the taste of the product in some cases. One aspect of packaging that is very influential is the package shape. One of the most successful campaigns has been the Absolut Vodka campaign in which the shape of the distinctive Absolut Vodka bottle is featured in all of its advertising. Whereas some people may not be able to differentiate among the tastes of vodka in a blind taste test, they can easily differentiate between the different packages. Coca-Cola has also been successful in creating a distinctive bottle shape that influences perceptions about the taste of their product. One of the most famous bottle shapes is the Heinz ketchup bottle, which has been called the "best-known bottle in the world." The irony in this shape is that it is not really conducive to the use of ketchup as it is difficult to get the product out of the bottle. Heinz however used this difficulty as a positive feature in their advertising by promoting "ketchup races" in which being the last one to come out of the bottle was perceived as an advantage because it indicated the ketchup was very thick.

During the 1990s, Campbell's was concerned about decreasing sales of the company's soup. The marketing department did research to try and discover how to increase consumers' interest in their soup. Their research indicated that new soup in the old package would taste the same, but familiar soup in a new can would taste different. So Campbell's redesigned the label on their soup cans. The familiar red and white Campbell's soup can (made famous by Andy Warhol) was changed so that the red banner was thinner and a photograph of the soup in a bowl was placed on the white banner on the can. In fact, Campbell's was so convinced that the new labeling, rather than a change in the soup, would be a decisive factor in persuading consumers to buy their soup again that they declared right on the can, "New Look, Same Great Soup."

GROCERY SHOPPING ON THE INTERNET?

Although there has been a great deal of interest in the United States in trying to make grocery shopping on the Internet a viable concern (for example, Webvan, HomeGrocer.com), few companies have been able to make it profitable. Part of the problem is the delivery of the groceries. In most residential areas in the United States, delivery locations are too far apart, meaning a truck can waste a great deal of time driving from one neighborhood to another. In order to make this kind of arrangement profitable, grocers will need a 25 to 30 percent gross profit on each order as well as average orders over $100. This just has not occurred yet in the United States, and the firms such as Peapod and Webvan that have tried to make it work have not been profitable so far.

One retailer that has made it work is Tesco in Britain. Tesco is Britain's biggest grocer with more than 650 sites; they have said that their online grocery site, tesco.com, was profitable in 2000. Tesco allows its consumers to make their decisions online, and these orders are then sent to the store nearest the customer, where a store employee picks out the items ordered. Once the order is assembled, vans carry it to the customer's house. Orders average sixty items, and perhaps surprisingly, the most popular items purchased in this way include fresh fruit and vegetables (*not* bulk items such as laundry detergent). Tesco reports that in 2000, its online business represented one percent of its total grocery business.

If a model does become viable in the United States, we can probably expect online shopping to differ from shopping in a physical locale. Online consumers can sort their purchases much more easily and are not constrained by the physical layout of the store. For example, when shopping online, consumers can sort by price or nutritional information or create a list of products that were bought last time. These conveniences could potentially make grocery shopping a more efficient and more enjoyable endeavor. On the other hand, the flexibility of layout on the Internet can also help marketers to position their products in such a way as to increase the likelihood of consumers' purchasing them. For example, more packaging or advertising information could potentially be made available online.

Framing Strategies

Another aspect of marketing that influences consumers' perceptions about the food, which in turn affects consumers' choices, is how the product is positioned or

GROCERY CART

The grocery cart was invented in 1937 by Sylvan N. Goldman for his Standard Food Stores in Oklahoma City, after he noticed that shoppers would quit shopping when their hand-carried baskets became too heavy. The grocery cart on wheels was a stroke of genius in food marketing: It promoted greater sales, led to greater efficiency, and saved on labor costs. It was the start of self-service.

Before the grocery cart, food store merchants kept food on floor-to-ceiling shelves behind counters; a clerk was needed to assist customers with each purchase. Using the shopping cart, customers could select food items directly from "gondola shelves" set across the floor space, lowered so they could reach the top shelf and set just far enough apart for two shopping carts to pass between them, and fill their basket themselves. The width of the carts determined the width of the aisles in supermarkets.

The first cart was a folding cart with two baskets one above the other. Initially, the carts reminded women of pushing baby buggies; men eschewed them thinking they were strong enough to carry groceries by themselves. One of the early models of a shopping cart is enshrined at the Smithsonian Institute.

Once shopping carts caught on, they changed forever the way people shop and the way stores are laid out. By the late twentieth century grocery carts had increased in size and took on various configurations. They came in metal and plastic, some with special seats for children and some motorized for handicapped shoppers. Grocery stores on two or more floors have carts with locking wheels to allow them to be taken up or down moving ramps between floors. Some department stores are experimenting with nylon mesh carts.

In 2001, a cart cost around $100 apiece in the United States and an average supermarket owned about 300 carts; at least 9.6 million grocery carts were in service (Weir, p. 37). In urban neighborhoods people would use them to transport their purchase home. Shopping carts are also commonly seen on the streets of big cities being used by homeless people as "portable households." Strategies to prevent the loss of carts include imposing fines on anyone found with a cart off the store premises, locking carts together with a small device that releases a cart when the customer inserts a coin, and installing electronic sensors around the perimeter of store parking lots or at the store's exit doors. These sensors detect when a cart is about to leave the premises and lock the wheels, making the cart impossible to remove.

The shopping cart is a symbol of a consumer-led economy that is fueled by an affluent and mobile society. It is a piece of equipment that has become part of the distribution system of goods between manufacturers and consumers. It allows consumers to expand their purchases until the cart is full, wheel them in the cart to their cars, and drive them home. It also changed the need for labor in stores and allowed mass merchandising to the masses. As Terry Wilson wrote in 1978, it is "the cart that changed the world."

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framed. Ground beef that is 75 percent lean beef and 25 percent fat can be labeled either way: as 75 percent lean or 25 percent fat. Although these alternative labels convey the same information, however, they will not affect consumers' perceptions about the product equally. Studies showed that labeling the beef as 75 percent lean as opposed to 25 percent fat increases sales. The framing of the product can even be implicit. For example, the placement of a product in a certain aisle in the supermarket can affect the framing of the product. Consider Guiltless Gourmet Tortilla Chips. Placing this item in the regular chip aisle suggests that the product is a low-fat, perhaps worse-tasting, alternative, compared to the other chips. Placing the same product in the health food aisle suggests that the product is a better-tasting snack as compared to other alternatives.

Supermarket Layout

In general, the physical layout of the supermarket can also affect consumers' food-shopping decisions. Everyone knows that many supermarkets place high-demand items such as milk in the back of the store so that consumers are required to walk through the entire store and perhaps purchase extra items. Similarly, marketers can

The original shopping cart consisted of two baskets attached to a frame with a handle and wheels. This woman is seen using one of the early models in a self-service store in the 1950s. © BETTMANN/CORBIS.

use cross-merchandising techniques in the supermarket to try to influence decisions. Cross merchandising is a promotional technique that ties a promotion for one product to the promotion of another. For example, Duncan Hines might include a coupon for its frosting in a cake mix box, or Rice Krispies might include a coupon for Marshmallow Fluff in its cereal box. Similarly, in the physical store, marketers can link together certain items to encourage purchase. For example, higher-priced salad dressing might be located closer to the fresh produce, or a coupon for one product might be located on the shelf of another, higher-traffic product category. In another example, an in-store coupon for a health and beauty aid product could be located in the high-traffic bathroom tissue aisle. Some of these cross-merchandising strategies might be even more effective if consumers begin shopping for groceries on the Internet.

Branding Strategies

Another aspect of food marketing that can very much affect consumers' decisions is branding. From the consumer's point of view, a brand name is generally a strong influence on purchase if three elements of the brand name are in place. First, the consumer must have a positive evaluation of the brand name. Second, the brand name must be easy to remember and strongly associated with the product category. The ease with which the name is remembered when a consumer thinks of a category will depend on the frequency with which the consumer has seen the brand associated with the category, how recently the consumer has seen the brand, and the salience of these connections for the consumer. In addition, a strong association with the category will depend on how similar the brand is to others in the category and also how prototypical the brand is to the category. For example, Coke is seen as a prototypical soft drink and thus will easily come to mind when the category "soft drinks" is evoked. Finally, the brand image and evaluation must be consistent over time. In particular, a very strong brand name is one in which a consumer holds favorable associations that are unique to that brand and that imply some kind of differential advantage over other brands.

One of the strongest brand names in food marketing is the Coca-Cola brand name. After years of advertising and marketing, Coke also has a very strong, clear, consistent brand image—therefore, consumers form clear associations with it. For example, consumers may recall the packaging (the distinctive bottle or the red can), the taste of the product, or the current advertising appeals—for example, "Coke is the real thing." It is thought of as a "fun drink." Coke is also positioned as a different drink than Pepsi or its other competitors. Finally, and perhaps most importantly, Coke has a clear emotional bond and relationship with its customers. Coke learned just how important that brand name was in 1985 when they considered taking the old Coca-Cola product off the grocery shelves and replacing it with "New Coke." This prompted strong consumer reaction. Consumers felt that Coke violated something that was "theirs"—they felt that the Coke brand name belonged to its consumers and that Coca-Cola could not remove this classic icon from the market. Coke eventually returned "Classic Coke" to the marketplace to the delight of its customers.

Brand names can also influence consumers' perceptions of new products. If a marketer puts a familiar brand name on a new product, for example, Oreo cookie ice cream sandwiches, the consumer immediately knows something about the product even if she has never seen it before. Marketers are usually very careful about which new products they support with existing brand names as sometimes these brand extensions can backfire. For example, although Miller Lite was a very successful brand extension because the new light beer was instantly recognized and adopted in the marketplace, the new light brand had a negative effect on the main Miller High Life brand by causing consumers to think the original brand was less hearty.

In conclusion, sometimes when consumers go into the supermarket or into a restaurant to buy food, they have clear preferences for the foods they are buying and are not influenced by the food packaging, merchandising, branding, or promotion. However, more often than not, food preferences are not that stable and are constructed on the spot. In these cases, what consumers end up buying can be swayed by marketing cues in the environment such as labeling, branding, and packaging.

See also **Advertising of Food**; **Food Cooperatives**; **Food Politics: United States**; **Food Supply, Food Shortages**.

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Barbara E. Kahn

MARKETING OF FOOD.

ALTERNATIVE (DIRECT) STRATEGIES

Direct marketing refers to the strategy in which the producer of a commodity sells that commodity retail, directly to the consumer or end-user, rather than through a broker, distributor, or wholesaler. Direct markets for producers of food commodities include roadside stands, pick-your-own, farmers' markets, community-supported agriculture, mobile marketing, and mail-order sales. The supply of many food products through direct channels will fluctuate in accordance with the local harvest calendar. This is particularly true for fresh fruits and vegetables and less so for other foods, such as milk and milk products, eggs, meats, fish and poultry, grains, beans, and cereals.

In the United States, direct marketing continues to grow as a method for small- and medium-sized producers to increase their profits. Several forms of direct marketing—farmers' markets, roadside stands, Community Supported Agriculture (CSA) farms, and pick-your-own operations—have accounted for most alternative marketing strategies. Newer forms, such as "farm-to-school" connections and Internet marketing, are also being developed and piloted in many locations through the United States. Direct marketing data from the Census of Agriculture showed that between 1992 and 1997, the number of farms involved in direct marketing increased 7.8 percent to 93,140 farms. The total value of direct-marketing sales and direct-marketing sales per farm also increased.

SENIORS FARMERS MARKET NUTRITION PROGRAM

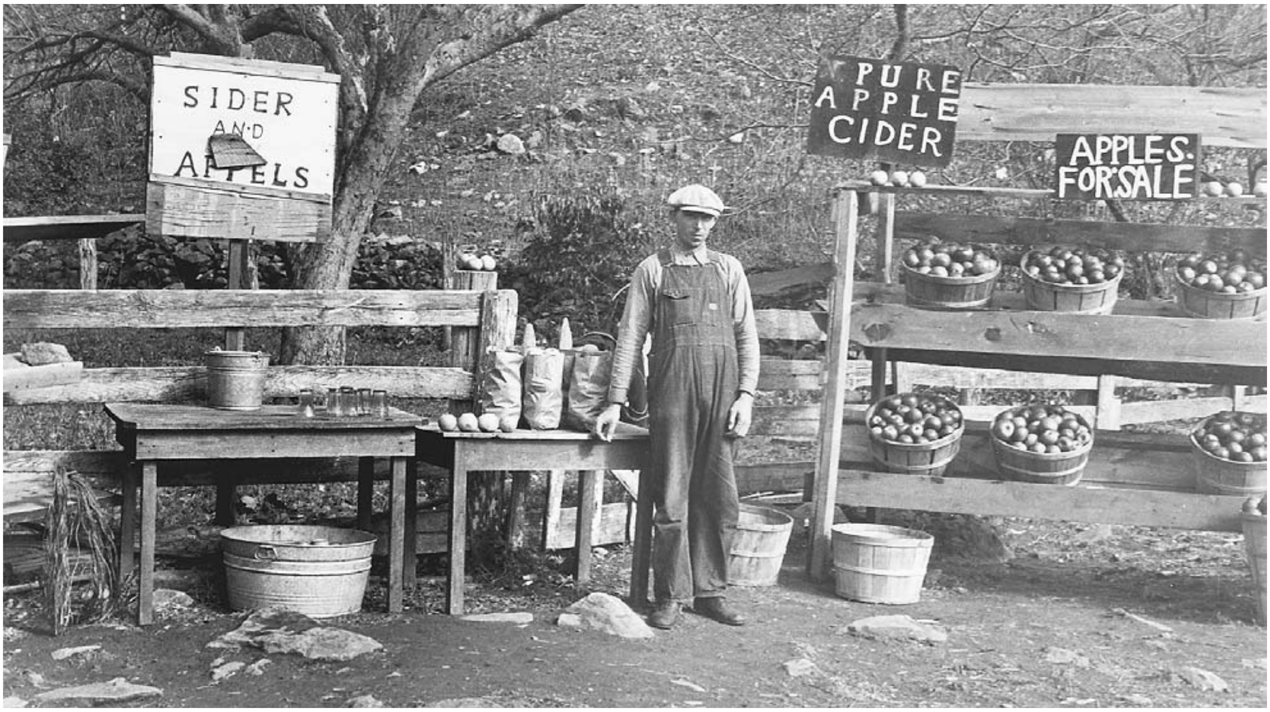
The Seniors Farmers Market Nutrition Program (SFMNPP) is a new program established by USDA's Commodity Credit Corporation (CCC). Under the program, CCC makes grants to states and to Indian tribal governments to provide coupons to low-income seniors that may be exchanged for eligible foods at farmers' markets, roadside stands, and community-supported agriculture programs. USDA CCC awarded almost $15 million in grants to thirty-one states and five Indian Tribal Organizations for the new program. State departments of agriculture, aging, and health and tribal governments administering the grants have developed creative partnerships. They are utilizing existing infrastructure to offer farmers' markets the opportunity to expand to serve seniors and to certify and distribute benefits to the estimated 370,000 low-income seniors this pilot is expected to serve.

"Alternative" or direct-marketing opportunities are part of a new agriculture that is being referred to as civic agriculture. The name suggests a locally based agricultural and food production system that is tightly linked to a community's social and economic development and to enhancing social capital. While civic agriculture may not represent a challenge to the conventional agriculture and food industry, it does include some innovative ways to produce, process, and distribute food. Additionally, the connections and relationships that are possible between producers and consumers from these marketing channels are unique to community-based food systems and civic agriculture.

Several factors have led to a growing consumer interest in purchasing directly from farmers: desire for fresh, high-quality products, the ability to personally interact directly with farmers who grew/raised the food, and interest in supporting local, small farms. Availability of product information such as growing method, instructions about use, recipes, and taste samples also draw customers to direct-marketing outlets.

Farmers' Markets

Farmers' markets, now an integral part of the urban/farm linkage, have continued to rise in popularity, mostly due



Apple vendor along the Lee Highway in Shenandoah National Park, Virginia, 1935. COURTESY OF THE LIBRARY OF CONGRESS.

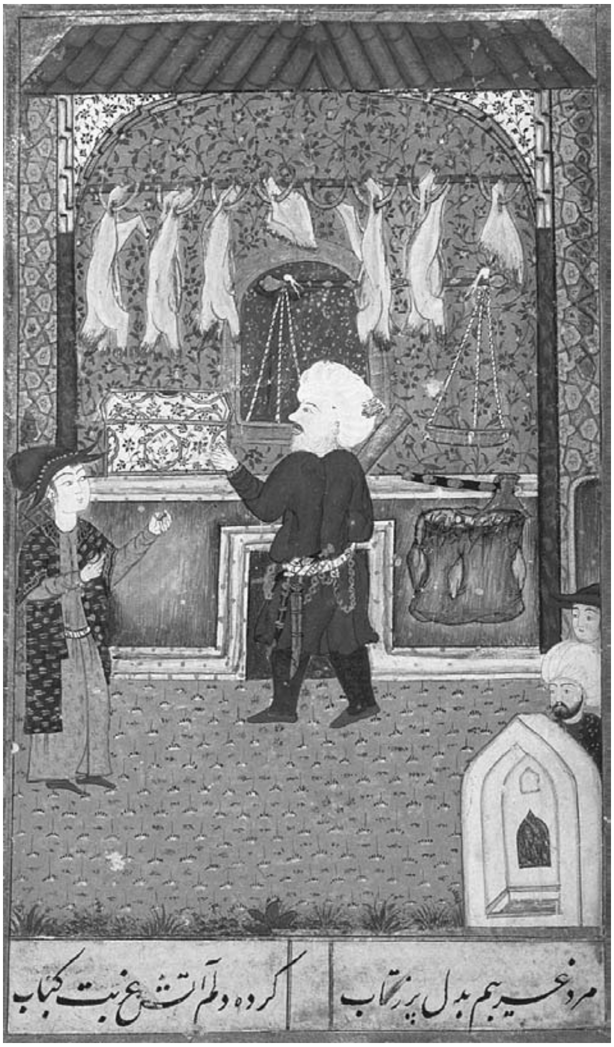
to growing consumer interest. The number of farmers' markets in the United States has grown dramatically, increasing 63 percent from 1994 to 2000. According to the 2000 National Farmers' Market Directory, nearly 3,000 farmers' markets now operate in the United States. This growth indicates that farmers' markets are meeting the needs of an increasing number of farmers with small- to medium-sized operations. Small farm operators benefit most from farmers markets—those with less than $250,000 in annual receipts who work and manage their own operations meet this definition (94 percent of all farms). Farmers' markets are also an important source of revenue. In the 2000 USDA Farmers' Market Study, 19,000 farmers reported selling their produce only at farmers markets. Communities also benefit from farmers' markets. Dollars spent on food are recycled several times within the community and thereby help boost the local economy.

Farmers' markets also serve an important role in increasing community food security. In many urban centers where fresh, nutritious foods are scarce, farmers markets increase the availability and access of these options for segments of the population that need them most. Farmers' markets also help to provide nutrition education, focusing on selection, storage, and preparation of a wide diversity of fruits and vegetables. Nearly 60 percent of markets participate in WIC Farmers' Market Nutrition Program, most accept food stamps (although the development of electronic benefit transfer [EBT] will make this difficult at many markets) as well as other local and/or state nutrition programs. A quarter of all farmers' markets participate in gleaning programs aiding food recovery organizations in the distribution of food and food products to needy families.

USDA's Women, Infants, and Children (WIC) Farmers' Market Nutrition Program (FMNP), established in 1992, provides additional coupons to WIC participants that they can use to purchase fresh fruits and vegetables at participating farmers' markets. The program has two goals: To provide fresh, nutritious, unprepared, locally grown fruits and vegetables from farmers' markets to WIC participants who are at nutritional risk; and to expand consumers' awareness and use of farmers' markets. Fiscal Year 2000 federal funding for the WIC Farmers' Market Nutrition Program was $15 million. The FMNP operates in thirty-nine state agencies, including four Indian tribes, one territory, and the District of Columbia.

Roadside Stands

Roadside stands or markets are a type of direct marketing system where a grower establishes a selling place (stand) near a roadway and sells produce directly to consumers. Often a stand is located on a farm or orchard. Produce sold in a roadside stand may be grown exclusively on the farm or may be purchased from outside sources. A roadside stand may be open only during harvest periods or throughout the year, depending on produce supply sources.



Direct marketing of food products is an age-old practice designed to eliminate middlemen. This Persian illumination from 1540 shows an Iranian butcher selling his cuts of meat from a stand along the street. © BURSTEIN COLLECTION/CORBIS.

To producers, a roadside stand often represents a supplemental source of income, additional employment for family members, and a way to market surplus produce. Besides measurable financial benefits, producers establish relationships through direct exchange with customers. These relationships provide critical feedback to farmers when making planting decisions, developing customer education, and developing marketing strategies.

Roadside stands allow direct market sales without off-farm transportation costs, although some stands are located off the farm to get closer to traffic volume or population centers. Generally, marketing costs depend on the size of the retail outlet. These range from self-serve tables at the end of a driveway to pseudo-supermarkets with a huge selection of off-farm merchandise in addition of farm products. As volume, traffic, and product selection increase, so too will stand size, operating costs, and management time.

Pick-Your-Own Operations

This type of direct marketing, where customers come to the farm and harvest produce directly, is most common at fruit farms in the northeastern United States. As fewer families now "put up" (can, freeze, or otherwise preserve) large quantities of food, the "farm experience" has become a more important reason for people to pick produce at a farm.

Farm-to-School Connections

Through the school meals programs during the school year and summer programs, schools, colleges, and universities represent a largely untapped opportunity to strengthen the market for farmers and increase access to locally grown, high-quality foods for young people. Such direct purchases are increasing through an expanding number of farm-to-school projects throughout the country.

Direct Marketing as a Way to Build Civic Agriculture

Increasingly, alternative or direct-marketing channels are seen as engines for growth in civic agriculture. Since over 80 percent of the consumer food dollar currently goes to pay for the marketing bill, leaving less than 20 cents for every dollar for the farmer, direct marketing may be critical to the economic survival of agriculture.

See also **Farmers' Markets; Food Cooperatives**; **Marketing of Food**; **Retailing of Food; WIC (Women, Infants, and Children) Program**.

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MARKETS. *See* **Farmers' Markets; Food Cooperatives; Food Marketing: Alternative (Direct) Strategies; Retailing of Food.**

MAYAS. *See* **Mexico and Central America, Pre-Columbian.**

McDONALD'S. *See* **Fast Food; Hamburger.**

MEAL.

Academic interest in meals, while crossing many disciplines, is concentrated mostly in the fields of social anthropology and sociology. The premise of much of this research is that whatever broader historical and social influences on food and eating may be identified in any cultural milieu, the taking of food is more often than not organized around some concept of the meal.

Historical Aspects

There is a modest literature that, while not focusing precisely on the meal, offers insights into the history of meals. Of undoubted importance is the reduction in the size of meals in Western civilizations. From the Roman poet Petronius's account of Trimalchio's feast in *The Satyricon*, through medieval banquets, to the gluttony of restaurant dining in France, the size of a meal in terms of the varieties and number of courses has declined, at least for the affluent social classes. One difficulty with historical studies of food and eating is their focus on aristocratic and bourgeois habits. This is perhaps unsurprising, as the diet of the poor appears to hold in variety and content less fascination, although John Burnett's *Plenty and Want* (1979) elegantly counters this view. Sociologist-historians like Norbert Elias maintain that the diminution in the number of courses represents a trend to civilizing taste through self-restraint such that the epitome of "good taste" is, crudely put, reflected in a "less is more" philosophy, and gluttony and excess is associated with the bestial side of human nature.

A second theme of interest is the impact on meal taking of industrialization, whose main consequences in the food arena include "improvements" in food production, preservation, and transportation, and the exploitation and creation of markets for existing and previously unavailable foods. The growth of agribusiness and subsequent opposition to it has cast doubts on these supposed benefits of industrialized society.

What is perhaps less appreciated about the industrialization of food is the extent to which it has created and supported the embedding of male and female roles in the home and elsewhere. This leads, thirdly, to the profound effects of industrialization on patterns of family life. In the last quarter of the twentieth century, the demands of industrialization have seen greater female participation in the labor force in much of the developed world that, taken together with the increasing application of technology to the culinary sphere, has had implications for food consumption. This is reflected in debates about the decline of the meal and the rise of snacking, or grazing, which, in recent years, have been linked to broader ideas about the "McDonaldization" of food and eating.

Functions of the Meal

No account of the role of the meal in society can ignore efforts to explain the apparent human need to dine communally. In a popular approach to understanding the nature of meal-taking, scholars have delineated five general functions of the meal and of feeding more generally. First, meals demonstrate much about the nature of status differences in society. The display and distribution of food as a means of demonstrating social status is common to many societies. The giving of food can be an act designed to heighten the status of donors by emphasizing the difference between them and the recipients of their largesse.

Second, whom one dines with and what one eats define social and status group membership and the closeness or distance of relationships between individuals. For example, a hot meal generally reflects closeness and intimacy and can be confined to immediate family and intimates (Douglas, 1972). Within the family, status and power differences determined by gender can be reflected in the distribution of food. Several researchers have demonstrated that high meat consumption is associated with men, and that women often give priority to male food preferences at the expense of their own tastes. In the workplace, class and status differences can be mirrored in a separate provision of food for managerial and related grade staff, and for "blue collar" workers (Murcott, pp. 45–53). Third, food has symbolic functions and meanings. Various forms of feasting serve to link individuals to the wider social fabric through shared understandings of cultural conventions (as, for example, with Christmas or Thanksgiving). Meals also offer opportunities for status symbolism, where food is a form of currency either literally (whereby animals are exchanged for goods and services), or through the medium of gift-giving (intended to elicit some reciprocal gift or service). Status symbolism is also conveyed in the case of dining out, in the selection by the host of a meal environment appropriate in its level of excellence and expense.

Fourth, meals give opportunities to demonstrate role performance. For a host, the meal allows demonstration of good taste and knowledge of what is relevant to particular dining situations. For all individuals, mistakes over etiquette and the actual eating of food can be embarrassing, discrediting a person in the eyes of others (for example, using the "wrong" knife or fork or employing the "wrong" terminology). Fifth, control of role performance is closely related to the role played by food in socialization. Meal times, as occasions when social groups are normally together, provide opportunities for the uninitiated—particularly the young—to observe what is acceptable in terms of food-related behavior. For children, meal times allow observation of what foods are routinely available for consumption and how these should be consumed; in other words, children are inculcated both formally and informally into matters of etiquette.

Structures of the Meal

The observation that in many societies, food consumption is organized around some concept of the meal led much early sociological research to focus on the nature and meaning of meal structure. The pioneering work of Mary Douglas offers theoretical grounding of the study of food and eating in localized empirical studies of dining. In her article "Deciphering a Meal" (1975), she identifies two contrasted food categories—meals and drinks. Meals are structured and named events (for example, lunch, dinner) whereas drinks are not. Meals are taken against a background of rituals and assumptions that include the use of at least one mouth-entering utensil per head; a table; a seating order; and cultural restrictions on the pursuit of alternative activities (such as reading) while seated at table. A meal also incorporates a series of contrasts: hot and cold, bland and spiced, liquid and semiliquid. Both meals and drinks reflect the quality of social relationships. Drinks are generally available to strangers, acquaintances, and family. Meals, by way of contrast, are reserved for family, close friends, and honored guests.

Douglas's key empirical study with colleague Michael Nicod relates meal structure to meal content. Nicod recorded over various periods the dining patterns of four English working-class families, whose diet of the time centered on two staple carbohydrates—potatoes and cereals, in contrast to upper- and middle-class diets, which made greater use of a range of cereals, beans, and roots. Focusing on the type and cycle of meals within the domestic economy, Nicod identified three types of meal: Meal A, a major meal, served around 6:00 P.M. on weekdays and in the early afternoon on weekends; Meal B, a minor meal taken at 9:00 P.M. or 10:00 P.M. on weekdays and 5:00 P.M. on weekends; and Meal C, consisting of a biscuit and a hot drink. This last meal was a flexible component available at any time in the daily dietary cycle but most often taken both in late afternoon, on the return home of the principal wage earner, and before retiring for the night.

Meal Content and Cycles

Of the three types, Meal A is accorded the greatest analytic importance by Douglas and Nicod. A strong correspondence between the weekday evening meal and the Sunday meal was apparent. In both instances, the first course was the main course, always hot and savory and based on a tripartite structure of potato, centerpiece (meat, fish, eggs, with one or more additional vegetables), and dressing—usually gravy. The second course repeated these rules of combination except that it was sweet. The staple took a cereal form (pastry, sponge), the centerpiece was often fruit, and the dressing custard or cream. On Sundays and other special occasions, the second course was often followed by a third consisting of a hot drink and biscuit(s). This third course maintained similarities in rules of combination in that a biscuit has a cereal staple form enclosing a fruit or cream-type filling. In one respect, however, the pattern differed, in that liquids and solids were totally separated, in contrast to other courses, and the structure was reversed in so far as the hot drink appeared in a cup or similar receptacle, whereas the cold biscuit was on a plate.

Thus, according to Douglas and Nicod, meals possess the following elements. First, they have rules of nonreversibility in the archetypal meal. Second, the order of food runs from savory to sweet and from hot to cold in terms of the principal food items consumed. Third, quantity decreases with each course as formal patterning of foodstuffs increases. Regarding the latter, Douglas sees the first course as fairly amorphous, but as a meal progresses, this gives way to increasing geometric precision and structure (Douglas, 1982; Wood, 2000).

The "Cooked Dinner"

Whereas Douglas places equal emphasis on meal structure and meal content, it is the latter that has driven many subsequent and empirical studies of meal taking. Murcott's (1982) study of thirty-seven pregnant women in South Wales is almost as important as Douglas's work for the elaboration of a research tradition. Murcott found that the "cooked dinner," an elaborated model of Douglas's principal Meal A type, comprising meat, potatoes, at least one additional vegetable, and gravy, was regarded as a "proper meal," and perceived as essential to family feelings of health and well-being. Structurally, the cooked dinner was thought of as a meal in itself, was heavy and large rather than small and light, and hot, never cold. Thus, although a succession of courses was permissible, the cooked dinner as centerpiece could, in contrast to sweet-based items, stand in its own right as a meal. Fresh meat was a priority, and potatoes were always specified and itemized separately from other vegetables. Certain meats had common circulation—beef, lamb, pork, chicken—whereas others, notably turkey, were reserved for special occasions. Fish was not regarded as an acceptable substitute for meat in the cooked dinner form. While potatoes were invariably a constant (roast on Sunday, usually boiled at other times), slightly more flexibility was evident in the choice of additional vegetables. Even here, however, certain rules appeared to operate. First, additional vegetables were almost invariably green and from "above ground" (typically peas, beans, sprouts, cabbage, and occasionally broccoli and cauliflower). Second, additional vegetables were prepared only in addition to these and were generally from "below ground" (for example, carrots and parsnips). Together with meat and potatoes, the final ingredient necessary to the structural integrity of the cooked dinner was gravy, last in the cooking and serving sequence, and poured onto the plate after other items had been assembled, an action Murcott sees as linking and transforming items in the cooked dinner into a coordinated whole. Cyclically, the importance of the cooked dinner to Murcott's sample was emphasized in the fact that it was eaten on only three or four days of the week (including, invariably, on a Sunday) and thus had relative scarcity in the family dietary system.

The "Cooked Dinner" in America

The British work of Douglas and others is echoed in various American studies, which generally support a view of meals as central to domestic dining systems. In a 1942 study of food habits in Southern Illinois, researchers found that food consumption centered on three staples: potatoes, beans, and pork. The authors term this the "core diet" and note that around the core was, first, a secondary core, consisting of many foodstuffs that had recently become available for purchase from local stores; and, second, a peripheral diet of infrequently used foods outside of the core and secondary core (Bennett et al., 1943). All three of these concepts are used in similar form by Norge Jerome, who charts content variations found in meals and snacks for all of "normal" weekday meals, "Sunday dinner" and festive meals (for example, Thanksgiving). Jerome argues that the dietary order consists of core and staple items; secondary core items, which are added to or substituted for items in the core as circumstances and contexts vary; and peripheral dietary items, which are those items used infrequently, including ceremonial foods.

In a much more complex series of studies of Italian-American diet in Philadelphia, Judith Goode and various colleagues relate variations in the selection of different meal formats to meal cycles (food consumption patterns over time), community values, and activity patterns of households, building up a many-layered picture of the interrelationships between the role of food in people's lives and other aspects of the social order (Brown, pp. 66–68).

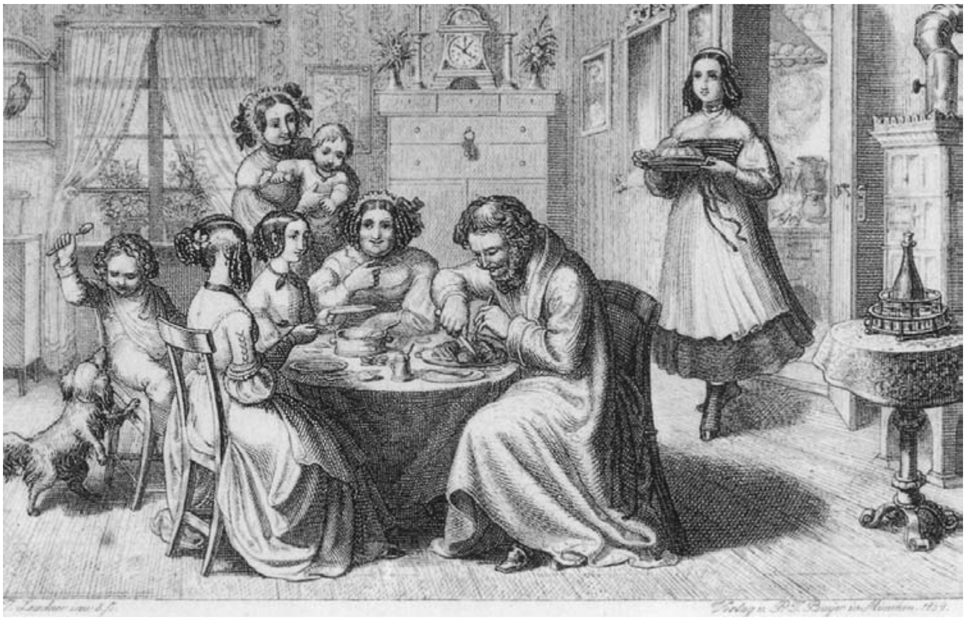
Gender and the Meaning of Meal Structure

For Douglas, the meaning of meal structure lies in its implications for family constitution. The patterning of food performs a regulatory function, encouraging family stability, a view with clear policy implications for dietary and nutritional intervention . For Murcott, an important symbolic feature of cooked dinners is the extent to which their preparation validates women's roles in family and marital contexts: "If a job defines how a man occupies his time during the working day, to which the wage packet provides regular testimony, proper provision of a cooked dinner testifies that the woman has spent her time in correspondingly suitable fashion . . . the cooked dinner in the end symbolizes the home itself, a man's relation to that home and a woman's place in it." According to Murcott, the overall responsibility for domestic affairs falls to the woman of the house, whose responsibility for the cooked dinner includes the process of accommodating family food preferences, especially those of the husband or male partner. Most women choose what food is purchased for family consumption, but, because of the need to balance factors such as family tastes and preferences, food cost, variety, and nutrition, this is often considered a burden rather than bestowal of authority to determine the domestic dietary cycle.

The construct or format of a meal varies greatly from one culture to the next. In this meal at Île de Gorée, Senegal, a family partakes of its food from a common bowl. © CORBIS (BELLEVUE).

Second, women frequently subordinate their own food preferences to those of male partners. Men, especially if employed, are regarded as requiring food in quantity, and male energy needs are regarded as exceeding those of other family members and, in particular, of women. Researchers Nickie Charles and Marion Kerr found that very high consumption of meat was almost totally confined to men, while very low meat consumption was associated primarily with women and children. Several other studies have shown that women often go without food, particularly in families where there is financial hardship. Women's voluntary denial is further reinforced by societal pressures to maintain "ideal" body weight and image.

Third, the "absence" of cooked dinners or a female to cook for men can disrupt the social fabric. Two very different examples of this are found in instances of domestic violence and of "womanless men." Researchers have observed that the centrality of food in marital relationships can often lead to violence as men turn on



In contrast to the family scene from Africa, this image from Biedermeier Austria depicts the essentials of a midday meal during the 1840s. Nanny with baby, the kitchen maid bringing in a pudding, father carving the roast—all of these are visual clues that tell us that this meal in a well-off household is being eaten in several courses and that there is probably a pecking order in terms of who eats what. COURTESY OF THE ROUGHWOOD COLLECTION.

women for perceived failures in the performance of those tasks that are accorded them and that men usually learn domestic cooking and practice that skill only when they have no woman to cook for them (Murcott, pp. 164–171, 172–177).

The Limitations of Structure

The investigations alluded to thus far are highly ethnocentric, useful for elaborating the parameters of the structural model of meal-based food consumption but limited in geographical scope. These studies also suffer from criticism of their over-reliance on evidence from studies of traditional working-class/blue-collar communities and families; an exaggeration of the extent to which women are the main providers and preparers of food, as these activities become much more democratically organized; and a failure to analyze the decline in meal taking and rise in snacking, or grazing.

"McDonaldization"

Arguments supporting the decline of the meal have received impetus in the thesis of George Ritzer that the global fast-food franchise McDonald's has been in the vanguard of the rationalization both of cuisine and of social life more generally. For Ritzer, the interplay between technology and food production has led to fragmentation of private and public food consumption. In fact, Ritzer's early work on McDonald's and "McDonaldization" is the summation of an extensive literature on fast food arguing similar themes (Leidner, 1993). Implicit in Ritzer's analysis is a view of American domestic cuisine at odds with research on the British experience. The relative absence, however, of parallel detailed studies of food in American domestic life makes it difficult to assess uniformity and diversity of the meal-taking experience in the United States.

Restaurant Meals

It was noted earlier that social scientific study of food and eating is a relatively young and under-researched field. Nowhere is this more true than in the study of dining out. The early work of Campbell-Smith (1967) promulgated the concept of the "meal experience" whereby customer satisfaction in dining out was attributed to multiple environmental factors and not food choice and quality alone. This view is probably no longer tenable. Studies of the restaurant "meal experience" suggest that consumers prioritize available food choice, price, and quality when dining out. According to researcher Joanne Finkelstein, dining out is a mannered act in which the participants rarely derive much enjoyment, since the very act of engaging in restaurant dining entails consumers subordinating themselves to the rituals and imperatives of the establishment, a condition Finkelstein calls "uncivilised sociality." Her analysis has attracted supporters (see Wood, 1995), but also detractors, whose own multimethod studies emphatically show consumer control and enjoyment of dining out. They also reject the arguments of theorists who argue that domestic dining and dining out have increasingly converged.

This convergence takes the form of public menus reflecting more and more the structured dining of the home with greater similarity of offerings and a concomitant overall reduction in the choices available to consumers. This "interpenetration" of private and public dining is supported by advances in technology, which have increasingly allowed foods eaten in the public domain to be purchased at the supermarket and consumed at home. Warde and Martens (2000) at least partially reject this view, instead concurring with Mennell (1985) that increasing variety is indeed a feature of public and private dining and claiming that writers such as Wood have exaggerated trends in convergence and the reduction of choice. This is despite finding some evidence of considerable similarities with domestic food consumption in the structure of meals taken outside the home.

Public to Private Again

Warde and Martens's arguments are often contentious but they set the pattern for future explorations of Western public food consumption in empirically grounded studies of actual consumer behavior. At the same time, a note of caution can usefully be sounded. The concept of meal and related structures as described in this article have for the most part been empirically demonstrated by reference to Anglo-American standards. Yet, similar structures (such as the centerpiece, carbohydrate staple, and dressing) compose many meal formats around the world even if they do not precisely mirror the "cooked dinner." Variation may not, in fact, be so great, since many cultures follow the stew or "ragout" model, combining centerpiece and dressing, and sometimes combining these with a carbohydrate staple (such as curries or certain pasta dishes), while others observe the carbohydrate "base" model (as found in pizzas, tacos, fajitas), where food is placed on the staple or enclosed within it.

Through the work of theorists of the latter half of the twentieth century, a social scientific study of the meal has emerged and, employing various models of structure, has advanced considerably. But many more diverse empirical studies remain to be done before we can gain confidence in any assertions about this fascinating and fundamental aspect of human existence.

See also **British Isles; Carbohydrates; Class, Social; Combination of Proteins; Custard and Puddings; Dinner; Etiquette and Eating Habits; Fast Food; Food Studies; Gender and Food; Gravy; Holidays; Household; Lunch; Meat; Petronius; Potato; Restaurants; Sociology; Table Talk; Take-out Food; Tea (Meal).**

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MEALS ON WHEELS. A change in the 1965 Older Americans Act (OAA) allowed prepared meals to be delivered to qualified individuals assessed to be homebound or otherwise isolated. In 1972 the OAA, which initially addressed the needs of the elderly to promote independence and successful aging, was amended to include nutrition. Federal funds were allocated for local

Meals on Wheels specializes in providing daily meals for shut-ins, especially the elderly. PHOTO COURTESY OF AP/WIDE WORLD PHOTOS.

communities to provide hot meals in group dining situations for persons over sixty years of age and their spouses, regardless of the spouse's age.

For those senior citizens who were unable to prepare adequate meals for themselves or attend the congregate nutrition centers because of ill health or physical incapacity, the first so-called meals-on-wheels program was established in Pennsylvania. Volunteers dubbed "Platter Angels" prepared, packaged, and delivered meals to homebound elderly in the community.

As the demand for the service continued to grow, additional neighborhood meals-on-wheels programs sprung up across the country. Volunteers organized programs and delivered meals. A fee was charged to cover the cost of food and preparation. Charitable institutions such as churches and civic organizations were called upon to subsidize costs for those unable to pay.

Although limited federal funds were available to the volunteer programs, Congress recognized that a major federal effort was needed. Another change to the OAA in 1978 (Title IIIC-2, Home-delivered nutrition services) provided for the home-delivered meals for those assessed as unable to participate in the congregate meal program. Administered by the U.S. Department of Health and Human Services Administration on Aging, the program focuses on those in greatest economic and/or social need.

By requirement, each home-delivered meal must supply at least one-third of the Recommended Dietary Allowances for this age group. It is estimated that 40 to 50 percent of most required nutrients are supplied in practice. Guidelines developed to assist in menu planning indicate both the types and the amounts of food to be included in each meal. Some state programs have chosen to offer additional services such as offering medical nutrition supplement products. Delivery packaging materials for the meals should be safe and acceptable for both hot and cold foods, they should prevent contamination, and be reasonable in cost. Improper handling by recipients leading to food safety issues has been raised as a concern. Evaluation studies of program effectiveness affirm that the nutrient-dense meals improve the status of the homebound.

Thirty percent of the cost of the home-delivered meals is met through OAA funds. Public and private partnerships leverage additional resources. Every $1 in federal funds leverages an additional $3.35 in the home delivered meals program. The demand for homebound meals has dramatically increased in concert with the growing number of frail and homebound elderly who want to remain independent. Based on the most recent figures, about 135 million home-delivered meals are served annually. From the program's inception more applicants were attracted than could be accommodated, and waiting lists in many areas are not uncommon.

A separate but similar national organization that complements the federally supported home-delivered meal service is the Meals-on-Wheels America (MOWA) program. Their additional home-delivered meal service is seamlessly integrated into existing meals on wheels programs. Meals-on-Wheels America helps local communities raise funds and expand their nutrition programs for homebound elderly.

With the elderly population expected to double by 2030, senior feeding programs such as meals on wheels will continue to provide much-needed ongoing services.

See also **Government Agencies**; **Government Agencies, U.S.**; **Poverty**; **WIC (Women, Infants, and Children's) Program**.

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MEAT. For most human beings, meat is a highly desired food, but it is more of a treat than a staple. Meat, whether obtained from hunted or domesticated animals, is more expensive than staple carbohydrate-rich foods because of the investment in land and labor required to produce it. This reality is often the justification for reserving meat, or the best parts of it, for those with higher status.

In a majority of the world's cultures, this elite is men and, sometimes, the women and children attached to them. Furthermore, when there is enough meat to go around, the preferred parts, usually the muscle, go to these same individuals.

It is this special status of meat that makes it of particular interest in human culture, psychology, and cuisine. Meat is also the only class of food that is frequently formally proscribed by certain religions, cultures, or cultural subgroups.

Ambivalence and the Psychology of Meat

The stakes are high with meat. Meat is both the most tabooed—and the most favored—food across the human race, in both developed and traditional cultures. Meat is a magnet of ambivalence for human beings. It is meaningful, in both the positive and negative sense. Eating meat is both attractive and repulsive. Hunting, too, is problematic. It is a skilled accomplishment at the same time that it is a destructive act. Meat provides a food for humans that is more similar to humans than any other type of food. The similarity means that the biochemical composition of meat is much like that of humans, so that, by eating it, humans get all the nutrients they need. The meat of any mammal is a complete, or almost complete, food, in contrast to vegetable foods. But this similarity means that microorganisms living in the meat are also likely to find a happy home in humans. Meat is thus the most nutritive and most infective food humans eat.

Samaritans sacrificing and roasting lamb at Passover on Mount Gerisim near Nabulus, Israel. © DEAN CONGER/CORBIS.

You Are What You Eat

It is quite natural and sensible to believe that a person takes on the properties of the food he or she eats. In general, when A and B are mixed, the resulting product shows properties of both A and B, so why should this not occur when A eats B? The problem, of course, as understood through the lens of biochemistry, is that after digestion the components of various foods, foods as different as beef and bananas, are the same molecules: amino acids, sugars, and so on. From this perspective, the identity of an eaten food is lost by the time it is digested. Nonetheless, the belief remains, and it is present in the thinking of almost every traditional culture. This "principle" is behind such notions as eating owls improves vision, eating swift animals increases running speed, eating rapidly growing plants speeds up growth, and the appearance of foods, including their color, can influence humans' appearance. "You are what you eat" is not just a primitive superstition; it is believed, implicitly, by educated people in technologically advanced cultures.

It follows from "you are what you eat" that the consumption of animals will impart some of their animal properties to the person consuming them. Although many animals have desirable attributes, they all share the property of not being human. And it is a major theme, across cultures, that humans are superior to, and qualitatively different from, animals. Yet, consumption of animals, according to the "you are what you eat" principle, would render humans more animal-like, that is, less distinctively human. This belief contributes to human ambivalence about eating meat, and may partially account for the disgust aroused by animal foods in some people.

Meat and the Human Primate

Primates show substantial variation in the types of diets they consume; however, there is a general focus on fruits. Some, particularly large primates, move to a more folivorous (leaf-eating) diet, and some consume a moderate amount of small animals, including insects. The larger stomachs and colons that characterize folivorous animals contrast with the smaller colons and stomachs of the carnivores. Frugivores (fruit eaters) typically have a gut that lies between the carnivore and the folivore extremes, and this is what humans have. This type of gut, and the associated general-purpose set of teeth, are well suited to generalist or omnivorous feeding habits, which characterize humans and chimpanzees. Humans can be distinguished from other primates, including chimpanzees, in their ability to hunt animals larger than themselves. This hunting capacity, related to the movement from the forest to savannah environment, has major implications for human nature and human evolution. First, it introduces the possibility of a substantial amount of meat in the diet.

Native American method of drying meat on racks. PHOTOGRAPH BY EDWARD S. CURTIS, 1908. COURTESY OF THE LIBRARY OF CONGRESS.

In addition, the demands of hunting encourage elaborate communication and cooperative effort as well as the creation of weapons and the technology that goes with them. The yield that results from killing a large animal encourages sharing, communal eating, and preservation technologies. It is fair to say that the shift to a diet with more meat in it, with the inclusion of large animal hunting, was a major force in human evolution. In an important sense, meat as food has shaped human nature.

Meat in Traditional Society

It is presumed that the hunter-gatherer mode of existence, with varying degrees of reliance on vegetable and animal products, was the situation of Homo sapiens prior to the appearance of domestication and agriculture. However, this should be recognized as a presumption. Studies of the diverse range of existing cultures that rely to a large degree on hunting and gathering suggest that meat, even at this stage of human cultural and biological evolution, assumed a central role. Meat is generally the favored food, the center of celebrations and social gatherings, and the food selectively available to adult males, the most powerful and high-status members of most hunter-gatherer societies. This situation probably results from a combination of the caloric density of meat and the fact that meat, unlike any particular vegetable, is a complete food. On the other hand, the relative rarity of meat, which usually constitutes much less than half of the diet, encourages rules for its selective distribution.

Even among hunter-gatherers, however, there are signs of ambivalence to meat. Most food taboos of hunter-gatherers, and they are extensive, are about meat. Taboos are sometimes general, namely that certain types of animals are forbidden as food. On the other hand, most taboos are conditional, restricting the eating of meat, or certain parts (muscle, innards) to particular groups. Generally, the adult males get the greater amount of meat, get to eat the preferred animals, and get the preferred parts (usually muscle). But there are many exceptions to this general rule. Meat or animal taboos, whether in hunter-gatherer or technologically developed cultures, seem to have a few general characteristics. In what has been referred to as "zones of edibility," tabooed creatures tend to be those very close to humans (humans themselves, primates, or companion animals), those very different from humans, and/or those that are rarely encountered.

Domestication

Meat figures prominently in what might be called the two most important transitions in human evolution: the development of complex cultures and sophisticated technologies. Just as hunting had a major influence in shaping human nature, the combination of agriculture and domestication laid the foundation for high densities of humans and the subsequent elaboration of culture. By making the human food supply more independent of the seasons and of short-term extremes in weather, agriculture and domestication set the stage for major changes in human life. Domestication made it possible for humans to be the only mammals that could have continued access to the almost perfect mammal food of infancy, milk; it also frequently made meat a less scarce resource. Just as hunting helped encourage the upright posture, the development of hand skills, and major cognitive developments, agriculture and domestication of animals freed humans to develop a wide range of impressive technologies.

Meat in Developed Societies

The tables have begun to turn on meat in today's affluent, developed world. The excitement of meat hunting has given way to factory farming. The butchering of the carcass takes place out of sight of almost everyone, so that the skills involved in butchering as well as hunting are almost gone. The caloric density of meat has lost much of its appeal because the threat to human health is too many calories, rather than too few. Similarly, the nutritional completeness of meat is a less salient virtue, what with the great variety of plant foods available in any neighborhood supermarket. The epidemiological revolution has shifted health risks from minimal diets, unbalanced diets, and infections spread by humans through food and other products, to degenerative diseases like heart disease and cancer. And animal fat has been implicated as a risk factor for heart disease. Finally, the affluence of modern societies permits the development of great sensitivities to nature and the morality of using animals as food; with many options available, it is possible to allow moral concerns to influence diet. Vegetarianism is on the rise, for both moral and health reasons, and many of the nonvegetarians in the urban developed world are queasy about the actual process of killing animals. This attitude appears even in the slaughterhouse itself, where responsibility for killing the animals is diffused across a number of different people and roles. In Britain, the United States, and Canada, the human approach to meat has become increasingly ambivalent. The human primate still loves the taste and smell of meat, while cultural knowledge and sensitivities argue against it.

Disgust

Disgust is a powerful emotion, and animal products often arouse it. Almost all foods that are labeled as disgusting in a number of cultures are of animal origin. It is odd, because "dis-gust" means 'bad taste', and meat is one of the best-tasting foods to humans. It is odd also because, given the superior nutritional properties of meat, it should not be the target of the strongest negative food-related emotion.

Meat preference may be a human predisposition, but it is probably not present in infants. Ironically, there may be some predisposition to find meat disgusting, but this as well is not present in the first few years of life. Human infants eat, or at least try to eat, everything they can get into their mouth. Feces, the universal core of disgust, and itself an animal product, is attractive as a food to human infants, as it is to other young and adult mammals. Presumably the odor of decay, associated as it is with microorganism-infested meat, would be innately repugnant, but there is no evidence for an infant aversion to this odor. Nor is there evidence for such an aversion in other primates or mammals. By age two or three, in Western developed cultures (which have provided all of the data up to this time), children have a clear aversion to feces, and a variety of other animal products, especially those that are decayed. This is probably the result of toilet training, although there is no account available of the actual process through which this aversion to feces and decay is aroused.

The foods that are disgusting to adults, cross-culturally, are almost entirely of animal origin, beginning with feces and, for Americans, extending widely to many of the edible parts of animals. Indeed, considering all of the possible animal foods (insects, mollusks, reptiles, amphibians), it is quite remarkable that Americans consume only four or five species of mammals, a few species of birds, no amphibians and reptiles, a moderate number of the many species of fish, only a few types of shellfish, and no insects. Furthermore, the meats eaten by Americans exclude many parts of edible animals; consumption is almost exclusively limited to muscle, and, in general, not the heart or tongue, although these are muscles. So far as is known, this idiosyncratic selection of animals and animal parts as acceptable food has no nutritional or health basis.

These facts lead to the conclusion that disgust at animal products, and the avoidance of most animal products, has an ideational base; it is based neither on taste (most of the "disgusting" types of meat have never been tried) or actual health risks. It is the *idea* of eating lizards, cow eyes or intestines, or insects that is upsetting and expressed as disgust, somewhat parallel to the formal taboos in other cultures against the consumption of many types of animals or animal parts.

Humans are clearly adapted to a partial meat diet and to liking the taste of meat, especially when it is cooked. But there are some negative sides to meat eating. Perhaps most important is the threat of microbial contamination; because animals are more like humans than plants are, animals are more likely to harbor microorganisms that can afflict humans. This microbial load also makes animal flesh vulnerable to decay after death. Many have argued that the use of many spices originated as a culinary means of discouraging spoilage of meat. During the twentieth century most of the microbial risks were overcome with controlled raising, preparation, and storage of meats. However, as feeding a population of

SAFE MEAT PRODUCTION

With the appearance in the 1990s of bovine spongiform encephalopathy (BSE; more familiar to the public as "mad cow disease") in England and France, and the deaths caused by its spread to humans who ate meat from diseased cows, vigilance with respect to safe meat production became even more critical. In spite of research demonstrating that the disease had been spread in herds that had eaten feed that contained meat products, some feed suppliers in the United States were found continuing the practice in 2001, and, without enough USDA inspectors to monitor meat production from start to finish, the public cannot be sure that the meat they eat does not come from cows infected with BSE.

Robin Kline

billions a diet with substantial amounts of meat became the goal, a new problem arose: it takes much more out of the environment to make a pound of meat than a pound of vegetable starch or fruits and vegetables. This was not much of a problem when there were fewer humans, and when animals were hunted rather than herded. For some it has become a serious issue that threatens the welfare of our planet.

Plants, of course, as the alternative food source, have their own problems. They are more likely to contain toxins, and they are less calorie dense and less complete nutritionally. As with the minimization of the microbial risks of meat consumption by technological rearing and preparation techniques, the risk of plant toxins can be reduced both by a culture-based selection of appropriate plant products to eat and by the development, through agriculture, of staple plant-based starches that are essentially toxin-free.

Meat and Vegetarianism

Most people in the Third World eat relatively little meat, mostly because of its cost and rarity. They would eat more if they could. On the other hand, in some religious groups, such as orthodox Hindus, all meat is prohibited. And within some meat-eating cultures, individuals or groups of individuals reject meat as food. This type of vegetarianism has a history that goes back at least to ancient Greece. Historically, this type of elective vegetarianism has been motivated primarily by moral or religious concerns, often having to do with negative reactions to the killing of animals or the psychological effects of consuming animals. Within many developed cultures, vegetarians invoke, in addition to moral, religious, or aesthetic concerns, worries about the long-term health effects of eating meat. Some vegetarians can be classified as either health or moral vegetarians, though most long-time vegetarians express a little of both motivations. Interestingly, moral vegetarians are more likely to find meat disgusting than are health vegetarians. When meat becomes disgusting, it is much easier to avoid it.

Vegetarianism seems to be growing in the Western world, impelled by health and moral motivations. For most people who choose this path, it is usually a long development over time, frequently a movement from rejection of a small category of animal products (for example, baby mammals or red meat) through larger and larger spheres of rejection (adding poultry, fish and shellfish, eggs and dairy products, and nonfood animal products). For many, the sequence stops at some point along this trajectory. People also often slide backwards, either abandoning a particular level of rejection for a less stringent set of prohibitions or completely abandoning the vegetarian style.

Mad Cow Disease

Although in general Americans seemed to be the most concerned group about the diet-health link as the twentieth century ended, the advent of mad cow disease engaged Europeans more than Americans. Mad cow disease (bovine spongiform encephalopathy [BSE]) is quintessentially about meat. Mad cow is doubly animal: it involves not only animal meat—beef—but also feed consumed by cows, animals that are normally vegetarian, that contains animal parts. Studies of risk perception by psychologists indicate that people tend to exaggerate risks when they are catastrophic, hidden, delayed, and not understood. Mad cow disease meets all of these conditions and adds the predisposition to be emotionally involved with foods of an animal nature. It is hard to believe that as much fuss would be made if this were mad broccoli disease. It is also just as likely that "mad broccoli disease," because it would not originate with diseased animals, would not lead to a delayed, unexpected, hideous, and certain, death.

See also **Aversion to Food; Cannibalism; Cattle; Disgust; Game; Goat; Hinduism; Horse; Hunting and Gathering; Mammals; Pig; Sheep**.

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MEAT, SALTED. The food industry incorporates sodium chloride (NaCl) in preservation, processing, and manufacturing operations for vegetables, poultry, fish, seafood, and meat. Although a number of food preservation techniques have been used for many years, including drying, freezing, heating, canning, filtration, enzyme treatment, high-energy irradiation, and chemicals such as organic acids, nitrate, and liquid smoke, salt remains one of the common methods of meat preservation with a long history. Salt is used to preserve meat in its dry form, as a brine, or in solution pumped into tissues (Doyle and Roman, 1982). Researchers still are examining the beneficial functional properties of NaCl in meats and other food commodities (Hajmeer, Marsden, Crozier-Dodson, Basheer, and Higgins, 1999; Pszczola, 1997).

Use of Salt in Meat and Meat Products

Sodium contents of unprocessed meat are about 55 mg/100 g of beef fiber, and 65 mg/100 g of pork fiber (Institute of Food Technologists, 1980). The level is increased when NaCl is added to the meat during processing. Salt has been used by the meat industry as a dry application and in the formulation of fermented, processed (cured or uncured), and restructured meats. Salt added to a meat system serves three main functions: extracting salt-soluble proteins, enhancing flavor, and extending the shelf life (Claus, Jhung-Won, and Flick, 1994).

Originally, in the absence of refrigeration, meat was dry-salted for extended periods of time to preserve it from microbial deterioration. Excessive salting and extended storage increased water loss, and dehydration removed water from the tissues by osmosis, lowering the water activity in the system to conditions unsuitable for microbial growth and leading to cellular plasmolysis, shrinking of cytoplasm away from the cell wall. In addition to dry-salting, NaCl is incorporated in fermented meats such as semi-dry sausage during preparation. Adding NaCl prevents growth of undesirable spoilage or pathogenic microorganisms by favoring the growth of acid-producing, salt-tolerant bacteria, such as lactobacilli and micrococci. Production of acid by these microorganisms gives the meat a desirable tangy flavor and lowers the pH of the system, which adds another safeguard against the growth of undesirable microorganisms.

In processed comminuted meats, for example, bologna, frankfurters, and summer sausage, and non-comminuted meats, for example, ham, bacon, and pastrami, NaCl is one of the basic ingredients, after the meat itself. Other ingredients include water, spices, nonfat dry milk, sweeteners, phosphates, and nitrite. Salt and nitrite are the main ingredients used to cure meats and are applied dry, by immersion, or by injection methods. Salt added to processed meats helps to extract NaCl-soluble proteins, increases the gel strength of the emulsion or batter, enhances the flavor, inhibits or minimizes microbial growth, and enhances antimicrobial activity of other compounds in the system. Salt-soluble proteins coat the fat molecules in the system and provide a stable emulsion, which is important in improving moisture retention and texture of the final product (Claus et al., 1994). Salting prerigor hot-boned meat to be further processed, for example, when making sausage, helps maintain its water-holding capacity (WHC) and fat-emulsifying properties (Hamm, 1981).

Salt, in conjunction with sodium tripolyphosphate, is used for protein extraction in the preparation of restructured meats, which are sectioned and formed non-cured products. Restructuring meats makes it feasible to use lower-grade, less expensive cuts and, similar to the concept of processing meats, restructuring them provides more diversified products that are flavorful, nutritious, affordable, and convenient.

Salt can be encapsulated with partially hydrogenated vegetable oil to prevent excess extraction of salt-soluble proteins during meat processing. This eliminates undesirable changes in meat texture and viscosity. Encapsulated salt used in sausage preparation produces desirable qualities such as high moisture, crumbly and tender texture, and good flavor (Pszczola, 1997). Normally, 2 to 3 percent NaCl is added during the chopping or emulsifying process to help extract the proteins, but this amount may range from as little as 1.5 to 5.0 percent (Claus et al., 1994).

Advantages, Disadvantages, and Limitations of NaCl

Salt enhances the flavor of meat by suppressing undesirable or unpalatable savors. It extends the shelf life by retarding microbial growth because it exerts both bactericidal and bacteriostatic effects on many microbes found in meat (Marsden, 1980). This might be associated with changes in water activity and ionic strength that render water unavailable to microorganisms (Hajmeer et al., 1999). Other factors include dehydration, the direct effect of chlorine ions, removal of oxygen from the medium, sensitization of microorganisms to carbon dioxide, and interference with the rapid action of proteolytic enzymes (Polymenidis, 1978).

Spoilage and pathogenic bacteria such as *Escherichia coli* O157:H7, *Listeria monocytogenes*, *Salmonella* spp., *Staphylococcus aureus*, *Clostridium botulinum*, and lactic acid bacteria have various tolerances and differ in their responses to salt. Among other factors, these depend on microbial tolerance to NaCl, type and concentration of NaCl, exposure time, pH, and temperature. *Salmonella* spp., *S. aureus*, and *C. botulinum* have the ability to grow in brine solutions with high salt concentrations and at low temperatures (Marsden, 1980). Therefore, using a combination of ingredients and processing methods, such as the curing process, that employ both NaCl and nitrite is important in controlling microbial growth.

Excess use of NaCl has undesirable effects on the flavor, color, and appearance of meat. Application of dry NaCl, for example, can result in an unattractive and darker color of lean (Pearson and Gillett, 1999). As a powerful prooxidant, NaCl has undesirable oxidative effects on meats. Processed frozen products containing salt become rancid and produce unacceptable flavors during extended storage (Claus et al., 1994). Incorporation of other ingredients in the meat system, such as sugar, nitrite, and antioxidants, for example, butylated hydroxyanisole (BHA) helps minimize or control these negative effects by masking adverse flavors, preventing color degradation, and reducing oxidative properties. Salt can have a synergistic effect and enhance the activity of other preservatives such as BHA (Stern, Smoot, and Pierson, 1979). However, impurities in NaCl can reduce its effectiveness in extracting NaCl-soluble proteins because they interfere with the WHC and emulsifying properties of the meats. Therefore, it is important to use a purified grade of NaCl.

Because of increased concerns regarding high salt intake and its role relative to hypertension, high blood pressure, and potential heart disease, public health authorities recommend reduction in NaCl intake (IFT, 1980). Intake can be reduced by lowering its levels during processing or by substituting potassium chloride (KCl) for part of the NaCl (Pearson and Gillett, 1999). Unfortunately, reduction of NaCl in meat products weakens its preservative capacity and the binding and WHC of the systems. Furthermore, complete replacement of NaCl with KCl is undesirable because of the aftertaste left by KCl. Polyphosphates and other chloride salts also can be used to replace NaCl.

NaCl levels in the diet have been of some concern, and maintaining public health is a priority. Salt use cannot be eliminated completely in the meat industry to reduce health risks because of the important technological functions it performs. It is important to determine the minimum levels of NaCl necessary to maintain its functionality while addressing the health concerns of consumers.

See also **Fish, Salted; Game; Hunting and Gathering; Iodine; Mammals; Meat; Military Rations; Preserving; Salt; Sodium**.

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MEAT, SMOKED. Smoking is an ancient method of food preservation that is still practiced because it adds an interesting flavor to meat, fish, poultry, and other foods; allows foods such as hams to be stored at room temperature; and slightly dries and preserves some foods, such as sliced salmon, that are eaten raw.

Smoking dates back centuries, especially for fish, which is highly perishable. Archeological evidence suggests that ninth-century residents of Poland smoked large quantities of fish (Shephard, p. 117). In medieval Europe, the religious practice of avoiding meat on certain days created a tremendous demand for fish, and enormous quantities of salmon and herring were salted and smoked in seaside towns before being shipped to the interior. Pork was also a popular meat for smoking since pigs were slaughtered in the fall and their meat could be preserved on the farm to last through the winter. Smoked pork was found in China as well as Europe. In South America, long strips of dried meat are called *charqui*, which has come into English as "jerky" as the name for a snack made from beef or turkey.

Smoking is a preservative because smoke contains chemical compounds that retard the growth of harmful bacteria. More than three hundred components of smoke have been identified. Carbonyl compounds in smoke contribute to the distinctive flavor and aroma of smoked meat, while the carbon dioxide and carbon monoxide help produce the bright red pigment. Phenolic compounds in smoke play a role in protecting fat from oxidizing and turning rancid, which is no doubt a major reason why fatty foods, such as herring or pork, were (and are) so often smoked. The composition of the smoke changes as the temperature of the fire rises, with the best quality smoke produced at a temperature of 650° to 750°F. Control of humidity in the smokehouse is also important since high humidity favors deposition of smoke on the surface of the food and absorption of the flavor. High humidity also assists in the rendering of fat.

Smoking operations fall into two categories: hot-smoking and cold-smoking. In hot-smoking, the temperature in the smoke chamber ranges from 120° to 180°F, which produces a strong smoky flavor. However, the meat is usually only partially cooked and must be finished in a conventional oven. In cold-smoking, the smoke is produced in a firebox but allowed to cool before being passed into the smoking chamber, where the temperature is a mere 70° to 90°F. The food is hardly cooked at all, but long exposure to cool smoke gives the food a mild, smoky flavor and dries it to some extent. Cold-smoking is used largely for foods that will be eaten raw, such as smoked salmon or smoked fillet of beef. The temperature range from 90° to 120°F is considered too hot for cold-smoking and too cool for hot-smoking. A temperature over 180°F is considered "cooking with smoke" rather than smoking as such; pork barbecue and regional dishes such as Texas beef brisket are in this category. A great variety of foods can be successfully cold-smoked or hot-smoked, ranging from fish to pork, poultry, and beef to wild game.

Many foods are cured before smoking, especially cold-smoking, to draw out the moisture, which would otherwise promote spoilage. The cure is a mixture of salt, sodium nitrate, nitrites, sometimes sugar, spices, and other seasonings, and additives such as phosphates or ascorbates. Nitrate and nitrites contribute to the flavor and coloration of products such as ham. Nitrite and salt inhibit the growth of *Clostridium botulinum*, the bacterium that causes botulism.

A dry cure can be applied by rubbing the meat with the mixture or packing the food in a container of the cure mix and letting it sit for several days or weeks. A wet cure can be applied through a brine of water or other liquid containing the cure ingredients; brine can also be injected into the food in order to impregnate its center and speed up the curing process. Once cured, the food is dried and smoked.

Some items, such as hams, are hung for weeks or months under conditions of controlled temperature and humidity to develop flavor. Humidity is controlled by the addition of steam or water vapor as well as the use of dampers. Air movement is also critical to uniform heating, curing, and flavor in the final product. High air velocities tend to produce more rapid drying and a firm consistency.

Home units for hot-smoking are typically upright cylinders with an electric hot plate, charcoal grate, or gas range at the bottom to produce heat; wood is placed over the heat source to create smoke, and the food is placed on a rack above the wood. A pan of water is often placed in the smoker to catch the drippings from the food so that they do not fall into the heat source and cause flare-ups. The more elaborate units include adjustable baffles and other controls to allow the cook to control the smoke. Double-chamber units for both hot- and cold-smoking are usually horizontal and tend to be rather large and heavy.

Different types of wood are used to produce different flavors in the smoke. Hickory is a great favorite in the eastern United States, while alder is popular in the Pacific Northwest. Maple, oak, and pecan are also used in the United States. In Scotland, peat fires were once used to smoke fish. Beech, oak, and chestnut are the most popular woods in Europe. Commercial operations use sawdust or logs, while most home smokers use wood chips set in a pan on the heating element; the large, dual-chamber home smokers can use small logs. Evergreens are usually avoided because they contain resins that can produce a sticky smoke and impart a bitter flavor to the food. However, resinous wood is sometimes used at the end of the smoking process to give the outside of the food a protective coating. No matter what fuel is used, a smoldering fire is preferred to an open flame because it produces abundant smoke and avoids very high temperatures.

Smoked salmon, usually sliced very thin, is an elegant dish. It is cold-smoked and eaten raw. Lox (from the Yiddish word for smoked salmon) is usually more heavily cured than other types and is often eaten on a bagel with cream cheese. Kippers are cured and smoked herrings, still very popular in Britain at breakfast, lunch, or tea. The village of Findon in Scotland gave its name to smoked haddock (finnan haddie), which is served hot after being broiled or poached. Halibut, sturgeon, and fish roe (eggs) are also cold-smoked. Eel, trout, and mackerel are hot-smoked and can be eaten without further cooking.

A whole ham is the hind leg of a pig. Many regions in the United States and Europe have particular styles of ham production and preparation. “Country ham” from Virginia, Tennessee, or Kentucky, for example, is heavily cured and smoked for weeks or months over smoldering fires of hickory or apple wood. The resulting ham is so dry and hard that it must be soaked overnight to get rid of some of the salt, and then boiled to soften it. Britain produces the York ham, popular for boiling, the Suffolk ham, cured with spices and honey, and the Bradenham, which is cured with molasses. Prague ham (from Czechoslovakia) is lightly smoked over beechwood coals and is said to be among the sweetest of hams. Many hams are smoked but eaten raw, such as Westphalian ham from Germany. (Prosciutto ham from Parma, Italy, is also raw but is not smoked).

Smoking also gives meat its distinctive reddish color. Sausages are often smoked, as are frankfurters. In the United States, bacon is usually smoked and often cured with sugar to give it a sweet taste.

Chickens, turkey, duck, and geese can be hot-smoked, usually after being cooked, and the resulting meat tastes like ham. Smoked poultry, however, is perishable and must be kept frozen or refrigerated until it is reheated or served cold. Boneless beef roast can be hot-smoked for several hours to the desired temperature and sliced very thin.

Nearly any type of game can be smoked, from squirrel meat to bear and wild boar. Hunters should ensure that game meats are properly handled and cooked to at least 180°F to eliminate the danger of botulism or trichinosis.

See also **Barbecue**; **Botulism**; **Cooking**; **Fish**; **Fish, Smoked**; **Game**; **Mammals**; **Meat**; **Pig**; **Preparation of Food**; **Salt**.

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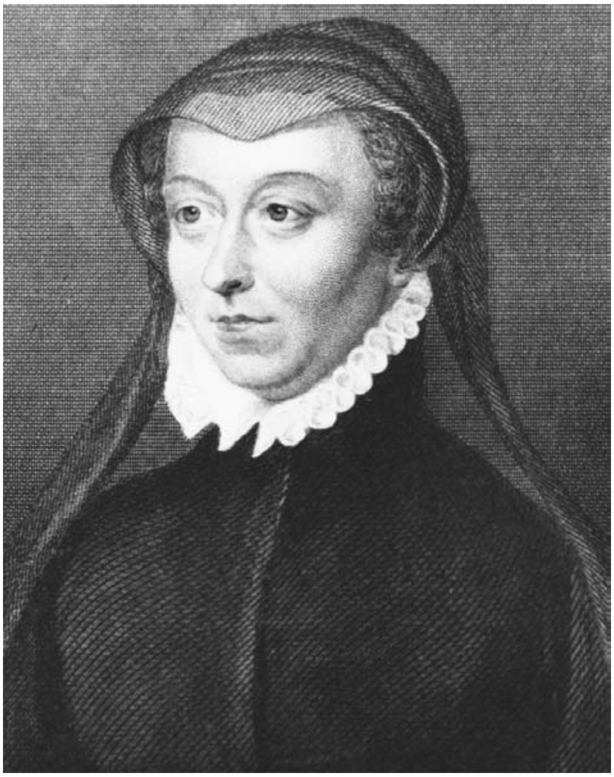
MEDICI, CATHERINE DE’. Orphaned soon after her birth in Florence, Catherine de’ Medici (1519–1589) inherited the wealth and theatrical style of her grandfather, Lorenzo the Magnificent, the most notable of the Florentine family who made the name of Medici synonymous with quattrocento (Italian fifteenth-



Catherine de’ Medici (1519–1589), wife of Henry II of France, was better known for her cruelty and political machinations than for culinary sophistication. Nineteenth-century engraving based on an original portrait. © CORBIS (BELLEVUE).

century) art and power. At age fourteen Catherine was sent to France to marry Henry of Orleans (Henry II), who inherited the French throne in 1547 at the death of his father Francis I. Catherine bore ten children. After the death of Henry II in 1559, three of Catherine's sons successively became kings of France, and Catherine served as queen regent.

The thirty-year length of her reign and the horrific religious wars of her time have given Catherine a symbolic identity that stretches historical fact. Popular myth has long named her the Italian queen mother of France's high cuisine, for she is often presumed to have imported new notions of cooking as refined as the other civilized arts reborn in the Italian Renaissance of the fifteenth century. But in fact Catherine's innovations were not culinary but theatric and were geared to politics rather than to gastronomy.

Regent of a weak government during the conflicts between Catholics and Huguenots that culminated in the St. Bartholomew's Day Massacre of 1572, Catherine used spectacle to create an image of stability and order when reality denied it. In 1564 she displayed the virtual power of monarchy in a grand tour through the countryside with her son Charles IX. Throughout her regency she staged court festivals or masques that used food as the excuse for lavish theatrical happenings, which combined drama with dance, music, sculpture, and the decorative arts. In France she created a new style for royal banqueting that achieved its apotheosis in the court of Louis XIV at Versailles.

See also **France; Italy.**

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MEDICINE. Food plays both a causative and curative role in health and disease. Thus, its role in medicine may be as a risk factor for, protector against, or treatment of an illness. While too much food or exposure to certain foods can reduce someone's health, too little food or inadequate amounts of certain foods can be equally damaging. In the years before modern transportation, packaging, and refrigeration, medicine was primarily concerned with food deficiencies and food spoilage. The focus of medicine was on the identification of critical components of food and common pathogens and on the prevention of nutritional deficiencies and foodborne infections. The role of food in medicine has changed as food production, preservation, and preparation techniques have progressed. Today far more people in developed countries such as the United States suffer from excessive food consumption than from food deficiencies. In addition, certain components of food have been found to have therapeutic or protective properties when administered in levels greater than generally considered necessary. For instance, large quantities of vitamin A are used to treat acne, therapeutic quantities of vitamin E may be protective against heart disease, and extra fiber appears to reduce the risk of colon cancer. However, the problems of malnutrition or inadequate food intake and foodborne illness have not been eliminated. Undernutrition continues to plague developing nations, while the prevention and treatment of foodborne illness is a concern for all nations.

The Basics of Food and Health

Food is fundamental to support life. People get energy, water, and all of the building blocks for growth and proper bodily functioning from the foods they eat and the liquids they drink. The components of food necessary to life are termed "nutrients" and the study of the role of food in health is called nutrition. The goal of medicine is to ensure health, and because adequate nutrition is necessary to accomplish this, nutrition is a crucial component of medicine. Nutritional science combines food science and medical science. Nutrients include protein, fat, carbohydrates, fiber, thirteen vitamins, seventeen minerals, and more substances that are still being identified. The majority of nutrients essential to health are found in a variety of different foods. No one food is absolutely essential to support life. People with access to adequate amounts of food get all of the nutrients they need by eating a varied diet complete with fruits, vegetables, meat or meat alternatives, dairy foods, and grains. However, some people are not able to or do not choose to eat the full variety of foods available. These people may require special foods or supplements to meet their nutritional needs.

The Study of Food in Medicine

All branches of medicine, from pediatrics to geriatrics and from internal medicine to surgery, study food and its role in health and disease. Nutritional scientists in government, industry, and academia are constantly seeking to understand the role food plays in illness and well-being. Meanwhile health-care practitioners treat patients with nutritional plans and food supplements. Registered dietitians are health-care specialists who integrate food into medical treatment—this is referred to as medical nutrition therapy.

The Role of Food in Maintaining Health

Although the presence of adequate nutrition does not ensure health, it is a significant contributor. The energy contributed by the protein, carbohydrates, and fat in food provides the fuel for every element of body functioning from breathing to thinking to fighting disease to running marathons. Adequate energy intake is crucial to promote proper growth and development as well as to maintain healthy functioning once one is fully grown. Food also provides the materials necessary to build healthy bone, muscle, skin, hair, etc. For example, bone is a complex matrix of calcium, phosphorus, and collagen fibers. A person's bone strength is directly related to their nutrient intake such that inadequate calcium intake is one of the primary reasons for bone disease such as osteoporosis. Nutrients are also necessary to support proper chemical and neurological functioning. For example, fat insulates nerve fibers such that they can conduct electrical signals along the length of the body. Meanwhile, those electrical signals are generated via channeling ions such as sodium, potassium, and calcium into and out of the nerve cells. Finally, the neurotransmitters released from the nerve cells are made from amino acids contributed largely from proteins in the diet. Thus, thinking and feeling are intricately connected to food.

Food for Those Who Can't Feed Themselves

Food is generally eaten, or drunk, and swallowed. However, many people cannot obtain adequate nutritional levels by conventional ways of ingesting food. In the past, these people would suffer and die from malnutrition. Modern nutritional medicine offers people several alternatives to conventional chewing and swallowing of food so that those who cannot do so will not die. Liquid solutions have been manufactured by pharmaceutical companies that are easier to digest than solid food and provide 100 percent of nutritional needs. People who can drink but not eat rely on these formulas just as babies who cannot breast feed rely on baby formula to meet their nutritional needs. People who cannot consume anything orally are fed via a tube inserted into the stomach or intestines. Finally, those whose gastrointestinal tracts cannot absorb even liquids are fed intravenously with solutions that provide 100 percent of human nutritional needs.

Examples of Food as a Cause of Disease

Food allergies and intolerances are common medical reasons for eliminating specific foods from one's diet. An *allergy* is an immune response to proteins in food that the body identifies as foreign. The most common food allergies include those to peanuts, tree nuts, shellfish, milk, soy, corn, wheat, and eggs. Most allergies appear in childhood and require complete elimination of the offending food if the symptoms are to be eradicated. Childhood food allergies may persist for a lifetime or may resolve a few years after getting rid of the offending food. Symptoms of allergies may include rashes and other skin irritations, gastrointestinal inflammation and bleeding, and respiratory distress, which may even involve arrest of breathing.

Food intolerances are not allergies but rather uncomfortable reactions to food that are not generally considered life threatening. One well-known example is lactose intolerance. Lactose is the carbohydrate in milk and other dairy products. The body requires a specific enzyme if lactose is to be absorbed. As people age their bodies may make less of the enzyme necessary to break down lactose and as a result they may experience gastrointestinal distress, including such symptoms as gas or diarrhea, when they consume milk products containing lactose. Most people with lactose intolerance can tolerate dairy products if they accompany their meal with a lactase enzyme pill or if they consume dairy products pretreated with lactase enzyme. Thus, food technology allows people with intolerances to tolerate the offending foods but avoidance is the only option for people with food allergies.

In countries such as the United States where food is abundant, some of the greatest medical risks result from overeating rather than insufficient eating. For example, an excess intake of energy in the form of food leads to an increased risk of obesity. Obesity increases one's risk of cardiovascular disease, cancer, diabetes, and obstructive pulmonary disease—among the most common and most deadly diseases today. Medical practitioners have tried to determine how much food is adequate to support healthy living. People who consume too much food and become obese may seek medical treatment to lose weight and treat diseases resulting from obesity. Treatments may include nutritional therapy, exercise programs, drug therapy, or surgery. *Foodborne illness* results from eating contaminated food. Foodborne illness can be caused by parasites, bacteria, viruses, toxins, or other pathogens that are harmful to humans. Food is not the direct cause but rather the carrier of the problematic agent. The effects of foodborne illness can range from flulike symptoms to death depending on the type of pathogen and the amount of exposure. Foodborne illnesses are generally prevented by appropriate growing, harvesting, packaging, preparation, cooking, and storage of food. However, many countries lack the technology and resources necessary to accomplish this. Thus, assuring food safety continues to be an area of international concern.

Food as a Treatment

Food is not only necessary to sustain health but it can also help ill people regain health. Although the common advice to "feed a fever" may sound like folklore it is actually based in scientific evidence. A rise in body temperature is required in order to fight disease. People with a fever also require extra energy if they are to have adequate energy to maintain their strength while they battle illness. Likewise, the immune system uses a wide range of nutrients to combat intruders. All infectious diseases result in increased need for nutrition to strengthen the immune system as if fights against invading viruses or bacteria. People who suffer from diseases such as cancer, cystic fibrosis, and acquired immunodeficiency syndrome (AIDS) generally require extraordinarily large amounts of nutrients to battle their disease. Likewise, young children who are ill require extra food to ensure that they have adequate nutrition to ensure normal growth and development. Food is crucial in combating both minor and major illnesses.

Many specific nutrients defend against disease. Calcium, a mineral found mainly in dairy products, is critical in the promotion of bone health and protection against osteoporosis. Fluoride, now added as a supplement to most water supplies, is crucial to tooth development. Iron is most commonly found in meats and protects against anemia. Folic acid prevents neural tube defects such as spina bifida in developing fetuses and has recently been found to protect against cardiovascular disease. In fact, almost every vitamin and mineral is known to be critical to one or more life processes. Nutritional specialists and medical practitioners are constantly studying the role each nutrient plays in protecting the body and investigating further possible cures.

See also **Dietetics**; **Digestion**; **Disease: Metabolic Diseases**; **Enteral and Parenteral Nutrition**; **Health and Disease**; **Hunger, Physiology of**; **Immune System Regulation and Nutrients**; **Intestinal Flora**; **Microbiology**; **Nutrient-Drug Interactions**; **Nutrients**; **Nutrition**; **Nutritionists**; **Safety, Food.**

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Jessica Rae Donze

MEDIEVAL BANQUETS. Banquets during the European Middle Ages were often given on such important ecclesiastical feast days as New Year and Pentecost. But the greatest ones for which we have records were given for weddings and the coronation of kings or installation of bishops. There were also banquets for funerals, the coming of age (or knighting) of a son, or such lesser occasions as a harvest, the feast day of the patron saint of the local parish guild, various civic occasions, or even a tournament. Who was invited depended on the circumstances; wedding guests were apt to be family and close friends, as today, but many people of quite humble status would be included in festivities at a manor house.

This is not to say that banquets were frequent: they were very special occasions. Of the twenty-seven menus given in the fourteenth-century *Menagier de Paris*, a work compiled by an elderly Parisian for his young wife, only three are banquet menus: two for weddings and one for a civic event (Brereton and Ferrier, *Le Menagier de Paris*, pp. 175–190). The fifteenth-century English manor house of Dame Alice de Bryene, for which we have complete records of meals served over a period of a year (28 September 1412–28 September 1413), had only one major banquet that year, serving dinner to 160 people on New Year's Day. But it also provided fairly lavish meals to many of those involved in gathering the harvest in August, with several dinners for from forty to sixty guests, about twice the number usually present at Dame Alice's table.

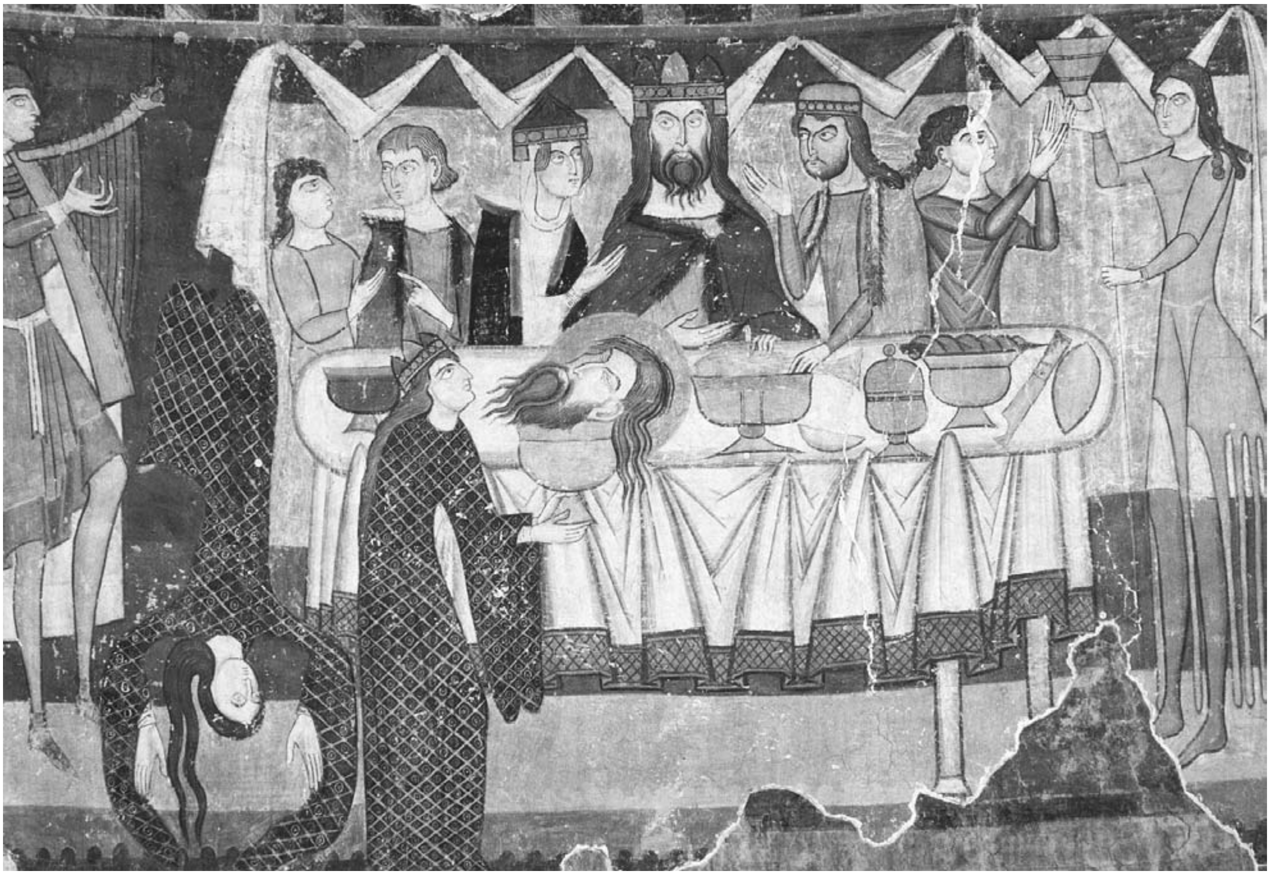
Menus

The food served was quite different in quantity, and in some respects nature, from everyday meals, which for most people were apt to start with (or, for the poor, consist of) vegetable pottages (soups or stews). For a banquet, vegetables, if any—in England, they rarely appear on feast menus—were vastly outnumbered by a parade of roasts or fish of all kinds, and more elaborate dishes. Even the pottages were usually ones considered as special treats, such as frumenty (a wheat or barley pottage) with venison, or a *blancmange* of chicken or fish in spiced almond milk, usually also containing rice.

What is most striking to the modern eye about the menus for important banquets is the number of dishes served. An extreme example is the banquet celebrating George Neville's installation as Archbishop of York in 1465, which had a first course containing seventeen dishes, a second with twenty, and a third with twenty-three—not counting the "subtleties," discussed below. Three was the normal number of courses for the high (head) table at an English banquet, two for lesser guests. At the coronation feast of Richard III, there were three courses for high table, two for the lords and ladies, and one for commoners—who included the Lord Mayor of London!

Usually the dishes given to those not at high table were a selection of those in the three-course menu, including the most basic dishes. A feature of the (fictional) thirteenth-century banquet of Walter of Bibbesworth (Hieatt and Butler, *Curye on Inglysche*, pp. 2–3) is that there was enough venison and frumenty for the "whole household," clearly suggesting that not everyone got a taste of all the goodies that followed.

Manuscript 279 in the British Library's Harleian collection gives two-course menus for "the lower part of the



Depictions of medieval banquets are not common in secular art, but in religious paintings, biblical stories are often shown as medieval events. In this case, the Banquet of Herod, during which Salome serves up the head of John the Baptist, appears as a medieval banquet complete with table linens and customary serving vessels. From the Convent of Saint John the Baptist. © SANDRO VANNINI/CORBIS.

hall" for the banquets celebrating the installation of John Stafford, Bishop of Wells, and the wedding of the Earl of Devonshire (Austin, pp. 63–64). In the first case, the two-course menu is a selection of seventeen of the forty-seven dishes on the three-course menu, but the wedding banquet has less overlap, substituting several dishes not found on the three-course menu. These are not all humbler dishes: they include Caudel Ferry, a dish of sweetened wine thickened with eggs, resembling a modern *zabaglione*, and doucetys, custard tarts.

Distribution of Dishes

Those lower in rank not only got fewer courses but also were served smaller portions. Only the host and any exceptionally high-ranking guest got an individual serving; other high-ranking guests shared dishes (messes), usually two to a mess. If there were lower-ranking guests, as there would have been at a manor house, they were more apt to dine three or four to a mess. Sometimes those of higher rank were so served, to judge by a German banquet scene showing a number of crowned ladies at the side tables being served four to a mess.

This does not mean that those at high table ate all they were offered. The lord (or lady) of the house was expected to give some of the choice dishes to others. The thirteenth-century "household rules" for the Countess of Lincoln, attributed to Bishop Robert Grosseteste, advise that her "dish be so refilled and heaped up, especially with the delicacies, that you may courteously give from your dish to right and left to all at high table and to whom else it pleases you." The fifteenth-century Latin poem *Modus Cenandi* tells us empty plates are to be brought to the host so that he may distribute delicacies to others, and many recipes tell us to allow a whole chicken for a lord but only a quarter for commoners ("The Way of Dining," Furnivall, pp. 231–257).

If the Countess of Lincoln was to offer food from her dish to others at high table, clearly even those honored guests were not served everything on the menu. Just how many they had to choose from in each course probably varied according to the wealth and generosity of the host. The fourteenth-century poem *Sir Gawain and the Green Knight* describes lavishness that is highly unlikely in real life when it states that the members of King Arthur's court at a New Year's feast had so many dishes that it was hard to find room on the table for them: "Every two had twelve dishes / Good beer and bright wine both" (translation of lines 128–129).

Order of Service

Generally there was soup or other pottage to start with, followed by meats (on a meat day), with the more commonplace boiled or roasted meat and fowl first; on a fish day, there would be salt fish. More "delicate" items, such as roasted wild birds and fresh fish, came next, along with other dishes, then sweet or richer foods including tarts and fritters. This order is already apparent in that banquet described by Walter of Bibbesworth, although there the pottages follow rather than precede substantial meats. But some fifteenth-century menus for grand occasions were so expanded that each course might run the gamut from soup to fritters.

The basic order is spelled out in *Modus Cenandi*, which calls for pottage to be followed by meat of large animals and fowls, then smaller ones, and finally "better dishes" (*fercula dant meliora*). This "natural rule" is also claimed in the *Liber Cure Cocorum*—that for a feast featuring fowl, the larger ones come first, then "bakyn mete" (mainly pies), with more dainty foods at the end. A similar order is found in continental banquet menus, with a few differences.

French banquet menus varied in the number of courses, but the basic model seems to consist of four courses. The first course was much like an English first course, except that it excluded roasts. Roasts, with some accompaniments, came in the second course, and more elaborate dishes (*entremets*) in the third. Any or all of these courses might consist of only one or two dishes, as is the case with one of the *Menagier*'s menus for wedding feasts. As in England, the French last course (*dessert*) usually included sweet dishes and/or fruit, although it might also contain meat or fish dishes we would not consider dessert today.

Italian banquets ran to more courses: eight, ten, and sometimes twenty or more courses, generally with two or more dishes in each. Sometimes they began with pasta dishes, but otherwise the order was much like the French: soups and meats in sauces preceded roasts. German banquets also ran to a good many courses, but most of them consisted of a single dish.

Setting and Protocol of the Banquet

The menu order, however, does not give the complete order of the banquet. The first thing given to all diners was water and a towel for washing hands, usually before they were seated at the table. They were seated strictly according to rank at tables which, for a large banquet, were arranged in a U-shape. The host and especially honored guests sat at the head (high) table, and the others at the side tables. The nearer a guest was placed to the host, the greater the honor. The principal salt cellar, often a very elaborate affair, was placed at the host's right hand: hence the saying that others sat "below the salt." Salt for general use was distributed in piles on pieces of bread that served as individual salt cellars.

On the table, guests would find bread, and often a knife, a spoon, and a napkin, but not a fork: fingers or pieces of bread were used to pick up food not eaten with a spoon. "Trenchers" of coarse bread were cut and placed in front of each diner to receive pieces of meat or fish. Wine and/or ale would soon be poured, but before the meal was served, grace was said. Food was brought from the (often distant) kitchen; the German banquet scene referred to above shows a servant bringing a pile of covered dishes, much like those used in restaurants today to keep food warm. Roasts were carved and served in the hall.

French banquets usually started with an aperitif, or *assiette de table* (as against the *première assiette*, first course). *Grenache*, a fairly sweet wine (compare modern French aperitifs), seems to have been usual, with such accompaniments as fresh fruits, butter, salad, or small meat or fish pastries. While English banquet menus do not mention aperitifs, John Russell's *Boke of Nurture* (Furnivall, *The Babees Book*, p. 122) advises serving soft fruits before dinner, and they would seem to be the same fruits recommended for the aperitif course in France.

It is thus possible that aperitifs may have sometimes preceded the first course in England. The English menus often omit mention of how the meal ended, although we know the custom was the same as in France: a sweetened, spiced wine was usually served with wafers, fruit and cheese being an alternative way to end the banquet. After grace and the final handwashing, the table was cleared (or removed) and more wine and candied spices followed, at least for the higher-ranking diners.

Entertainment

Anyone who has seen medieval pictures of banqueting scenes will have noticed musicians almost invariably present, blowing fanfares to herald the beginning of a course or playing to entertain the diners while they eat. Other entertainers might include minstrels, jugglers, mummers, or players putting on a pageant or interlude, a form of theatrical entertainment referred to in *Sir Gawain and the Green Knight.* This poem is also one of many sources of evidence that the guests themselves did a lot of singing and dancing. Since the banqueting in the poem takes place in the Christmas season, much of the singing and dancing consists of carols. But a major source of entertainment at a medieval banquet was apt to be culinary in nature, at least in part. This was what was known in England as a subtlety, usually a creation of sugar, marzipan, or pastry depicting one or more birds, beasts, or people, brought out at the end of every course. At the coronation feast of Henry V, the subtlety at the end of the first course was a (confectionery?) swan surrounded by cygnets, all of whom carried messages in their bills that were lines of verse. But that was not enough. Twenty-four more swans followed, each one carrying the last line of the poem. Some subtleties were considerably simpler, including foods decorated with a motto or appropriate symbol, such as a coat of arms.

In France, subtleties were known as *entremets*, indicating their placement between courses. But the situation is complicated by the fact that *entremets* were originally just interesting dishes brought out between courses: the *Menagier* considers any elaborate dish to be in this category, including jellies and frumenty. This explains why frumenty with venison, which invariably appears at or near the beginning of the first course in England, occurs in the third or fourth course in France.

Still, the French also prepared elaborate *entremets* that are certainly in the category of subtleties. One of the manuscripts of the *Viandier de Taillevent* contains a number of these, some of which are edible: for example, the "helmeted cocks" for which roasted chickens are mounted on roasted piglets, with paper helmets and lances, probably wooden but covered with foil. But the *Viandier*'s "painted entremets" are strictly decorations, made of wood and other inedible materials, depicting such subjects as a knight in a swan boat, sailing on a cloth sea.

See also **Christianity: Western Christianity**; **Middle Ages, European; Renaissance Banquets.**

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Constance B. Hieatt

MEDITERRANEAN DIET. The Mediterranean diet is defined variously. It sometimes refers simply to the dietary patterns and social mores surrounding eating in the countries bordering the Mediterranean Sea. In nutritional parlance the meaning is somewhat more confined. It applies to the traditional diet of European countries on the Mediterranean as characterized by foods and by patterns of nutrient intake.

Italy, Greece, France, and Spain are particularly associated with the diet because they were involved in the several ecological studies of dietary patterns, lifestyles, and coronary artery heart disease in the 1950s and 1960s led by Ancel Keys of the University of Minnesota (Keys, 1970, 1995; Keys et al., 1954). These landmark studies associated the relatively high dietary fat intake in those countries with a much lower prevalence of coronary artery disease than in the United States or northern Europe. Since dietary fat was thought to be the major culprit in coronary artery disease, this seemed remarkable at the time. Later discoveries linked saturated fat and cholesterol rather than total fat to heart disease risk. Olive oil, high in monounsaturated fat, and fish, high in polyunsaturated fat, which constituted the majority of the fat in the Mediterranean diet, were associated with lower risk. Other aspects of the food and nutrient profiles and lifestyles (for example, more physical activity, less smoking, etc.) may have contributed to low disease risk as well.

Reasons for Interest

Originally, interest in the Mediterranean diet was based on that association with decreased risk of coronary artery disease. The traditional Mediterranean diet included liberal amounts of fruits, vegetables, legumes, grains, and wine; high amounts of monounsaturated fats; moderate consumption of alcohol; liberal amounts of fish; and low amounts of meat and milk products. The diet was accompanied by a lifestyle that involved a good deal of obligatory physical activity, no smoking, and a relaxed attitude toward life. The actual diets were usually moderate in energy for physical activities. They were also relatively low in saturated fats and sugars and relatively high in most of the fat- and water-soluble nutrients and phytochemicals.

In the late twentieth century nutritional scientists attempted to examine whether or not the Mediterranean diet is associated with decreased risks of other diseases. Where traditional diets conforming to the Mediterranean pattern are eaten, health benefits seem to be present. In addition, the increased American interest in fine dining, ethnic cuisine, and food habits contributed to the popularity of the Mediterranean diet.

Evolution of the Mediterranean Diet Concept

Keys popularized the Mediterranean diet in the early 1970s, and other nutritionists, culinary experts, and commodity groups subsequently advocated it. In the early 1990s, Oldways, a group dedicated to preserving traditional eating patterns, joined members of the Harvard School of Public Health in conducting a series of conferences and other activities to popularize the Mediterranean pattern. This group published a healthy-eating Mediterranean pyramid based on the dietary traditions of the region.

Mediterranean Diet Pyramid

The Mediterranean diet pyramid is available at the website. W. C. Willett, and colleagues described it at length in "Mediterranean Diet Pyramid," published in the *American Journal of Clinical Nutrition* in 1995. The pyramid puts bread, other grain products, and potatoes at the base. The second tier is vegetables, including beans, other legumes, and nuts, and fruits. Third is a shallow tier for olive oil, and next is a cheese and yogurt tier. All of these foods should be consumed daily.

Near the top of the pyramid are small blocks for foods consumed a few times a week, including fish, poultry, eggs, and sweets. At the peak of the pyramid are foods consumed only a few times a month, including red meats, fats, oils, and sweets. The pyramid is accompanied by a wineglass to indicate "wine in moderation" and a running stick figure with the headline "regular physical activity" (Wilson, 1998).

Acceptable Alternative or Dietary Imperative?

Is consumption of a Mediterranean diet mandatory for good health? The notion of a single Mediterranean cuisine has been criticized on the grounds that no single such diet exists and that to contend one does promotes stereotypes and fails to account for the dynamic nature of dietary changes. Also, diets in the Mediterranean region and elsewhere in Europe change rapidly and no longer reflect those of yesteryear. Many healthful dietary patterns are associated with diets designed to reduce chronic disease risks. It is not necessary to consume diets similar to those traditionally eaten in the Mediterranean to stay healthy, but the Mediterranean diet is one alternative that provides an appropriate and healthful nutrient pattern.

Does the inclusion of Mediterranean-type foods make contemporary American diets healthier? This depends on a number of factors, chiefly how they are used. While decreased risk is associated with traditional Mediterranean diets, the patterns in these countries have changed a great deal since the early 1950s. They may not always provide all of the health advantages their traditional counterparts did, especially if food is eaten in excess. The specific health benefits of individual foods rather than the entire Mediterranean pattern are also unclear. Although most of the traditional foods are delicious and nutritious, other foods with similar nutrient compositions would seem to be equally effective. Therefore simply adding one or more "Mediterranean" foods to American diets does not necessarily provide positive health effects. The overall pattern in moderation has been linked to positive health outcomes.

During the late twentieth century, awareness of the considerable culinary and aesthetic advantages of the Mediterranean diet grew. Many staples of traditional Mediterranean diets have become popular and are widely available in the United States and other Western countries.

The plant-based Mediterranean diets of the early and mid-twentieth century were environmentally sound and responsible in the locales in which they flourished. Whether they are exportable and feasible on a large scale in other climates in non-Mediterranean countries is a matter of debate.

Traditional food habits typical of countries bordering the Mediterranean Sea in the mid-1950s have health and nutritional advantages. Guides for eating in the Mediterranean manner are readily available, but following their advice is not mandatory for good health.

See also **Africa: North Africa**; **Ancient Mediterranean Religions**; **Greece, Ancient**; **Greece and Crete**; **Italy**; **Rome and the Roman Empire**.

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Johanna Dwyer

MELANESIA. *See* **Pacific Ocean Societies.**

MENU. *See* **Places of Consumption; Restaurants.**

MESOAMERICA. *See* **Central America; Mexico; Mexico and Central America, Pre-Columbian; South America.**

MESOPOTAMIA, ANCIENT.

Cuneiform clay tablets from ancient Mesopotamia, the region between the Euphrates and Tigris Rivers (mostly present-day Iraq), preserve a few kitchen recipes dating from the eighteenth to the seventeenth centuries B.C.E. Except for these texts, the oldest recipes known, our information about food supplies and their processing is indirect: on the one hand, dictionarylike lists of foodstuffs and, on the other, administrative texts recording the acquisition and expenditures of raw staples and kitchen supplies. A few proverbs and literary passages occasionally give additional details. Although an enormous number of names of edible plants, animals, condiments, and the like is known, in too many cases their exact identification is not possible. In contrast with Egypt, food remains of ancient Mesopotamia, other than bones and seeds, are extremely rare (Ellison et al.). In Mesopotamia, cooking was considered to mark, alongside clothing, the beginning of civilization. To quote an ancient Sumerian poem ("The Debate between the Ewe and the Barley," Alster and Vanstiphout) describing prehistoric times:

> The men of those remote days
> did not have bread to eat,
> did not have clothes to wear.
> People went around with naked limbs,
> ate grass with their mouths, like sheep,
> drank water from the gullies.

The onset of historical time is metonymically described as "when bread was eaten in the shrines of the land, when the ovens of the light were burning" ("Gilgamesh and Enkidu," George).

Lexical Information

Extensive word lists covering the botany, zoology, and material culture of southern Mesopotamia are a typical element of cuneiform literature. Among the oldest intelligible tablets (c. 2900 B.C.E.) there are lists of cereal and dry meat products, vegetables and alliaceous plants, fish, and birds. These lists were expanded through the centuries, culminating after the fourteenth century B.C.E. in long classical lists that were in use until the second century B.C.E. In an encyclopedic compilation of twenty-four tablets, of an average length of three hundred lines each, there is one dedicated to domestic animals (XIIIth tablet), one to wild ones (XIV), one to meat cuts (XV), one to plants (XVII), one to birds and fish (XVIII), and two to foods and drink in general (XXIII–XXIV). In detail, Tablet XXIII has three long sections:

1. soups
2. beer and brewery products
3. flours and bread

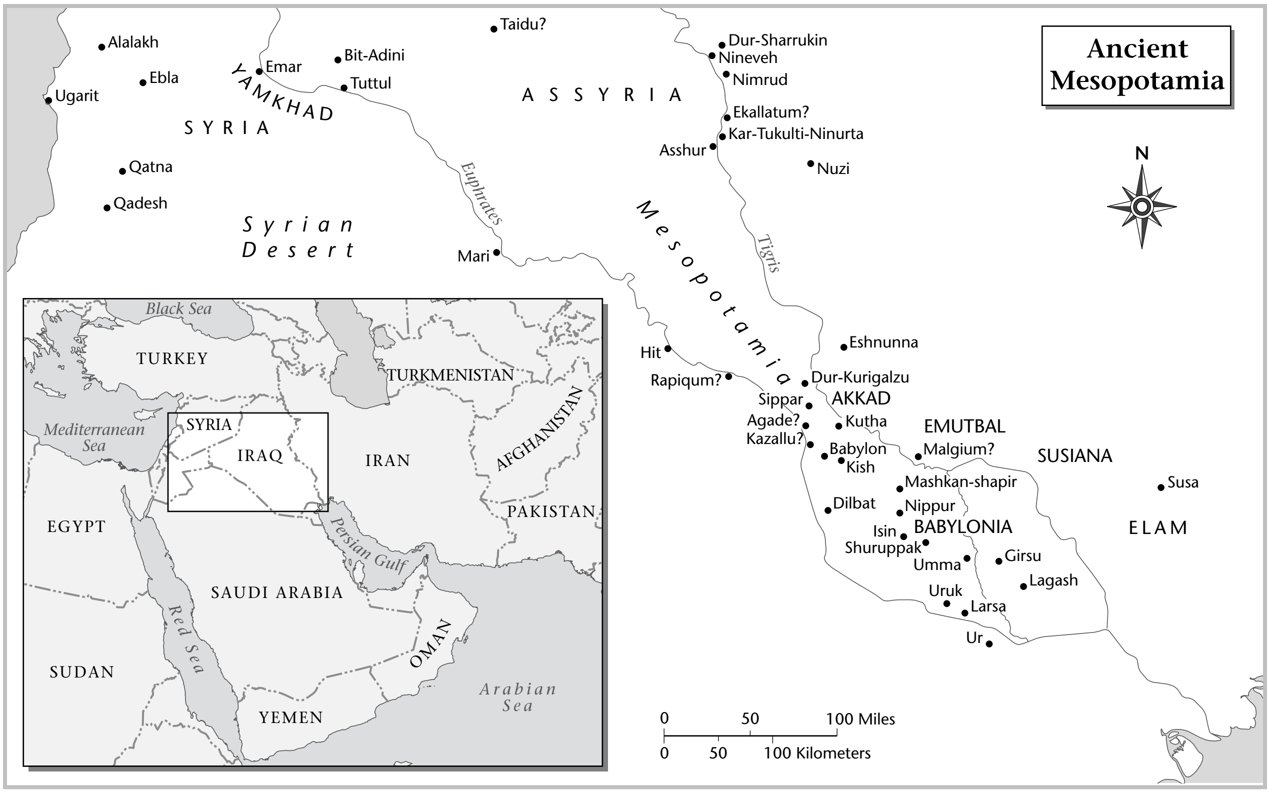
Tablet XXIV is more varied:

1. syrups and honey (12 entries)
2. oils and fats (53)
3. spices (11, also treated elsewhere in other tablets)
4. seeds (12, also treated elsewhere)
5. dairy products (34)
6. pulses (8)
7. emmer and wheat (10)
8. barley (67)
9. straws (10)
10. fruits: figs, raisins, pomegranates (10), dates (at least 38).
11. salt and condiments (12)
12. melons and cucumbers (8)

These lists are Sumero-Akkadian bilinguals (Mesopotamian culture was bilingual from its earliest days). Sumerian is an isolated language, but Akkadian is Semitic, a sister language of Hebrew and Arabic, and thus it is helpful in the identification of some food names, although too many uncertainties still remain. For instance, the names of the two condiments more often mentioned, after salt, in the texts of the end of the third millennium, are *gazi* and *zahili*. Neither of them is unambiguously identified.

Accounting

A meticulous and detailed accounting system is another typical feature of Mesopotamian civilization. Adminis-


Ancient Mesopotamia
N
Alalakh
Ebla
Ugarit
Emar
YAMKHAD
Bit-Adini
Tuttul
SYRIA
Taidu?
ASSYRIA
Dur-Sharrukin
Nineveh
Nimrud
Ekallatum?
Kar-Tukulti-Ninurta
Asshur
Nuzi
Qatna
Qadesh
Syrian Desert
Euphrates
Mari
Mesopotamia
Tigris
Hit
Rapiqum?
Eshnunna
Dur-Kurigalzu
Sippar
AKKAD
Agade?
Kazallu?
Kutha
Babylon
Kish
EMUTBAL
Malgium?
SUSIANA
Susa
Mashkan-shapir
Dilbat
Nippur
Isin
BABYLONIA
ELAM
Shuruppak
Umma
Girsu
Lagash
Uruk
Larsa
Ur
0 50 100 Miles
0 50 100 Kilometers
Black Sea
TURKEY
TURKMENISTAN
Mediterranean Sea
SYRIA
IRAQ
IRAN
AFGHANISTAN
PAKISTAN
EGYPT
Persian Gulf
SAUDI ARABIA
Red Sea
OMAN
SUDAN
Arabian Sea
YEMEN

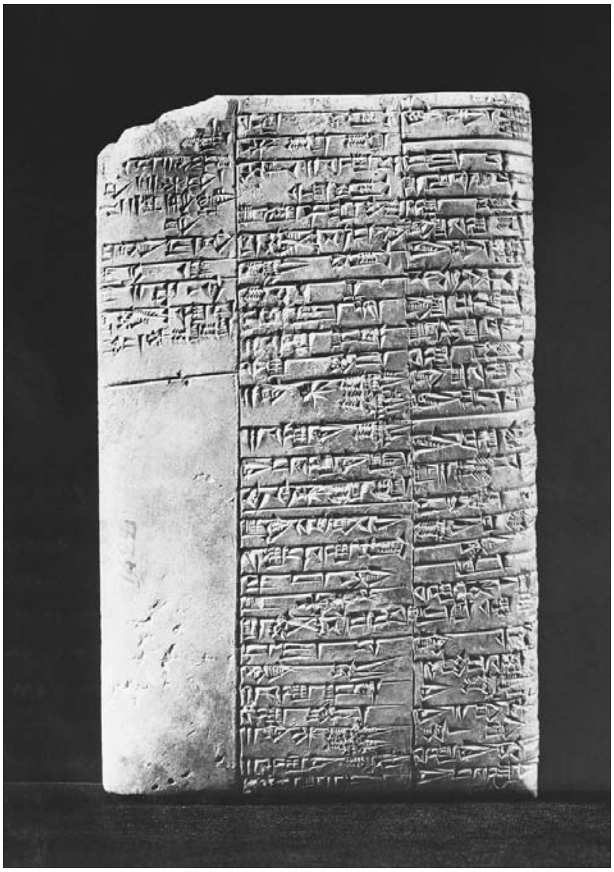
trative tablets, found by the tens of thousands, give a general idea of the circulation of goods, of supplies, their origin, and their destination. A substantial number of these tablets deal with alimentation. Thus, for instance, an archive of c. 2400 B.C.E. from the town of Girsu gives us detailed information about the teams of fishermen, their catch classified by species, the amounts regularly provided to the governor's palace, and so on. By their nature, these accounts give better information about the tables of the upper classses, and very little about the diet of the working population. What is known about the latter comes from payment sheets that show that a workman would get about six liters of barley for a hard day's work. Women and children were given less.

Cereal Products

Locally grown cereals, mostly barley and relatively small amounts of emmer wheat and wheat, constituted the nutritional base in ancient Mesopotamia. Cereals were consumed in the form of bread, soups, and beer.

Bread. Bread (Sumerian, *ninda;* Akkadian, *akalu*) must have been made, at least in some cases, from leavened dough. There are no direct descriptions, but allusions to its bulky size and to leaving the dough overnight to rest seem to be indications of fermentation. One may assume, however, that in most cases the bread was made from unleavened dough shaped into flat, round loaves, similar to the present-day Near Eastern *khubuz*. This bread was baked in a peculiar, ubiquitous type of oven called an *öurin* (Sumerian) or *tinûru* (Akkadian). It was a clay implement of cylindrical shape, tapering to a conical form in its upper part and with a side opening at its base. The whole was between 3 and 4 feet high. Once the oven was sufficiently heated, the flat, unleavened loaves were plastered to the side for baking. Salaries of the workers were often paid in bread. Roasted barley was sold in the streets and at the marketplace.

Alcoholic drinks. The Mesopotamian brewing process is relatively well known: the fermentation of a mixture of malt and barley bread, with the addition of sugar in the form of dates, produced different types of beer (Sumerian, *kaö*; Akkadian, *öikaru*) consumed by drinking with a straw from a communal jar. This beer had a short shelf life due to a certain instability caused, among other factors, by the absence of hops. Only in later periods, after the seventh century B.C.E., are there indications of the addition of an element, perhaps cuscuta, with a function similar to hops. Lists of supplies to brewers give the relative amounts of ingredients for various types of beer, but the absence of any indications about the processing does not allow any evaluation of the final product. The same ingredients can result in products of quite different taste and aspect, depending on the processing. A fermented beverage made of dates was also known. Chemical residues have identified some jars as wine containers in the late Uruk period, c. 3500 B.C.E. (Badler et al.). Wine, nevertheless, is mentioned rarely, and although there were some vineyards in the south, in the Lagash area and



This 4,000-year-old Sumerian tablet in the collection of the museum of the University of Pennsylvania is inscribed with one of the oldest known medical remedies. The ingredients are ground to a powder, then served to the patient in beer—a primitive form of medical dietetics. Other tablets in the same collection contain culinary recipes. © BETTMANN/CORBIS.

in the eastern hills toward Iran at the end of the third millennium, the climatic conditions were in general unfavorable for growing vines. The conditions were better in the north, in the hilly regions of Assyria. Some wine may have been imported from the northwest in Syria where the conditions were better. Consumption of alcoholic drinks, beer above all, seems to have been substantial. The rations given to the royal couriers and travelers consist always of bread and beer. There are lists of supplies for festive occasions, and drinking parties (*kaö-dé-a*, literally, "the pouring of beer") are mentioned. These parties—one could perhaps call them "receptions"—were celebrated for religious, social, or political reasons such as the visit of foreign ambassadors, often with the presence of the king and his court.

Animal Products

Meat, from sheep, goats, and cattle, seems to have been consumed regularly by the upper classes, only occasionally by the rest (Limet). Salted, dried strips of meat are mentioned already in the oldest texts. The use of meat must have been more extensive than sparse mentions in texts seem to suggest. The consumption of pork, initially frequent, seems to have declined after the beginning of the second millennium. The extreme south of Mesopotamia was an immense estuary with lagoons and marshes where fowl and fish were present in huge quantities. Fish is better documented for the older periods up to 3000 B.C.E. Whether the subsequent decline in fish consumption is real, for reasons of taste or availability, or apparent, due to administrative changes, is hard to say. Semitic populations seem to have held fish in low esteem. Fats for cooking were predominantly of animal origin (lard, tallow, suet); vegetable oils, presumably from sesame, were reserved mostly for cosmetic, ritual, and technical (tanning hides, cloth finishing, etc.) uses. For example, the total production of vegetable oil in the Girsu province in 2047 B.C.E. was some 14,445 liters, but none of it was earmarked for cooking. Dairy products, including clarified butter and various types of cheeses, were very important, but there are no indications about the consumption of fresh milk by adults; its preservation must have been severely limited by climatic conditions. Dairy fats were the only ones used in the confection of pastries. Hunting (enormous flocks of gazelles roamed the desert until a few centuries ago) is often described in royal commemorative texts but has left no trace in bureaucratic records and must have been a sport (lions and boars being a favorite prey) rather than a means to procure subsistence. As for more exotic foods, an Assyrian relief shows a servant carrying locusts impaled on long sticks.

Vegetables and Fruits

If close to a hundred names of green vegetables, as well as their parts and varieties, are known (from Tablet XVII of the compilation listed above), their use is poorly documented, due probably to their perishability, which made them unsuitable to be recorded by the bureaucratic administration. An exception are the alliaceous plants (onions, garlic, leeks), which are less perishable, and evidently much esteemed and consumed in large amounts by all levels of the population. There are detailed accounts of the production of onion beds. Lettuce was particularly appreciated, judging from its mention in literary texts. The names of many spices are known but, as usual, their identification is extremely difficult. The fruits more frequently mentioned are apples, figs, and pomegranates; the first two were often dried, and a ring of dried apples from the royal tombs of Ur (c. 2700 B.C.E.) has been exceptionally preserved (Ellison et al.).

The date palm occupied a place apart. It grew easily in extensive gardens on the southern plain and the tree production was the object of careful bookkeeping. Besides the fruit, which was eaten dried and was a source of a fermented drink, most parts of the palm were useful for making ropes, baskets, and ceiling beams. Date syrup seems to have been the main sweetener; beekeeping is

Recipes from Ancient Mesopotamia

Genuine cooking recipes, written about 1700 B.C.E., have been preserved on three cuneiform tablets in the collections of Yale University and are available in a professional edition and commentary by Jean Bottéro. One of them gives instructions to prepare "twenty-one meat soups and four vegetable ones" in a rather concise style. The other two are much more detailed, but the text is less well preserved. They are almost completely devoted to the preparation of fowl dishes. It is quite possible that these cuneiform tablets are survivors of a large collection of culinary works. The style of cooking described represents probably the activities of the cooks of some royal court, perhaps from the later part of the Larsa Dynasty (ended 1763 B.C.E.) since it appears from older texts that birds were a favorite dish at the queen's table. The interpretation of these recipes is hampered by the usual uncertainties in the identification of the spices and other ingredients, as well as in the meaning of some highly technical terms. Follow the translations of the recipes (adapted from Bottéro, 1995) for a simple soup and for a complicated dish of wild pigeon (additional comments in square brackets):

1. To prepare goat's kid soup. Singe the head, legs, and tail [the parts of the animal to be used], the meat will be ready. Prepare the water, add fat, onions, *samîdu* [a type of flour preparation, or a spice], leeks, and garlic bound with blood, crushed *kisimmu* [a type of cheese or coagulated milk], and an adequate amount of wild onion [*Allium desertorum*].

The addition of blood (of what animal is not specified, the kid's presumably here) as a binding and flavoring agent is frequent in these recipes. Amounts and cooking times are left to the experience of the cook.

2. To prepare wild pigeons (*amursânu*) in broth. Slaughter the wild pigeon and, after soaking it in hot water, pluck it. Once plucked, wash it with cold water and skin the neck, leaving attached to the body the skin with its meat. Cut out the ribs. Open the underbelly and remove the gizzard. Wash and soak the bird in cold water. Open and peel the membrane from the gizzard. Cut open and chop the intestines. To cook in broth, first put in a kettle the gizzard, intestines, and head, as well as a piece of mutton [fat], and cook it. Remove from the fire. Wash well [the bird] with cold water and wipe carefully. Sprinkle with salt and assemble all the ingredients. Prepare the broth, adding a piece of fat from which the gristle has been removed, some vinegar, *samîdu* flour, leek and garlic, mashed with onion, and if needed add some water. Let simmer. When it is cooked, pound and mash together leek, garlic, *andahöu* [a kind of onion], and *kisimmu* to add to the dish [follows a damaged passage in which apparently the pigeon is disjointed and the legs are covered with dough]. When everything is cooked, remove the meat from the fire, and before the broth cools, serve it accompanied with garlic, greens, and vinegar. Carve and serve. The broth can be consumed later by itself.

The kind of wild pigeon of this recipe is known to have been regularly supplied centuries earlier to the royal kitchens for its consumption by the queen and ladies of the court. These recipes also include instructions to make a sort of bread to accompany the fowl dishes. It was made of sifted *sasku* flour, a sort of semolina, mixed with milk and condimented with *siqqu*, a salty paste made from fish and crustaceans, akin to the garum of the Romans. It was kneaded "being careful that it remains pliant," and condimented with leek and garlic. Part was formed to line the bottom of the serving plate, and part to make small loaves (*sebetu*). It was left to rise, and then baked on the bread oven already described.

These are at present the oldest known recipes. Nothing has survived from the following centuries, except for a short isolated recipe written in a small tablet probably from the fifth or fourth centuries B.C.E. It describes the preparation of a spiced liquid in which to cook meat:

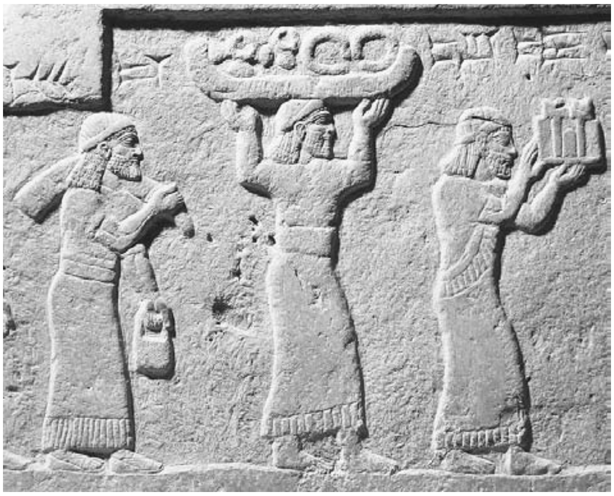
> The right amount of roasted *nuhurtu*, roasted [seeds of] mustard(?), roasted cuscuta, and roasted cumin. Boil slowly with [dried] cucumber in 6 quarts of water until it is reduced to 1 quart. Filter it. Kill the animal [to be cooked] and throw it [in the liquid].

This is a general-purpose cooking liquid for meat. The recipe illustrates once more the problems raised by the difficulties in identifying the ingredients.

not documented until very late times, and whenever the texts mention "honey," it must be generally assumed that it refers to date syrup. There are isolated allusions to mushrooms, but their consumption seems to have been considered a barbaric custom: the stereotyped ethnic description of the Bedouin nomads has them digging for truffles. Present-day Bedouins are still very fond of the white truffle (*Tarfezia leonis*) and of a smaller red-brown one, growing in the desert after rain from February to April.

Religious and Social Uses of Food

The sacrifice of cattle and smaller animals was an essential part of many religious rites, generally accompanied



Bas-relief on the ancient Assyrian throne of Shalmaneser III depicting offering bearers carrying various items of food. Courtesy of the Iraq Museum, Baghdad. © GIANNI DAGLI ORTI/CORBIS.

by bread, pastry, and beer libations. The only food taboo mentioned is the abstinence from fish and leeks by some type of priests (and by some evil spirits). Banquets and dining halls, but with very vague information about the dishes served in them, are mentioned in the mythological and historical texts. Meat dishes (lamb mostly, rarely beef) and beer are invariably included in the menu.

In 879 B.C.E., the Assyrian king Assurnasirapli II boasts, on an inscription on a stele (Grayson, pp. 288–293), of having given a gigantic banquet, on the occasion of the inauguration of his new palace, for no fewer than 69,574 guests, from workers to dignitaries, local and foreign. The supplies for this banquet give an idea of the requirements of the Assyrian gourmet, leaving aside the question of the historical precision of the round numbers: 1,000 oxen, 1,000 calves, 14,000 sheep, 1,000 lambs, 500 deers, 500 gazelles, 1,000 large birds, 500 geese, 500 cranes, 1,000 mesukku-birds, 1,000 qaribu-birds, 10,000 pigeons, 10,000 turtle doves, 10,000 smaller birds, 10,000 fish, 10,000 akbiru (a small rodent), 10,000 eggs, 10,000 containers of beer, 10,000 goatskins of wine, 10,000 jars of a hot condiment, 1,000 boxes of fresh vegetables, and large quantities of honey, pistachios, roasted grain, pomegranates, dates, cheeses, olives, and all kinds of spices. These are the highlights of a list thirty-six lines long on the stele.

Kitchens and Utensils

Professional cooks (Sumerian, *muhaldim*; Akkadian, *nuhatimmu*), assigned to palaces, temples, and other institutions, are known from remote antiquity. The common name for the kitchen was "the cooks' house," or "the cooks' room." The most frequent type of bread oven, often encountered in the ruins, has already been described above. The names of larger ovens, called *udun* and *kir*, are also known, but their physical features are difficult to ascertain. Although remains of large ovens and fireplaces of various types have been found in archeological excavations, there is no comprehensive study so far of their characteristics. Cooking and serving utensils, from large kettles to soup bowls, are known by name, but it is not easy to assign these names to the various types of clay and metal containers recovered by the archaeologists.

Recipes

There was a tradition according to which the kitchen recipes came from Enki, the god of wisdom and knowledge. Thus, one reads in a literary text: "King (?)ulgi will have a banquet in his pleasant palace after large beautiful dates mixed with raisins, butter from the holy sheepfold, and the sweetest (date) honey have been worked together, and the sweets have been mixed with fine flour, according to the good instructions of god Enki" (unpublished translation). This passage describes the preparation of a very traditional type of cake (Sumerian, *ninda-ì-dé-a*; Akkadian, *mirsu*). The administrative "shopping lists" give at times the ingredients for a given dish or confection. From them one can infer that this cake required, for instance, the following proportion of ingredients: fine flour: three cups; clarified butter: one-fourth cup; dates: one cup. Small amounts of cheese or raisins were occasionally added. This of course is not really a recipe; it tells what, but not how.

See also **Food Archaeology; Greece, Ancient; Middle East**.

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Miguel Civil

METABOLIC IMPRINTING AND PROGRAMMING. It has long been recognized that environmental influences during early development have profound and long-lasting effects on humans and other animals. Metabolic imprinting describes a subset of such effects, comprising subtle but persistent responses to prenatal and early postnatal nutrition. This article will describe how the term "metabolic imprinting" was conceptualized and will provide some examples of putative metabolic imprinting phenomena to illustrate the important roles they may play in human health.

Background

A growing body of human epidemiologic data suggests that the quality and quantity of nutrients available during prenatal and early postnatal development can affect susceptibility to various adult-onset chronic diseases, including cardiovascular disease, type-II diabetes, and hypertension. Some of the earliest indications of such relationships were gleaned from ecological data showing a regional correlation between infant mortality and mortality from cardiovascular disease several decades later. These data led researchers to postulate that a poor environment that causes high infant mortality could also impair the development of surviving infants, increasing their susceptibility to cardiovascular disease in adulthood.

David Barker's group in the United Kingdom bolstered the ecological data by collecting retrospective data on individuals. By linking obstetric records from the early 1900s with mortality records from several decades later, his group found that individual birth weight was related inversely to adult cardiovascular disease mortality. In numerous populations in industrialized countries, similar relations were later found between birth weight and morbidity and mortality associated with cardiovascular disease, coronary heart disease, and type-II diabetes. Viewing birth weight as a proxy for the quality of the prenatal environment, these relations were interpreted to indicate that prenatal factors (such as maternal nutrition) could "program" the development of adult chronic disease. Extensive epidemiologic research investigating this so-called "fetal origins" hypothesis is underway. However, the inherent weaknesses of human epidemiologic research in this field, including the long period of follow-up from exposure to outcome and inability to accurately adjust for various potential confounding variables, limit our ability to draw causal inferences from epidemiologic relations alone.

The Concept of Metabolic Imprinting

It remains unknown whether developmental responses to fetal and early postnatal nutrition are major determinants of chronic disease susceptibility in humans. Understanding the biological mechanisms underlying such phenomena in appropriate animal models should help to gauge their potential importance to human health. The term "metabolic imprinting" was proposed to provide a framework for the investigation of such biological mechanisms. Metabolic imprinting encompasses adaptive responses to specific nutritional conditions early in life that are characterized by 1) susceptibility limited to a critical ontogenic period early in development (the critical window), 2) a persistent effect lasting into adulthood, 3) a specific and measurable outcome, and 4) a dose-response relationship between exposure and outcome (Waterland and Garza, 1999). "Programming" has been used as a more general term to describe effects that occur when "an early stimulus or insult, operating at a critical or sensitive period, results in a permanent or long-term change in the structure or function of the organism" (Lucas, 1991; p. 39). However, imprinting, first used to describe the setting of animal attachment behavior based on early experience, more effectively conveys the important characteristics of the phenomena under consideration. As Konrad Lorenz noted, ethological imprinting occurs only during "a quite definite period" in the animal's life and the imprinted behavior "cannot be 'forgotten' " (Lorenz, pp. 126 and 127). The remainder of this section will discuss the most salient features of metabolic imprinting.

Adaptive responses are those that contribute to survivability of the organism. Limiting the scope of metabolic imprinting to adaptive responses excludes persistent effects of severe nutritional deficiencies or exposure to toxic levels of specific nutrients during critical stages of development. For example, it is well established that neural tube defects can be caused by maternal folate deficiency during early embryonic development. Also, fetal exposure to pharmacological levels of vitamin A can cause teratogenesis. Clearly, both of these examples represent persistent effects of early nutrition, but neither is adaptive. It may seem illogical to propose that adaptive responses putatively characterized as metabolic imprinting could contribute to adult chronic disease susceptibility. However, adaptive responses in early development are not necessarily beneficial throughout an individual's life. A metabolic response that increases prenatal or early postnatal survivability in one environment may prove detrimental to the individual in a different environment or at a later ontogenic stage.

The "critical window" criterion in the definition of metabolic imprinting limits consideration to effects resulting from nutritional perturbation of developmental pathways. Mammalian development occurs in stages. At each stage, specific processes must be completed in a limited time frame to enable progression to the next stage. A given nutritional stimulus may have diverse effects, depending on the developmental processes underway during the stage at which the stimulus is applied. Therefore, each specific metabolic imprinting phenomenon should have a finite critical window.

To illustrate, the fertilized mammalian egg proceeds through a series of reductive cell divisions (cleavage) to the formation of the three germ layers (gastrulation), to the establishment of organ rudiments (organogenesis), to the stage of histogenesis, when cellular differentiation results in the formation of specialized cell types and, lastly, to metabolic differentiation, during which the specialized functions of the different cell types proceed toward functional maturation. Organogenesis requires inductive interactions between adjacent germ layers. Hence, during organogenesis, localized concentrations of diverse nutrients or their metabolites could alter organ structural development by interacting with these signaling systems. As another example, the wave of rapid cell proliferation that follows cellular differentiation in various organs puts a high demand on the nutrients necessary for the synthesis of cellular components. Transient deficiencies (or excesses) of these food-derived precursors during limited periods of rapid cell proliferation could result in permanent alterations in cell number and, hence, metabolic activity.

Examples of Putative Metabolic Imprinting Phenomena

It should be emphasized that metabolic imprinting remains a theoretical construct intended to provide a framework for investigations into the biological mechanisms linking early nutrition and adult chronic disease susceptibility. Research is underway to identify candidate phenomena that satisfy the criteria of metabolic imprinting. This discussion therefore focuses on candidate phenomena that appear most consistent with metabolic imprinting.

Retrospective studies linking birth weight to adult chronic disease outcomes represent by far the most numerous class of epidemiologic data in support of metabolic imprinting. Studies of many different populations have found that individual birth weight is related to adult risk of coronary heart disease, hypertension, type-II diabetes, stroke, overweight, and other disorders. In most cases, there is a simple inverse correlation, with adult disease risk increasing as birth weight decreases. Some adult outcomes, such as type-II diabetes, appear to follow a "U-shaped" relation with birth weight, with adult risk increasing at very low and very high birth weights.

Proponents of the fetal origins hypothesis conclude that these examples demonstrate that nutritional status during critical periods of fetal life influences the development of diverse organ systems, leading to effects on adult chronic disease risk. As discussed above, however, there are many limitations to the interpretation of such long-term retrospective epidemiologic studies. Moreover, there are several reasons that birth weight is not an ideal proxy for fetal nutritional status. For example, maternal nutritional status during pregnancy is just one of many factors that determine infant birth weight. Also, an individual's genetic makeup could influence both fetal growth and adult susceptibility to a specific disease, leading to an association between birth weight and adult chronic disease that is not mediated by fetal nutritional environment. Conversely, it is likely that fetal nutrition can affect metabolic development without affecting birth weight. Hence, a misplaced focus on birth weight as the major early-life predictor of adult chronic disease susceptibility could result in a gross underestimation of the importance of metabolic imprinting to human health.

For these reasons, studies of human populations with documented exposure to extreme nutritional conditions in early life are an important source of support for the metabolic imprinting hypothesis. The best characterized of such populations comprises individuals exposed perinatally to starvation during the Dutch famine of 1944–1945. In 1976 Gian-Paolo Ravelli and co-workers published an analysis of Dutch military draft induction records of 300,000 young men and found that, compared to those born in non–famine-stricken control areas, men who were exposed to famine conditions at some time during the first six months of fetal development experienced an 80 percent higher prevalence of overweight. In contrast, those exposed to famine during the last trimester of gestation and/or the first five postnatal months experienced a 40 percent lower prevalence of overweight. Perinatal famine exposure was later related to adult glucose tolerance in several hundred individuals from the Dutch famine cohort. During standardized glucose tolerance tests, plasma glucose concentrations were higher in adults who had been exposed prenatally to famine than in individuals born before the famine. Because the timing, severity, and geographical extent of nutritional deprivation caused by the Dutch famine were well documented, these studies are not weakened by the methodological issues inherent to observational studies predicated on birth weight.

In the only large-scale experimental trial designed to investigate metabolic imprinting–like phenomena in humans, Alan Lucas and co-workers randomized preterm infants to receive standard infant formula, a special preterm formula, or banked breast milk during the first month of postnatal life. At the start of the trial, none of the feeding alternatives were clearly superior for preterm infants, allowing ethical randomization of early diet in this cohort of several hundred individuals. In this ongoing study, long-term follow-up has already shown that subtle differences in early postnatal diet affect cognitive development and bone mineralization in childhood. Conversely, childhood growth, body composition, and blood pressure were not associated with the early dietary exposure.

Controlled experimental investigations in animal models have demonstrated the biological plausibility of metabolic imprinting. Such studies have confirmed that subtle variation in prenatal and also early postnatal nutrition can affect adult outcomes including glucose-stimulated insulin secretion, blood pressure, body weight, organ structure, and lipid metabolism. Guided by the framework of metabolic imprinting, future animal studies of candidate phenomena should identify the tissues responsible for their effect persistence and characterize their critical windows to generate testable hypotheses about the effects of early nutrition on specific developmental processes.

Significance

Subtle nutritional perturbation of developmental pathways may have an important impact on human health. The immediate challenge for researchers in this field is to elucidate the specific mechanisms by which nutrition influences biological development in appropriate animal models. Doing so will suggest specific areas of focus for future research into the biological links between early nutrition and adult metabolism in humans. Clearly, the potential importance of gaining this information is great, especially in populations that continue to be at high risk for marginal nutritional status in early life.

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METAPHOR, FOOD AS.

"The essence of metaphor is understanding and experiencing one kind of thing in terms of another" (Lakoff and Johnson, p. 5). Many aspects of social and cultural life are talked about and experienced in terms of food. This kind of comparison occurs easily because of the systematic organization of food and food habits within each culture. Through language and through daily practices, food is ordered in terms of the categorization of foods, the organization of food production and consumption, and the linguistic expressions about food and eating. Cultural systems of food and food habits form conceptual frameworks that are metaphorical in nature. In other words, food, as anthropologist Claude Lévi-Strauss tells us, is good to think with.

Food can serve as a metaphor for family, religion, sex, gender, social position, and group identity, among other things. These principal metaphors appear across cultures, but are organized locally as different peoples speak of different foods and equate them with specific elements of their lives. The following overview of food as metaphor provides explanations of the different metaphorical constructs with a variety of specific local examples.

Food as a Metaphor for Religion

Food is a powerful metaphor for sacrifice, order, obedience, self-discipline, purity, generosity, and other key values in religious and ritual life around the world. Special rules and practices concerning dietary standards and ceremonial behavior distinguish and make concrete complex values and belief systems.

For example, Jewish food practices revolve around kashruth, the dietary laws outlined in the Old Testament books of Deuteronomy and Leviticus. Kashruth prohibits the consumption of pork, shellfish, reptiles, and amphibians and calls for the strict separation of dairy and meat foods. Anthropologist Mary Douglas interprets this regulation of food as part of a larger process of ordering the natural world according to social and moral precepts. By systematizing everyday experience into categories of clean and unclean, kashruth provides a practical foundation for understanding theological classifications and the proper relationship to God. The value of order is reiterated in the Passover seder, a ritual meal that metaphorically reenacts the Jews' flight from slavery in Egypt.

In the Hindu belief system, food is a metaphor for body, mind, and spirit. Daily and ceremonial rituals of food-giving demonstrate the values of generosity and selfless service. Fasting and dietary self-control are metaphors for mental clarity and religious authority, while prohibited or improperly prepared foods are believed to cause spiritual unrest and poor health. Anthropologist R. S. Khare notes that Hindu holy people are highly sensitive to individual foods and must strictly monitor their diets in order to maintain physical, mental, and spiritual balance.

Food as a Metaphor for Sex and Gender

Ideas about "Man the Hunter" and "Woman the Gatherer" permeate understandings of gender in contemporary Western societies. The man who "brings home the bacon" is a competent provider for his family; "he's a meat and potatoes man" connotes a hearty appetite and robust character. These and other sayings connect masculine qualities such virility and strength with the provisioning and consumption of meat. After all, "real men don't eat quiche."

Among the indigenous peoples of Papua New Guinea, food production, gender relations, and human reproduction are intertwined in a metaphorical cycle of energy exchange. Men are credited with cultivating staple crops to meet the nutritional needs of the community, while women's task is to raise children, supplying the next generation of "manpower." In this context, men's agricultural practices are understood in terms of feminine procreative abilities. Watering the crops is likened to breast-feeding, and men who are actively cultivating their gardens are subject to the same food taboos as pregnant and nursing women (Meigs).

Food is not only used to communicate ideas about gender roles; it can also express overtly sexual qualities. Food acts as a visual metaphor for sex in many art forms. It can convey voluptuousness and sensuality (a lingering shot of ripe fruit), temptation and the arousal of desire (oysters as aphrodisiacs), and consummation and fulfillment (sharing food as an exchange of bodily juices). Food is also used in linguistic metaphors when food items are compared to body parts in scatological references to sexual activity, and, more generally, as terminology for sexual "appetite," "hunger," and pleasure is common also for food and eating.

Food as Metaphor for Family

Food can be used metaphorically to talk about and enact various elements of social interaction and organization, one of which is the family. Cross-culturally, the family represents many things. It is a basic form of social organization, an economic unit, and a structure for social and cultural reproduction.

In some societies, growing certain crops, distributing food, and preparing food are the responsibility of one side or another of the family—of the woman's side of the family in some societies (Richards), of the man's side in others (Weiner). Food production and preparation represent and enact the extended family networks that structure kinship-based models of social organization.

In many contemporary Western societies, the nuclear family is often the basic economic unit, in which money for food provisioning and then food preparation are centered. The way people organize their food and meal-related activities also helps define the roles of individuals in the household. These roles may be gendered or age-dependent. The pleasure of eating and serving food becomes a metaphor for the structure and emotion of family relationships (Ochs et al.). A family discussion about food preparation tasks, or about who eats what and why, may also actually be a more concrete means of addressing issues of household division of labor, family power structures, and family dynamics.

When family commensality takes place around a table, or around a cooking hearth, the place for the meal is a metaphor for family solidarity. Indeed, in many cultures the hearth is thought of as the center of the home—home in the sense of family space.

The affective and sensory aspects of food, as well as shared experiences of foods, can help cement the family unit via associations of certain foods with specific people and events. For example, the smell of a roast turkey may evoke fond memories of a time when family comes together. In this way, tasting and reminiscing about food items metaphorically bring up family members and family bonds without explicitly mentioning them. Recipes and food-related stories also provide links between generations and help ensure the transmission and reproduction of cultural practices and family, ethnic, local, and national identities.

Food as Metaphor for Social Hierarchy

Regulation of food and food habits is a persistent metaphor for social stratification. Such varied systems as class, caste, and status can all be thought of in terms of food. For example, food as class positioning arises in discussions of people and their consumption patterns. In the consumer societies of North America and Europe, eating caviar and foie gras and drinking expensive Champagne are seen as consuming luxury goods and are associated with the wealth of the upper classes. In certain Andean countries, the kind of starch eaten most frequently marks overlapping boundaries of class and ethnicity, with potatoes consumed by poor, rural farmers of Native American descent and white flour and bread consumed mainly by the more wealthy urbanites of European descent (Weismantel).

Food as Group Identity: Local and National Identities

The idea of food as metaphor for the eater's identity comes across clearly in popular parlance. For example, the expression "You are what you eat" goes beyond the physical realities of the human digestive process and nutrient absorption. It compares one's existence to one's eating habits and can extend to others' existences—and, hence, to people's perceptions of others and their ways of labeling others.

National identity. People's nationalities are sometimes spoken of in terms of the foods they eat. Not always positive, food stereotyping can be pejorative, as in the case of the French being called "frogs" by the British and the British being referred to as "roastbeefs" by the French. While food metaphors can deconstruct identities, they also construct them.

Anthropologist Emiko Ohnuki-Tierney analyzes Japan's elaborate mythic histories, rituals, and public debates about rice as attempts to define the essence of a distinctive national identity. As a central metaphor in Japanese culture, rice is surrounded by a complex system of beliefs: each grain of rice is a living being with its own soul; "the Deity of the Rice Paddies" is a benevolent, peaceful figure embedded in the agrarian landscape; the soul of the deity is manifested in the perfection of rice grains; eating rice is a religious act as the consumer ingests the spiritual energy of rice and the rice god. Rice is also a focus of artistic and literary production: writers extol the beauty of rice, and painters idealize agrarian society. In daily life, a meal is not complete without rice, women are judged by their ability to cook it, and family cohesiveness is expressed by serving rice from a communal bowl. Efforts to restrict the importation of "foreign" rice reveal the extent to which Japanese notions of self- and national-identity are intertwined with this staple food.

Local identity. Preserving local food habits both practically and metaphorically promotes the survival of a variety of local and ethnic groups because community members experience and transmit their local identity in terms of food-related experiences. For example, in some minority cultures of the southeastern United States, such as the Gullah of South Carolina and Georgia, community-centered storytelling, recipe-sharing, cooking instruction, everyday food preparation techniques, and festival rituals maintain cultural identity by preserving the specificities of rice-based foodways (Beoku-Betts).

Sometimes local identities are constructed or maintained in the face of more encompassing identities. In this sense, food is a metaphor not only for the specific local identity in question, but also for political and cultural resistance. Some French farmers promote local, artisanally produced foods against the pressures of globalization in the food industry. For example, José Bové has made headlines in the United States and in Europe by leading demonstrations against international food companies, such as McDonald's, and by promoting his locally produced Roquefort cheese outside the doors of international trade meetings.

Conclusion

Not just figures of speech, metaphors express relationships of ideas, using the terms of one conceptual system to achieve understanding of another. As frameworks for thinking about the world, metaphors are shaped by their cultural context. Yet food-based metaphors crop up around the globe. Food and food systems are "good to think," often serving as a metaphor for complex issues such as family, religion, sex and gender, social position, and group identity.

See also **Gender and Food**; **Religion and Food**; **Sex and Food**; **Women and Food**.

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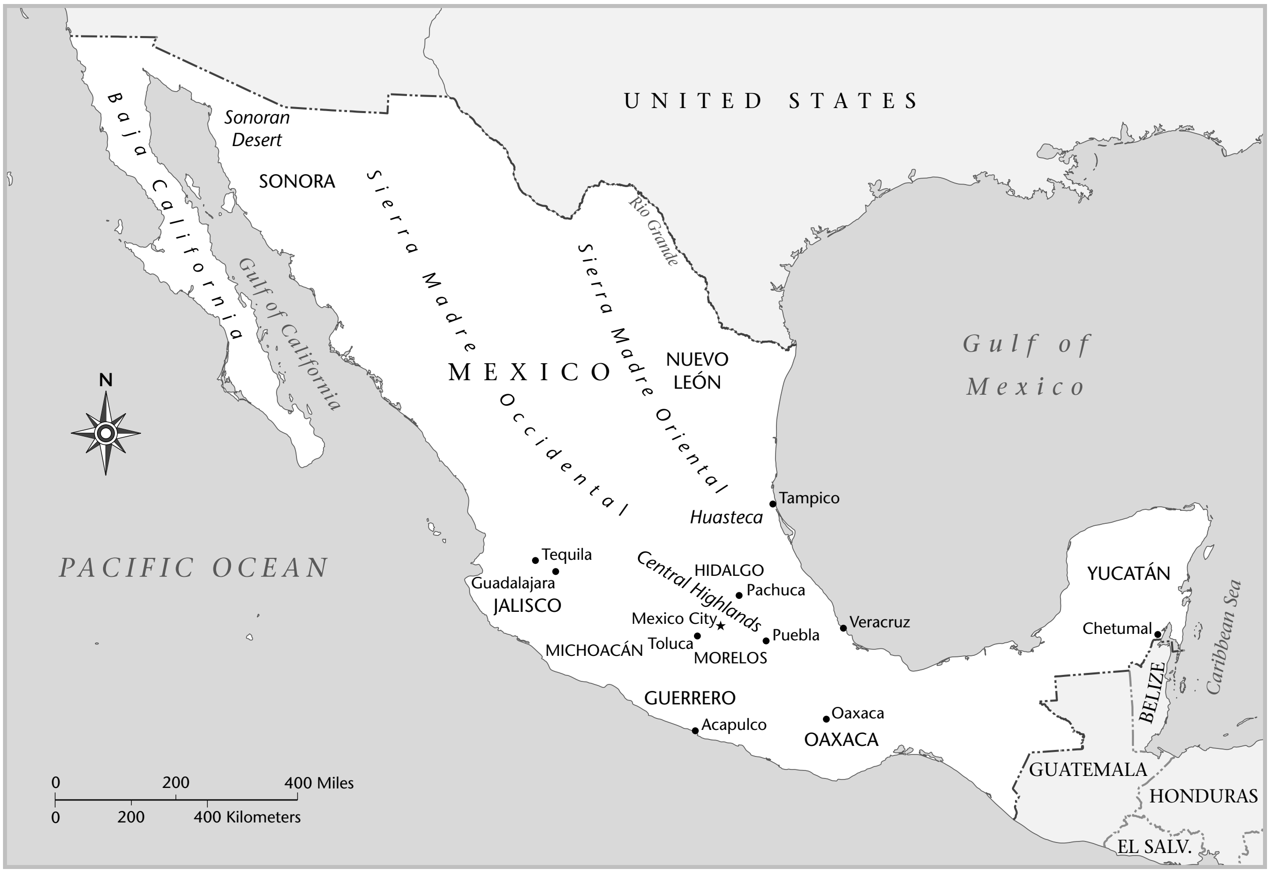
Wendy Hunnewell Leynse
Ramona Lee Pérez

MEXICO. The Mexicans form a mestizo nation, born of the intermarriage of Spaniards and Native Americans, and their foods reflect this mixed heritage. Before the conquest of Mexico by the Spanish, the indigenous people created a sophisticated cuisine based on the staple grain maize (corn), which they cooked in a multitude of fashions, from everyday tortillas (griddle cakes) to festive tamales (dumplings). The conquistadors, hoping to establish a New Spain in the Americas, transplanted their familiar foods, particularly wheat bread, which was the foundation of the Mediterranean diet and the only grain accepted by the Catholic Church for the Holy Eucharist. Royal officials attempted to segregate Hispanic and native societies throughout the colonial period (1521–1821), but widespread race mixing occurred nevertheless. Ethnicity became a function more of culture than color, and eating corn or wheat, like speaking Spanish or Nahuatl, denoted a person's status. While the staple grains


UNITED STATES
Sonoran Desert
SONORA
Baja California
Gulf of California
Sierra Madre Occidental
Sierra Madre Oriental
Rio Grande
MEXICO
NUEVO LEÓN
Gulf of Mexico
N
Tampico
Huasteca
PACIFIC OCEAN
Tequila
Guadalajara
JALISCO
Central Highlands
HIDALGO
Pachuca
Mexico City
Toluca
Puebla
MORELOS
MICHOACÁN
Veracruz
YUCATÁN
Chetumal
Caribbean Sea
BELIZE
GUERRERO
Acapulco
Oaxaca
OAXACA
GUATEMALA
HONDURAS
EL SALV.
0 200 400 Miles
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remained largely separate, culinary blending took place among the condiments, as indigenous cooks incorporated European meats into their moles (chili pepper stews) while Hispanics adopted native chilies and beans. The rejection of European doctrines of racial superiority came only after the revolution of 1910, when Mexicans accepted *mestizaje* as the national identity, and the combination of wheat bread and corn tortillas as the national cuisine.

In addition to class and ethnic divisions, Mexican cuisine contains tremendous regional variation. Perhaps the simplest classification consists of three complementary pairs: the mestizo foods of the central plateau and the indigenous center of Oaxaca in the south; foods of the frontiers of the Maya in the southeast and of Spanish settlement in the north; and the distinctive foods of the Gulf and Pacific coasts. Although Spanish influence tended to prevail in the north while the Indians better retained their culture farther south, no simple formula can capture the disparate topographies, climates, and settlement patterns that combined to produce these rich regional cuisines.

This diversity notwithstanding, a number of characteristics, common throughout Mexico, compose an identifiable national cuisine. As the original site of the chili pepper's domestication, Mexico has both the greatest botanical wealth of chilies, with some ninety different varieties, and the highest per capita consumption, since virtually no Mexican considers a meal complete without some kind of peppers. The structure of the meal, with a succession of individual courses, unifies the Mexican dinner table and distinguishes it from the combination plates found in restaurants north of the Rio Grande, which jumble together the rice—properly eaten before the main course—with the beans that should follow. A common calendar also exists, combining religious feasts such as Christmas and Easter, secular holidays like Independence Day, and community and family celebrations of saints' days and weddings, each with their own traditional foods. The Mexican diet has been changing recently as a result of globalization and the spread of both junk food and haute cuisine, but these influences represent merely the latest in a long series of culinary encounters.

Cosmic Cuisine

José Vasconcelos helped define the Mexican national identity in *La raza cósmica* (*The Cosmic Race*, published in 1927), which rejected Social Darwinist views about the problems of race mixture and instead proclaimed mestizos to be the highest form of human evolution. This new nationalist ideology, called *indigenismo*, brought about the revalorization of Mexico's native heritage, including the indigenous cuisine based on corn. But embracing the pre-Hispanic past did not imply a rejection of Spanish contributions to Mexico's development, especially wheat bread and European livestock. Many other ethnic groups also contributed to Mexico's "fusion" cuisine, from African slaves and clandestine Jews in the colonial period, to European and Chinese immigrants in the nineteenth century and Lebanese and North Americans in the twentieth century.

One of the most fundamental cultural clashes between Native Americans and Spaniards in the colonial period revolved around the staple grains, corn and wheat. Maize not only provided the nutritional basis of pre-Hispanic civilizations, accounting for as much as 80 percent of the caloric intake of common people, it also served as the basis for religion and identity. Spanish missionaries therefore sought to substitute the European wheat as part of their work of extirpating the idolatry associated with indigenous corn gods, but their evangelical mission was undermined by economics as well as taste. Corn made an ideal subsistence crop, growing well in all manner of ecological niches from the tropical forests of Yucatán to the mountains of the central plateau. Wheat, by contrast, was here a fragile plant, susceptible to disease, requiring lavish irrigation, and offering comparatively low yields even under the most favorable circumstances. As a result, corn remained the staple crop of the rural masses in both native and mestizo communities, while wheat was grown as a market crop for wealthy Hispanic city dwellers. The price differential between wheat bread and corn tortillas persists to the present day, as do many of the stereotypes formed during the colonial period. Affluent Mexicans invariably keep wheat bread on the table, even when serving dishes such as mole, which is more properly eaten with corn tortillas.

The greatest European influence on Mexican cuisine came from the introduction of livestock. Before the Spanish arrived, the native inhabitants consumed a basically vegetarian diet incorporating only two domesticated animals, turkeys and dogs. The deaths of millions of Native Americans due to Old World diseases such as smallpox and measles, against which they had no natural immunities, opened up large amounts of formerly cultivated land for grazing. With no competitors, the cattle, sheep, goats, and pigs, and chickens brought by the Spanish reproduced at a fantastic rate, although their numbers soon declined through overgrazing. During the colonial period, the elite retained the Spanish preference for mutton, and only the poor consumed beef. Over the course of the nineteenth century, with the adoption of French fashions, the consumption of beef surpassed that of mutton. Mexicans also developed an elaborate art of *tocinería* (sausage and other pork products), and pork fat became the invariable cooking medium, despite European preferences for olive oil and butter. Culinary blending occurred through the incorporation of chili peppers into Spanish dishes such as chorizos (sausages) and *adobos* (marinades). Although Native Americans initially rejected the taste of lard, they eventually learned to add it to tamales and beans, improving their taste and texture.

The complexity of culinary blending can best be seen in the debate over the origins of the national dish, *mole poblano*, an elaborate festival food of turkey served in a deep brown sauce of chili peppers, diverse spices, and a small amount of chocolate. Anthropologist Margaret Park Redfield, who studied the foods of a native community near Mexico City in the 1920s, at the height of the *indigenista* movement, described mole as an essentially pre-Hispanic legacy of chili cookery. Fifty years later, disillusioned by the Mexican government's refusal to respect indigenous rights, anthropologist Judith Friedlander examined a neighboring village and reached the opposite conclusion: that mole, with its numerous Asian spices, had been imposed by Spanish missionaries. A third interpretation, based on popular legend rather than scholarly analysis, attributed the complexity of *mole poblano* to the Baroque artistry of the city of Puebla, where colonial nuns supposedly combined Old World spices with New World chilies to symbolize the mestizo "cosmic race." The lack of pre-Hispanic and colonial culinary literature makes it impossible to resolve the question definitively, but all three versions probably contain an element of truth.

Successive waves of immigrants, despite their relatively small numbers, have added significantly to the culinary blending of Spanish and Native American. Jews fleeing the Spanish Inquisition came to the colonies, par-

Coca-Cola
Coke

Woman preparing tortillas with salsa and beans in Mérida, Mexico. © Robert Holmes/CORBIS.

ticularly the northern province (now state) of Nuevo León, where their distinctive dish, *cabrito* (roasted kid), remains a regional specialty. African slaves meanwhile diffused their skills with rice agriculture throughout the Caribbean basin, including coastal Mexico. In the eighteenth century Italians began arriving from Naples, then part of the Spanish Bourbon empire. They had already established noodle factories in Mexico City by the 1790s, not long after the industry was founded in southern Italy. After independence in 1821, British miners brought with them a taste for meat pies, called *pastes*, around Pachuca (Hidalgo), site of the Real del Monte silver mine. German immigrants opened up breweries, and by the twentieth century their beers had supplanted the native beverage pulque, the fermented juice of the maguey (century [agave]) plant. French foods were the most fashionable among the nineteenth-century Mexican elite; nevertheless, all of these immigrant foods underwent a process of nationalization, so that Parisians today would scarcely recognize many of the dishes served under French names in Mexico City.

More recent immigrants have also left their mark on Mexican cooking, although none more so than the fast-food invasion from the United States. Large numbers of Chinese settled in northwestern Mexico in the late nineteenth century after the United States passed exclusion laws forbidding them entry. Then in the 1920s Lebanese immigrants began arriving, particularly in Puebla and Yucatán, and the gyro became the inspiration for *tacos al pastor* (shepherd's tacos). By the 1940s industrial processed foods from the United States had acquired enormous popularity among the rising middle class. Aunt Jemima pancakes became a favorite breakfast food, while Coke and Pepsi battled for the soft drink market. Moreover, these imports had to compete with domestic products such as Pan Bimbo, a Mexican clone of Wonder Bread. The spread of junk foods to even the most remote indigenous communities by the 1970s further complicated Mexico's diverse gastronomic geography.

Many Mexicos

Of the many culinary regions in Mexico, none exhibit the mestizo blending to a greater extent than the central highlands. The city of Puebla, legendary home of *mole poblano*, illustrates Iberian cooking techniques used on native ingredients through the production of *camotes* (candied sweet potatoes). Toluca is known for superb chorizo sausages combining pork with chili peppers. In the state of Hidalgo, shepherds pit-barbecue lamb wrapped in the leaves of the maguey to make a local specialty called *mixiotes*. Nahua Indians in the states of Mexico and Morelos cook *nopales* (cactus paddles), squash blossoms, and *cuitlacoche* (corn fungus) in quesadillas (corn pastries fried in pork fat). All of these different foods, and indeed the culinary traditions of the entire country, can be found in cosmopolitan Mexico City, with its countless markets, restaurants, and street vendors.

Oaxacan cuisine. In contrast to this cultural blending, indigenous communities such as the Zapotecs and Mixtecs in the southern state of Oaxaca have preserved their traditional foods. Unlike the complex blend of spices in *mole poblano*, the Oaxacan *mole verde* (green mole) derives its pristine taste from a few simple chilies and herbs, most notably the anise-flavored *hoja santa*. Oaxacan cooks wrap tamales in banana leaves instead of the corn husks common farther north, and they have raised tortilla making to a high art with the large, soft *blanditas* and *tlayudas* as well as the crisp *totopos*. The tiny grasshoppers known as *chapulines*, another local specialty, are flavored with smoky *chipotle* chilies and eaten in tacos with guacamole.

The Gulf Coast. Cooks along the Gulf Coast prepare seafood in both Mediterranean and pre-Hispanic styles. The snapper Veracruz (*huachinango a la veracruzana*) served in the eponymous port city contains olives, olive oil, tomato, capers, and only the mildest green peppers. Farther up the coast, at Tampico, one can sample the fiery hot crab soup called *chilpachole*. In the northeastern tropical forest of the Huasteca, ethnic groups such as the Totonacs make more than forty different types of tamales, including the legendary meter-long *zacahuil*, which can feed an entire village. Other seafood specialties of the region include baked pompano, *robalo al mojo de ajo* (snook cooked in garlic), and various seafood soups, cocktails, and *escabeches* (pickled seafood).

The Pacific Coast. The most typical food of Pacific Coast states is not from the sea at all, but rather *pozole*, a hominy stew made with pork. This dish comes in a number of different varieties, red in Guadalajara, green and white to the south in Guerrero, and with tripe in the northern state of Sonora. A common street food, eaten late at night, *pozole* is served with chili powder, oregano, chopped onion, sliced radishes, shredded lettuce, and limes for squeezing. In port cities such as Acapulco, the citric acid of lime juice is used to "cook" fresh seafood into *ceviche*. The Purépecha Indians of Michoacán prepare a variety of distinctive tamales, most notably the triangular *corundas* and fresh-corn *uchepos*.

Yucatán. Mexico's southeastern frontier, the Yucatán peninsula, is home to the ancient Maya civilization, whose pre-Hispanic traditions can still be found in dishes such as *papadzules*, the "food of the lords." These enchiladas, made entirely of native ingredients, require the freshest possible tortillas, to avoid the need for frying with pork fat. They are stuffed with chopped hard-boiled eggs in place of cheese, then covered in two sauces: a green *pipían* made of pumpkin seeds and a tomato sauce lightly flavored with habanero chilies. Yet the Maya have also adapted to the latest trends of globalization with the *queso relleno*, a large Dutch cheese, imported duty-free at the port of Chetumal, and stuffed with *picadillo* (chopped meat filling).

Northern cuisine. The Mexican foods best known in the United States, wheat flour tortillas and beef fajitas,

Tzotzol Maya prepare tortillas at dawn at Joigelito, Chiapas, Mexico. © Danny Lehman/CORBIS.

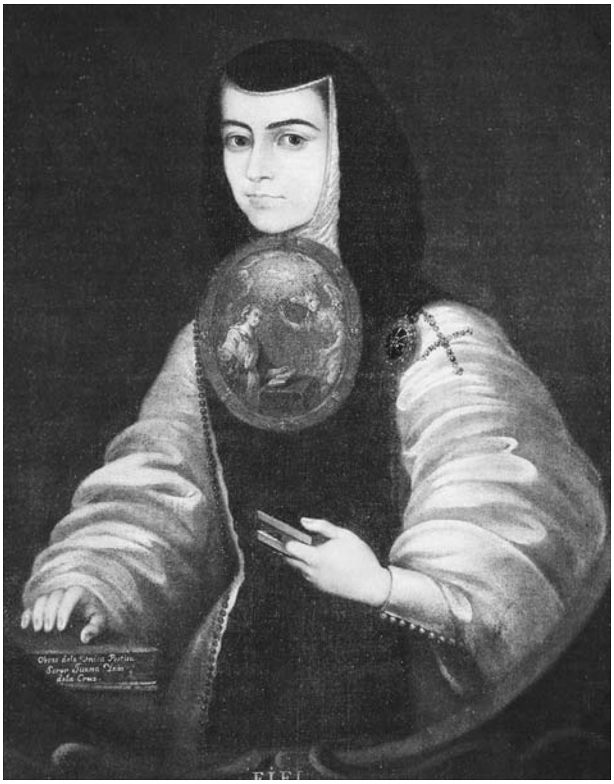
exemplify the cuisine of northern Mexico. Wheat tortillas represent a mestizo adaptation of Native American cooking techniques to the European grain in areas where expensive milling and baking facilities were unavailable. The finest wheat tortillas are from the Sonoran desert, where settlers learned to roll them into paper-thin, eighteen-inch rounds. Fajitas illustrate how working-class Mexican Americans took an inexpensive yet flavorful cut of meat, the flank steak or diaphragm muscle, then tenderized and cooked it in thin strips. Restaurateurs devised the sizzling iron plate as a fancy way of presenting an ordinary taco—bits of meat rolled up in a soft tortilla—although Mexicans generally eat corn rather than wheat tortillas. Another Tex-Mex food, chili con carne, was the simplest of moles: just beef, chili powder, oregano, and cumin. The addition of beans to chili probably began with Anglos, because it violates Mexican ideas about the proper sequence of a meal.

Daily Bread and Tortillas

The foods eaten daily by rich and poor Mexicans differ significantly, but there is nevertheless a common structure to their meals. Work in the fields governs the eating habits of campesinos (rural laborers), who generally take two meals, a small breakfast before men set off in the morning, and a more substantial dinner when they return in the evening. To have fresh tortillas ready for breakfast, women traditionally had to awaken several hours earlier to grind corn on a basalt metate (concave grindstone) and pat it out by hand into thin disks. Because tortillas grew hard and stale after a few hours, they had to be cooked on a *comal* (earthenware griddle) before each meal; the *nixtamal* (dough) likewise kept poorly, so the laborious grinding had to be repeated each day. One of the most significant social changes in Mexican history came in the first half of the twentieth century with the spread of mechanical mills capable of grinding the moist *nixtamal.* Freed from this onerous daily burden, women had the time to engage in commerce and craft production and thus begin to challenge the male domination of society.

In contrast to the austerity of the working class, wealthy Mexicans traditionally ate large amounts of food. The day began with *desayuno*, a simple breakfast consisting of a bread roll and coffee or hot chocolate, followed in midmorning by a substantial brunch, *almuerzo*, consisting of perhaps *mole poblano* or an omelette. The main meal, *comida*, began about two o'clock in the afternoon and progressed through an invariable sequence of four courses: a wet soup such as chicken broth, a dry soup of either rice or spaghetti, a main plate of roasted or stewed meat, and then beans. The elite accompanied their meals with imported wine, while members of the middle class drank the native pulque in the nineteenth century, and more recently beer. After awakening from an afternoon siesta, Mexicans took a *merienda* or snack of sweets, then returned to work for several hours. The *cena* or supper was taken quite late at night, often in cafés, with street foods such as enchiladas or tacos.

Class and ethnic distinctions were manifested less in the foods themselves than in their place within the daily routine. Native Americans in Oaxaca and elsewhere introduced European foods at the periphery, for example, by eating wheat bread for breakfast, while retaining the



Sor Juana, otherwise known as Juana Inés de la Cruz, was not only the most intellectual woman in 17th-century Mexico, she compiled the oldest surviving Mexican cookbook on confectionery. Consisting of 36 recipes, it is today a foundation text for the study of cloister cookery in the New World. Portrait courtesy of the Philadelphia Museum of Art/CORBIS.

indigenous staples corn, beans, and chilies for their main daily meal. By the same token, the Hispanic elite consumed European foods for the central *comida*, and sampled lower-class foods of indigenous origin during the evening *cena*. Indeed, "slumming" at an all-night taco stand is still a favorite diversion of stylish Mexico City youth. The recent spread of an American-style workday, without the lengthy afternoon *comida* and siesta, has caused considerable loss of business for many upscale restaurants. Nevertheless, the traditional eating habits are preserved in numerous festivals throughout the year.

Celebrating Saints and Feeding the Dead

The festival foods of Mexico are as extravagant as the campesino diet is meager. Pre-Hispanic calendars contained numerous feasts dedicated to indigenous deities, which were replaced by Catholic holy days after the Spanish arrived. Each native community adopted a patron saint, and the inhabitants dedicated their meager savings to celebrating the saint's day with lavish abandon. Women worked for days with little rest to feed the entire community with dishes such as mole, tamales, and chocolate. These same elaborate foods were also prepared for family ceremonies including weddings, christenings, and funerals. The wealthy Hispanic society also feasted on such occasions, although their foods tended to feature more imported goods from Europe. In recent years, traditional festival foods have even replaced French cuisine in the most fashionable restaurants.

The primary feasts of the Christian calendar—Christmas, Easter, and All Saints' Day—are celebrated throughout Mexico. The traditional Hispanic Christmas Eve feast includes an elaborate salad of lettuce, fruit, nuts, and beets, followed by *bacalao a la vizcaína* (Biscay-style cod), made with tomato, olive oil, olives, and capers, and served with wheat bread and wine. Indigenous and mestizo families celebrate the Nativity with tamales and mole instead of imported luxuries. Good Friday features fish, lentils, *romeritos* (dried shrimp fritters with greens) and *capirotada* (bread pudding). All Saints' Day is stretched out over three evenings, from 31 October to 2 November, known as the Days of the Dead. Families decorate the tombs of deceased relatives and construct altars incorporating salt, water, candy skulls, and *pan de muerto* (bread of the dead), decorated with strips of dough resembling human bones.

The most important civic holiday, Independence Day, celebrated on the eve of 16 September has no definite culinary traditions. There are many tricolor dishes, most notably *chiles en nogada*, stuffed green chilies with white walnut sauce and red pomegranate seeds. Nevertheless, the essence of the holiday is the *grito* or cry of independence repeated by public officials in plazas throughout the country, which lends itself not to elaborate cookery but to simple street foods: tacos, fritters, beer, and tequila.

Traditional festival foods have provided the basis for the latest trend, *la nueva cocina mexicana*, which combines Native American ingredients with the techniques of international haute cuisine. This "new Mexican cuisine" actually began in the 1950s, with dishes such as corn fungus *cuitlacoche* served in crêpes with bechamel sauce, invented by Jaime Saldívar to make a lower-class indigenous food acceptable for elite tables. By the 1990s hybrid dishes like *huauhzontle* pesto, pistachio mole, and *cuitlacoche* mousse had become ubiquitous on menus, and no fashionable Mexico City restaurant could avoid offering some version of the rose petal sauce invented by Laura Esquivel for her best-selling novel, *Like Water for Chocolate.* Many of these restaurants were owned by women, who thereby rejected the male dominance of Mexico's traditional society. Meanwhile, in the town of Tequila (Jalisco), firms such as Sauza and José Cuervo had improved their distilling technology to a level equal with that of the finest Scotch whisky and French cognac.

The *nueva cocina* represents simply another example of Mexico's ongoing gastronomic blending. Ever since the Spanish Conquest, cooks have combined native and European ingredients and techniques to create a sophisticated and original cuisine. It was only after the revolution of 1910 that Mexicans embraced their mestizo heritage, including the indigenous foods made of corn. The acceptance of diverse regional culinary dialects came, moreover, just as many rural cooking traditions began to be lost because of migration to urban areas and the arrival of mass-produced foods from the United States. Despite the spread of soft drinks and snack crackers, the elaborate tamales and moles prepared to celebrate festivals remain a vital source of identity within families, communities, and the Mexican nation.

See also **American Indians: Prehistoric Indians and Historical Overview; Chili Peppers; Day of the Dead; Iberian Peninsula; Inca Empire; Maize; Mexico and Central America, Pre-Columbian; United States,** *subentries on* **Ethnic Cuisines** *and* **Southwest**.

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Jeffrey M. Pilcher

MEXICO AND CENTRAL AMERICA, PRE-COLUMBIAN. When the Spanish conquistador Hernán Cortés set foot on the beach in the Mexican state of Veracruz, he encountered advanced cultures whose existence had not been previously suspected. The great Aztec empire, ruled by a people called the Mexica, had conquered much of the region, establishing a city of grand temples and causeways called Tenochtitlán, while the rainforest cities of the Maya were slowly returning to the jungle after being abandoned several centuries earlier. Cultures including the Totonac, Tlaxcalans, and Zapotec also met the Spanish at this time, some as friends, others as enemies. All, however, impressed many of the Spanish with their cities, governments, markets, and material goods that rivaled those of the Old World. The food and cuisine of these cultures of present-day Mexico and Central America, an area termed by anthropologists and archaeologists as Mesoamerica, are the subject of discussion here.

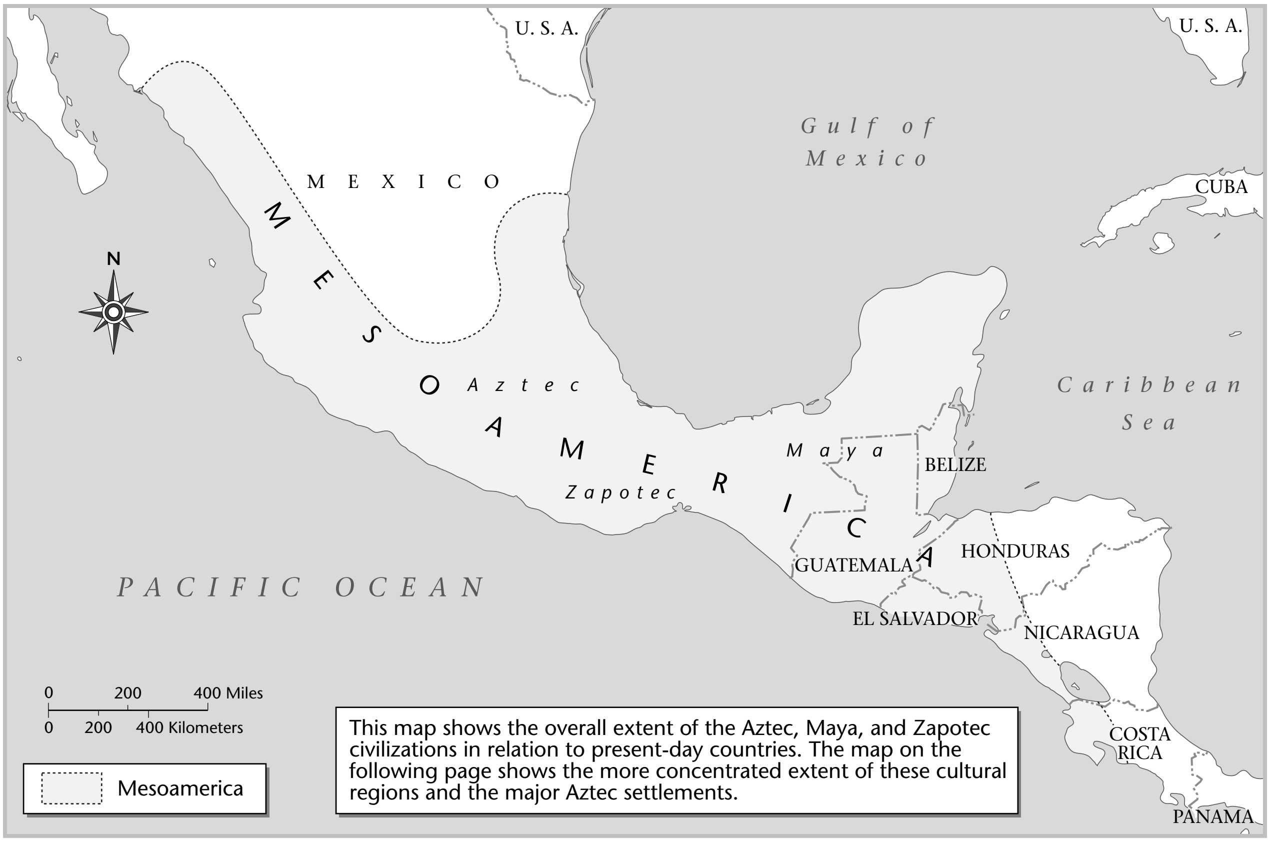
While these cultures lived in different areas, had different forms of social and political organization, and spoke a variety of languages, there were certain shared traits, including an intricate calendrical system, hieroglyphic writing, and a distinct architectural style. These cultures all made use of corn, beans, squash, chili peppers, chocolate, and domesticated dogs and turkeys. Despite some differences in preparation and availability of ingredients, many of the dishes and their style of preparation in these varied cultures were very similar.

Evidence for Pre-Columbian Cuisine

How do we know what and how ancient people ate? Fortunately Mesoamerica provides several lines of evidence. The documents written by the early Spanish conquistadors offer invaluable insight into the customs of early Mesoamerican civilizations. Many priests and nobility accompanied the explorations of Columbus and Cortés and learned and recorded the language, customs, and beliefs of the indigenous cultures. These documents reveal methods and techniques of food preparation, farming techniques, and available ingredients.

Archaeology provides a second line of evidence for reconstructing the foodways of these cultures. Whereas the colonial documents record what the Spanish witnessed or were told by their informants, archaeology, and the subdisciplines of paleoethnobotany and zooarchaeology, provide material evidence invisible in the ethnohistoric record. The Spanish did not often take note of foods eaten by the commoners, and without modern scientific nomenclature, it is sometimes difficult to determine exactly what plant or animal the Spanish were talking about. Archaeology often helps to clarify these problems.

The translation and interpretation of the writing and iconography of codices, the term for pre-Columbian and early Colonial books, pottery, and other works of private and public art, also provide evidence for pre-Columbian food use. Decipherment of Mayan hieroglyphs on ceramic vessels, for example, gives new insight into their use, and lists of tribute items demanded by the Mexica of their dependents show us what food items were kept in their central storehouses.



This map shows the overall extent of the Aztec, Maya, and Zapotec civilizations in relation to present-day countries. The map on the following page shows the more concentrated extent of these cultural regions and the major Aztec settlements.

Grains

All cultures utilize a staple food around which the rest of their cuisine is based; in Europe and the Middle East it is wheat, and in the Far East, rice. In Mesoamerica, the staple undoubtedly was corn, or maize (*Zea mays*). And not only was maize the primary foodstuff, forming the basis of virtually all meals, it had spiritual and religious significance as well. From birth, when the umbilical cord would be cut over a maize cob, to death, when a small piece of maize dough was placed in the mouth of the deceased, maize played a central role in the cultures of Mesoamerica. According to the *Popol Vuh*, the "bible" of the Maya, humans are not made of earth but rather were formed from maize dough.

Maize was prepared in a variety of ways, depending on the time of year, the race of maize, and the particular meal. For the most part, however, maize was prepared by a process called nixtamalization. The ripe maize grains were first soaked and then boiled in water mixed with burned and ground limestone or ash. After boiling, the maize kernels were ground to varying degrees on a *metate*, a flat grinding stone, and this resulting dough was used in all manner of preparations. The boiling in lime or ash makes the maize easier to grind, as well as creating a chemical reaction that makes it much more nutritious. Combined with beans, another important Mesoamerican crop, nixtamalization provided an almost complete nutritional package.

Once processed, maize was prepared either as a solid breadstuff or as a beverage. The term "beverage" is helpful for describing certain dishes, but these preparations could easily be called a gruel, porridge, or even a stew, especially with the addition of different foods. Maize dough was also soured by being stored in containers or wrapped in leaves used just for that purpose, much like sourdough bread.

Atolli is the Nahuatl term for a beverage made from the most finely ground maize dough mixed with water. Whole maize kernels, beans, chili pepper, marigold leaves, toasted squash seeds, and even boiled and mashed root crops, especially sweet potato, were stirred into the beverage, creating more of a stew or soup. Honey or, in the Mexica and Zapotec areas, maguey syrup, could be added for sweetness. Elite and commoner alike consumed *atolli*, although the finest, bone-white maize was reserved for the nobility, as was the addition of cacao seeds. It was generally drunk in the mornings, although it could complement a meal at any time of day.

Tortillas and tamales formed the basis of the solid breadstuffs. Tortillas are cakes of maize dough flattened to varying degrees of thickness and cooked on a ceramic griddle called a *comal*, on a hot stone, or simply over the hot ashes of a fire. *Comales* are frequently found in archaeological deposits throughout central Mexico, attesting to the importance of the tortilla in the daily diet, and

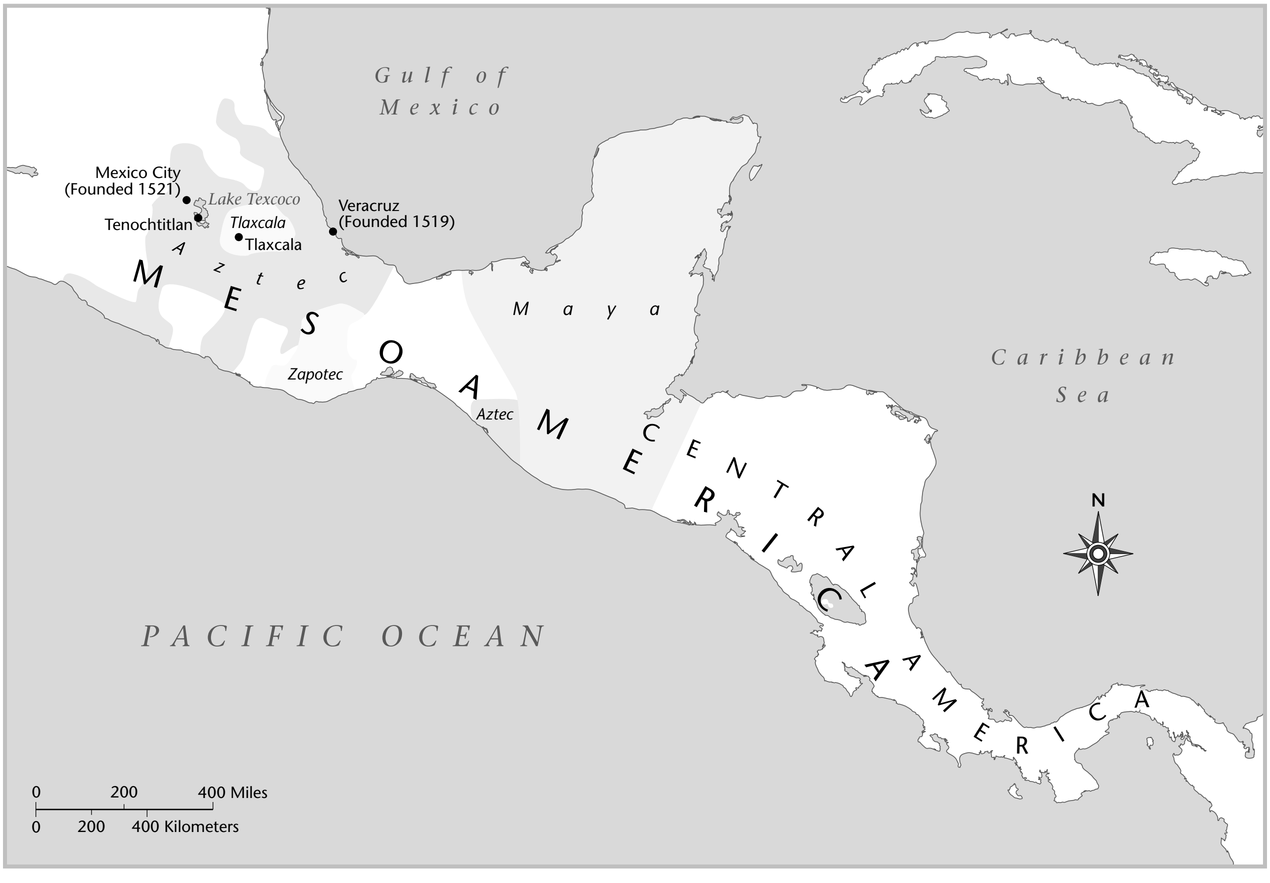
Spanish documents mention that many women were brought along on long journeys or during warfare to grind corn and prepare tortillas. Tortillas were generally paired with a sauce or casserole of spices, herbs, and vegetables and served both as food and as a utensil to transport the food to the mouth. There were different grades of tortillas, from paper-thin, pure white tortillas enjoyed by the elite, to thick and heavy tortillas for everyday consumption or for long journeys.

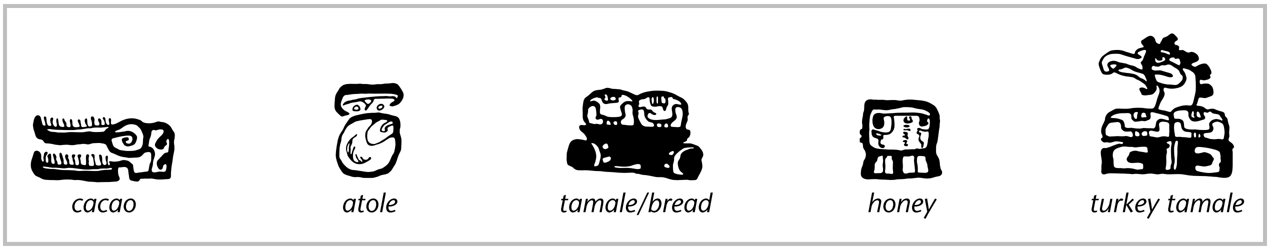
The presence of the tortilla among the Maya is less definite. We find few *comales* in the Mayan area, leading some to suggest that the tortilla was less important and tamales more prevalent. Tamales are thick maize dough, mixed with a vast array of foods—beans, chilis, eggs, meat, fish, and mushrooms were all incorporated into tamale dough—wrapped in leaves or corn husks, and steamed or baked in a fire. Mayan iconography also shows plates with round balls that resemble tamales, rather than flat cakes indicative of tortillas.

> And then the yellow corn and white corn were ground, and Xmucane did the grinding nine times. Food was used, along with the water she rinsed her hands with, for the creation of grease; it became human fat when it was worked by the Bearer, Begetter, Sovereign Plumed Serpent, as they are called.
>
> After that, they put it into words:
> the making, the modeling of our first mother-father,
> with yellow corn, white corn alone for the flesh,
> food alone for the human legs and arms,
> for our first father, the four human works.
>
> From Tedlock, *Popol Vuh*, p. 140

A fermented beverage called *balché* was made from maize and flavored with different fruits and spices. Fermented beverages were quite common in the New World (except for areas north of Mexico), and quite intoxicating as well. The Maya drank *balché* for the most part, whereas the drink in the more arid regions was called pulque and was fermented from the sap of the maguey, or agave. These fermented beverages were mostly used for rituals, and public drunkenness was especially frowned upon in the Aztec empire, being punishable by death.

Maize was not the only grain utilized by Mesoamerican cultures. Amaranth, a seed crop of the genus





cacao atole tamale/bread honey turkey tamale

Mayan hieroglyphs showing a few of the important food terms used in pre-Columbian America. Turkey tamales were consumed by the Mayan nobility. DRAWINGS COURTESY OF THE AUTHOR.

Amaranthus, was brought under cultivation throughout central Mexico and was one of the four primary tribute items demanded by the Mexica along with maize, beans, and *chia*, a relative of sage. Called *huautli* in Nahuatl, amaranth was prepared in a similar manner to maize, ground into flour for tortillas, tamales, and *atolli.* Amaranth was also popped like popcorn and ground into a lighter flour, or incorporated into regular maize dough. It was prized as a gourmet food, and the nobility enjoyed specially prepared tamales and tortillas of amaranth, as well as a sauce from the highly nutritious greens.

But the most important use of amaranth was in religious rituals. Popped amaranth flour tamales and a mixture of popped amaranth and sweet maguey syrup, called *tzoali*, were offered to certain deities. The contemporary descendents of *tzoali* are the Mexican treats *alegrías*, popped amaranth bound with molasses, which can be found throughout Mexico City. Of special importance to the Mexica were the seeds of bright red amaranth, whose color resembled blood, the most sacred of human substances. This special ritual role of amaranth, and the desire of the Spanish to eliminate any evidence of indigenous religion, may have led to its sudden disappearance from the modern diet.

Vegetables and Fruits

The staple foods of maize and amaranth were supplemented in the daily diet by a diverse array of vegetables and fruits. Beans, although not technically a vegetable, were perhaps the most extensively cultivated crop outside of maize and amaranth. The New World beans all belong to the same genus, *Phaseolus*, and are represented by the modern-day varieties navy, wax, lima, pinto, kidney, and black, although many more were cultivated in pre-Columbian times.

Beans were not harvested green but were picked and stored dry. They were prepared generally by boiling, often with the addition of epazote, a flavorful herb that is said to reduce gassiness. The boiled beans were mashed and added to maize dough for tortillas or tamales, or made into a stew. Quite often, however, they were simply boiled in plain water, flavored with a little chili, and scooped into the mouth with tortillas.

Different types of squashes (*Lagenaria* and *Cucurbita* spp.) complemented the Mesoamerican diet in a number of ways. The cleaned and dried shells were often used as serving vessels and eating utensils. Toasted and ground, their seeds were added to tamales and tortillas, used as a flavoring for various sauces, used as a relish, or even mixed with ground beans to make a drink. The flesh was used to a lesser extent, often roasted or stewed in honey. And as is the fashion with many Mesoamerican crops, all parts of the plant were used, with the flower blossoms added to soups and stews and the greens used as wrappings for tamales or meat dishes.

A great many other vegetables were utilized by Mesoamerican cultures, including tomatoes, tomatillos, many types of greens, and a variety of root crops, such as sweet potato, manioc, and jicama. These were all commonly used in the sauces and casseroles that formed the primary part of a meal along with tortillas and tamales. Root crops have been the subject of debate in Mesoamerican archaeology. Some see their role in the diet as relatively minor, whereas others stress their importance beyond what is indicated in the ethnohistoric record. Little mention is made of them by the Spanish, yet records of explorations in the Mayan area mention large fields of root crops, interspersed with other cultigens.

Although technically a fruit, avocado (*Persea americana*) generally played the role of a vegetable. It could be eaten simply sliced and wrapped in a tortilla, added to soups, or prepared as a relish, similar to guacamole. Also eaten were the cactus pads and fruits of a variety of cactus, primarily *Opuntia* sp., as well as different parts of the succulent agave (*Agave* sp.), also known as maguey. Fruits, and especially fruit trees, play a major role in Mesoamerican cuisine, although their methods of preparation were fairly simple. Commonly known and frequently used New World cultigens include pineapple, papaya, and passion fruit, while lesser-known fruits such as chico zapote (*Manilkara zapota*), the various species of Annona including soursop and cherimoya, and hog plum (*Spondias mombin*) were also eaten. When not eaten plain, fruits were often made into intoxicating beverages used in ceremonies and rituals. The fruit tree orchards held special significance to the Maya, and when the Spanish forced them to cut them down, in large part because of the excessive drinking and intoxication from fruit beers, the Maya were devastated. Orchards were not simply locations for harvesting fruit, but were sacred sites passed down and maintained through generations.

Spices, Herbs, and Specialty Items

Fundamental to Mesoamerican cuisines is the chili pepper (*Capsicum* sp.) perhaps second in importance only to maize. It acquired the name "pepper" as it was the closest to black pepper (*Piper nigrum*) that Columbus could find in the New World, although it is not very similar at all. However, as an all-purpose spice to flavor nearly all concoctions, it fulfilled the role of black pepper quite well. It was sprinkled over sauces, ground into maize dough, and boiled with beans, providing taste as well as great quantities of vitamins A and C. Its importance is evident in the ritual fasting of the Aztec priests, who considered a "fast" an abstinence from salt and chili, as well as meat.

Chilies were also used in nonculinary fashion. Children were punished by being held over chili smoke, and during warfare, calabashes (squash shells) with coals and chilies were thrown at the enemy to create a pungent smoke.

No discussion of Mesoamerican cuisine can proceed without mentioning chocolate, or cacao (*Theobroma cacao*). Primarily used by the elite, cacao was prepared as a beverage and was served as the last course of a meal. Cacao beans were prepared by being fermented, cured, roasted, and then ground into a powder, which was added to hot water and frothed. The Aztec would create a foamy head to the drink by using a spoon or a special utensil, whereas we see from some Mayan iconography that they would pour the cacao from one vessel to another to make the foam. Creating this foam was integral to the preparation of cacao, and to be served a drink without it was a grave insult.

An innumerable array of additions flavored these cacao drinks. Honey or maguey syrup was added for sweetness, maize dough could be added to thicken the drink, and herbs, spices, and flowers provided different tastes and flavors. The Aztec and Maya frequently mixed in vanilla, the seedpod of an orchid grown on the Gulf Coast, and achiote (*Bixa orellana*), although the latter was more to impart a deep red color than for taste. Achiote, the seed of a small tree, was actually used to tint many things, including human skin.

Countless flowers also flavored cacao drinks. Marigold (*Tagetes lucida*), *Cymbopetalum penduliflorum*, and *Quararibea funebris* were all added to the cacao drink, each flower providing a different taste, ranging from cinnamon to black pepper to ripe melon. Some flowers were added to the finished beverage, whereas others were closed in a sealed container with the dried beans to impart their aroma.

Cacao was reserved solely for the elite, and generally only the males. At the great Aztec banquets, the men were served vessels of cacao at the completion of the meal, whereas the women drank a beverage of chia seeds and chili. Priests also likely drank cacao, as it was often mixed with hallucinogenic substances such as psychoactive mushrooms or peyote.

Cacao also served as a form of currency. The beans were used as a coin, and there were those who would attempt counterfeiting by filling empty cacao shells with clay, although this was a heavily punishable offense. The use of cacao as currency continued up to the twentieth century in parts of Mesoamerica.

Meat and Fish

When the Spanish arrived, they likened the diet of the inhabitants of Mesoamerica to a perpetual Lent, so little was their meat consumption. Prehistoric environmental factors left Mesoamerica with few large mammals. Among the few animals raised in Mesoamerica were the dog, the turkey (*Meleagris gallopavo*), and the Muscovy duck (*Cairina moschata*). One could also include among the domesticated animals several types of stingless honeybee and the cochineal insect, the latter used for a red dye later employed by the British for their "redcoats."

The meat of these domesticated animals was reserved for special feasts, with the exception of the nobility, who enjoyed meat on a daily basis. For any one of these feasts, a huge quantity of dogs, turkeys, and duck would be fattened and slaughtered and prepared generally in tamales or in one of the many soups and stews. Turkeys were considered a feast food, with the Maya especially reserving this bird for ceremonies related to planting and rain. After the introduction of the chicken, the role of the turkey diminished, although it was still used in the most important rituals.

At the time of European contact there were many dog breeds, including a rather large, hairless breed that has since become extinct. These breeds were separate from the dogs used as guard dogs, for hunting, or for companionship. The raising of edible breeds was a lucrative profession, and the animals were fed a rich diet of maize and even large quantities of avocado.

The New World was replete with wild game, however, and these were hunted and even somewhat "tamed." Several types of deer, while technically "wild," were kept in pens nearby the living quarters, and it was even said that Mayan women would suckle baby deer from their own breasts. Deer was probably the most commonly hunted and eaten of the wild animals; it has been found in archaeological contexts from the highest nobility to the lowest of peasants. Also utilized were two types of iguana, whose eggs and flesh were eaten, the armadillo, the peccary, the tapir, and several types of monkeys.

Food from the sea was important as well. Tropical fish, lobsters, other shellfish, and manatees were all caught and transported great distances to the major Aztec, Mayan, and Zapotec cities to be enjoyed by nobility and commoner alike. The fish were usually sun-dried or salt-dried, using the resources from the massive saltworks along the coastal regions.

From freshwater lakes and streams came turtles, crocodile, and many types of fish. The Aztec, who lived by Lake Texcoco, made perhaps the most extensive use of their lake resources, extracting a variety of fish, shrimp, insects, and insect eggs. A type of water bug called *axayacatl* was collected, formed into balls, and cooked in maize husks, and the eggs of this same water bug, called *ahuautil*, were eaten in tortillas and tamales. A tiny worm that lives in the lake was gathered and cooked with salt and chili until black and soft, and a type of algae was skimmed off the top of the lake, formed into bricks, and left in the sun until it turned black, when it was utilized somewhat like cheese. The Aztec were not the only ones to indulge in insects. The Maya and the Zapotec prepared and ate many insects, which apparently disgusted the Spanish, but little is known of how they were prepared.

The contact between Europe and the New World fundamentally changed the cuisines of the world. Where would Italian cuisine be without the tomato; Indian cuisine without the chili pepper; or the cuisines of northern Europe without the potato? Some of the ingredients and dishes presented here are instantly recognizable, whereas others are not, but this far from comprehensive list gives only an idea of the wealth and complexity of the pre-Columbian cuisines of Mesoamerica.

See also **Central America**; **Chili Peppers**; **Feasts, Festivals, and Fasts**; **Fermented Beverages other than Wine or Beer**; **Flowers**; **Game**; **Iberian Peninsula**; **Inca Empire**; **Legumes**; **Maize**; **Meat**; **Mexico**; **South America**; **Squash and Gourds**.

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Andrew R. Wyatt

MICROBIOLOGY. Microbiology is the study of a diverse group of microscopic organisms, or microorganisms: bacteria, fungi, algae, protozoa, and viruses. Bacteria are prokaryotes; the other microorganisms are eukaryotes. Prokaryote cells lack a nuclear membrane and membrane-bound organelles. Recently, bacteria have been divided into eubacteria and archaebacteria, with the latter more closely related to eukaryote cells. Bacteria are mostly unicellular and range in size from tiny mycoplasmas, 200 nanometers (that is, 200 billionths of a meter, or less than 1/100,000 of an inch) in diameter, to the recently discovered *Thiomargarita namibiensis*, at one millimeter (or about 1/25 of an inch). *E. coli* cells are one to two micrometers in length (about five to ten times the diameter of the mycoplasmas). Fungi include yeasts, molds, and mushrooms. The bread, wine, and beer yeast, *Saccharomyces cerevisiae*, is ten micrometers (about 1/2,500 of an inch) in diameter. Algae are photosynthetic organisms, unicellular or multicellular. Protozoa are microscopic, unicellular, and usually motile. Viruses are not cellular organisms; they are intracellular parasites of animals, plants, or bacteria. They are composed of nucleic acid (DNA or RNA) enclosed in a protein coat. Viruses range from 18 to 450 nanometers (from less than one-millionth to almost 1/50,000 of an inch). Microorganisms, with the exception of viruses, can be observed with a compound light microscope (up to ×1,000 magnification). Electron microscopes (up to ×100,000 magnification) are used to visualize viruses.

History of Microbiology before Pasteur

Microorganisms were first visualized by Antoni van Leeuwenhoek (1632–1723), a Dutch cloth merchant and an expert lens grinder. His simple microscopes magnified up to three hundred diameters. In the eighteenth century, many people still believed that living organisms could arise spontaneously from organic matter—the doctrine of abiogenesis, or spontaneous generation.

Lazzaro Spallanzani (1729–1799), an Italian priest and physiologist, did an experiment that came close to proving that life (in this case, microorganisms) does not arise spontaneously from nonliving matter. He sealed flasks containing broth and then boiled them. No spontaneous generation or growth occurred in the flasks; however, the debate continued, as proponents of the doctrine said that air was needed for spontaneous generation. Opponents of this doctrine had a very difficult task trying to prove a negative, namely that something did not happen.

The ancient Egyptians and Romans were comfortable with the idea that organisms invisible to the naked eye could cause disease. During the Dark Ages and the medieval period of Western history, this idea virtually disappeared. In the sixteenth century, Girolamo Fracastoro (1483–1553) described disease passing from one person to another by "germs." Athanasius Kircher (1602–1680) furthered the "germ theory" by observing bacteria from plague victims.

History from Pasteur Onward

Louis Pasteur (1822–1895) was an intellectual giant who dominated science in the middle of the nineteenth century. In 1861, in the midst of a twenty-year study of microbial fermentation, Pasteur dealt the deathblow to the doctrine of spontaneous generation by demonstrating the presence of microorganisms in the air and then by showing that sterile liquid in a swan-necked flask remained sterile. Air could enter such a flask, but microorganisms could not. In 1875, Ferdinand Cohn (1828–1898) published the first classification of bacteria, and used the genus name, *Bacillus*, for a spore-forming bacterium. In 1875, Robert Koch (1843–1910), a German bacteriologist, proved that a spore-forming bacterium, *Bacillus anthracis*, caused anthrax. His experiments demonstrated four principles, now known as Koch's postulates, which are still the hallmark of disease etiology: (1) the microorganism must be present in every diseased animal studied, but not be isolated from healthy animals; (2) the microorganism must be isolated from the animal and cultivated; (3) an animal inoculated with the microorganism must develop the disease; (4) the same microorganism must be isolated from the diseased animal inoculated with the microorganism. Working independently on anthrax, Pasteur and his colleagues confirmed Koch's findings. Koch introduced three practices that allowed bacteriologists to obtain pure cultures simply: (1) a semisolid medium composed of nutrients solidified with gelatin, (2) platinum needles sterilized in a flame to pick up bacteria, (3) streaking of bacteria onto a gelatin surface to obtain single cells that would grow into colonies. In 1881, Fanny Hesse, the wife of German bacteriologist, Walther Hesse, suggested using a seaweed extract, agar, which she used to thicken jam, to solidify media in petri plates. Agar had neither of the disadvantages of gelatin: it was rarely degraded by microorganisms and it stayed solid at temperatures above 28°C (about 82°F). Agar is still the solidifying agent of choice. In 1882, Koch used the pure-culture techniques to isolate the bacterium that causes tuberculosis. In 1884, Charles Chamberland, a collaborator of Pasteur's, developed a porcelain filter that would retain all bacteria. When, in 1892, a young Russian scientist, Dmitri Iwanowski, transmitted tobacco mosaic disease to healthy plants using a porcelain-filtered extract, he postulated the presence of a toxin. In 1898, the Dutch microbiologist, Martinus Beijerinck, reproduced Iwanowski's results, but he postulated the existence of very small infectious agents, "filterable viruses." Thus began the field of virology, although visualization of viruses had to wait until the development of the electron microscope in the 1930s. Medical bacteriology progressed rapidly at the Pasteur Institute in Paris, where Pasteur presided, and the Koch Institute in Berlin, where Koch presided.

YEAST EXTRACT

In the United Kingdom, South Africa, and Down Under, people enjoy yeast spreads—that is, spreads made from a dark-brown, extremely salty yeast extract. Oddly enough, one, Marmite, is preferred in Australia, and another, Vegemite, is preferred in New Zealand. Some say Marmite is sweeter than Vegemite; others say that Marmite has more caramel flavor. One of babies' first foods Down Under is toast fingers spread with Vegemite or Marmite. These spreads are rich in niacin, thiamine, and riboflavin. Neither of these spreads is tolerated well by North Americans.

History of Food Preservation Microbiology

In 1810, Nicolas Appert (1750–1841) applied Spallanzani's results to develop a system of preserving food by sealing it in airtight cans and heating the cans. Without understanding that the heat treatment, or "appertization," was killing microorganisms in the canned food, Appert established the basis for the modern practice of canning. In 1852, Napoleon III asked Pasteur to study the problem of "wine diseases," particularly wine souring. In 1886, Pasteur proclaimed that the off-flavors in wine were caused by contaminating microorganisms. He suggested heating (pasteurizing) the grape juice to kill the spoilage bacteria. He discovered that some microorganisms could grow in the absence of oxygen. He used the term "anaerobic" to apply to microbial metabolism that occurs only in the absence of oxygen, and "aerobic" for metabolism that occurs under normal atmospheric conditions. Fermentation of grape juice by yeast is one kind of anaerobic metabolism. He also described the anaerobic degradation of protein, or putrefaction, by bacteria. Aerobic bacteria, namely the acetic-acid bacteria, were the cause of wine souring. Some of these bacteria metabolize ethanol to acetic acid; others metabolize the acetic acid to carbon dioxide and water. The process of pasteurization, a mild heat treatment of liquids, originated as a means of preserving the

BACTERIA AS FOOD

In the pre-European Aztec culture, people harvested the cyanobacterium, *Spirulina,* from lakes for food, and still do so in Chad. Cyanobacteria are capable of photosynthesis, and so some lakes in Chad and in Mexico develop a deep green color. *Spirulina* may be the only bacterium directly consumed by people. Today, about nine hundred tons a year of *Spirulina* is produced, mainly by the United States and Thailand. The spirulina product is 65 percent protein and amino acids, 20 percent carbohydrates, and 5 percent fats. Spirulina is rich in vitamins A, D, K, and $B_{12,}$ as well as beta carotene.

desired flavor of milk, fruit juices, beer, and wine. For example, Pasteur recommended that heating bottled wine for a short time at 122°F (50°C) would kill the lactic-acid and acetic-acid bacteria that can spoil wine. In traditional pasteurization, liquids are heated at about 145°F (63°C) for thirty minutes, then held at 50°F (10°C). Nowadays, flash or high-temperature, short-time (HTST) pasteurization is the preferred method (about 162°F [72°C] for fifteen seconds, followed by rapid cooling to 50°F [10°C]) because it has less effect on the flavor of the food being heated. Currently, milk is pasteurized to eliminate the bacteria responsible for tuberculosis, food poisoning, undulant fever, and Q fever. The treatment does not result in sterilization of milk, which can contain twenty thousand bacteria, such as lactobacilli, per ml post-pasteurization. More common in Europe than other parts of the world, is ultrahigh temperature (UHT) treatment (300°F [148.9°C] for one to two seconds), which sterilizes milk, allowing it to be stored without refrigeration for more than the limit of two to three weeks for pasteurized milk. Many brewing companies pasteurize their bottled or canned beer at 140°F (60°C) for a few minutes. Pasteurization is infrequently used, however, in modern winemaking, as it adversely affects the flavor.

Cohn and John Tyndall (1829–1893) both demonstrated that the endospores of *Bacillus subtilis* cells were far more resistant to heating than were vegetative bacteria. Tyndall developed a method of sterilizing liquids that contained bacterial spores: a medium was first incubated to allow the spores to germinate, then heated to kill most of the bacteria. This process, later termed "tyndallization," was repeated several times. This was a very important development in food science since the bacteria that form endospores include the food-borne pathogens, *Clostridium botulinum*, *C. perfringens* and *C. difficile.* Today, canned food is subjected to a temperature–time treatment that ensures the death of heat-resistant bacterial endospores, particularly those of *C. botulinum.*

For hundreds of years, substances that inhibit microbial growth have been added to foods in an attempt to prevent spoilage. One of the oldest practices is the salting of meat and fish as a means of preservation. Growth of most bacteria is inhibited by the high osmotic strength generated by the salt. In a relatively dry climate, salted meat can last up to twelve months. In 1958, the United States government determined that no chemical could be added to food or beverages without having been tested for safety. Three important antifungal preservatives for acidic foods (foods with a pH of 4.6 or less) such as canned drinks, salad dressings, cheese, and wines, are benzoic acid, sorbic acid, and propionic acid (or their salts). Sodium nitrate has been used in meat in China and the Middle East since 1200 B.C.E. A bacterial conversion of nitrate to nitrite results in a reaction with the heme pigment, giving the pink color of ham. Nitrite is antibacterial and prevents the germination of *C. botulinum* and other anaerobic bacteria in meats like ham, bacon, and frankfurters. Sulfur dioxide in some form, for example as produced by sodium metabisulfite, is used to control yeast and bacteria in wines and bacteria in brewing. Sulfur dioxide or bisulfite is an unusual chemical in that it is also an extremely effective antioxidant. Fermentation is another method of preservation. A commonly held dictum is that pathogenic bacteria do not grow at pH levels below 4.5. Fermented foods are inoculated with microorganisms, which reduce the pH of the food by producing acid during their growth. Acids such as acetic or citric acid are also added to decrease the pH of foods. Heat treatments are more effective at killing microorganisms at lower pH. It appears that low pH does not ensure safety from pathogens: in 1993, *E. coli 0157:H7* in fresh-pressed apple juice caused an outbreak of diarrhea and hemolytic uremic syndrome. *Yersinia* spp. may also be able to survive in low pH foods.

Irradiation is a process that destroys microbial pathogens in food. Gamma rays from cobalt 60 or cesium 137, X rays (five million electron volts [5 MeV] maximum), and electrons (10 MeV maximum) are approved sources in the U.S. Irradiation was first used in the U.S. to ensure safe food for astronauts. Subsequently, the Food and Drug Administration (FDA) approved irradiation for wheat, wheat flour, and potatoes. Currently, irradiation is used mostly for spices, but also to disinfect cured meats, to kill *Trichinella spiralis* in pork, to control salmonella on chicken carcasses, and to reduce microbial load on fresh fruits and vegetables. There is some public resistance to irradiated foods, as the thought is that the food becomes radioactive. It does not.

Control of Microorganisms in Food

The contemporary food microbiologist has the challenges of a growing number of food pathogens and food spoilage. For example, eighty percent of commercial chickens in the U.S. are contaminated with *Campylobacter jejuni.* The food microbiologist may be involved in food manufacturing and processing, in retail food, in research in a university or government organization, such as the Agricultural Research Service of the United States Department of Agriculture (USDA), FDA, Centers for Disease Control and Prevention, and National Institutes of Health (NIH); or in food-plant inspection or the USDA's Food Safety Inspection Service (FSIS). In food plants, the food microbiologist is often a food technologist with a thorough training in chemistry as well as microbiology, who establishes a laboratory quality assurance manual (LQAM), a training program, and a statistical quality-control program. The food microbiologist must be versed in good manufacturing practices (GMP's), standard operating procedures (SOP's), sanitation, Hazard Analysis and Critical Control Points (HACCP's), rapid methods for the isolation and identification of microorganisms, as well as assays for toxins. HACCP's are designed to ensure food safety, extending beyond microbiological hazards, to chemical (for example, those from mycotoxins and pesticides) and physical (for example, from glass breakage) dangers. To generate an HACCP, the hazards in the plant's processes must be identified, the risk involved at each Critical Control Point must be established, and the critical levels of pathogens at each step in the process must be determined. The process must be monitored, and the monitoring verified. HACCP's are rapidly being required by government industries for more and more food processors. The USDA now mandates that all meat and poultry processors that are federally inspected have an HACCP in operation. The FDA now requires HACCP's for fruit-juice producers. Sanitation methods and monitoring are an extremely important part of any HACCP and a chief duty of a plant's food microbiologist. Surfaces in food-processing plants, meat carcasses, fruits, and vegetables must be kept pathogen-free. The use of simple rapid ATP detection systems (ATP—adenosine triphosphate—degrades quickly and is only found in living cells) allows a food microbiologist to involve plant workers in the sanitation effort. Workers swab sanitized surfaces, process the swab, and read the printout that has been calibrated to tell them the level of cellular contamination. They can resanitize surfaces until the results are acceptable.

In food-production and retail-food plants and in the home, good hygiene, especially hand washing, is the most effective way to eliminate the transmission of these pathogens. Another important practice is proper refrigeration of foods. Finally, proper cooking of raw meats, fish, and eggs by the consumer will destroy any remaining pathogens.

The explosion in genetic and immunological research in the 1980s resulted in many antibody-based and DNA-based methods for the identification of bacteria and toxins. These methods are rapid, reliable, sensitive, and becoming simpler daily. The time-consuming step in the assays is the necessity of initially growing or in some way enriching for the pathogen of interest. There are DNA-based assays for all the major food-borne pathogens. These assays use either DNA probes (usually of 16S rRNA genes, since there are relatively so many copies of these genes in cells) or PCR (a short DNA sequence is amplified in a thermocycler). There are also antibody-based assays for the major food-borne pathogens and toxins. These assays depend upon an antibody produced to some component of a bacterial cell or toxin. The most commonly used antibody-based assay is an ELISA, an enzyme-linked immunosorbent assay. It is described as a "sandwich assay." The test substance is added to a solid support to which the antibody to a particular pathogen is bound. The cell or toxin binds to the antibody. A secondary antibody, which is conjugated to an enzyme, binds to the primary antibody. Addition of the enzyme's substrate results in activity that can be detected. As the field of diagnostics speeds on, the food microbiologist must devote time to a continuing evaluation of newly emerging technologies aimed at reducing or eliminating pathogens as well as microorganisms that adversely affect the quality of food.

Use of Microorganisms for Various Helpful Ends

Before ancient people had any idea of microorganisms, they were using them to ferment foods. Bacteria, yeast, and molds are now used extensively to preserve foods and improve their aroma and flavor. Beer is probably the oldest fermentation product consumed by humans. Its history has been traced back to the Sumerians in 7500 B.C.E. The basic component of beer is a grain or cereal, for example, malted barley, rice, corn, or millet. The major food source in cereals is starch. Barley is germinated to produce starch-degrading enzymes, or amylases. This mixture, "malt," is used to process the starch in barley or other cereals; starch must be broken down into sugar for fermentation to take place. Strains of *Saccharomyces cerevisiae* are used for lager-style beers, and strains of *S. uvarum* for ales. Wine, also an ancient beverage, is made by inoculating fruit juice, usually grape juice, with strains of *S. cerevisiae*, fermenting the high level of sugar in the juice. Many kinds of lactic-acid bacteria (LAB) are also found during yeast fermentation: *Lactobacillus* spp., *Leuconostoc* spp., and *Pediococcus* spp. Winemakers often inoculate their wines with commercial LAB cultures to reduce overly high acidity of juice (grape juice, for example, has a pH of 3.0 to 3.8) and, through their metabolism, to add flavors or "complexity" to the wine.

The bacteria that Pasteur identified as wine spoilers, the acetic-acid bacteria, are used to make vinegar. Wine or cider is inoculated with *Acetobacter* spp., which produce acetic acid by oxidizing ethanol.

Basic bread is made by adding water and salt to wheat flour. Yeast is added to "leaven" bread. The Egyptians obtained yeast from beer vats to leaven their bread. The Greeks and Romans used yeast from wine vats. Now,

Salmon Color

Farmed salmon are pale in color. The color of wild salmon comes from their consumption of crustaceans in the ocean. A red yeast, *Phaffia rhodozyma,* is now fed to farmed salmon to color them red. The red pigment in the yeast, astaxanthin, is a carotenoid similar to that found in lobsters.

strains of *S. cerevisiae* are used to ferment the sugars in bread dough. LAB are also used to give special flavors to some breads: for example, *Lactobacillus sanfrancisco* for sourdough and *Lactobacillus plantarum* for rye bread.

LAB are most important in dairy products. In 1878, Joseph Lister (1827–1912) isolated, in pure culture, a bacterium that caused milk souring. LAB are used to curdle milk for cheese production, and to ripen certain cheeses *(Propionibacterium* spp., for instance, for Swiss cheese). LAB are also used in the production of yogurt, buttermilk, and kefir, an alcoholic fermented-milk product. Molds, mainly of the penicillia family, are used to break down the fats in cheese and add distinctive flavors, for example, *Penicillium roqueforti* in Roquefort cheese.

Plant material is fermented to make pickled vegetables, sauerkraut, Spanish-style olives, and soy sauce. LAB, for example, are used to ferment cabbage into sauerkraut. Several genera of bacteria, including LAB, and fungi are used to ferment olives, which are inedible before this processing.

Many fermented products are made in the Far East, often from soybean meal. A *koji*, or mixed culture of bacteria, yeast, and molds, is used to inoculate the food. For soy sauce, for example, soybean meal is inoculated with a *koji* containing *Aspergillus oryzae* and LAB such as *Lactobacillus delbrueckii.* Other common fermented-soybean foods are tempeh, miso, and *sufu* (a traditional Chinese cheeselike product). The acids these microorganisms produce, chiefly acetic, butyric, and lactic, prevent the growth of most other microorganisms. The fermentations not only favorably modify flavors and textures, but also have preservative action.

A bacterium, *Xanthomonas campestris*, produces a polymer, xanthan gum, which is used as a thickener in such foods as salad dressings, cottage cheese, yogurt, ice cream, and frostings.

Harmful Microorganisms

Bacteria, viruses, and protozoa that cause gastroenteritis are transmitted by the fecal–oral route— that is, by the consumption of food or water fecally contaminated by infected persons. The major bacteria that cause gastroenteritis are *Salmonella* spp, *E. coli*, *Campylobacter jejuni*, *Vibrio parahaemolyticus*, and *Yersinia enterocolotica.* Ingesting toxins produced by bacteria that have grown in food can also result in gastroenteritis. Bacteria that cause gastroenteritis by producing toxins are *Staphylococcus aureus*, *Clostridium perfringens*, and *Bacillus cereus.* Rotavirus and the Norwalk virus group are the two major viruses causing gastroenteritis.

Milk is pasteurized to eliminate *Mycobacterium tuberculosis*, *M. bovis*, *Salmonella* spp., *Listeria* spp., enteric viruses, *Brucella* spp., *Coxiella burnetii*, and *Campylobacter jejuni.*

Food-borne bacteria can cause serious diseases: *Salmonella typhi* causes typhoid fever; *Shigella* spp. cause bacillary dysentery; *E. coli* strains can cause dysentery; *M. tuberculosis* and *M. bovis* cause tuberculosis; *Vibrio cholerae* causes cholera; *Brucella* spp. cause undulant fever; and *Coxiella burnetii* causes Q fever. *Listeria monocytogenes* causes listeriosis in predisposed populations, for example, immune-compromised individuals. Hepatitis is caused by the Hepatitis A virus and the recently discovered Hepatitis E virus, which is common in Africa and India and other Asian countries, but not in Western countries. In meat and poultry products, *Salmonella*, *E. coli*, *Campylobacter jejuni*, *Listeria*, and *Clostridium perfringens* are the major pathogens. *Listeria monocytogenes* is the major cheese pathogen. Unlike other food-borne pathogens, its temperature growth range (from 31 to 122°F [–0.4 to 50°C]) allows it to grow under refrigeration conditions. Hepatitis viruses and *Yersinia enterocolitica* are major oyster pathogens. Some of the pathogens found on fish are of marine origin, for example, *Vibrio vulnificus*, *V. parahaemolyticus*, and *V. cholerae*, and others are from sewage, for example *Salmonella* spp. *and Campylobacter s*pp. Nuts and grains can become contaminated with mycotoxins, aflatoxins produced by *Aspergillus flavus*, being the most dangerous.

Prions are particles, smaller than viruses, and mostly composed of protein. It has recently been proposed that prions are the cause of four diseases: Creutzfeldt-Jacob disease and kuru in humans, bovine spongiform encephalopathy (BSE or mad cow disease) in cows, and scrapie in sheep. It is now thought that several dozen people have gotten a human form of BSE by eating the meat of infected cattle. This disease has been named new variant Creutzfeldt-Jakob disease, or nvCJD.

See also **Beer; Cheese; Dairy Products; Fermentation; Fermented Beverages other than Wine or Beer; Government Agencies, U.S.; Microorganisms; Packaging and Canning; Pasteur, Louis; Safety, Food; Wine**.

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MICRONESIA. *See* **Pacific Ocean Societies.**

MICROORGANISMS. Microorganisms are organisms (forms of life) requiring magnification to see and resolve their structures. "Microorganism" is a general term that becomes more understandable if it is divided into its principal types—bacteria, yeasts, molds, protozoa, algae, and rickettsia—predominantly unicellular microbes. Viruses are also included, although they cannot live or reproduce on their own. They are particles, not cells; they consist of deoxyribonucleic acid (DNA) or ribonucleic acid (RNA), but not both. Viruses invade living cells—bacteria, algae, fungi, protozoa, plants, and animals (including humans)—and use their hosts' metabolic and genetic machinery to produce thousands of new virus particles. Some viruses can transform normal cells to cancer cells. Rickettsias and chlamydiae are very small cells that can grow and multiply only inside other living cells. Although bacteria, actinomycetes, yeasts, and molds are cells that must be magnified in order to see them, when cultured on solid media that allow their growth and multiplication, they form visible colonies consisting of millions of cells.

Many people think of microorganisms mainly in terms of "germs" causing diseases, but some "germs" are beneficial to humans and the environment. Disease-causing (pathogenic) microorganisms need to be controlled, and in many cases, beneficial microorganisms are also controlled in plant and food production.

For thousands of years, people had no concept or knowledge of organisms invisible to the naked eye. In fact, it is only within the last several hundred years that magnification systems (lenses, magnifiers, microscopes) were developed that enabled scientists to observe microorganisms. In 1673 Antoni van Leeuwenhoek, a linen merchant in Delft in the Netherlands, was the first to observe and study microorganisms, using single lenses that magnified objects fifty to three hundred times. The role played by microorganisms was not clarified until the 1830s, when Theodor Schwann in Germany demonstrated that yeasts were responsible for alcohol production in beer and wine fermentations.

In 1854, Louis Pasteur in France found that spoilage of wines was due to microorganisms (bacteria) that convert sugars to lactic acid, rather than the alcohol produced by yeasts. He developed the process of "pasteurization," in which the temperature of food materials is raised to about 140 to 158°F (60 to 70°C), thereby killing many spoilage organisms. Pasteur also discovered that certain bacteria are responsible for the souring of milk. Today, milk is generally pasteurized to reduce its content of microorganisms, to extend its keeping quality, and to protect against pathogenic microorganisms that may be present.

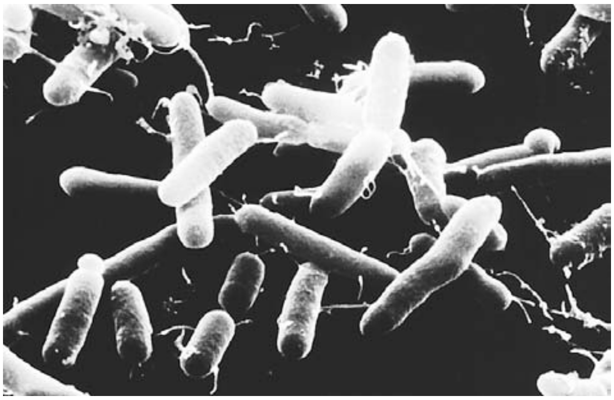
Pasteur also discovered that each type of fermentation, as defined by the end products, is caused by specific microorganisms and requires certain conditions of acidity or alkalinity. He discovered further that some microorganisms, the aerobes, require oxygen and others, the anaerobes, grow only in the absence of oxygen. The latter probably developed in the earliest days of the earth when there was no oxygen in the atmosphere.

Microorganisms are present in high populations in soil, and in varying numbers in the air we breathe, the water we drink, and the food we eat; they are on our skin and in our noses, throats, mouths, intestinal tracts, and other bodily cavities. They are everywhere in our environment.

Evolution of Microorganisms

Microorganisms came into being on earth over a period of about 1.2 to 1.5 billion years. Fossil microbes have been found in rocks 3.3 to 3.5 billion years old. Since then, microorganisms have had the principal task of recycling organic matter in the environment. As such they are absolutely essential to the health of the earth. Without them, the earth would be a gigantic, permanent waste dump.

Microorganisms are responsible for recycling the huge masses of organic matter synthesized by plants as


A microscopic view of *Salmonella,* the bacteria that contaminate food and cause widespread illness. Courtesy of Photo Researchers, Inc.

life on earth evolved. Furthermore, microorganisms—the cyanobacteria or their DNA in the chloroplasts in plant cells—were the source of most of the free oxygen in the early atmosphere. They also oxidize ammonia (the universal end product of protein metabolism) to nitrate, which is the only nitrogen source used by plants and is therefore essential for production of our plant foods. Microorganisms also are responsible for cellulose hydrolysis in the rumens (first stomach compartments) of cattle, facilitating the production of animal protein for human consumption. And, in recent times, microorganisms have been the sources of antibiotics that have enabled the cure of numerous diseases.

Blue-green algae (cyanobacteria) are prokaryotes (that is, their cells have no distinct nucleus). They are very independent nutritionally since they can perform photosynthesis using chlorophyll a. Thus they can synthesize sugars for energy from carbon dioxide using the sun's radiation. They also release oxygen. They can respire aerobically and can fix nitrogen, generating amino acids and protein. They require only water, nitrogen gas, oxygen, carbon dioxide, some minerals, and sunlight. The evidence is that they were on earth 3.2 billion years ago. The cyanobacteria are among the earliest microorganisms and very important even today.

Green algae are eukaryotes (that is, their cells have a distinct nucleus). They evolved about one billion years ago. They contain chlorophylls a and b, which enable them to convert carbon dioxide, through sunlight radiation, to sugars, and to polymerize sugars to starches, hemicelluloses, and celluloses—some of our most important sources of food energy.

Green algae are still major sources of food in the oceans. Green algae were likely the life forms that evolved into plants, which first lived primarily in the oceans but moved to the land about 450 million years ago, about the same time as the amphibians and first land animals evolved. It is believed that the first mammals evolved about 150 million years later, along with insects and reptiles, which were dominant. Another 150 million years later, dinosaurs and the first birds evolved, along with the first flowering plants. During the entire period from 3.6 billion years ago, microorganisms were consuming and recycling the organic matter from themselves and other forms of life as they lived and died. For several billion years, bacteria, algae, and other microorganisms served as food for other microbes and for higher animals as they evolved. When plants evolved in the oceans and then subsequently moved to land, they became the major sources of food for other forms of life, including microorganisms, animals, and eventually humans.

Evolution of Plants: The Basis for Human Foods and Animal Feeds

For at least 400 million years before humans appeared on earth, plants were producing food consisting of leaves, stems, seeds, nuts, berries, fruits, tubers, etc., that made life possible for humans and animals when they evolved. Early plant evolution was essential not only for food but also for producing an oxygen environment necessary for animal and human survival. Plants introduced a very effective way of using the sun's radiation to transform carbon dioxide into food materials, such as sugars, starches, and cellulose, through the green pigment chlorophyll and the organelle that serves as the site for photosynthesis, the chloroplast.

Both plants and animals evolved in a microbial environment, where the microbes were ready and able to recycle organic matter. Plants and animals had to develop ways of resisting microbial invasion. Plants did this in part by developing a lignocellulosic body resistant to microbial breakdown. Humans also evolved in a sea of microorganisms and have a tough skin over their bodies resistant to microbial invasion. They had to develop internal immune systems against invasion by microorganisms. Human blood contains phagocytes similar to and probably derived from free-living amoebas, which search out and consume invading bacteria. Then as now, some microorganisms could invade the live animal or human, causing disease.

Microbes enter our bodies in the air we breathe into our noses and lungs, into our mouths and throats, stomachs, and intestinal tracts via the water and foods we swallow, through our eye sockets, through our skin via abrasions and punctures, and through our genitals and other mucous membranes. This intimate contact with microbes begins at birth and continues through life. Some microorganisms become regular inhabitants, parasites of our bodies; they become what can be described as our normal flora. Some microorganisms are virulent, invading our bodies and upsetting our metabolic activities and causing disease; these are the pathogenic microbes. Other microbes are normal microbial flora or pathogens on plants. Still other microbes are continuously invading plant food materials and recycling the organic matter. If this activity is controlled and stopped at the proper levels, these become our fermented foods, which include alcoholic foods and beverages; vinegars; lactic-acid-fermented cabbage and other vegetables (that is, sauerkraut and pickles); lactic-acid-fermented milks and cheeses; sourdough breads; Indian *idli* (from rice); Ethiopian *enjera* (a bread made from teff, an indigenous cereal grass); textured-vegetable-protein meat-substitutes, such as Indonesian tempeh (from soybeans or, sometimes, peanuts) and *ontjom* (from peanuts or, sometimes, soy fiber); high-salt meat-flavored amino acid/peptide soy sauces and pastes; African alkaline-fermented foods such as *dawadawa*, *soumbara*, and *iru* (all from locust beans *[Parkia biglobosa]* or soybeans); Indian *kenima*, Japanese *natto*, and Thai *thua-nao* (all from soybeans); and leavened yeast breads.

Microorganisms Causing Food Poisoning

Three species of bacteria cause food poisoning via preformed toxin: *Clostridium botulinum*, *Staphylococcus aureus*, and *Bacillus cereus.*

Clostridium botulinum is a bacterium that grows in the absence of oxygen and produces one of the most toxic, deadly chemicals known to humans. It was first isolated from sausages, but later was responsible for death in persons consuming home-canned vegetables. The symptoms are flaccid paralysis eighteen to thirty-six hours after ingestion, with respiratory paralysis and death if untreated. There are antitoxins against botulinum toxin, if the type is identified and the antitoxin is injected in time. Botulinum toxin can be inactivated by heating the food to boiling for five minutes. Interestingly enough, botulinum toxin, in spite of its great toxicity is finding a use in eliminating lines and wrinkles from human skin by preventing activity of muscles directly involving those areas of the skin that have wrinkles or expressions. This is partially a response to the fact that very toxic substances in minute quantities can become stimulants.

A second serious type of food poisoning is caused by the ingestion of staphylococcal toxin produced by *Staphylococcus aureus* in foods such as cream puffs, mayonnaise, ice cream, or other nutritious foods that become infected with staphylococci, often carried in the nasal secretions of food handlers. Staphylococcal toxin causes a rather violent nausea and vomiting thirty minutes to six hours after consuming food contaminated with the toxin. Staphylococcus toxin is not inactivated by boiling. It generally is not fatal.

Bacillus cereus also produces a food-poisoning toxin. Steamed rice held overnight at room temperature has been a typical food causing *Bacillus cereus* poisoning. There are two toxins involved—one causing nausea and vomiting, the other causing diarrhea. The toxins are not inactivated by boiling.

Microorganisms Producing Food Poisoning by Toxins Formed in the Intestinal Tract

Clostridium perfringens, an anaerobic microorganism that can cause gangrene in wounds, can also cause food poisoning if it overgrows food materials, such as gravies and meats, which are then consumed. It produces its toxin in the intestinal tract of the consumer and causes diarrhea.

Vibrio cholerae is a major cause of cholera in man; it is spread via contaminated water and food. The symptoms are profuse diarrhea, which, if not treated to replace fluids in the body, will lead to death. *Vibrio parahemolyticus*, found in contaminated shellfish, also leads to profuse diarrhea and requires fluid replacement and antibiotics.

Shiga toxin–producing *Escherichia coli* (STEC), found in contaminated water and meats such as hamburger, is a serious food pathogen leading to hemorrhagic colitis (diarrhea with blood). Bovine products are a major source, but lettuce, alfalfa sprouts, and apple cider have also been implicated.

Enterotoxigenic *E. coli* (ETEC) is frequently found in developing countries in contaminated water and food and is associated with travelers' diarrhea (diarrhea without blood).

Food-Borne Bacteria Invading Intestinal Epithelial Cells

Common causes of food-borne illness are salmonella bacteria. *Salmonella typhi* and *Salmonella paratyphi*, gram negative bacilli that invade the intestinal epithelial cells, cause typhoid and paratyphoid fever, respectively. They are generally found in water or food contaminated with fecal material from carriers of salmonella. Other salmonellae are carried by infected poultry meats and eggs.

Campylobacter spp. are now recognized as one of the most common causes of food gastroenteritis. Main vehicles are raw meats (especially poultry), milk, and water. Fever (sometimes high), headache, and myalgia (muscle pain) precede nausea, vomiting, and diarrhea. *Yersinia* spp., carried chiefly in undercooked pork but sometimes also in milk, is another serious food-borne infection.

Listeria monocytogenes is the cause of a food-borne disease that is frightening because of its high mortality (fatality is over twenty percent). Among incriminated foods are milk, cheese, raw vegetables, and undercooked meat, including frankfurters.

Viral food-borne pathogens include hepatitis A, hepatitis E, rotavirus, and Norwalk virus. Although these viruses do not reproduce in food or water, they are spread by contaminated human carriers and food handlers through such media.

Fermented Foods

Seeds for plants germinate in the soil surrounded and covered with microorganisms. A pinch of dirt can contain a billion microorganisms of many types. The plants destined as foods for humans and animals grow in soil surrounded and covered with microorganisms ready to invade any organic matter and recycle it (essentially consume the organic matter and return it to compost utilizable by new seeds and plants). When the plant materials—seeds, nuts, leaves, tubers, stems, roots—are harvested, they are contaminated or infected with the types of microbes present in the soil; the microbes immediately start to grow on any susceptible organic matter that is available, as long as there is sufficient moisture to allow growth. Dry seeds and leaves are resistant to overgrowth by microorganisms, but as soon as they absorb enough moisture, they become susceptible to microbial growth. If the products of the microbial growth have desirable or attractive aromas and flavors and if they are nontoxic and do not cause disease when consumed, they can be described as "fermented foods" and can become an accepted food in the diet. If they have unpleasant aromas or bad flavors or if they cause food poisoning or death when consumed, they are considered to be spoiled and become garbage on their way to compost or soil. From the earliest times, our food supply has been strongly affected by fermentation.

Alcoholic beverages. The earliest sweet food on earth was likely honey, produced by honeybees and stored for their future use. Humans, in competition with animals such as bears, have always striven to collect honey for their own consumption. Honey is very resistant to spoilage in its concentrated form (about eighty percent sugars), but if it is collected and stored in a container and becomes diluted by rain water, yeasts present in the environment ferment the sugar in the honey to ethyl alcohol (ethanol). The products are called mead or honey wine, one of the earliest alcoholic beverages known to humans and still consumed today.

Similarly when humans started collecting sweet fruits and berries in containers, the juices as well as the fruits and berries themselves were quickly invaded by yeasts on the surfaces of the fruits that ferment the sugars to alcohol (actually a step in recycling), producing a primitive wine. For better or worse, humans have prized alcoholic beverages and they are still consumed in large quantities throughout the world except in those populations that avoid alcohol because of religious restrictions. In some religions, wines are a component of the religious services. Humans discovered ways of producing other alcoholic beverages. For example, early man probably discovered that chewed corn when mixed with water and stored in a container produces an alcoholic beverage. The process occurs because saliva contains an enzyme, diastase, that converts starch in the corn to sugars; then yeasts in the environment ferment the sugars to alcohol. The beverage thus produced is called *chicha* in the Andes region of South America. In ancient times, an emperor in that region could hold office only as long as he delivered sufficient *chicha* to the citizens to keep them happy. Even today, among families in the Andes region, husbands will get drunk one weekend and wives will get drunk the next, ensuring that at least one parent is sober and able to look after the children.

Juices from palm trees are collected by cutting the flowers and allowing the sap to flow through bamboo tubes into a container. As the juices flow through the tubes, they become infected with yeasts and other microorganisms. The sugars are fermented to alcohol and the product, palm wine, is produced in large quantities in the tropics. It is very rich in vitamins valuable to the consumer.

When cereal grains such as rice, barley, wheat, and corn are collected and soaked, or if they become wet from rain, they start to germinate, and starch in the seeds is changed to fermentable sugars that are fermented by yeasts in the environment, yielding an alcoholic beer. It has been suggested by anthropologists that this process was an early cause of fundamental social change. To ensure the continuity of supply of fermentable sugars, people settled in permanent locations. Agriculture, in turn, was a way of ensuring the regularity of production of fermentable cereal grains.

Alcoholic beverages are major fermented foods in the diet of humans. The yeast fermentation not only leads to a highly accepted beverage, it is a safe method of preserving fruit and berry juices until they can be consumed. The yeasts also enrich the beverages with B-vitamins.

As long as the wine or beer is kept anaerobic (air is excluded), it is preserved, but if there is access to air, there is a second fermentation by bacteria *(Acetobacter)* in the environment that transforms the alcohol to acetic acid (vinegar), which is even more preservative than ethyl alcohol. Many primitive wines and beers contain both alcohol and acetic acid. The vinegar fermentation is an ancient process that is still very important today. Vinegar is used to preserve cucumbers and other vegetables as pickles, which make an important contribution to the food supply of people around the world.

Milk products. As soon as humans started milking cows, they found that milk held a few hours at room temperature became sour. They did not know why, but it was, in fact, the streptococci and lactobacilli in the environment that produce lactic acid from lactose in the milk. This is the basis for yogurts, and the souring process as practiced in the early days also led to the development of cheeses.

The principal early milks were those from sheep or goats. Milk was often collected and stored in animal stomachs or hides, which allowed for the souring process to occur, the butter to be removed, and the milk curds to accumulate. The skin of a sheep or goat was carefully removed undamaged. The openings of the limbs and neck and the natural openings were tied. The hair was removed and the skin bag was used to collect the milk. During souring, the curds separate from the whey. The curds gradually lose moisture through the porous container, and further microbial activity and chemical changes lead to a primitive cheese. Today there are more than three hundred types of milk cheeses available. They have a wide range of flavors and textures and add variety and high-quality nutrition to the diets of consumers.

In addition to the bacterial cheeses, fungal cheeses involving growth of *Penicillium roqueforti* (Roquefort cheese and blue cheese) and *Penicillium camemberti* (Camembert cheese) on or in the cheese curd led to new flavors and textures for this class of fermented foods.

The Chinese developed a cheese from soybean milk, called *sufu*. Soybeans are soaked, ground with water, filtered to obtain the fluid milk, and heated to near boiling, and the curd is precipitated with calcium or magnesium salts. The filtered and pressed curd is then inoculated and becomes overgrown with *Mucor* spp. mold, after which it is aged in a salt and alcoholic brine. It is then ready for consumption.

Lactic-acid fermentations. An ancient food-fermentation technique is found in the South Pacific, where islanders centuries ago discovered that foods such as cassava, plantains, and bananas could be preserved for long times by piercing them and packing them in pits that were sealed against oxygen entry. Lactobacilli, *leuconostocs*, and streptococci ferment sugars in the stored food materials to lactic acid, acidifying them and preserving the food against spoilage as long as the pits remain sealed. Pits opened after one hundred years of storage have revealed edible products—the result of bacterial fermentation.

In Ethiopia, pulp of the false banana, a starchy paste, is similarly stored in pits and undergoes lactic-acid fermentation, preserving the starch, which serves as a base for bread. Lactic-acid fermentations of cabbage—for example, sauerkraut and Korean kimchi (which is based upon Chinese cabbage, radishes, and red pepper)—are important processes around the world. Sauerkraut and kimchi are particularly interesting applications of bacterial fermentation. The cabbage is shredded and two to three percent common salt is added. The salt extracts nutrients from the cabbage and a series of bacterial species *(Leuconostoc*, *Lactobacillus*, *Pediococcus)* overgrow the cabbage, producing lactic acid and carbon dioxide that preserve the cabbage; and as long as the product is kept anaerobic, it remains preserved.

Soybeans, with a content of about twenty percent fat and forty percent protein, are a very nutritious food source, first cultivated in Asia. They are harvested dry and have an excellent keeping quality. However, if they are moistened or soaked in water, they become susceptible to overgrowth by bacteria that first acidify them. Then they may be boiled, as in preparation for eating. After this, they become susceptible to overgrowth by molds. In Korea and northern China, the average temperature is cool, below 86°F (30°C), and the moistened soybeans become overgrown by *Aspergillus oryzae*, a mold that is present in the environment, particularly on the soybean straw. If such soybeans are stored under the roof, as is commonly practiced, the soybeans first become white from the mold mycelium (a mass of filamentous growth). Then they become green from the mold spores. During this time, the mold is producing many kinds of digestive enzymes. If such mold-covered soybeans are then mixed with water and salt to form a paste, it will be found that the paste has a meatlike flavor because of the amino acids and peptides released by the mold as it digests the soybean proteins. The end product of this process, called miso in Japan and *chiang* (soybean paste) in China, is used extensively as an ingredient for soup. If the mold-covered soybeans are placed in salt water, especially concentrated salt brine, it is found that the soybeans, which are initially bland in flavor, become meat-flavored, as in the miso process. The product, when filtered, is soy sauce. Today, soy sauces are used to season and marinate foods, not only in Asia but around the world.

Soybeans are also used in Southeast Asia—in Indonesia, Malaysia, and Vietnam. However, the average temperature is generally higher, about 90 to 100°F (32 to 38°C). *Aspergillus* molds grow optimally at about 77 to 86°F (25 to 38°C), so they tend to invade the soybeans in North Asia. In Southeast Asia, other molds such as *Rhizopus oryzae* and *Mucor* spp. grow faster and better at the higher temperature. Thus the environment becomes infected with spores of these molds. When soybeans are soaked or moistened in Southeast Asia and are then cooked and cooled, they become overgrown with molds of the *Rhizopus* or *Mucor* types. If allowed to digest as a paste or in salt brine, they also can lead to a soy-sauce or miso flavor, but the Indonesians and Malaysians allow the mold-covered soybeans to become knitted into a cake that can be sliced and deep-fat fried or used in soups as a substitute for meat, which is generally in short supply in the diet. The product is called *tempeh kedelee* when made from soybeans. The Indonesians have developed other products using peanut and coconut press cakes (from the production of oil) as substrates. The pulverized, soaked press cakes are re–formed into cakes and steamed. They then become overgrown with *Rhizopus* or *Neurospora* molds to produce foods called *ontjom* (peanut) and *bongkrek* (coconut) that like tempeh have a texture that allows them to be sliced and used as a substitute for meat in soups.

Fermented foods have been consumed by humans for centuries and are generally safe, but it should be cautioned that some molds produce toxic, even carcinogenic, products (for example, aflatoxins) and should not be consumed.

There are numerous other fermented foods that utilize edible microorganisms in their production and add variety and nutritive value to our diets.

The Role of Microorganisms in Soil

Plant life, our basic food supply, is dependent upon the trillions and trillions of microbes that exist in the soil, degrading organic matter, recycling nitrogen and carbon, and producing new soil in forms plants can use directly. Thus, good soil, far from being dead, should be described as "living soil," because of its content of living microorganisms. In fact, the rhizosphere, the area surrounding the roots of most plants, contains a wide variety of microorganisms that help the plant to absorb minerals and other plant nutrients. Some plants, such as legumes, have nodules on their roots that contain nitrogen-fixing bacteria, which take nitrogen from the air and produce nitrogen compounds the plants use in the synthesis of amino acids and protein; these are an important protein source in the human diet.

Microorganisms as Food

Blue-green algae of the genus *Spirulina* have been harvested from ponds and eaten for centuries by the ancient Aztecs in Mexico and Africans in the region of Lake Chad.

Mushrooms, the fruiting bodies of microorganisms that live on decaying lignocellulosic compounds in soil, are highly prized as food by nearly all human societies, as well as by many animals, including insects.

Fermentation plays several roles: (1) enrichment of the human diet through development of a wide diversity of flavors, aromas, and textures in food; (2) preservation of substantial amounts of food through lactic acid, alcoholic, acetic acid, and alkaline fermentations; (3) enrichment of food substrates biologically with protein, essential amino acids, essential fatty acids, and vitamins. Protein content is often increased, as for example in Malaysian *tape ketan* and *tape ketella* by utilization of the carbohydrates, lowering their percentage and raising the percentage of protein in the food. Protein quality is also increased by the synthesis of essential amino acids such as lysine, first limiting amino acid in rice. In the Malaysian *tape* fermentation the content of lysine is raised, improving its protein quality. In the Indian *idli* fermentation, it has been reported that methionine, the first limiting amino acid in many legumes, is increased from 10.6 to 60 percent. Highly polished rice is deficient in thiamine (vitamin B_1), and consumption can lead to beriberi, a disease characterized by muscular weakness. In the Malaysian *tape* fermentation, thiamine content is raised to that of the original unpolished rice. In the Indonesian *tempeh* fermentation the content of riboflavin doubles, niacin increases seven-fold, and vitamin B_{12}, which generally absent in vegetarian foods, is synthesized. In the African kafir beer fermentation, riboflavin doubles and niacin/nicotinic acid concentration nearly doubles. Mexican *pulque*, the oldest alcoholic beverage on the American continent, contains thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, and biotin that are of particular importance to the low income children of Mexico.

There is much hunger, starvation, and malnutrition in parts of the world today, and the world population is predicted to reach eight to twelve billion by the year 2050. As world population increases, the supply of meat and other animal products available per person is likely to decrease. A large, capable research institute in England has developed a process in which edible mold mycelium is grown and used to provide protein and texture for meat analogues (substitutes) for the human diet. Microbial protein can also be extracted from cells, and then concentrated, isolated, and spun or extruded to make meat substitutes.

Although this would appear to be very advanced technology, the Indonesians for centuries have overgrown soaked, partially cooked soybean cotyledons with the mold *Rhizopus oligosporus* (as mentioned above), which knits the soybean cotyledons into a firm cake that can be sliced and deep-fat fried or used in chunks as a substitute for meat in soups. The protein content rivals that of meat and the cost is very low, within the means of the average Indonesian. Also, the microorganisms involved enrich the food with vitamin B_{12}, increase niacin by a factor of seven, and double the riboflavin content.

Among plants, the grasses are the most efficient fixers and utilizers of carbon dioxide, producing sugars, starches, and cellulose; they are also synthesizers of protein, using nitrogen from the soil. Grasses can double their cell-mass in two to three weeks. A 1000 kg harvest of grass can be repeated every two to three weeks. However, yeasts are much more efficient in this regard. A yeast (1000 kg) grown in tanks on limited land space can produce 168,000 kg of cells containing 84,000 kg of protein every two weeks.

Bacteria are even more efficient: whereas yeasts can double their cell mass in about two hours, some bacteria can double their cell mass in twenty minutes. Still, 1000 kg of yeast growing in a suitable fermentor can produce 1000 kg of new cells for harvesting every two hours, with a daily production of 12,000 kg of cells containing 50 percent or 6000 kg of protein. (Molds generally grow more slowly, doubling their cell mass in four to six hours.) Since the protein content of bacterial cells may reach 80 percent (compared with 40 to 45 percent in soybeans, for example), there is no method of producing protein that can compete with microbial cells. Except for algae, microbes require energy sources such as sugars, starches, cellulose, or hydrocarbons—all derived originally from the sun's radiation. But they can utilize energy sources that humans cannot digest, such as cellulose and lignocellulose found in straw. As described earlier, mushrooms are a good example of such microorganisms: they produce delicious, edible food directly from straw and sugarcane bagasse.

Only about twenty-five species of more than two thousand edible fungi are widely accepted as human food. The four most important mushrooms are the commonly cultivated white mushroom or button mushroom *(Agaricus campestris)*, the black forest mushroom shiitake *(Lentinus edodes)*, the straw mushroom *(Volvariella volvacea)*, and the oyster mushroom *(Pleurotus ostreatus)*.

Mushrooms can be grown on a wide variety of inexpensive, inedible substrates such as cereal straws, sugarcane bagasse, banana leaves, sawdust, cotton wastes, and animal manure. World production of straw is estimated to be about two billion tons. One kg of dry straw compost material can yield one kg of fresh mushrooms. Thus, straw, if all were used for production of mushrooms worldwide, could provide eight billion consumers with 250 grams of fresh mushrooms daily. Mushrooms are high in essential amino acids and nutritional value. They also appeal to almost all consumers for their flavors and flavor-enhancing capabilities. Mushrooms, a microbial product, are thus likely to play an important role in feeding the world in the future. And straw, after serving as a substrate for mushroom production, is nutritionally superior to raw straw for feeding cattle. The straw has been partially recycled and made more digestible in the process.

As world population rises in the twenty-first century, microbes may be used to a much greater extent to feed mankind, or at least feed animals that, in turn, will yield meat for the human diet. Humans, plants, and animals have been intimately involved with microorganisms ever since they evolved. While some of the microorganisms cause serious diseases, there are also many that provide foods and feeds and are beneficial to other life on earth.

See also **Cheese**; **Fungi**; **Microbiology**; **Packaging and Canning**; **Pasteur, Louis**; **Safety, Food**; **Southeast Asia**; **Soy**.

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Keith H. Steinkraus

MICROWAVE OVEN. While experimenting with radar during World War II, Percy Spencer of Raytheon Corporation in Waltham, Massachusetts, discovered the heating properties of microwaves. With a candy bar in his pocket, he leaned in front of the microwave tube and the candy bar promptly melted. This event led to the birth of microwave ovens.

In 1945 Spencer submitted his first patent application for heating food with microwaves. The patent described two parallel magnetrons that heat food that passes by on a conveyor belt. Two years later, William M. Hall and Fritz A. Gross, Spencer’s co-workers, applied for a patent for a microwave-heating device enclosed in an oven. This device consisted of two microwave-generating magnetron tubes packed in a metallic box. The oven included a timer and a means of controlling power.

Raytheon’s president, Laurence Marshall, was interested in Spencer’s patent. A prototype microwave oven was constructed in 1946 costing an estimated $100,000. Marshall was also enthusiastic about the prototype and ordered engineers to develop an oven in which cold sandwiches could be heated. A contest was held to name the new oven—the winner was “Radarange.”

Commercial Microwaves

The first commercial Radarange model was a freestanding white-enamel unit operating at 220 volts of electricity and with an internal water-cooling system. The first Raytheon microwave oven was sold to a restaurant in Cleveland, Ohio, in 1947. Subsequent Radaranges incorporated sliding vertical doors. With a price tag of $3,000, sales were mainly limited to restaurants, railroads, cruise ships, and vending-machine companies.

Development of the microwave oven continued during the 1950s. Raytheon dominated the field of commercial microwave ovens and heating applications: It was the only manufacturer of ovens for restaurants and was the principal magnetron manufacturer. Raytheon licensed other companies, such as Hotpoint, Westinghouse, Kelvinator, Whirlpool, and Tappan, to manufacture the ovens. Raytheon furnished power supplies, magnetrons, and basic-oven design data to each company. The Tappan Company began experimenting with a Radarange installed in their lab. Tappan engineers, who were experts in cooking, teamed up with the Raytheon microwave engineers. In January 1952 the Tappan Company developed the first domestic commercial Radarange. It was powered by a 1,400- to 1,700-watt magnetron that was water cooled and required plumbing connections. The unit was five and a half feet high and weighed 750 pounds.

Domestic Microwaves

The experimental unit developed by Tappan was impractical for domestic use. What was needed was a magnetron requiring less power and a heat dislocation system that could replace the water cooling mechanism. Tappan engineers designed a cabinet with an air-cooled system. Eventually, the magnetron and related components, which had fed microwaves directly into the cavity, were relocated behind the oven. In October 1955, Tappan introduced the first domestic microwave oven for the consumer market. Designed to fit a standard forty-inch range or for built-in use, the unit had a stainless-steel exterior and aluminum oven cavity with a glass shelf. The oven featured two cooking speeds (500 or 800 watts), a browning element, timer, and a recipe-card file drawer. It retailed for $1,295. The unit was marketed as an "electric range." Its advertised advantages were cooking speed, a cool oven, and a unique reheating capability.

General Electric's Hotpoint division, which also had been researching microwave cooking, unveiled its electronic oven the following year. Both the Tappan and Hotpoint oven generated unprecedented enthusiasm and interest in 1956, but sales were dismal. The price was high for the average consumer, and food-processing techniques for the microwave were not well understood. Few food processors took the technology seriously, thus few microwaveable foods were produced.

Breakthroughs

Tappan continued to improve its product. By 1965 Tappan had introduced the first "microwave cooking center," which consisted of a microwave oven mounted above a conventional range. This unit still retailed for well over $1,000. Despite these advances, only ten thousand households in the United States owned microwaves by 1966.

Two events revolutionized the microwave industry. The first was the invention by Keisha Ogura of the New Japan Radio Company—40 percent of which was owned by Raytheon—of a compact, low-cost magnetron. The second was Raytheon's acquisition of Amana Refrigeration, Inc. George Forestner, Amana's president, was a microwave visionary. Amana appliance engineers teamed up with Raytheon experts to develop and design a household Radarange. In August 1967, Amana released its first microwave oven, the Amana RR-1. It operated at 115 volts and sold for $495. The unit was well received. The Amana RR-1 set off a revolution in microwave oven technology, and Amana's success encouraged other appliance manufacturers to produce microwave ovens.

Another important microwave oven manufacturer was Litton, which acquired a small microwave manufacturer called Heat & Eat in 1964. Previously, Litton had manufactured commercial microwave ovens for restaurants. Its newly named Microwave Cooking Products Division in Minneapolis targeted the home market. Litton's Model 500 used 115 volts and was compact. These ovens were installed on TWA planes in 1965, and Litton dominated the restaurant business by 1970.

Microwave Challenges

Despite the initial successes, there were still problems to overcome before the microwave oven would be generally accepted. Manufacturers needed to convince the public that microwave ovens were safe. This fear began with the U.S. Congress's passage of the Radiation Control for Health and Safety Act in 1968. On 4 January 1970, the U.S. Department of Health, Education, and Welfare published the results of microwave oven radiation tests. The tests showed that microwave ovens leaked microwaves. Thus the federal government developed new standards and required changes in the construction of ovens beginning on 6 October 1971. These new regulations required design changes that would result in safer microwave ovens. Public apprehension slowly abated.

Another crucial challenge was convincing food processors to repackage their products. Foods packed in foil blocked microwaves and damaged ovens. Also, frozen foods contained too much water for microwave use. At first, food processors were not interested in working with microwave manufacturers. By the 1970s, however, more than 10 percent of all U.S. homes possessed microwaves, many microwave ovens were in use in vending businesses, and numbers were steadily increasing. Major food processors quickly reversed their direction and invested in microwaveable food products, and specialized microwave cookware was introduced. By 1975 microwave ovens outsold gas ranges, with sales of over one million units. In the early twenty-first century, the primary use of microwave ovens in the United States was to reheat food.

See also **Fast Food; Frozen Food; Kitchen Gadgets; Kitchens, Restaurant; Popcorn; Preparation of Food; Storage of Food**.

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MIDDLE AGES, EUROPEAN. To understand medieval cuisine, we have to start with Roman culinary practice, which probably kept its influence long after the decline of the Roman Empire. Two ingredients were of particular importance here: the liquid salt called *garum* or *liquamen* and the granular gum *asa foetida* or *laser Parthicum. Liquamen* or *garum* was the liquid salt of Roman high cuisine; it was usually made not by the cooks themselves but in factories, notably in Pompeii. For this purpose a vessel holding about thirty liters was filled with layers of fish, salt, and dried herbs, and then covered. This mixture stayed in the sun for a week and was then stirred well daily for twenty days until the fish and herbs were fully pulverized by fermentation and blended into a liquid. This was strained and sold in amphorae. Often it was combined with olive oil and wine, sometimes with honey or sweet wine and with pepper, lovage, and sweet marjoram as well. Some of the herbs for the *garum* were dill, coriander, fennel, celery, savory, sage, rue, mint, lovage, thyme, and sweet marjoram. These herbs are available today in dried or fresh form, and we can more or less imitate the *garum* ourselves. We also can make use of a Vietnamese product, called *nuoc mam*, which is prepared in the same way and has the same function. The advantage of liquid salt in comparison with solid salt is that the liquid keeps the meat succulent, whereas the solid salt extracts the juices.

The Romans also made a cheaper version with fewer herbs by not putting the fish, salt, and herbs in the sun for fermentation, but boiling them for a short time. In this way, the fish quickly becomes pulverized and releases its liquid, which, depending on the quality of the bones, tends to become a jelly. Just before this happens, the liquid is strained and kept as a substitute for *garum*. The Romans called this salty juice *allec*, which in the Middle Ages became the word for (salted) herring.

Besides *garum*, the Romans used another favorite product now called *asa foetida*. This gum, derived from the roots of a Near Eastern umbellifer, not only smells bad but also tastes bad; nevertheless, it seems to have been consumed lavishly by the Romans. Originally, the Romans had used not this plant, which they called *laser Parthicum*, but the *silphium* or *laserpicium* from North Africa, a plant they consumed so recklessly that it was nearly extinct at the beginning of our era. The Romans then started to import *laser Parthicum*, which is called "ferula asafetida" by modern pharmacists, as a substitute. In large quantities it is hardly digestible for our stomachs and soon gives one a feeling of satiation and even nausea, but in small quantities it is not disagreeable.

From these two products, *liquamen* or *garum* and *asa foetida*, we may conclude a lot about the taste preferences of the Romans: savory with herbs from the Mediterranean region, which were grown partly in their own gardens. They favored East Asian spices like ginger and cardamom much less, although these were well known. Only the peppers, both black and white, were commonly used. As for sweeteners, sugar was still unknown; it was not imported from Ceylon and Asia Minor until the seventh century. Sugar cane was grown by the Arabs in Sicily starting in the tenth century, but it was only after the Crusades that it found its way to Europe as a very expensive kind of spice. Instead of sugar, the Romans used honey or reduced wine (*defrutum*) and raisins, dates, and figs. For the rest, their victuals consisted of fish, fowl, a bit of pork, beef, or mutton, many legumes such as chickpeas and lentils, fruits, vegetables, olive oil, eggs, cheese, and various kinds of grain.

Pasta already existed, if we may translate the word *tracta* this way; however, it was not pasta in strands like spaghetti but in sheets like lasagna. These were used as dividers between wet fillings to make layers within a pie. The very thin, round sheets, called *tracta*, were rubbed between the fingers and used as a binding agent for stews, a practice which survives as *Reible* in South German cooking.

The Early Middle Ages

How long this kind of nourishment held the stage in Western Europe during the Middle Ages is hard to say because detailed information is lacking. We can only conclude that there must have been a certain continuity in the taste for herbs and spices, at least until the Carolingian era of the ninth century. This can be deduced from a 716 charter of the Merovingian king Chilperic II for the abbey of Corbie in Northern France that was, in turn, a confirmation of a charter of King Chlotar III from the third quarter of the seventh century. In the charter, freedom from duties at the toll in Fos near Marseilles was granted for the following imported foodstuffs: olive oil, *garum*, pepper, cumin, cloves, cinnamon, spikenard, *costum* (an aromatic root from India), dates, figs, almonds, olives, peas, and rice. So *garum* was still in use in that period together with a few Indian spices, but *asa foetida* is no longer mentioned.

Not only some of the spices, but also the garden herbs must have remained in favor, judging from the last chapter of the *Capitulare de Villis* (Ordinance in chapters about the demesnes) of Charlemagne, in which the cultivation of about seventy kinds of herbs and vegetables in the gardens of every demesne in his empire was enumerated. There we find most of the herbs needed for the making of *garum*, as well as several other plants like beans, peas, onions, chives and garlic, cucumbers, watermelons, gourds, beets, endive, and lettuce, as well as fruit trees. The Carolingian population could be assured of a healthy diet if it lived according to the prescriptions of Charlemagne.

The same holds true for the monks at St. Gall in Switzerland, provided that they actually grew and used all the plants that are shown on the map of their monastery from about 817. There we find three gardens with edible plants: the *hortus* or vegetable garden, the *herbularius* or herb garden, and the orchard. The species, however, were not strictly separated, for in the *hortus* there were not only vegetables like onions, garlic, leeks, celery, beets, black radishes, lettuce, parsnips, and cabbage, but also herbs like coriander, dill, parsley, chervil, and savory, and, for medical use, poppy and corn-cockle. In the *herbularius* we not only find roses, lilies, and iris, but also beans, next to herbs like savory, costmary, goat's horn, rosemary, peppermint and water-mint, sage, rue, cumin, lovage, and fennel. In the orchard we come across apple, pear, prune, mountain ash, quince, medlar, fig, chestnut, peach, hazelnut, walnut, almond, mulberry, and bay.

Monks were allowed to eat vegetables and fruits, for the Rule of St. Benedict states that at every meal, fresh vegetable or fruit, when available, were to be served in addition to two cooked dishes (which were probably made of fish, dairy products, and grains). Walafrid Strabo, ninth-century abbot of the Benedictine monastery at Reichenau on Lake Constance in Switzerland, celebrated in his poem "De cultura hortorum" (About the cultivation of gardens) the plants in his abbey's garden, such as sage, rue, lemon herb, gourd, water-melon, fennel, lovage, chervil, mint, celery, catnip, and black radish, along with poppy, rose, lily, and iris. For the most part we find these plants as well in the *Capitulare de villis* and on the map of St. Gall, from which we may conclude that they were widespread in the Carolingian period. But recipes for preparing them are not known, and nothing can be said about the refinement of the dishes served. The same holds true for the eleventh-century food prescriptions from the abbey of Werden on the Ruhr River in Germany, according to which the monks alternately had fish, cheese, and eggs, or cheese with vegetables for dinner, with wine and ale for drinks and mead on Sundays.

It must have been possible to compose quite delicate menus with simple ingredients that were permissible for the monks; this is indicated by the ironic words of Bernard of Clairvaux in 1124 in his *Apologia ad Guillelmum* (Apology to the Abbot William [of Saint Thierry near Reims]) about the eating habits of the abbey of Cluny in Burgundy. In this treatise he ridiculed the many ways of preparing a simple ingredient like eggs and reproached the abbot for the manner of serving one dish after another when the stomach had already been fully satisfied, but the eye remained curious about new colors and shapes. In this way, he condemned exactly those characteristics that would later become the glory of French cuisine, especially the refined sequence of the courses, in which the former dishes did not give a feeling of satiation but on the contrary stimulated the appetite for the latter ones.

The Later Middle Ages

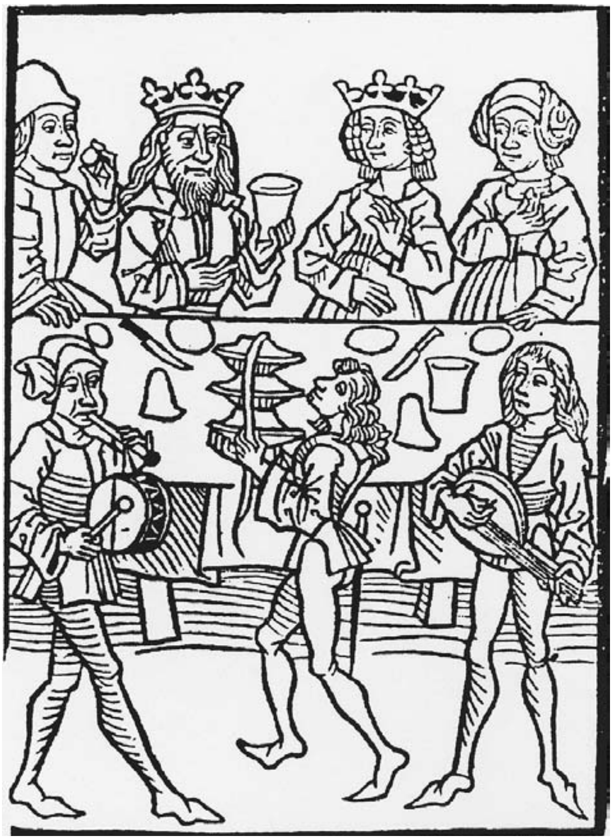
In the meantime, however, this refined sequence of courses was far from common if we judge from the existing menus of the meals of princes and other nobles in the later Middle Ages. These menus contained in England in the fourteenth and fifteenth centuries no more than two or three courses—each course, however, consisting of at least ten dishes without any specific sequence of sweet, savory, sour and sharp, fish or fowl or meat, boiled, baked or roasted. In France the dishes at a festive dinner were divided among five or six courses, but there was also no fixed sequence like that of later ages. A common feature of aristocratic foodways all over Europe was the accent on meat, fowl, and fish (sometimes game, although less than one would expect), in contrast to the rather vegetarian eating habits of former centuries.

It is possible to study late-medieval recipes and to imitate them more or less exactly. By the late Middle Ages, tastes had changed rather drastically from those of the Carolingian period; new spices from East Asia with vinegar or sour grape juice, called *vertjus*, had taken over the role of primary seasonings, replacing the many herbs and vegetables with *garum* that had been favored earlier. Parsley, savory, sage, and hyssop were still used, but other herbs had become rare. Salt, when it was used at all, was added after cooking. This was due not to the presumed expensiveness of salt—the Asiatic spices were much more expensive—nor to the fact that much salted fish and meat was used, but probably to the dominant role of spices like ginger, cinnamon, cloves, mace, nutmeg, galingale, cardamom, and pepper. These ingredients provide enough flavor that the absence of salt is not noticeable, even in dishes that are prepared with fresh meat, game, fish, or fowl.

In this context, another critical point must be made. We sometimes hear or read that people in the Middle Ages needed so many sharp spices because their meat was always spoiled, and they had to hide the bad smell and taste. But although their means of controlling the quality of their food was less elaborate than in the modern Western world, it is nonsense to pretend that they were always balanced on the edge of food poisoning and tried to conceal this with heavy seasonings. They certainly had other medical conceptions than today, but in practice they understood very well how to combine these theories with wisdom gained from long experience. People knew quite well what was healthy and what was not and were on their guard not only against really spoiled meat but also against unsafe water: instead of water, they used wine or broth or boiling liquid from peas (*purée de pois*) in the kitchen. They drank beer and ale in Northern Europe, wine in Southern Europe, and cider in a narrow strip from England to Normandy and Brittany. So the difference in our eating habits is not in the lack of hygiene, but in the fact that they dined less frequently but in bigger quantities with more calories at the same time, and, in the case of the strict rules and regulations in the monasteries, no more than twice a day.

The change in taste after the Carolingian era was caused not by the consumption of half-spoiled meat or fish, but by other factors, largely economic ones. The merchants of the tenth and eleventh centuries had a keen eye for the fact that the small ships and simple harbor equipment of their time meant that the best gains were to be expected from articles that took little space and at the same time were very expensive because they were rare. The Asian spices fit these requirements exactly. They were transported through Asia along land routes and brought to the Levantine harbors of the Mediterranean, and then taken by Venetian ships to Italy. From there they were traded along rivers and land routes to the North, where in the fairs of Champagne in France there were middlemen who exchanged the spices for the products of Flanders and Scandinavia, such as woolen cloth and timber.

Included were not only the spices that had been known and favored in antiquity, such as pepper, ginger, and cardamom, but also cinnamon, nutmeg, mace, cloves, and galingale. Added to these was an article from Asia Minor and the Balkans that was and still is even more expensive than the Asiatic spices—saffron, the dark-yellow stigmas of the stamen of the *Crocus sativus.* In antiquity, saffron was mainly used as a dye and a medicinal drug, but in the Middle Ages it became obligatory in high cuisine and primarily served the purpose of coloring the food yellow. Pure, genuine saffron was as expensive as gold. Adulteration of the stigmas, mainly in the shape of powder and mixed with other yellow stuff had already been the nightmare of physicians in antiquity and was punished with heavy fines or mutilation.



Fifteenth-century woodcut depicting a medieval banquet where both the king and queen are shown with their tasters. Tasters were nobles who generally came from the royal entourage. Their purpose was to ensure that the food was not poisoned. Before each of the diners is a slice of bread called a trencher. It served as a plate and was changed often during the course of the meal. ROUGHWOOD COLLECTION.

Fasting Prescriptions

Colors played an important role in medieval cookery because the cooks not only tried to make dishes as attractive as possible, but also very often to disguise their real nature. This tendency was connected with the impediments the Christian Church imposed on the foodways with strict rules about fasting and abstinence. People had to abstain two days a week—for example, Wednesday and Friday, or Friday and Saturday—from the meat of quadrupeds. However, fish and other aquatic animals were permitted on those days, as were chicken eggs and dairy products. During some periods of the year, however, not only the meat, but also the milk, butter, and cheese of quadrupeds were forbidden, together with fowl and its eggs. Only fish, snails, and aquatics like mussels and oysters remained outside these prescriptions: they were always allowed as long as they were not prepared with butter or lard.

There were periods of the year in which not only a two-days-a-week abstinence but a full fast was ordered; this meant that dairy products and eggs, in addition to meat, were forbidden. The most important of these periods was the forty days of Lent from Ash Wednesday to Easter (not including Sundays, which were never fast days). The so-called Ember days were also a time of fasting. These days, whose name is a corruption of *quatuor tempora* (four seasons), coincided more or less with the change of the seasons. They were the Wednesday, Friday, and Saturday following the Feast of Saint Lucia (December 13), Ash Wednesday, Whitsunday (Pentecost), and Holy Cross Day (September 14). Religious were required to fast during the four weeks of Advent, but this was not obligatory for laymen.

Fish was always permitted, for the Church did not promote pure vegetarianism, and the regulations were not made out of compassion for the suffering of animals. It is possible that the fasting cycle was not a Christian invention at all, but an adaptation of medical conceptions about the need for refraining from food during a short period in order to prepare the body for a new season. The physical meaning of the four seasons with their various qualities, derived from the humoral system, was already implicit in the writings of the physician Galen of Pergamon in the second century C.E. The Christian Church adopted this concept and interpreted it by applying it to the avoidance of the capital sins and the devout observance of Lent. The forty days before Easter required a total change-over of the kitchen, especially in those regions that did not have good vegetable oils (like olive oil in Greece, Italy, and Spain) but used butter, bacon, and lard, as was the case in England, Scandinavia, and large parts of Germany and the Netherlands.

Food Imitations

During fasting weeks, wealthy people ate a lot of fish, salted like herring or dried unsalted like "stockfish" (i.e., cod that has been split and then unfolded and dried hanging on a stick), but also fresh fish from the sea, the rivers, and the lakes or ponds. Fresh fish was very expensive because of the difficulty of transporting it without ice to keep it cool. Ordinary people who lived far from the water had to be satisfied with salted herring, a popular food of which, however, people tired. Anyone who could afford it tried to stimulate the appetite not only with fresh fish, but also with imitation eggs and meat. Eggs were imitated by mashing white almonds with a mock-yolk that was colored with saffron. Meat could be imitated by forming dough into the shape of an oxshank, like the Dutch *duvekater*, which is seen in seventeenth-century paintings but must have been much older. The marzipan sausages that are still sold in Germany and the Netherlands in December are relics of this medieval custom. Such meat substitutes were common during the Ember days around the Feast of Saint Lucia in December. Other ingredients that were typically used during periods of fasting, especially in Lent, were dried fruits like figs, raisins, dates, and currants, as well as nuts, particularly almonds. Colors were very important in medieval cuisine, not only in these imitation dishes, but in other recipes as well; litmus was used to color sauces flaming red, sandalwood (*Pterocarpus santalinus*) was used for a reddish brown, the juice of parsley and other garden herbs for green, and saffron for a goldish yellow. As mentioned, saffron was originally meant not for the kitchen but for the pharmacist's shop because of its stimulating influence. Especially in combination with wine, it makes one feel high, an effect that soon turns into a deep fatigue. The Greek pharmacy knew of more remedies that were recommended for their medicinal effects but might at the same time be used as delicacies as well. For example, confitures, prepared with fruit juice and honey, had a laxative effect but were enjoyed by people with normal bowels, too. The best known of these confitures are marmalade or quince jelly (derived from Greek *melon kudonion*, which means 'quince') and the *diamoron* or mulberry jelly. These recipes from the Greek pharmacy reached medieval Latin medical books, such as the *Antidotarium Nicolai* (Nicholas's book of antidotes) and the *Regimen sanitatis Salernitanum* (A Salternitan regimen of health) through Syrian and Arabic translations. Greek medical science from the time of Hippocrates (fifth century B.C.E.) and Galen (second century C.E.) had been studied at the School of Salerno since the late eleventh and twelfth centuries.

Medical Theory

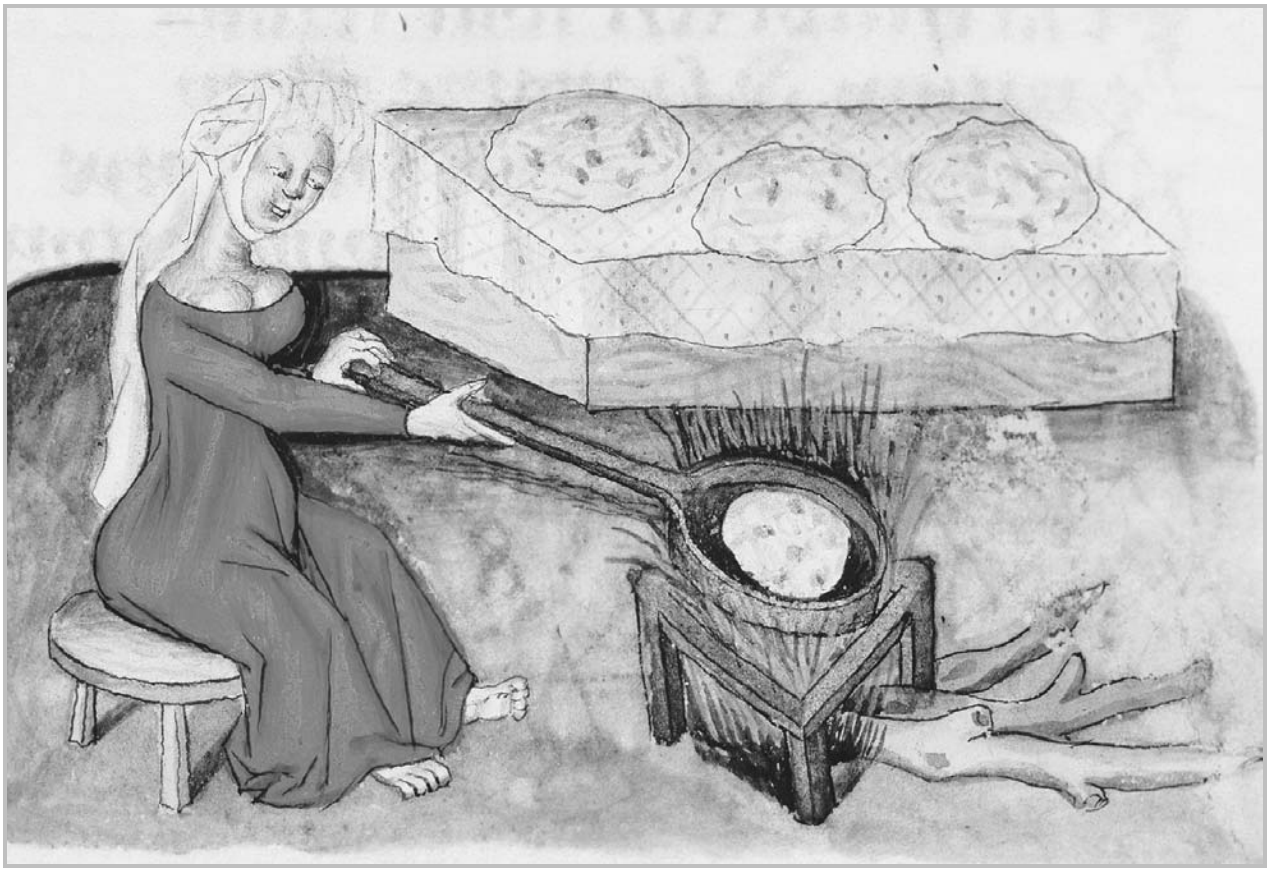
The medical science of the Greeks developed the theory of the four humors or fluids (blood, yellow bile, black bile, and phlegm), which corresponded with the four human temperaments (sanguine, choleric, melancholic, and phlegmatic). Each fluid belonged to a distinct season and a distinct period of life and had two qualities: blood was humid and warm and belonged to spring and youth; yellow bile was warm and dry like summer and adolescence; black bile was dry and cold like autumn and midlife; and phlegm was cold and humid like winter and old age. In the course of life, a person slowly changed his or her temperament, although some dominant characteristics remained the same. One's mood also changed a bit with the seasons, in such a way that an adaptation of the body in the Ember days was necessary from a medical viewpoint.

Food played a crucial role in this adaptation because it was held that illness depended not on internal factors but on external ones, mainly on foodstuffs that were contrary to the temperament and age of the patient. The balance between the fluids was disturbed, and the physician had the duty to restore it. An example that still appeals to us is the "hippocras," a beverage of wine with spices and honey, named after the Greek physician Hippocrates, that was supposed to be warm and dry and for that reason to counterbalance the cold and humid phlegm of a flu. Wine and spices like ginger, cinnamon, cloves, and nutmeg were regarded as "warm" and "dry" and were therefore held in high esteem. Moreover, they were expensive, a fact that may have contributed to their use in high society.

In this way the exotic spices found an expanding market in Europe to such an extent that they altered the dominant taste quite strongly. Alas, cookbooks are lacking for the period between late antiquity and the end of the thirteenth century, so that we cannot tell exactly how and when the use of the many spices became fashionable in monastic and courtly circles. The Crusades and pilgrimages to the Holy Land presumably played a role in this process because more people found their way to the Near East and told about their adventures on their return. Another product of this contact was cane sugar, which was grown in Syria and Egypt and became a major cash crop for the kingdom of Cyprus. It appeared in Western Europe around the twelfth century. Sugar was much more expensive than honey and, like the Asian spices, was only available to the very wealthy.

Ordinary People

How the mass of the population was fed in these periods is difficult to ascertain because of the lack of documentation. We can suppose that rye bread, grain porridge, lard, sausages, and salted herring belonged to their food supply, together with vegetables like onions, leeks, cabbage, and white parsnips. Certainly some kinds of fruit were consumed, like apples, pears, and prunes, but they were probably processed in pies or stews, not eaten raw. Raw fruits, being humid and cold, were not considered to be healthy.



An illumination from a fifteenth-century French manuscript based on the *Tractatus de Herbis* by the ancient Greek physician Dioskorides. The woman is making fry-bread, round slabs of sweet dough pan-fried in lard or butter. This type of food was eaten only on feast days. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

Cookery Books

Our knowledge of medieval kitchen recipes is derived from fourteenth- and fifteenth-century cookery books, of which more are extant than most people think. The most famous cookbook was the *Viandier* of Guillaume Tirel dit Taillevent (c. 1310–1395), who was the chief cook of the French king Charles V. This manuscript was copied several times in the fourteenth century and influenced the other famous French cookbook of the fourteenth century, which is called *Le Ménagier de Paris* (The goodman of Paris) after its anonymous author. The *Viandier* of Taillevent appeared around 1490 in a printed edition that includes not only the fourteenth-century recipes, but also quite a few newer ones that might have originated in the court of the dukes of Burgundy.

The capacity of cookbooks to become bestsellers is also proven by the many printed editions from 1475 onward of the Latin work by the Vatican librarian Bartolomeo Platina, titled *De honesta voluptate et valitudine* (On right pleasure and good health). His book was based on the handwritten cookbook by Maestro Martino, chief cook of the patriarch of Aquileia, who lived in Rome in the middle of the fifteenth century. Actually, Platina did nothing more than translate Maestro Martino's Italian recipes into Latin and add some medical remarks about their qualities as related to the humoral theory. Maestro Martino's recipes, although more often than not qualified by Platina as unhealthy, can be easily imitated and enjoyed today. They were derived partly from Byzantine as well as Spanish-Catalan cuisine, of which a fourteenth-century cookbook, *El libre de Sent Sovi* (The book of Sent Sovi), is known. There the Armenian Arabic influence is notable, for example in the use of mashed almonds stirred with cooking liquid for the binding of sauces and stews, and of pasta in strands like spaghetti. The use of ground almonds became common practice in high cuisine all over Europe, but pasta in strands remained limited to the Mediterranean regions: in Italy several varieties were developed, like vermicelli and macaroni, along with pasta in sheets like lasagna, which was probably known already by the Romans.

No less professional a cook than Maestro Martino was Maistre Chiquart, who wrote his book *Du fait de cuisine* (On cookery) while in the service of the Duke of

Savoy around 1420. A little bit earlier, around 1390, a collection of recipes from the English royal household was composed under the title *The Forme of Curye* (The way of cookery). Several other English collections of recipes date from the fifteenth century. In the German language the oldest known collection of recipes is *Daz Buoch von guoter spise* (The book of goodly fare), which was composed in Würzburg around 1350 by a high official of the bishop and, therefore, probably reflected the food served in an ecclesiastical household. But there are also some recipe collections from secular German courts, for example, the cookbook of Maister Eberhard, cook of the duke of Bavaria-Landshut in the fifteenth century. All of these handwritten texts are now available in modern editions. The earliest printed German cookbook is the *Küchenmeisterey* (Mastery of the kitchen), which was published in Nürnberg by Peter Wagner around 1490.

As for the Netherlands, the series starts rather late with some fifteenth-century written recipe collections and a cookbook printed in Brussels around 1514 by Thomas van der Noot, called *Een notabel boecxken van cokeryen* (A notable book of cookery). Why this occurred so late is difficult to tell: Is it because older texts are lost or because Dutch courts mainly used foreign cookbooks? Certainly the bourgeois cuisine of the Low Countries, for which the *Notabel boecxken* was intended, was deeply influenced by French and German as well as English sources.

In general, we should realize that handwritten and printed cookbooks in the Middle Ages were only accessible to educated people, who were able to either read themselves or have the books read to them: ecclesiastics, noble ladies, and wealthy bourgeois. The foodways of the average population in towns and villages can therefore not be learned from cookbooks.

With the invention of printing and the advance of teaching in town and chapter schools, the number of people who could read and write increased, as did the readership for cookbooks. Could a book like Platina's *De honesta voluptate* even be counted among the bestsellers? We must ask, however, whether these books were meant for use in the kitchen or rather as showpieces in the owner's library. A Latin collection of recipes with medical remarks like Platina's is more conceivable in the latter case. Innovations in culinary practice are not to be found there but rather in sixteenth-century handwritten household collections that were sometimes later printed.

The Renaissance

A remarkable innovation of the Renaissance was the return to the natural taste and shape of the ingredients, which came about under Italian influence in reaction to the medieval predilection for faux preparations and spiced stews. Certainly, the sausages made of marzipan did not disappear—on the contrary, as cane sugar became cheaper, people could indulge in the luxury of more imitated animals and other sweets—but such items were driven to the edge of the dinner instead of being the main course. Fish was now allowed to taste like fish with a simple sauce of boiling liquid and vinegar. A novelty was the consumption of raw salads with a dressing of oil, vinegar, pepper, and salt. Salad comes from *insalata*—'salted'. In Italy the habit of eating green leaves with *garum* or salt had never been dropped, and although it was contrary to the medical theory about the humid and cold qualities of raw vegetables, this practice slowly reached the regions north of the Alps as well. By way of concession, however, the physicians advised placing the salads at the beginning of the meal, in order that the warm and dry dishes that would follow them could correct their injurious qualities.

Under the influence of the Protestant Reformation, the fasting prescriptions of the Roman Catholic Church were gradually mitigated, so that the strict prohibition of animal fats like butter and lard during Lent was dropped. It was in precisely those countries that did not possess good vegetable oils and had therefore always experienced the greatest impediments during periods of fasting, that the Reformation gained its staunchest adherents—perhaps not by accident. So dairy products became more important in the kitchen, and in the coastal regions along the North Sea a remarkable increase in the number of dairy cattle can be observed in the sixteenth and the beginning of the seventeenth centuries, in comparison with former ages, when horned cattle had been raised mainly for their meat. A larger output of butter and cheese was the result, together with more recipes for sour and curdled milk.

Through the discovery of America, many new plants became known that were more or less successfully introduced in Europe. Travels to India over the sea made the Asian spices available to many more people: they became cheaper and ceased to be a status symbol. This fact certainly played a role in the change of tastes back to the natural flavors of foods and away from the camouflage of sharp sauces and stews.

In this way, the mainstream of history always has exercised its influence upon our civilization and upon our eating habits as well. Next to long waves and secular trends in our foodways, those habits always have been moving and changing.

See also **Christianity: Western Christianity; Fasting and Abstinence: Christianity; Medieval Banquet; Poisoning; Renaissance Banquet; Rome and the Roman Empire.**

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Johanna Maria van Winter

MIDDLE EAST. The Middle East is that part of Western Asia extending from the eastern Mediterranean coast of Turkey and Syria, through the desert to Iraq and Arabia, and to the East through Iran to the Caspian, the Caucasus, and the Black Sea. Into Africa, it includes Egypt, and, by some accounts, Arab North Africa. This area comprises mountains, deserts, fertile plains irrigated by grand rivers, and seacoasts. Climatically, the Middle East ranges from the temperate Mediterranean coast, to the extreme heat of the arid desert areas, to snowy mountains. This variety of terrain produces a wide range of food ingredients.

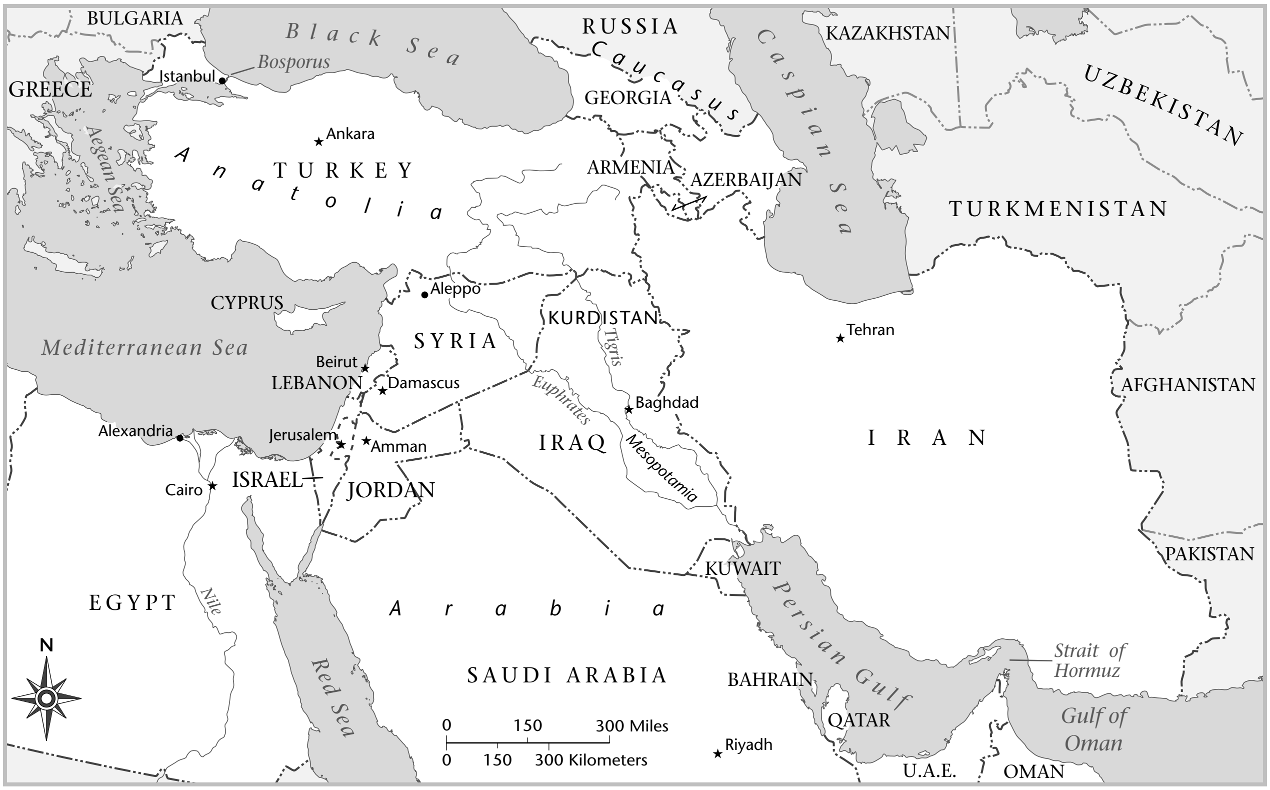
The Population

The ecology of these lands fosters different modes of adaptation. Nomadism was a prevalent form of existence for much of the history of the region, and remains so on the margins. Equally, the region saw the earliest agricultural settlements and the first cities in human history. Indeed, the contrast and conflict between nomad and city dweller is an ever-present theme in the culture, lore, and politics of the region from earliest times. Ethnically, it embraces Arabs, Persians, Turks, Kurds, Armenians, and, until recently, Greeks, as well as many pockets of ancient ethnicities and religions. Jewish communities, many of ancient ancestry in the region, partook in this ethnic diversity, most of them now settled in the state of Israel, which also includes many European and African Jews, creating a melting pot of diverse cultures and cuisines.

Islam is the majority religion in the Middle East and enters into the constitution of many of its cultural elements, including food and drink. There are many Christian communities, of diverse denominations, and their religious prescriptions of feasting and fasting have also left their mark on food culture. Ancient religions and sects persist in some quarters, notably the Zoroastrians of Iran, as well as many sects, such as Baha'i, professing syncretistic combinations of old Persian religion with Islam and Christianity.

History and Culture

Successive conquests and rule of different empires have shaped the civilizations and cultures of the region, and led to the common themes in its culture that we find today. The ancient civilizations of Mesopotamia and Egypt were subject to subsequent conquests and incorporation in wider empires, starting with the Persians and the Greeks, then the Romans, including Byzantines, which Hellenized much of the region. The Muslim Arab conquests established a vast political entity, soon fragmented, but retaining common cultural elements. The Islamization of much of Iran and the Byzantine Empire brought these elements of older cultures to shape the emergent civilization, notably its culinary elements. The last empire to rule the region (before European colonial rule) was the Ottoman, which also included much of southeast Europe, creating a wide cultural synthesis of Turkish statecraft, Arab religion, Persian culture, and many elements from the territories under its control. This synthesis included the food cultures. An important epoch in the history of the region, which also affected food culture, was that of Arab Spain, from the eighth to the fifteenth centuries. Moorish Spain created its own cultural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Bosporus
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GREECE
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Anatolia
TURKEY
ARMENIA
AZERBAIJAN
TURKMENISTAN
Aleppo
CYPRUS
KURDISTAN
Tehran
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synthesis, which is evident in Spain and North Africa to the present day. Spain and Morocco never came under Ottoman rule, and this exclusion, as well as distance from Ottoman lands, has left its traces in the distinction of Moroccan food culture.

Ingredients, Techniques, and Cooking Media

Cereals and breads. Cereals constitute the bases of the Middle Eastern diet, historically and today. Wheat and rice are the major and preferred sources of staple foods. Barley is common in the region and is an ingredient in cheaper bread, and millet and sorghum are used in a few places to make porridge and gruel. Maize became common in some areas, notably the Black Sea coast of Turkey, as well as in parts of Egypt. It is made into a kind of cake and eaten as bread. A wide range of breads are baked, mostly from wheat, but also in combination with barley. Bread is generally leavened. Flat breads are the most common. Naan in Iran, *pide* in Turkey, *khubz* or *'aysh* (more of a generic term for bread) are all similar forms of flat bread made from leavened and risen dough in an oven. In Iran and many Arab lands as well as in Anatolia, a *tannour* or *tandir* is the most common oven: an earthenware pot built into a wall or freestanding, is fired with wood or charcoal, and disks of dough are stuck to its sides until baked, usually soft with crisp edges and a bubbly surface. Modern, industrial ovens are becoming more common for large-scale commercial production, which include both flat breads and European style loaves. Another kind of flat bread, called *lavash* in Iran and Turkey, or *khubz saj* in Arabic (also *saj ekmegi* in Turkish), is cooked over a concave iron pot, a *saj*, much like Indian chapati. Bread is a universal staple in the region, eaten, in one form or another, by all classes and groups, practically at every meal.

Another common use of wheat is in the forms of bulgur (Turkish; in Arabic, *burghul*) and couscous. *Burghul* is cracked wheat, made by partially cooking the wheat grains in water, drying it in an oven or in the sun, then breaking it into pieces, in different grades of size. It is used as a staple in a wide area covering Anatolia, Syria, and northern Iraq. Typically, it is cooked in water, with flavorings, much like rice. It is also used in making meat pies, *kibbe/kubba* (see below), and as an ingredient in salads, notably in tabbouleh, with chopped parsley, tomato, lemon, and oil. Couscous, almost exclusive to North Africa, where it is a staple, is made from rolling semolina grains (mostly durum wheat, but it can be barley) in flour, to make a kind of cross between grain and pasta. This is typically steamed and served as a base to meat and vegetable sauces. Another wheat product is *firik* or *frik*, cracked green wheat, sometimes from burned fields, to give a smoky flavor. It is used much like *burghul*, but considered finer.

Rice

Rice is produced in particular parts of the region with suitable climate, soil, and water. Notable rice-producing areas include the Caspian provinces of Iran, the delta of Egypt, and the marsh area of southern Iraq (before its recent drainage). In the areas where it is produced, rice can be a staple, to the extent of making bread from its flour in southern Iraq. Elsewhere in the region, rice was considered a luxury item to be eaten on special and festive occasions. *Burghul*/bulgur in wheat-producing areas was considered a cheaper substitute for rice, such as the *bulgur pilavi* of Anatolia (*pilav* originally referred to rice).

There are many types of rice produced and consumed in the region. Varieties that cook into separate grains (*ruz mufalfel*) are the most valued, and aromatic varieties are also prized. Traditional varieties in Egypt and Turkey were mostly round or boat-shaped grains, much like Italian rice, while in Iran and Iraq, mostly slender, long grains were grown. In recent years, however, much of the rice consumed in the region is imported from North America or the Far East. Basmati rice from India-Pakistan is highly valued: it is aromatic and produces the desired separate grains. Cheaper long-grain varieties are common.

There are a number of different cooking procedures for rice. Iran boasts the most elaborate and refined rice cookery. The standard procedure there is for the rice to be washed in several changes of water, ostensibly to remove the starch (it is not clear that this operation is necessary with modern rice varieties), then it is soaked in water for at least one hour, but preferably for much longer. It is then drained and thrown into boiling salted water for a few minutes, until grains are just cooked, at which point it is drained (much like cooking pasta), then returned to the pot over some fat, oil, or melted butter; the pot then is covered with a cloth and a lid, and left over a low flame for at least half an hour. Known in Iran as *chelow*, this plain rice is served under grilled meats (*chelow kebab*) or with meat/vegetable stews (*khoresht*). More complex rice dishes are called *polow* (*pilaf* , used in Turkish for all rice dishes). When the rice is drained after boiling, it is then layered in the pot with meats and/or vegetables and/or sauces, as well as nuts, currants, or other dried fruit in some dishes, and always with some fat or oil, then covered and steamed as with *chelow*. These methods of cooking are also followed in some communities in Iraq and in Anatolia. More typical methods of cooking in Turkey and the Arab world involve covering the raw rice (sometimes after washing and soaking) with just enough water to cook it, adding salt, and perhaps aromatics, as well as oil, then boiling until the water is absorbed, at which point it is covered and allowed to steam. More complex rice dishes are prepared by first frying the raw rice in oil or butter, sometimes with onions or other aromatics, then adding water or stock, sometimes with meat or vegetables, and allowing it to cook in the same way.

Oils and Fats

Butter and clarified butter (called ghee in India) are, traditionally, the preferred medium of cooking for those who can afford them. Olive oil is prevalent in the Mediterranean coastal areas. It has many nonculinary uses, such as in making soap and as a lighting oil (which is how it is mentioned in the Qur'an). It was used for cooking predominantly by Christians and Jews. Christians use it during Lent, when meat and dairy products are excluded, and Jews use it in place of animal fats such as butter to avoid mixing meat and dairy products. In regions where olive oil was not prevalent, as in Iraq, Iran, and most of Egypt, Christians and Jews used other oils, mainly sesame.

In Turkish cookery a whole class of vegetable dishes is labeled *zeytinyagli*, a reference to olive oil. These are usually eaten cold. In the refined cookery of the urban upper classes, butter was used for cooking meat, poultry and rice, while oil would be used for cooking or dressing vegetables or salads.

Another cooking medium is rendered meat fat, especially that derived from the fat tail of a local breed of sheep. Traditionally much appreciated and featured in historical recipe books and manuals of the princes and the upper strata, it is now largely avoided on account of its strong odor and the health worries of consumers. In recent times, modern industrially produced vegetable oils predominate in the region, and seem to have replaced butter and olive oil in cooking. Cheapness and convenience, as well as perceived health benefits, are involved. The use of olive oil persists in particular regions, such as coastal Tunisia and parts of Aegean Turkey, where there are strong traditions of its consumption, although even there, cost diminishes its accessibility to the poorer sectors.

Spices and Herbs

Most regions in the Middle East use spices. Typically, a stew will include a small amount of a spice mixture called *baharat*, which includes cinnamon, clove, cumin, and coriander. Black pepper is common, and chili peppers are used occasionally, especially as a separate sauce, or as a pickle. Some dishes require specific spices, such as *kamouniya*, a meat stew with cumin, or the Egyptian *molokhiya* (see below), with coriander. Iranian cookery features a more extensive use of spices, including the pungent fenugreek leaves and whole dried limes.

Parsley is commonly used in cooking and in salads, and so is mint. Varieties of thyme are common in Syria, Lebanon, and Palestine, and a mixture of dried thyme and sumac, crushed sour berries, is a common breakfast item with oil and bread. Sumac is also sprinkled over grilled meat. Garlic is common to many dishes and salads.

Meat, Poultry, and Fish

Lamb and mutton have always been the favored meats of the region, with veal as a subsidiary choice in some instances, and, in other places, goat. Pork, prohibited in the religions of Islam—though there are accounts of wild boar being hunted and eaten by some Bedouins—and

Judaism, was also largely avoided by the Christians of the region. Beef was generally considered to be an inferior meat, consumed, if at all, by the poorer classes. This may reflect the quality of the beef it was possible to produce on the sparse pastures of the region. Beef, however, was considered suitable for certain dishes, such as *harissa*, a porridge of pounded grain and meat. Camel meat was consumed in some parts, but is not so commonly now.

Prominent among the meat preparations were the grilled meats, kebabs, which distinguish the region. There is a wide variety of these grills, with many regional specialties and styles. The most common are the cubed cuts on skewers, known as shish kebab in most places, but *tikka* in Iraq (and India). Chicken may also be grilled in the same fashion. Another common variety is *kofta kebab* (*kebab kobedeh* in Iran, or just *kebab* in Iraq), made from ground meat, sometimes with onions and spices, shaped around the skewer like a long sausage and grilled. A popular kebab of recent origin is the *doner kebab*, also known as *shawarma* in much of the Arab world (*gass* in Iraq). It is either layers of meat and fat or a shaped ground meat loaf, placed on a large skewer that rotates vertically next to a strong heat source that cooks the outside crisp. The cooked outside pieces are then sliced off and served with bread and salad. There are many other types of kebab: ribs, thin slices of meat wrapped around a skewer; small cubes of liver, kidney, and sweetbreads, sometimes alternating on a skewer with cubes of fat (*kofte* or liver); wrapped in caul fat, like a sausage, and many others.

Kebab is typically a street or restaurant food, served with bread (rice in Iran), salad, and pickles. It is not usually prepared in domestic kitchens. In recent years, kebab, and especially the *doner/shawarma* variety, have become regular features of fast-food joints in European and American cities.

Meat and vegetable stews, served with rice, bulgur, or bread, are the other genre of typical meat preparation in the region. A typical domestic meal for those who can afford meat would be a stew of lamb in butter or oil, with onion, tomato (usually as paste), and spices with one vegetable, such as okra, beans, or aubergine (eggplant). Often poorer families would use little meat, usually on a large bone, to flavor the stew. There are many variations on this theme, including the distinguished Iranian stew of *korma sabzi*, of lamb in butter and a mixture of green herbs minced fine, as well as whole dried limes, often with the addition of red kidney beans or split peas.

Offal, tripe, heads, and feet are much appreciated in many quarters. A typical broth found in practically all parts of the region is *kelle pacha*, made with sheep heads and feet. This is typically found at a street or specialized restaurant, which is often open all night or very early in the morning, catering to early-rising workers for breakfast, and to revelers after a night of partying and drinking.

Kibbe (Syria) or *kubba* (Iraq) is a genre of pie or dumpling made with meat and cereal. The most common are made with ground meat (typically lamb) and *burghul*, worked together like a dough, then stuffed with minced meat that has been fried with onion, aromatics, and, sometimes, pine nuts or almonds and raisins. This can either be in the form of individual small dumplings (usually shaped like a torpedo), or in slices like a cake, baked on an oven tray with the stuffing placed between two layers of the dough. In the form of small dumplings, this can also be cooked in a sauce with vegetables. One striking variation is a *kibbe niyye*, raw *kibbe*, made by pounding lean meat and *burghul* together with seasoning, which is then served as small dumplings, sometimes with dips of lemon juice and chili sauce. In Anatolia this genre is known as *kofte*, in common with other ground meat *rissoles:* the stuffed version is called *icli kofte*, and the raw one is *cig kofte*. In Iraq and Iran, there are versions of this dumpling made with rice instead of *burghul.*

Poultry. Chicken is ubiquitous in the region. Squab pigeon is eaten in some parts, notably Egypt and Morocco. Wild fowl, especially duck, quail, and pheasant, are appreciated by some, especially in the Caspian region of Iran, but also in many other parts where there is a tradition of hunting.

In the past, before the introduction of industrial production of chicken, these birds were tough, and were generally boiled and stewed, often in sauces and vegetables, just like meat. If they were to be fried, they would be boiled first (in pieces), then finished in a frying pan in oil or butter. A banquet dish would be chicken stuffed with rice or some other grain with meats, nuts, and aromatics, then stewed or baked in butter and further aromatics. Modern battery hens are tender and do not require boiling or long cooking. But old habits persist, especially in domestic kitchens, though many cooks are now roasting and frying their chickens.

In Egypt, pigeon is served grilled (after being spatchcocked, or opened flat) or stuffed, typically with rice or *firik*, and baked or stewed.

Wild fowl are cooked in a similar fashion as chicken. One unique dish of wild duck comes from Caspian Iran and is called *faisanjoun*. The pieces of duck are stewed in a sauce of pomegranate syrup and walnuts. This dish has now become popular all over Iran and in parts of Iraq, but chicken is substituted for the duck. Iranians regard it as one of their foremost national dishes.

Fish cookery and consumption tend to follow specific local tastes and styles, depending on local varieties, forms of fishery, and, sometimes, religious beliefs. Even the names given to the same fish vary widely, and in Mediterranean regions, often follow Greek or Italian derivations. Fried or grilled fish are the most common, as indeed elsewhere in the world. However, local styles are important even for simple grilling. In Baghdad, for instance, Tigris fisherman developed a method of grilling the local carp and barble (called *shabbout*, and highly valued, now almost extinct), by opening the fish flat, like a kipper, and skewering it on robust sticks, which are then erected around an open wood fire on the ground. This is called *masgouf*, and Iraqis came to consider it as a national dish.

Istanbul and the Aegean region of Turkey have a rich and varied fish culture, as does the Black Sea region. There are numerous fish restaurants and bars (known as *meyhane*) along the shores of the Bosphorous, serving varieties from the Mediterranean and the Black Sea. A notable fish from the latter is *kalkan*, a kind of turbot that is much appreciated. They also feature sea bass, different types of bream, a kind of bonito, and mackerel. These are fried or grilled, or sealed in paper, foil, or a salt crust and baked. A typical Turkish dish is *buglama*, a kind of fish broth. Any of these fish or *hamsi*, the small anchovy-like fish from the Black Sea, are boiled in a broth of vegetables and aromatics, with oil or butter, and served in the pot. Fish stews are common elsewhere, such as the *salona* of Iraq, in which fillets are stewed in onions, tomato, tamarind, and other spices.

In many regions, fish is cooked or served with rice. In Iran, fried fillet of fish is served over *sabzi polow*, "green" rice, cooked with a herb mixture. *Sayyadiya*, "fisherman's dish," is typical of the Syrian coast, in which pieces of fish are fried with onions and spices, then cooked with rice. In the Black Sea region of Turkey they have *hamsi pilavi*, combining rice with the fried small fish. Similar dishes are found all over the region.

Seafood, in the sense of crustaceans and mollusks, such as shrimp, crab, squid, and mussels, are available in the coastal region, but not always consumed. There is a widespread religious taboo against this genre, similar to the Jewish prohibitions. It is not, however, common to all Muslims, but confined to particular interpretations of religious law. These foods are widely appreciated in Istanbul, the Aegean, Alexandria, and parts of Syria and Iraq. A typical street and bar food in Istanbul is mussels stuffed with rice, pine nuts, and raisins.

Vegetables and Pulses

Vegetables and pulses are the predominant everyday food of the great majority of the people of the Middle East. They are boiled, stewed, grilled, stuffed, and cooked with meat and with rice. Among the green leaf vegetables, many varieties of cabbage, spinach, and chard are widely used. Root and bulb vegetables, such as onion and garlic, as well as carrot, turnip, and beet are equally common. Fruit vegetables include marrow or squash, tomato, and eggplant. *Bamia* (okra or gumbo) is a distinctive element in the cookery of the region, appreciated for the peculiar consistency of the stews made in combination with meat, tomato, and spices, often with a sour flavoring. A similar consistency is achieved with *molokhiya* (mallow), a green leaf, used fresh or dried, chopped up fine and cooked in a broth with chicken or meat. This is most common in Egypt, where, traditionally, it was cooked with rabbit. Aubergine or eggplant is perhaps the most distinctive vegetable of the region, cooked and served in diverse fashions. It is fried in slices and dressed in yogurt and garlic; or roasted over an open fire, then pulped and dressed with tahini (sesame paste), lemon juice, garlic, and cumin, a dish known as *mutabbal* or *baba ghannoush*; stuffed with various ingredients and roasted in the oven, as in the famous Turkish dish of *imam bayeldi* ("the imam fainted!"); pulped into a sauce for meat in the Turkish *hunkar begendi* ("the king liked it"); or combined with meat in various stews. Tomato, a relatively recent import from the New World (it arrived in most places in the nineteenth century), is now the most ubiquitous ingredient in Middle Eastern cookery. It is used fresh in a variety of salads, cooked, either from fresh tomatoes or as a preserved paste, in almost every stew and broth, and grilled with kebab.

Beans and pulses are crucial to the diet of the region, second only to cereals. The fava bean (broad bean in England) is original, indeed ancient, to the region. Known as *foul* in Egypt and Syria, and *baqilla'/baqelli/bakla*, in Iraq, Iran, and Turkey, they are eaten green and dried. Dried, they are boiled in one of the most popular Egyptian foods of *foul medames*, a domestic and street food, eaten for breakfast or any other meal, mashed and dressed in oil, lemon, and chili. Similar dishes are found in all other parts of the region. The famous *ta'miyya* or falafel, now popular in Europe and America, was originally made from dried fava, crushed and formed into a *rissole* with herbs and spices, then fried. It is also made from chickpeas, or a mixture of the two. Green fava are cooked like other green beans, boiled and dressed in oil, or stewed with meat. A famous Iranian dish is *baghelli polow*, green fava with rice and dill, often with meat; versions of this combination are found elsewhere. The haricot bean (*fasoulya*) is used fresh or dried, boiled and dressed, sometimes as an accompaniment to grilled meats, or stewed with meat. Black-eyed beans (various names, mostly *loubia*) are typically used dried, boiled, often with green leaves, and dressed in oil and lemon.

Lentils, split peas, and chickpeas are widely used in soups, with rice, in salads, or with meat. *Homous bi-tahina*, made from chickpeas and sesame paste, is now common throughout the world, but originated in Syria/Lebanon. Lentils are cooked with rice in various dishes, notably *mujadarra*, found in many parts of the Arab world, as well as in adaptations of the Indian *kichri*. This latter, in the form of *kushari*, is the most popular street food in Egypt. Macaroni is added to the rice and lentils to extend its bulk with a cheaper ingredient, and the taste is enhanced with fried onions and a chili sauce.

Stuffed vegetables are a dish most associated with the Middle East in the popular mind. They are commonly called *dolma*, the Turkish word meaning "stuffed," but also the Arabic *mahshi*. *Yaprak*, "leaves" in Turkish, often vine leaves, but also chard and cabbage, are stuffed with rice, ground meat, pine nuts, and spices, then stewed in oil and tomato, and, less commonly, with a small amount of rich meat such as sheep's feet or breast. There is a version without meat, cooked in oil and served cold, known as *yalinci dolma*, or "false dolma." Many vegetables are similarly stuffed and stewed or baked, such as squash, onion, tomato, eggplant, peppers, and even carrots. There are many regional and local variations of ingredients and flavorings, such as the use or not of tomato or lemon, or the addition of sugar.

Dairy Products

Milk, fresh or soured, was commonly consumed by Arabs, with camel milk predominating in Bedouin regions. Yogurt, a Turkish contribution, is commonly consumed plain, used in cooking, used in salad dressing, or diluted as a drink (Turkish, *aryan*). Butter, as we have seen, was the favored cooking medium. White cheese, like the Greek feta, is the most common in the region, the best made from sheep or goat milk, as is the much valued *halim* or *haloumi*. There are many local and little known cheeses, especially in the mountainous regions of Anatolia, Kurdistan, and Lebanon, which offer rich pastures.

Meals

Patterns of consumption depend, of course, on class, region, and communal affiliation. Desert nomads, for instance, consumed milk, fresh or soured, butter, if affordable, and dates with bread at most meals. Meat was a luxury eaten on festive occasions when a camel or a sheep was slaughtered, boiled in great cauldrons, and served on rice with copious quantities of butter, a rare delight. Rural inhabitants had similarly limited diets. Egyptian peasants, as well as the urban poor, eat a great quantity of bread (often at subsidized prices) combined with a little salted cheese and onion. Anatolian and Syrian peasants eat much cooked *burghul*/bulgur, sometimes with yogurt, in season with tomato. Many urban workers purchase many meals in the street from vendors of *kushari* (rice, lentils, and macaroni) in Egypt, *foul/baqella'*, in that country and Iraq, boiled turnips and beets, roasted corn, kebab, and bread with everything, in many parts of the region depending on income and season.

Historically, meal patterns varied greatly, and the one feature that seems to be common to all regions and classes was a large midday meal. Most people also ate something in the evening, usually a lighter meal. Now the daily three-meal pattern is common among the urban classes, especially the more prosperous.

Breakfast, if eaten, was not usually a distinctive set of foods, but items and leftovers from other meals. Balls of boiled rice washed down with tea in Caspian Iran, for instance, or the ubiquitous foul or *kushari* in Egypt. Prosperous households would serve grilled meats or stews for breakfast. Over the course of the twentieth century, many of the urban prosperous and middle classes have come to regard breakfast as a specific meal, influenced by Western models. Breads or pancakes of various kinds with butter, yogurt, and preserves are often served, as well as eggs in various forms.

Lunch and supper are not distinct from one another. Which one is more substantial depends on work patterns and lifestyle, mostly now tending to the Western pattern of emphasis on an evening meal after work, at least for the upper and middle classes. Except, that is, on weekends, holidays, and festivals, when larger lunches are eaten. A typical Middle Eastern meal would consist of a stew of meat (or chicken) with a vegetable, such as beans or *bamia*, served with rice and bread, and perhaps a salad. Soup, fried fish, roast chicken, or grilled meat are possible additions or variations. The meal finishes with fruit, and sometimes other sweets or pastries. Historically, however, pastries and sweets were not eaten at the end of the meal, but as a separate snack or as a meal in itself. To this day, poorer people lunch on pastries as a special treat.

Eating Out

Restaurants are not traditional to the region, but have developed over the course of the twentieth century. Vendors of cooked food, however, are traditional, and continue to do good business in Middle Eastern cities. The central market areas of cities are redolent with the smells of grilling meat and onion from the kebab stalls, of *kibbe* or falafel frying, displays of pastries, sweet and savory. Tales of the *Thousand and One Nights* feature many of these cook shops and their wares. You see people standing, sitting on stools, or crouching around these stalls, sampling their wares. Historically, many urban people did not have domestic kitchens and sent out for their cooked food, as did market people in their shops and workshops, and many still do. The vendors also cater to the customers of surrounding teahouses, taking food to their tables where they are drinking tea, smoking, and playing games. Now, of course, pizza and hamburgers are added to the repertoire of street food.

The Tavern and the Meze

A type of food specifically related to drink is the meze. Drinking alcohol and drink cultures are widespread, especially in the Mediterranean regions. Historically, wine was the most common alcoholic drink, but during the twentieth century, distilled liquor (typically *arak* or *raki*) became common, and more recently beer. Historically, most "respectable" people who drank did so at home, with friends. Taverns were rough and low-class. The making, distribution and serving of alcohol were carried out predominantly by Christians—in Turkey mostly by Greeks and Armenians—and they were usually the tavern keepers. This picture changed over the course of the twentieth century. An increasingly cosmopolitan, modern, and educated middle class patronized public places of entertainment and association, including cafes, bars, and restaurants that served alcohol. That is where the distinctive meze developed into a kind of convivial meal around the drink table. It consists of a number of small dishes (*mezze* is a Persian word meaning "taste"), picked at leisure: cheese, melon, nuts, various salads and dips, such as *tabboule* (chopped parsley, tomato, and a few grains of

A chef prepares falafel in a restaurant kitchen in Cairo, Egypt. © HANS GEORG ROTH/CORBIS.

burghul), *homous* and *mutabbal*, pickles, and also more substantial items, such as grilled meat, *kibbe*, and sausage. The centers of excellence of meze preparations were initially the Middle Eastern cities with a strong Christian presence, such as Istanbul, Beirut, and Aleppo, but it later became more general, and meze is now widespread in Europe and America, primarily through Lebanese restaurants.

Feasting and Fasting

Festivals and fasts, mostly religious, are celebrated with particular foods, which vary by community and region.

Ramadan, the fasting month for Muslims, is the most important occasion in this respect. Paradoxically, it is the month during which food consumption increases dramatically throughout Muslim communities. Fasting is prescribed for the daylight hours, to be broken at sunset of each day, then people can eat and drink through the night, until daybreak. Breaking the fast becomes a banquet, with exchanges of invitation between kin and friends, and public banquets held by charities and associations. The cafes and pastry shops are open at night, and a carnival atmosphere prevails in the streets. Many Muslims, following the reported example of the Prophet, break their fast with a date, followed by a variety of dishes. A common Ramadan dish in many regions is *harisa* (Arabic), *keshke* (Turkish), or *halim* (Persian), a porridge of meat (often beef) and wheat, boiled then pounded to a paste, spiced with cinnamon and sometimes sugar, or fried onions and strong spices. Lentil and other substantial soups of meat broth and pulses are common items. Otherwise, the Ramadan table consists of a selection of the popular local foods, of rice dishes, fava beans, salads, and dips, and so on. Sweet pastries and puddings are ubiquitous on Ramadan nights everywhere, and the large-scale consumption of dates is common. A common drink for breaking the fast is that made from *qamareddin*, dried apricots pulped and dried in sheets, like paper, which is found throughout the Arab world.

The end of Ramadan is marked by a festival, Id ‘al-Fitr, a feast that breaks the fast, during which a great quantity and variety of sweets and pastries are consumed. The other major Muslim feast is that of ‘Id al-Adha , feast of the sacrifice, which occurs during the pilgrimage month, and at which an animal, usually a sheep or a goat, is slaughtered in every household that can afford it, and great banquets are prepared, with an obligation to give food to the poor.

Lent, the Christian fasting period before Easter, is distinguished by its own foods, dishes that avoid meat and dairy products. This generates a great many dishes made with vegetables, pulses, and oil, many of them described above.

Jewish Saturday meals. Every Jewish community has its typical Saturday dish, one that is prepared on Friday (Cholent) and cooks overnight for Saturday, preferably with the means to keep it hot, but with an extinguished fire. Iraqi Jews, for instance, prepared a dish of stuffed chicken with rice called *tebit*, "overnight." The chicken is stuffed with rice and aromatics, boiled in a broth with tomato paste and spices, then more rice is added to the broth; the whole ensemble, in a large pot, is then put over a wood fire, covered with old blankets and cushions (to keep the heat), and allowed to cook slowly overnight. At Saturday lunch, the fire will have been extinguished, allowing the handling of the food without fear of breaking the Saturday rules. Eggs were placed over the rim of the pot to cook slowly, and these were eaten for breakfast.

Ancient festivals, pre-Islamic and unrelated to the existing religions, are also celebrated with food. *Nowrouz* is the Persian New Year and spring festival, falling at the spring equinox in March. It is celebrated in Iran, Kurdistan, and some parts of Anatolia and Iraq. The *haft-I sin* (seven S's) is a tray on which seven symbolic items, all of whose names begin with the letter "S," are displayed in every household: these include apple, garlic, and vinegar. Part of the ritual of this feast is eating in the open air, which engenders many picnics in parks, gardens, and in the countryside. Another spring festival is the Egyptian Shamm al-Nasim, "the breathing of the breeze," which also requires eating outdoors and having picnics. *Fasikh*, the traditional dish for this festival, is best eaten outdoors, as it consists of rotted fish (usually mullet) eaten with raw onions.

Globalization

Global commerce, travel, tourism, and the new media have affected Middle Eastern food patterns in diverse ways. Most commentators note the spread of Western fast foods, such as hamburgers, pizzas, and fried chicken—in what has been dubbed "McDonaldization." But this is only one part of the story. Another is the region's development of standard restaurant repertoires, based largely on Lebanese styles, and the spread of these styles to Europe and America: McDonald's in Cairo and *shawarma* in New York. Another element has been the "invention of tradition": placed on the global stage through tourism and communications, caterers and cooks responding creatively to the demand for "authentic" national and local cuisines. Many hotels and restaurants in Istanbul are reviving a so-called Ottoman cuisine, and grand hotels in Cairo are serving *foul* and *ta'miya*, as well as obscure village dishes, to tourists. Globalization, then, does not necessarily lead to uniformity in cuisine, but to diversity, and hopefully, to creativity.

See also **Africa: North Africa; Fasting and Abstinence; India: Moghul India; Iran; Islam; Judaism; Passover; Ramadan.**

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MIDWEST. *See* **United States.**

MILITARY RATIONS. Rations are the foods issued to soldiers, particularly those given when they are engaged in field operations. Since rations are often carried over long distances, they have to be as nonperishable as possible. Dry bread and salted meat were the mainstay of soldier's fare until modern preservation techniques were developed.

In the days of the Roman Empire, soldiers on active service were supposed to get two pounds of bread per day, plus meat, olive oil, and wine. If baker's bread was not available, the soldiers were given grain that could be mixed with water to produce a gruel or porridge, or baked into flat (unleavened) bread. In the Byzantine army, the soldiers were given *paximadion*, a biscuit baked twice to make it light and, more importantly, very dry, since it would keep better that way than bread with any moisture in it.

From the fall of Rome to early modern time, armies in Europe were typically small and temporary. They collected grain for bread and animals for meat; when on the march, they depended largely on supplies purchased or simply taken from civilian populations. Before setting off on an expedition to France in 1294, for example, Edward I of England procured cattle and swine to be slaughtered for meat, and salt to preserve it. Bread, flour, and wheat were also issued to the units for the soldiers to eat. Records indicate that while some of these supplies were purchased on the open market, others were requisitioned from apparently unwilling sellers. Forces heading off on longer trips, such as Crusaders, carried hard money to buy provisions along the way.

When more permanent armies were established, the problem of sustaining them on the march was again solved with bread and salted beef or pork, plus dried peas or beans. The Continental Congress decreed in 1775 that the daily ration for soldiers was to consist of a pound of beef, three quarters of a pound of pork, or a pound of salted fish, plus a pound of bread or flour, along with a pint of milk and a quart of spruce beer or cider to wash it down. Quantities of peas, beans, and rice or cornmeal were also allotted. Unfortunately, these generous rations were often not available, the Continental supply system not being up to the task.

In the American Civil War (1861–1865), soldiers on both sides ate salted beef or pork and made johnnycakes out of flour and fried them in bacon grease, or kneaded the dough into a long roll, wrapped it around a ramrod, and roasted it over a fire. They became accustomed to hard bread, or hardtack, so hard that the best thing to do with it was to smash it with a musket butt and soak it in the soup or coffee. The federal army attempted to provide a more balanced meal through a concoction of dehydrated potatoes, cabbage, turnips, carrots, parsnips, beets, tomatoes, onions, peas, beans, lentils, and celery called "desiccated vegetables." The soldiers had little luck trying to cook the newfangled product and called it "desecrated vegetables."

The process of preserving food by sealing it in tin cans and heating it to high temperatures was invented by the Frenchman Nicholas Appert around 1800. The French army and navy were the first to adopt canned rations. Other armies adopted "iron rations" as the technology was perfected and industrialized. Quality control was critical, however: inadequate canning led to death by food poisoning for some U.S. soldiers in the Spanish-American War.

Canned corned beef—"bully beef"—became the mainstay of British army rations in World War I, along with the usual dry bread, called "dog biscuits" by the soldiers. "Maconochie rations"—a canned soup of turnips and carrots—provided men in the trenches with some variety, but was unappealing when eaten cold, as it often had to be.

In World War II, the U.S. Army's "C" rations were individual canned items such as beef and beans or corned beef hash. "K" rations—said to be named after Dr. Ancel Keys, the nutritionist who helped develop them—were complete meals in a water-resistant package, such as a breakfast of canned hash, biscuits, a compressed cereal bar, instant coffee, a fruit bar, and chewing gum. They were intended for short-term use and became monotonous when eaten for days or weeks on end. K rations were discontinued in 1948, although C rations remained in use through the Vietnam War.

NAVAL RATIONS

Soldiers' food in times past was bad enough. Sailors on long voyages had it even worse, subsisting mainly on ship's biscuit (similar to soldiers' hard bread) and salted beef or pork. The meat often stayed in casks for years before being opened, and was distinctly unappetizing: "It was of a stony hardness, fibrous, shrunken, dark, gristly, and glistening with salt crystals," as the British poet and historian John Masefield put it. A sailor handy with a knife could turn a chunk of salt beef into a box or other useful item. The lack of vegetables and fresh food led to scurvy, a disease caused by vitamin C deficiency that could decimate crews on long voyages. The British eventually solved the scurvy problem by issuing sailors lemon or lime juice. The juice ration gave rise to the nickname "limeys" for British seamen.

The concept of a complete, packaged meal was obviously sound, and armed forces have developed new versions with the food sealed in plastic pouches. The U.S. "Meal, Ready To Eat," or MRE, comes in twenty-four varieties reflecting the range of tastes in the United States, from grilled beefsteak to pasta with alfredo sauce and chicken with Thai sauce. Side dishes such as beans or noodles, fruit, crackers, and dessert round out the meal. The meals provide an average of thirteen hundred calories each. Other armies have similar ration packs, with the British version heavy on tea and puddings while the French version offers duck or salmon appetizers and veal or stewed lamb among the entrees. None of them are particularly popular with the troops, and American soldiers say "MRE" stands for "Meals Rejected by Everyone."

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MILK. *See* **Dairy Products.**

MILK, HUMAN. Human milk is a food that evolved to ensure optimal growth, development, and survival of human infants and young children. All female mammals are uniquely equipped to provide species-specific nourishment and immunity through the provision of milk to their newborns.

Lactation refers to the physiological process of producing milk and its removal by an infant. Women produce breast milk as a response to the baby's suckling in an efficient system of supply and demand. Two hormones, prolactin and oxytocin, play important roles in this process. Prolactin is essential for both the initiation and the maintenance of milk production, while oxytocin stimulates milk ejection. Both hormones play complementary roles in breast-feeding, helping the mother relax and easing the infant into sleep. Oxytocin is particularly intriguing because it controls milk letdown, which can be affected by fear, pain, stress, and anxiety. The oxytocin reflex is more complex than the prolactin reflex. The mother's thoughts and fears may hinder the letdown reflex, and thinking about her baby may trigger the production of oxytocin and milk ejection.

Colostrum, the first milk mothers produce after giving birth, meets all the nutritional needs of the newborn. It has strong antiviral properties, strengthens the newborn's immune system, and acts as a laxative to remove meconium (first feces) from the digestive tract. It is thicker and richer in minerals and protein than mature milk. Colostrum is particularly rich in vitamins E and A. Infants usually consume only a small amount of this first milk. Within one or two days colostrum becomes transitional milk, and the supply increases greatly. The rate at which colostrum changes to mature milk varies from woman to woman, however, mature milk is present within two weeks.

Human milk is a living substance, changing constantly and adapting to meet the changing needs of the infant. For example, it changes from the beginning to the end of a feed. The fore milk has more protein, vitamins, minerals, and water and the hind milk has more fat to signal the end of the feed. Human milk has the highest fat content in the morning and the least at night. It even changes by season, age of the infant, and according to the baby's demand. Human milk reflects the environment, the diet, and the germs of the mother. Ultimately the infant determines the composition of the feed in an interactive process. Although breast pumps are available to many women in urban settings, a breast-feeding infant is the most efficient remover of human milk.

Human milk contains the right mixture of proteins, carbohydrates, fats, vitamins, and minerals to meet all the nutritional needs of infants for about the first six months of life. After the addition of other foods, breast milk continues to offer important nutritional benefits. In May 2001 the World Health Assembly confirmed by unanimous resolution that infants should be exclusively breastfed for six months and continue to be breast-fed to age two and beyond.

One liter of human milk provides approximately 750 calories and contains 70 grams of carbohydrate, 46 grams of fat, and 13 grams of protein in addition to vitamins and minerals. Breast milk composition is remarkably stable around the world and changes only slightly with different maternal diets and under different environmental conditions. Fat is the most variable component, since maternal diet can modify the fat content of milk. Milk fat provides essential fatty acids and fat-soluble vitamins. The fats in human milk are in forms appropriate for the age of the infant and are readily bioavailable. Lactose is the primary carbohydrate in human milk. Human milk contains both casein and whey protein, but with more whey than casein, human milk is easier for human infants to digest than cow's milk.

The variety of vitamins and minerals produced in breast milk meets the needs of a full-term healthy infant. Water soluble vitamins, however, are influenced by maternal diet. Minerals in breast milk are highest in the first few days after birth. Infants build up iron reserves in utero, and the iron in breast milk is easily absorbed. As a result breast-fed babies are rarely iron deficient. Breast milk contains enough water for a baby, even in hot climates.

The amount of milk produced by a breast-feeding mother varies from around five hundred milliliters a day at day five to around eight hundred milliliters a day at six months, with a slow decline in volume as other foods are added to the diet. Women exhibit differences in the rate of milk synthesis, although the nutritional status of the mother does not significantly affect milk volume or quality. Current research suggests that differences in breast milk storage capacity among women may exist.

Knowledge about the properties of human milk is accumulating rapidly but remained incomplete at the beginning of the twenty-first century. Debates about how human milk is affected by drugs and chemical contaminants center on health consequences for infants and on the ethics of raising concerns when evidence is inconclusive and new mothers are most vulnerable to negative suggestions about the quality of their milk.

Mother's milk has also been recognized as a medium for early flavor experiences, since it is flavored by the mother's ingestion of foods such as garlic, mint, and vanilla. Human milk provides an opportunity for infants to become familiar with the flavors that they will encounter in the household cuisine.

Breast milk is a living substance. It contains living white blood cells that fight infection. Maternal antibodies are passed to the fetus through the placenta before birth and through breast milk after birth, providing temporary immunological protection for newborns. Milk proteins, such as lactoferrin, play an important immunological role, as do enzymes, immunoglobulins, and leukocytes. Human milk is clean and free of bacteria. Unlike artificial milk substitutes, human milk contains nonnutrient substances with the capacity to enhance immunity and destroy pathogens. Human milk has antibacterial, antifungal, and anti-infective properties that have been recognized for centuries. For example, expressed human milk has been used as a folk remedy for conjunctivitis. The protective effect of human milk is strongest for gastroenteritis and respiratory infections. However, the beneficial and protective effects of human milk include lowering the risk of allergies, multiple sclerosis, Crohn's disease, and sudden infant death syndrome (SIDS).

Human milk is seldom considered as a food resource or recorded in food composition tables. It has been suggested that it should be included in the calculations of a country's food supply and food balance sheets. Norway calculated the national production of breast milk to be 8.2 million kilograms in 1992, valued at U.S. $410 million (at U.S. $50 per liter). Norway has subsequently included human milk in calculating national food balance sheets.

Woman nursing her baby. PHOTO BY KARIN GOZZANO. © PICTURE PRESS/CORBIS.

It is impossible to put a precise economic value on human milk because it is seldom sold in the marketplace. Attempts to calculate its value include estimating the costs of breast milk substitutes or replacements or more rarely from the price charged for donated breast milk in milk banks. As a unique, incomparable product, its value to human survival is beyond calculation.

See also **Baby Food; Lactation; Nutrient Bioavailability.**

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Penny Van Esterik

MINERALS. Living organisms appear to selectively concentrate certain elements from the environment while rejecting others. The adult human body contains approximately thirty-five elements. Four of these (hydrogen, oxygen, carbon, and nitrogen) constitute 99 percent of the atoms in the body. As a comparison, the most abundant elements in the Earth's crust are oxygen (67 percent), silicon (28 percent), and aluminum (8 percent). The remaining 1 percent of the elements in the human body (with the exception of sulfur) are the inorganic or mineral constituents of the body and thus form the ash when the body is "burned." Seven of the remaining elements, sodium, potassium, calcium, magnesium, phosphorus, sulfur, and chloride, together represent about 0.9 percent of the body's weight. The seventeen others make up the remaining 0.1 percent, some of which, but not all, are considered nutritionally essential. These elements appear in the body at measurable concentrations but may not perform an essential biological function. Cadmium is one such example. The newborn infant is virtually free of this element, but gradually accumulates cadmium by ingestion and inhalation, such that over a lifetime an average person living in an industrial society accumulates milligrams of this element. Not only does cadmium appear to serve no essential function in the body, it is also likely to be undesirable and potentially detrimental.

Most experts agree that thirteen mineral elements are nutritionally essential. These are minerals that when deficient consistently result in an impairment of a function that is prevented or cured by supplementation. There still is some question about seven others (Table 1).

The functions of mineral elements are structural, osmotic, catalytic, and signaling. Calcium plays the most obvious role as structural component of bone but also participates in many examples of cell signaling. Sodium, chloride, and potassium constitute the majority of minerals whose function is to maintain osmotic and water balance and membrane electrical potentials. The micromineral elements listed in Table 1 have historically been classified as "trace" elements primarily because they occurred at levels below past methods for detection. In general, these minerals function as biocatalysts. Iron is the most prominent example because a deficiency of iron is probably the most common nutritional deficiency on earth (anemia afflicts more than 15 percent of the world's population). Copper and zinc are the prototypical biocatalysts because virtually all of their known functions involve either catalytic or structural roles in many different enzymes. Copper is unique in that all of the known deficiency symptoms in experimental animal models can be explained on the basis of failure of known enzymes. Zinc deficiency, on the other hand, presents symptoms that are not directly attributable to any of the fifty or more enzymes in which it is found. Selenium, manganese, and molybdenum are also constituents of enzymes. Deficiency symptoms for selenium and manganese have been well characterized but a nutritional deficiency of molybdenum has not been satisfactorily demonstrated. The most compelling reason to include molybdenum among the thirteen nutritionally essential elements is because of its presence (and thus function) in several important enzymes. Some microminerals serve a very narrow range of biological functions. Iodine and cobalt are exclusively constituents of thyroid hormones and vitamin B_{12}, respectively. No other role has been identified for these el-

TABLE 1

Known nutritionally essential minerals

Element	Amount in 70-kg Human (g)	Function
Macrominerals		
Calcium	1,200	Component of bones; signal transduction in hormonal action, muscle contraction, blood clotting; and structural role in proteins
Phosphorus	700	Component of bone Necessary for activation of high energy intermediates
Potassium	240	Osmotic, electrolyte, and water balance
Chloride	120	Osmotic, electrolyte, and water balance
Sodium	120	Osmotic, electrolyte, and water balance
Magnesium	35	Activation of ATPases, kinases, and other enzymes
Microminerals		
Iron	4.0	Catalytic redox reactions, oxygenation, and O_2-carrying proteins
Zinc	2.0	Catalytic as a Lewis acid and structural function for some metalloenzymes
Copper	0.1	Catalytic in redox reactions some involving iron
Selenium	0.020	Structural and catalytic component of peroxidases, especially glutathione peroxidase. Provides antioxidant protection
Iodine	0.015	Component of thyroid hormones
Molybdenum[a]	0.012	Structural component of enzymes, especially xanthine oxidase and sulfite oxidase
Manganese	0.015	Catalytic role in enzymes involved in cartilage formation
Co[b]	0.001	Structural component of vitamin B_{12}

Abbreviations: ATPase, adenosine triphosphatase.
[a] Biochemical evidence only that it is essential.
[b] Essential only as a component of vitamin B_{12}.

ements. The remaining mineral elements are those that occur in significant concentrations in the human body and most probably serve an important biological function. However, consistent findings regarding deficiency symptoms and specific biochemical functions have not been reported. Fluorine is a unique example of a mineral that currently has no definitive biological function but because it appears beneficial to dental health, it is a recommended nutrient.

Calcium and Phosphorus

Approximately 99 and 85 percent of the total calcium and phosphorus, respectively, in the human body are found in bone. Both ions leave the bone and are deposited back each day representing normal metabolic activity or "turnover" of bone. The remaining 1 percent of calcium is found in both extracellular and intracellular pools and is absolutely critical for normal body function such as muscle contraction and nerve activity. Although very rare, a sudden drop in extracellular concentrations of calcium (>50 percent) can lead to an emergency situation such as tetany or convulsions. Nerve cells bathed in hypocalcemic fluid spontaneously "fire," leading to uncontrolled nerve activation and muscle spasm. The majority of the extracellular calcium is in chemical equilibrium with bone. Approximately 30 percent is under hormonal control by several hormones, parathyroid hormone, vitamin D, and thyrocalcitonin. As a result, the concentration of extracellular calcium is remarkably constant. Blood levels of phosphorus fluctuate much more and appear to be determined in large part by urinary excretion.

The absorption of calcium from the diet is dependent on a number of dietary and physiological factors. Vitamin D is synthesized in skin when exposed to ultraviolet irradiation [290 to 315 nanometers of ultraviolet (UV) light]. Sunscreen lotions [Sun Protection Factor (SPF) 8] can reduce this synthesis as much as 90 percent. Inadequate sunlight exposure was most likely the cause of calcium deficiency rickets observed at the turn of the century in countries at northern latitudes. A change in dietary calcium absorption in humans appears to take several weeks to accomplish but accounts for the ability of humans to tolerate diets that provide relatively little calcium (200 to 400 mg/day). This activation process becomes less potent with age and may account in part for the increased calcium requirements with age.

Dietary factors affecting the absorption of calcium are well known. They include chelating organic acids such as oxalic and phytic acid. The former is the most potent and is responsible for the markedly diminished "availability" of calcium found in spinach.The amount of calcium contained by a food is only an approximation of the amount of calcium that is ultimately "available." Estimated fractional absorption (percent of intake absorbed into the body) of calcium from these foods ranges from 5 percent for spinach to 61 percent for broccoli. Vegetables of the Brassica family such as broccoli and cabbage appear to contain little oxalate and thus contain calcium that exhibits higher bioavailability than dairy products. Milk and dairy products have relatively high calcium

Calcium and Osteoporosis

The relationship between dietary calcium and osteoporosis has been studied for many years. Early indications suggested that dietary calcium intake was not correlated with bone density (a indicator of bone strength) or the bone loss that naturally occurs with aging. The complexity of the issue is illustrated by observations that many people consume relatively low calcium diets and yet show little evidence of osteoporosis. The genetic contribution to bone density is well established. Studies of identical twins demonstrate that a considerable proportion of the variation in bone density is attributable to inheritance. Mothers with osteoporosis have daughters (thirty years of age) who possess bone density that is significantly less than age-matched controls. Dietary intervention with calcium has been attempted in many different studies. Those in the past decade suggest that some changes may be effected by increased calcium intake but they are relatively minor and perhaps short-lived. For example, calcium supplements of 500 mg/day over three years were found to affect bone density of some bones significantly only in older women whose habitual calcium intakes were relatively low (<400 mg/day). Supplements had no effect in older women who had higher habitual calcium intakes. This study seemed to indicate that there might be a subset of elderly women who may benefit from increased calcium intake. Because vitamin D has such a critical role in the absorption of calcium, some workers have examined both vitamin D status and calcium supplementation. Overall, the results not surprisingly support the idea that vitamin D may be a limiting factor in the absorption of dietary calcium. Many other dietary variables may also be important in optimizing the effectiveness of dietary calcium. Dietary acidity, which is promoted by protein intake and ameliorated by the consumption of fruits and vegetables, may contribute. Alkaline diets rich in potassium appear to reduce the loss of body calcium and thus preserve bones. Elevated sodium intake also appears to increase urinary calcium losses. Therefore, the development of osteoporosis is unlikely to be a simple matter of too little dietary calcium consumption, especially in the later years of life, but more of an effect of total dietary conditions superimposed on a particular genetic background.

content as well as relatively high fractional absorption (30 percent), resulting in the highest amount of calcium per serving. Lactose in milk enhances the absorption of calcium in infants but its effect in adults is less clear. Other dietary factors affect the retention of dietary calcium but have little impact on its absorption. For example, high intakes of either sodium or protein are thought to result in increased urinary losses of calcium. Protein increases renal calcium loss by increasing acid load while sodium increases losses via shared renal transporters. Both of these conditions may affect calcium balance and ultimately the requirements for this nutrient. The bone loss associated with chronic calcium losses or negative calcium balance may ultimately lead to weakened bones or osteoporosis. Calcium supplements may adversely affect the bioavailability of iron.

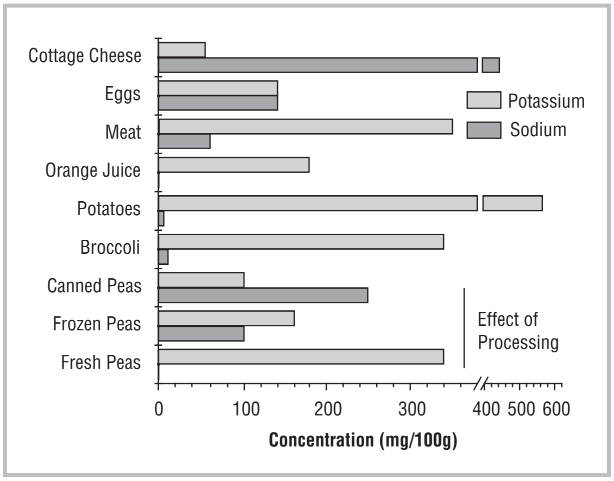
Calcium deficiency occurs primarily as rickets or osteomalacia in young children. Bones are deformed (bowed legs) and weak due to inadequate calcification of the protein matrix of bone. This deficiency can arise as a result of too little dietary calcium (relatively rare) or inadequate vitamin D synthesis. Historically, the latter has been the major cause brought about primarily because of reduced exposure to sunlight. It is conceivable, however, that dietary factors such as oxalates and cultural customs (clothing) may interact to play a role in the development of rickets especially since recent cases have been reported in areas of the world near the equator where sunlight should not be limiting. Calcium deficiency does not appear to be a primary cause of osteoporosis. This condition is characterized not by inadequate bone mineralization but by a loss of total bone both protein matrix and mineral. Bones weaken and become susceptible to fracture.

Sodium and Chloride

Total body sodium is approximately one-tenth of that of calcium. One-third of body sodium is found in bone but its metabolic significance is unknown. Sodium and chloride constitute the major cation and anion, respectively, in the extracellular fluid of humans. Sodium is the primary determinant of the osmotic pressure of the extracellular fluid and as such is the main determinant of extracellular fluid volume. The sodium ion concentration changes less than 3 percent day in and day out despite dramatic fluctuations in sodium intake. This is a reflection of a very tightly controlled and highly regulated system to maintain constant osmotic pressure. Through most of human evolution, the availability of dietary salt has been very highly restricted. Much of dietary sodium (and chloride) were derived from sources such as meat and vegetables, which contain very low levels. Consequently, humans and other mammals have evolved physiological mechanisms that permit sodium conservation under extreme conditions. This physiological conservation system comprised of pressure receptors, renal renin, lung angiotensinogen, adrenal aldosterone, and vassopression all makes dietary requirements extremely difficult to assess. For example, the Yanomamo Indians in Northern Brazil have been found to excrete as little as 1 mEq/day of sodium (Na) per day. This reflects a dietary consumption of approximately 60 mg salt per day (over 100 times less than that which is normally consumed in Western populations). At the other extreme are the northern Japanese, who consume nearly 26 grams of salt each day. These regions of Japan have unusually high incidences of cerebral hemorrhage, most likely related to the high incidence of hypertension. Other areas of the world such as Northern Europe and the United States consume approximately 10 g/day or less of salt. The sodium and potassium contents of some selected foods are shown in Figure 1. It is apparent that many "unprocessed" foods contain very little sodium. Estimates of sodium intake suggest that over 85 percent of the sodium consumed in Western diets is sodium added during processing. This is clearly illustrated by the progressively higher sodium content of peas (fresh, frozen, and canned) and perhaps more important, the dramatic reduction in potassium content. The net result is a reversal of the naturally low sodium to potassium ratio found in all fresh plants.

A deficiency of sodium normally does not occur even in areas where salt is scarce. The abnormal loss of sodium and other electrolytes, however, could occur under conditions of extreme sweat loss, chronic diarrhea and vomiting, or renal disease, all of which produce an inability to retain sodium. Acute episodes of diarrhea or vomiting resulting in a loss of 5 percent of body weight could lead to shock. The most important therapy under these circumstances is to restore sodium and water or circulatory volume. Chloride deficiency has been reported in infants consuming low-sodium chloride formulas. They show signs of metabolic alkalosis, dehydration, anorexia, and growth failure. Potassium depletion most notably affects cardiac function where either elevations or reductions in serum potassium can cause arrythmias.

FIGURE 1



Magnesium

Magnesium is an important intracellular ion involved in many enzymatic reactions of food oxidation and cell constituent synthesis. Approximately 60 percent of total body magnesium is found in bone, where approximately half can be released during bone resorption. Magnesium food sources are widely distributed in plant and animal products with the highest content found in whole grains and green (high chlorophyll) leafy vegetables. Refining wheat with the removal of the germ and outer layers may remove nearly 80 percent of the magnesium from wheat. Meats and most fruits and vegetables are poor sources of magnesium. The absorption of magnesium appears to be unrelated to the absorption of calcium (that is, is independent of vitamin D) and is relatively unaffected by food constituents. Phytate and phosphates, however, may adversely affect magnesium availability by forming insoluble products although their practical significance is unclear. Experimental magnesium deficiency has been produced in humans. Urinary magnesium drops virtually to zero while plasma levels are relatively well preserved. The change in urinary excretion reflects a "urinary threshold" for magnesium. After continued deficiency, however, neuromuscular activity is affected, ultimately leading to tremors and convulsions. Serum and urinary calcium levels are profoundly reduced and not restored by parathyroid hormone administration. It was concluded that magnesium is essential for the mobilization of calcium from bone. A deficiency of magnesium under normal conditions is unlikely but may occur with the presence of other illnesses such as alcoholism or renal disease.

Iron

Over 65 percent of body iron is found in hemoglobin, the respiratory pigment used to transport oxygen within and between tissues. One-third of body iron is a "storage" form that can be mobilized during times of need. The amount of "storage" iron may vary greatly with age and gender. Food sources of iron are complicated by numerous factors that affect the bioavailability of dietary iron. Non-heme sources of iron are found in plant and vegetable products and the absorption from these sources (versus heme found in meat products) is generally lower and influenced to a greater extent by total diet composition. Vitamin C is probably the most signficant enhancer of non-heme iron absorption, while plant phenolics such as tannins found in teas and phytates found in cereals are some of the most potent inhibitors. None of these factors, however, affect the absorption of heme iron found in meats. Iron status can markedly affect the amount of iron absorbed from a meal—low status increases iron absorption. The effect is most pronounced for non-heme iron, changing over fourfold compared to 50 percent for heme iron. Although iron status can influence absorption, the most important determinant of iron availability is the composition of the diet. It is clear that non-heme iron absorption is markedly affected by the characteristics of the food with which it is eaten and that there are clear differences in the nature of absorption of heme and non-heme iron. Iron deficiency is seldom related to iron intake per se. Major causes of anemia (too little hemoglobin) include blood loss and/or diets containing either no enhancers (such as meat or ascorbic acid) or high levels of inhibitors. Infection can also change iron metabolism significantly such that much of the anemia in the world is due to chronic infection. The losses for iron for both men and women are known precisely but the amount of dietary iron requirement depends on the overall diet.

SODIUM AND POTASSIUM

In the early 1950s, scientists found that experimental animals could be selected genetically to be susceptible to dietary salt-induced hypertension. Lewis K. Dahl and colleagues established a genetic strain of rat that was sensitive to high dietary salt. These rats showed remarkably elevated blood pressure when dietary salt was increased approximately ten times above normal. The rats' kidneys appeared to have a genetically programmed sensitivity to salt-induced hypertension. However, in the absence of high dietary salt, these animals were normal. Dietary potassium was also recognized as an important factor since high concentrations could ameliorate the effect of sodium chloride. Establishing a direct link between high dietary salt intake and hypertension in humans has been difficult to prove. The problem has been that not all individuals within a population are equally sensitive. Much evidence has come from studies of populations with widely differing salt intake. Populations whose sodium intake is low (less than 100 milligrams of salt) do not appear to develop elevated blood pressure with age. Those whose intake is relatively high do show increased blood pressure with age and evidence of increased incidence of essential hypertension. Recent studies with nonhuman primates have clearly shown that changes in salt intake alone are sufficient to induce changes in blood pressure. Many other studies suggest that lower potassium intake may also be important in the etiology of elevated blood pressure. Certain individuals may be more susceptible or sensitive to sodium-induced changes in blood pressure (similar to experimental animals). All of the known mutations resulting in a phenotype of hypertension involve some aspect of sodium renal excretion and/or retention. It is likely, then, that genetic sodium sensitivity will be a prerequisite to an environmentally induced development of hypertension.

Zinc

Zinc is present in all tissues and performs both structural and catalytic functions in many different enzymes. Unfortunately, changes in the activities of these enzymes are not sufficient to explain the pathological effects of experimental zinc deficiency. Experimental animals refuse to eat experimental diets that are very low in zinc. Human zinc deficiency was demonstrated nearly two decades ago in the United States. Young children from 6 months to 5 years of age showed low amounts of zinc in the hair relative to other groups. Hair zinc and taste acuity were restored after three to five months of zinc supplementation. Earlier studies also revealed zinc deficiency in regions of Iran and Egypt. It is very difficult to assess zinc status in humans. Serum zinc is not adequate to assess nutritional status. In experimental situations, serum zinc falls remarkably (>50 percent) following a low zinc intake without immediate (or apparent) ill effects. In 1974, a Recommended Dietary Allowance (RDA) of 15 mg/day was established for zinc. (It was not until 1974 that we had enough information to estimate an RDA for zinc, at which time the value was established at 15 mg. The RDA presented in 1989 gives 15 mg per day for adults. The 2001 Institute of Medicine value is 11 mg per day.) Approximately 70 percent of zinc consumed by most people is derived from animal products. Cereals contain appreciable zinc but the availability varies considerably. Several plant compounds interfere with the absorption of zinc. The most prominent of these is phytates (inositol hexa- and pentaphosphate). These inhibitors most likely contribute to the natural incidence of dietary zinc deficiency observed in humans.

Copper

Although the importance of copper deficiency in animals has been recognized since the 1930s, it is still not possible to establish an RDA for copper in humans because of the uncertainty regarding the quantitative requirements. There is no doubt that copper is an essential nutrient for humans. Current estimates of the minimum copper requirement are between 0.4 and 0.8 mg/day. Copper is critical for the function of several enzymes, especially blood ceruloplasmin. The activity of this enzyme in blood falls dramatically in experimental animals soon after giving copper-deficient diets and is thought to be a good indicator of copper depletion even in humans. Ceruloplasmin is essential for iron absorption (it catylizes the oxidation of Fe^{2+} to Fe^{3+} required for binding of iron to the blood transport protein, transferrin) and explains the anemia observed in copper deficiency. In contrast to zinc, all of the symptoms of a copper defeceincy under experimental conditions can be explained by changes in various enzymes that require copper. Two inherited diseases associated with abnormal copper metabolism have been observed—one (Menkes' disease) is associated with copper deficiency, while the other (Wilson's disease) is a disease of excessive copper accumulation. Excessive intake of zinc can precipitate a copper deficiency. An example of zinc-induced copper deficiency has been reported in humans and is attributed to a reduction in the absorption of copper. Excessive zinc may induce intestinal proteins that bind copper and thereby prevent its transfer from the intestine into the body.

Iodine

Approximately 80 percent of total body iodine (20 milligrams) is found in the thyroid gland. All of the iodine that leaves this gland does so as a component of the thyroid hormones—thyroxine and triiodothyronine. In fact, all of the functional significance of iodine is as a component of these hormones. Iodine deficiency represents the most common cause of preventable mental deficits in the world's population. Since most of the world's iodine is found in the oceans, coastal areas are not deficient. However, mountainous areas such as the Himalayas, European Alps, and the mountains of China, as well as the flooded river valleys of Asia, areas where leaching of iodine from soils has occurred for eons, produce iodine-deficient crops and plants. Iodine deficiency during pregnancy causes cretinism, a diet-related birth defect that is characterized by permanent mental retardation and severe growth stunting. In young children and adults, iodine deficiency results in enlarged thyroid glands or goiter. Although various foods such as cassava, cabbage, and turnips contain goitrogens, substances that interfer with iodine metabolism, their practical signficance is not clear. Cassava, the dietary staple in regions of Africa and other areas, may be the exception, especially when not well cooked. The cyanide released by the ingestion of this plant is transformed and ulitmately leads to an inhibition of the uptake of iodine by the thyroid. Goiter was once common in areas of the United States near the Great Lakes and westward to Washington State, but the introduction of iodized salt almost competely eliminated goiter in these areas by the 1950s. The minimum requirement for iodine to prevent goiter is approximately 1 μg/kg/day whereas the recommended intake is nearly twice this amount.

Selenium

Although selenium was first recognized as a toxic trace element for livestock, it is now clear that selenium is an essential nutrient for all animals. During the 1930s, livestock grazing in parts of the Great Plains of North America were found to contract a disease characterized by hair loss, lameness, and death by starvation. The cause of this disease was excess selenium obtained from the plants grown in soils containing high selenium concentration. In fact, selenium, more than any other essential trace element, varies greatly in its concentration in soils throughout the world. Plants accumulate selenium from soils but are not thought to require selenium for growth. Although human toxicity was not observed in affected regions in the United States, endemic selenium poisoning has been observed in high-selenium regions of China where the symptoms included loss of hair and nails. China also possesses regions of very low selenium where, in fact, humans have been diagnosed with selenium deficiency—Keshan disease (cardiomyopathy) and Keshan–Beck disease (degenerative joint disease). Although other factors may be involved, selenium deficiency is clearly a predisposing factor. Selenium functions as part of several important enzymes. The most prominent is a soluble enzyme, glutathione peroxidase, whose function is to reduce hydrogen peroxide and organic (lipid) peroxides, thus preventing the oxidative destruction of cell membranes. Selenium is incorporated into the enzyme as the amino acid selenocysteine by reactions that are unique to selenium. Together with vitamin E, selenium, as a structural component of glutathione peroxidase, forms an antioxidant defense against oxidative stress. The requirement for selenium has been estimated by various methods. On the basis of intakes in regions of China with and without deficiency disease, approximately 20 μg/day is considered an adequate amount to prevent deficiency. The estimated safe and adequate selenium intake suggested by the U.S. National Research Council ranged from 50 to 200 μg/day in 1980. An amount to maintain the highest serum glutathione peroxidase activity appears to be 70 and 55 μg/day for an average man or woman, respectively, which became the Recommended Dietary Allowance (RDA) in 1989. In 1996, the World Health Organization recommended 40 and 30 μg/day for men and women, respectively. Intakes greater that 400 μg/day are considered to be the maximum safe level. Selenium is thus an example of a nutrient that possesses a relatively narrow range of intakes that are safe and that meet requirements.

Manganese

Normal body content of manganese is very low—approximately 15 milligrams or very similar to iodine. In contrast to iodine, manganese deficiency has not been observed in humans but has occurred naturally in chickens and experimentally in many other species. Manganese is required by several enzymes, which may or may not be inolved in the symptoms of a manganese deficiency. Symptoms include impaired growth, skeletal abnormalities, and defects in lipid and carbohydrate metabolism. The role of manganese in the synthesis of the mucopolysaccharide component of bone and cartilage is the most crucial whereas mineralization of bone appears to be independent of manganese. Excessive manganese will interfere with iron absorption. Under conditions of iron deficiency, manganese absorption is increased. Both iron and manganese appear to share a common site for absorption. The recommendations for manganese intake are based on estimates of normal dietary intakes of 2 to 5 mg/day. This amount is thought to be sufficient to replace the 50 percent of body manganese that is lost every 3 to 10 weeks.

Chromium

Chromium is one of the most intriguing and potentially important trace elements because it appears to influence the action of a critical hormone, insulin. Unfortunately, the definitive role of chromium in this regard awaits further study. Decreased sensitivity of peripheral tissues to insulin appears to be the primary biochemical lesion in experimental chromium deficiency. Impaired glucose tolerance has been attributed to chromium deficiency in several experimental models. Also, several patients receiving total parenteral nutrition have responded to chromium supplementation in the predicted manner, that is, improved glucose tolerance. These findings have established chromium as an essential nutrient for humans but the specific deficiency symptoms in those who receive enteral feeding have not emerged. Overt chromium deficiency is very unlikely under normal conditions due to the small amounts of chromium needed. Moreover, a marginal deficiency is very difficult to identify due to the lack of reliable markers for diagnoses concerning chromium. Currently, there is little or no evidence that chromium supplements are either warranted or effective. Even the recommended intakes for adults (50 to 200 μg/day) are uncertain due to the lack of reliable methods for assessment.

Fluoride

Fluoride is not generally considered to be an essential element for humans. It is, however, considered beneficial in that normal intakes appear to reduce the incidence of dental caries. The mechanism of this benefit is thought to be due to incorporation of fluoride into the mineral matrix of tooth enamel, thus producing a more resistant mineral apatite crystal. Over 99 percent of the fluoride found in the body is found in bones and teeth as a component of this mineral apatite crystal. An unusually high intake of fluoride causes permanently discolored or mottled teeth, a condition identified in children drinking water with 2 to 3 parts of fluoride per million. The level of fluoride commonly maintained in municipal water supplies is 1 part per million.

Silicon and Nickel

Silicon is the most abundant mineral in the Earth's crust. It is thus surprising that a need for silicon in biological systems has not been more prominent. Limited research conducted since 1974 has indicated a role for silicon in the development of mature bones in chickens and rats. A human requirement has not been established but estimates in the range of 10 to 20 mg/day have been suggested. Most likely intakes of this magnitude occur under normal conditions. Nickel deficiency has been experimentally produced in several species. Growth depression and changes in iron metabolism have been described. Nickel has been discovered in the enzyme urease from bacteria, fungi, yeasts, algae, plants, and invertebrates. Many other enzymes exist for which nickel is apparently a component. Thus, it is likely that nickel plays an essential functional role in higher organisms, including humans.

Molybdenum

Molybdenum is an essential component of at least three important enzymes found in animals and humans. A deficiency of one of these enzymes, sulfite oxidase, can have severe consequences—seizures and severe mental retardation in infancy. This deficiency has arisen in patients with genetic mutations in cofactor synthesis but not as a primary molybdenum deficiency. The dietary requirements of molybdenum cannot be given, or even approximated, for any animal species including humans. A deficiency of molybdenum has not been observed under natural conditions for any species. Despite this, the biochemical role of molybdenum as a component of several enzymes establishes it as an essential nutrient for humans.

See also **Assessment of Nutritional Status; Calcium; Dietary Assessment; Dietary Guidelines; Fluoride; Food, Composition of; Fruit; Iodine; Iron; Malnutrition; Nutrients; Nutrition; Sodium; Trace Elements; Vegetables; Vitamins.**

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MOLLUSKS. Mollusks exist in diverse forms, and although a mollusk is easily recognizable as such to a scientist who studies them, there is no obvious relationship between, say, an oyster and a flying squid. In fact people with no specialist knowledge are more likely to think of them as comprising separate groups: the gastropods (single shells), such as abalone or whelk, inhabiting single shells; the bivalves, such as clams and oysters, which have double shells; and the cephalopods (the name literally means "head-feet," referring to their strange configuration), which include cuttlefish, squid, and octopus.

The number of species in each of these groups is huge. The biodiversity of mollusks is far greater than that of fish and is exceeded only by the vast armies of insects. Three-quarters of the species of mollusks are gastropods, the category that is on the whole of least interest to human consumers. Next come bivalves. Third in numbers but greatest in size are the cephalopods. In relation to the human diet, the bivalves were probably the most important in prehistoric times, because most of them do not move around and many of them exist in the intertidal zones, or in very shallow waters, and are therefore easily gathered. Excavations at Skara Bray in the Shetlands have uncovered huge middens (a term used by archaeologists for a prehistoric refuse-heap of shells and bones) of bivalve shells, indicating very heavy consumption of them during the Stone Age. Evidence from coastal areas in many other parts of the world, including Japan, confirms this. Although consumption of clams and oysters and mussels and scallops is considerable today, especially in Europe and North America, it is the cephalopods that have become most important globally. The fishery for squid is conducted on a huge scale, and squid are a major source of protein for people in the Indo-Pacific area, as well as elsewhere.

In very ancient times, only people living near the coasts could benefit from eating marine mollusks ("marine" is specified in order to distinguish this group from terrestrial mollusks such as edible snails). Even if transport had been available to take mollusks far inland to other communities, the perishability of most of them (still a major factor today, despite the advent of refrigeration and freezing) would have ruled out such traffic. However, there may have been some exceptions. Preservation by drying is a method that is not applicable to many mollusks but can be used for cephalopods. The Greek practice of drying octopus is probably of great antiquity.

In developed countries where modern techniques are available, the transport of even delicate mollusks such as oysters (which have to be kept alive until consumption) is well assured and there is hardly anywhere in these countries where customers cannot enjoy the full range of mollusks. Availability accounts for increased demand, as does the dramatic increase in the size of human populations. However, the factor that has done most to make mollusks almost ubiquitous on dining tables is undoubtedly the great advances made in fishing techniques since medieval times. The huge resources of oceanic squid were simply not accessible in earlier times, whereas today there are few parts of any of the oceans where squid are relatively safe from capture. The sophistication of the equipment used by the vessels that fish for them, especially those from Japan, is extraordinary.

Before considering the three groups of mollusks in more detail, there is one question of nomenclature to consider, and another of classification.

The term "shellfish" is defined in the *New Shorter Oxford English Dictionary* as "any aquatic invertebrate animal whose outer covering is a shell, usually a mollusc (as an oyster, a winkle, a mussel, etc.) or a crustacean (as a crab, a prawn, a shrimp, etc.), especially one regarded as edible." The term is commonly used for crustaceans and for any mollusk living in an exterior shell. Thus it would apply to the single shells and bivalves but not to cephalopods, with one exception: the so-called chambered nautilus shells, which count as cephalopods but do inhabit shells. A few species of nautilus have value as food in the Indo-Pacific area. It is also relevant to point out that the other cephalopods tend to have what might be called "internal" shells, for example, the "cuttlebone" found in the cuttlefish. These constitute traces of external shells that have disappeared in the course of evolution. The chambered nautilus is, so to speak, poised to take a further step in evolution and abandon its shell, whereupon it would bear some resemblance to a small squid. The question of classification referred to above is this: does the term mollusk include miscellaneous sea creatures such as the sea cucumbers and sea anemones that are eaten in some parts of the world and that are neither fish nor crustaceans but, owing to their general appearance, might be taken to be mollusks? The answer is no; they belong to separate orders. For example, the sea cucumbers belong to the order Holothurian. Furthermore, if a creature is not a fish but does have a shell, must it be either a crustacean or a mollusk? Again the answer is negative. The sea urchin, whose ovaries are a prized delicacy, has what would normally be called a shell (covered usually with spines to repel predators), but it belongs to the phylum Echinodermata.

Seafood merchant selling octopus in Tokyo, 1986. © ROBERT HOLMES/CORBIS.

Having thus cleared what might otherwise be muddy waters for some readers it is time to look more closely at the three main groups of edible mollusks.

Single Shells

The gastropods, or single shell mollusks, have contributed less to human nutrition than either the bivalves or the cephalods. This is not because the single shells are too small. Some, such as whelks, attain a considerable size, up to 90 cm (35 inches) in the case of the species *Melongena pugilina*, which is eaten in Malaysia and the Philippines. Large whelk, often called conch, are eaten in the Caribbean, where they are known locally as *lambis* or *lambie*. One speciality is the conch stew of Martinique and Guadaloupe while another is soused conch, (*lambie souse*). In *Life and Food*, Cristine Mackie describes this specialty as well as other food of the region, and makes one particularly interesting observation. She believes that the native inhabitants, who are known to have consumed conch in large quantities and whose experience preparing it stretches back over many centuries, probably showed early white settlers how to extract the meat and clean it, a special skill requiring instruction.

Even very small single shells are eaten, for example, the little top-shell of the Mediterranean (*Monodonta turbinata*, of the family Trochidae) or the equally small periwinkle (*Littorina littorea*, family Lacunidae), known locally as winkles and found on North Atlantic shores, both east and west, but mostly appreciated in Europe. In general, however, the appetite for single shells has diminished in many parts of the world, largely because they are fished locally and few of the edible species have more than minimal gastronomic merit.

Nevertheless, one family among the single shells, Haliotidae, to which the abalone belong, certainly does merit attention for human consumption. There are species all round the world. In California, for example, the red abalone (*H. rufescens)*, is probably the best known although *H. tuberculata* has been famous since classical times in the Mediterranean and on the European Atlantic coast as far north as the Channel Islands (where it is known as ormer in English and *ormeau* in French). However, supplies are not abundant. Indeed, along much of the northwest coast of the United States the fishery is either closed outright or subject to severe restrictions. In Japan there is a tradition that stretches back to antiquity of husband-and-wife teams fishing for abalone; the wife dives while the husband tends the boat and the lifeline. Depending on the quality of the various species, the Japanese may eat them raw, diced and iced and furnished with a dipping sauce, or grilled and steamed. Generally, abalone is tough and must be tenderized before being cooked.

Although some abalone can reach a size of up to 25 cm (10–11 in.), they may be regarded as a sophisticated descendant of the ordinary limpet. Limpets, seen clinging tenaciously to seaside rocks, are much smaller and biologically less complicated creatures, but are edible and utilized in interesting local recipes; for example, in some parts of Scotland people were known to mix limpet juice with oatmeal.

Bivalves

The aristocrat of bivalves, in the western world, is the oyster. This is odd because in the nineteenth century oysters were so plentiful and cheap that they were considered to be a food of the poor. Today virtually all the oysters brought to market are cultured. In France especially, there are complex systems followed by oyster farmers, from the initial seeding (planting on special tiles) of the spat of existing oysters through various changes of environment designed to afford protection from predators and to encourage growth. Oysters thrive in the "parks" created for them, and are carefully graded before being transported live to markets. The district of Marennes-Oléron accounts for well over half the French production, but other place names such as Arcachon indicate other famous oyster areas. In England the oysters of Colchester in Essex and of Whitstable in Kent were once of great renown, but nowadays most of the oysters reaching British markets come from the south of Ireland.

What is said above relates in part to the European oyster, *Ostrea edulis*. However, populations of this species have been very seriously depleted, in some places to vanishing point, and 90 percent of the oysters now consumed in Europe belong to the species *Crassostrea angulata*, popularly known as the Portuguese oyster. It is a native of Portugal and Spain and also known in the Indo-Pacific as the Giant Pacific oyster.

In North America, the American oyster, *Crassostrea virginica*, holds sway. Like the Portuguese, it is larger than the European. American oysters are marketed under many names, indicating the place of origin, for example, Cape oysters from Cape Cod (notably Wellfleet and Chatham); Long Island (Bluepoint, Gardiners Bay), and the Chesapeake Bay area (Chincoteague Bay). Of the other American species of oyster, the best is probably the Olympia oyster, a subspecies of the Californian oyster, *Ostrea lurida*.

Australasian oysters include the Sydney rock oyster, *Crassostrea commercialis*, which is perhaps the most esteemed of all seafoods for Australians.

Whereas oysters are always visible, many bivalves are not. They burrow into the sand and all one can see is perhaps their "siphon" protruding, or a little hole left by the siphon. Some species are remarkably adept at burying themselves quickly and deeply. The razor shells (so-called because they resemble old cut-throat razors) are among the champions in this art. They are known in Orkney as "spoots," and "spooting" by hand is a pastime that calls for great expertise. There are many other clams in both hemispheres that live closer to the surface of the sand and are gathered more easily. Consumption is highest in North America, where they play a leading role in the traditional clambake, which is an important feature of the seafood cultures of many coastal areas, especially New England. Kathy Neustadt explains the cultural and social importance of clams in *We Gather Together: Food and Festival in American Life*. A purely practical description is found in the classic cookbook by Mrs. Lincoln, *Mrs. Lincoln's Boston Cookbook* (1891).

Mussels dominate the European market, at least in terms of quantities sold. The waters surrounding Galicia in the north of Spain include bays that are ideal for the culture of mussels on big ropes suspended from the surface of the sea. By the end of the twentieth century, Spanish exports of mussels had grown to such an extent that they dominated the market, although there is a smaller but substantial industry in the Netherlands, providing mussels mainly for consumption in Belgium. Mussels with french fries (*moules et frites*) is counted by some as the national dish of the Belgians; it enjoys popularity there which is without a parallel anywhere else in the world. However, there are many other ways of preparing mussels including the famous French dish *moules à la marinière* (mussels steamed open in a large covered pot with chopped shallots, herbs, white wine, vinegar, and butter). Mussels are also a useful ingredient in seafood stews and kindred dishes. Mussels can be steamed or fried, and it is also possible to dry mussels (after a boiling). In Thailand dried mussels are coated with sugar and then fried, producing an intriguing dish that might seem strange to western palates.

Those familiar with Irish culture know the song about Sweet Molly Malone who, in the streets of Dublin (where she is commemorated by a charming statue), would cry her wares: "Cockles and mussels alive alive o'." Cockles constitute a large and important group of bivalves, with the European *Cerastoderma edule* being the most important. In some places it is quite remarkably abundant; densities of over ten thousand individuals per square meter have been recorded. With a maximum measurement around 6 cm (2 inches), this is not the largest cockle; that distinction goes to the spiny cockle of the Mediterranean, *Acanthocardia aculeata*, whose body inside the shell is blood red, may reach 10 cm (4 in.). One of the cockles of the Pacific coast of North America, *Clinocardium nuttalli*, may be slightly larger still. Cockles resemble clams in their burrowing down into the sand.

Like oysters, mussels are visible wherever they grow. Another visible bivalve of gastronomic importance is the scallop, who for most of its life is not attached to anything but swims freely, using the rapid opening and shutting of its two shells as a means of propulsion. The muscle connecting the two shells is therefore particularly large and strong, a feature welcome to consumers since this white muscle is the principal edible part. (The orange-yellow coral is also eaten and the "mantle" or "frill" more rarely.)

Of the many species, *Pecten maximus*, the Great Scallop, and *Pecten jacobaeus*, the Pilgrim scallop, are the best known in Europe. The former may measure 16 cm (6 in.) across, while the latter is smaller. It is, however, the latter which has a special religious significance, since its shell has for very many centuries been the badge worn by pilgrims to the shrine of St. James at Santiago de Compostela in Galicia. Indeed, the French name Coquille Saint-Jacques is sometimes applied to scallops in a more general way, as in the famous dish *Coquilles Saint-Jacques à la provençale*. Besides being a badge for pilgrims, scallops have a cultural significance in many other contexts, a point that is well brought out by Cox (1957).

The so-called bay scallop, *Argopecten irradians*, is the common commercial scallop of the American Atlantic coast. Its muscle, which is usually the only part sold, is a great delicacy. If really fresh, it may be eaten raw, flavored by its own juices. There is also a growing North American fishery for the Atlantic deep-sea scallop, *Placopecten magellicanus*.

The scallop is well provided with eyes. About fifty of these, green ringed prettily with blue, are set in the frill. These do not show the scallops where they are going, since they are necessarily always going in the other direction, but they do warn them of any danger approaching from behind.

Edible bivalves can be very small, such as the little wedge shells. Other bivalves, of which parts only can be eaten, are huge, notably the giant clam of the Indo-Pacific, *Tridacna gigas*, which can measure 1 meter (40 in.) across and weigh several hundred kilos; the shells from one of these can provide two washbasins or church fonts.

Because bivalves have two shells joined together, they symbolize in Chinese and other cultures a married couple. Although many of them are plain in color, some have very striking patterns on the outside of their shells, such as zig-zag markings.

Cephalopods

A comprehensive reference book published by the Food and Agriculture Organization, or FAO (by Clyde F. E. Roper, Michael J. Sweeney, and Cornelia E. Nauen), provides a good overview of the cephalopod fisheries, offering information on over two hundred species. Although confined to species "of interest to fisheries," this work does include some which are utilized at the subsistence and artisanal levels only and some which at present have only a potential value in commerce. A few cephalopods are of outstanding importance in commerce: squid of the genus *Loligo* and *Todarodes pacificus*, the Japanese flying squid, are outstanding examples. Squid account for approximately 70 percent of the world catch, while cuttlefish represent between 10 and 15 percent and octopus between 10 and 20 percent.

The "flying squid" do not really fly but can propel themselves out of the water and glide. They have longer and thinner bodies than other squid, which makes them less suitable for being stuffed. All squid have eight short and two long tentacles. The long ones can be shot out to catch prey. The size of adult squid varies greatly from little more than 20 cm (8 in.) to 20 m (67 ft.) overall.

Cuttlefish also have eight short and two long tentacles, but they are more compact than the squids, having a broader body. Their "ink," like that of squid, is contained in sacs but may be expelled in large clouds to facilitate evasive action. Cuttlefish ink was used historically to make the color sepia, and the Chinese have called the cuttlefish "the clerk of the sea-gods," in a reference to the ink (Read, 1939). Generally, Chinese names for cephalopods are far more descriptive than English ones. For example, the Chinese call one small squid "shallow water soft fish," indicating where it is found, while the cuttlefish may be known as "tiger-blotched black thief." This highly specific nomenclature is in line with the fact that cephalopods play a larger part in food culture in China than in most other countries. While it is true that

Palestinian refugees washing squid in a courtyard in the Gaza Strip. © ED KASHI/CORBIS.

cephalopods, especially squid, have now reached the market in almost all important countries of the world, it is only in certain regions, including the whole of the Mediterranean, that there is a long tradition of eating them. Full acceptance in North America is still to come, although the influence of Americans from a Mediterranean background has done much to show the way to others.

Those repelled by the appearance of cephalopods might be especially upset by the octopus. The name octopus refers to its eight arms, each armed with suckers for grasping prey. The best octopus for eating have arms with a twin row of suckers on each. The most common octopus of the Mediterranean, *Octopus vulgaris*, has been important since classical times in many of the cultures of the region, and has figured frequently in art, as on Greek vases of the late classical period.

The flesh of the octopus is notorious for being tough and requiring treatment to soften it before cooking. This does not apply to tiny baby octopus, but the larger specimens are beaten against rocks by fishermen, or struck with mallets, to tenderize them. Delicious and flavorful octopus dishes include the Spanish *pulpos con papas*, the French *poulpe à la niçoise*, and the Neapolitan *polpetielli alla Luciana*.

In connection with the last-named dish, a Neapolitan author, Signora Jeanne Caròla Francesconi (1965), has given a vivid description of methods of fishing based on the fact that the true octopus (the kind with two rows of suckers on each arm) is especially attracted by the color white. Thus a piece of white rag may be placed in the center of a five-pronged hook and lowered down to ensnare the octopus. "It is also fished with a pottery amphora (called a 'mummarella') which is likewise painted white and contains white stones; this is lowered to the bottom on the end of a rope, near a rock. The 'true' octopus, if he sees it, will empty the pebbles out and instal himself inside as though in a nest. The fisherman, alerted by seeing the white pebbles scattered outside the amphora, pulls it up and thus catches the octopus." Although the octopus is thus outwitted, it is fair to add that of all mollusks it possesses the most intelligence. Experiments conducted at an aquarium in Naples established that an octopus is capable of learning, for example, how to move from one tank to another, when there are several apparent exits of which only one allows passage.

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Alan Davidson

MONTAGNÉ, PROSPER. *See* ***Larousse gastronomique.***

MOOD. Eating and drinking affect, sometimes markedly, people's moods. The interaction runs the other way, too, so that depressed, manic, or anxious states lower or sometimes heighten appetite, or a particular mood can affect food choices. The connections between food and mood have implications for advertisers of snack foods, for those seeking to lift their spirits through binge eating or drinking, and for gourmands planning successful dinners.

Alcohol can manipulate mood by affecting the release of certain chemicals in the brain called neurotransmitters. The caffeine in coffee and other drinks is another stimulant whose overuse has detrimental health effects. Herbs have a range of medical effects, and some mushrooms are mind-altering. But while a variety of foods contain chemicals with known psychotropic properties, they are generally in such minuscule quantities as to have little discernible effect on human consumers.

More noticeable changes occur through a combination of cognitive, sensory, cultural, social, and environmental factors. For example, chocolate contains chemicals that alter mood, such as caffeine, theobromine, and phenylethylamine, in quantities too small to account for the cravings of so-called "chocoholics." Instead, people value chocolate's sweet taste and voluptuousness, because it melts just below body temperature, and so coats the tongue. The pleasurable sensations release chemicals, called opioid peptides, in the brain that lift mood. Chocolate has long been advertised as a luxury, and parents and others choose it to reward good behavior. All these uses reinforce chocolate's reputation as an "indulgence," "temptation," and even "sin."

Likewise, some acclaimed aphrodisiacs contain traces of chemicals that might stimulate sexual activity (suggestions include the zinc in oysters and a chemical related to the male hormone testosterone in truffles). But the pleasures associated with their consumption can be more striking than any actual chemical effect. One of these foods is extraordinarily slippery and the other headily aromatic. In addition, the seducer may offer them in a mood-inducing setting, such as a comfortable, candlelit room filled with "mood music."

Even the psychological response to alcohol is dependent on numerous factors, not the least of which are the experience and existing mood of the drinker, the setting, and the organoleptic or sense-stimulating properties of, perhaps, a fine wine. As such, the same drink can make people feel euphoric, merry, riotous, bored, or maudlin. Some researchers have found that high-carbohydrate foods reduce tension and cheer people up, while high fat foods have the opposite effect, but this theory is not supported by the English writer Charles Lamb's paean to pork crackling, "Dissertation on Roast Pig," published in the 1820s. With mock seriousness, Lamb attributes the discovery of cooking to the "oleaginous . . . ambrosian" deliciousness of pork fat.

An angry remark, an overlong gap between courses, a disturbing location, or the overdoing of food and drink can destroy the pleasant mood of a meal. But an enticing plate of food placed in front of a willing guest can be entrancing. An experienced waiter can guide indecisive diners, turning their entire evening around. The right foods, company, and circumstances cast a positive spell, whether of gaiety, carefreeness, reverie, or joy.

The New Testament refers often to "joy" (in Greek, *charà*), frequently experienced at meals. A blissful state is encapsulated in many of the brief *Rubáiyát* of Omar Khayyám, written nearly one thousand years ago, and most famously in Edward FitzGerald's translation: "Here with a Loaf of Bread beneath the Bough, / A Flask of Wine, a Book of Verse—and Thou."

Jean-Anthelme Brillat-Savarin analyzed the special mood attainable at the table in his gastronomical classic, *The Physiology of Taste* (published in 1826). Reporting on a lifetime of dinners, closely observed, he consistently suggests that a meal's greatness depends less on particular foods than on achieving an overall mood. His term, *le plaisir de la table*, has often been translated in the plural as the "pleasures of the table." However, the book's "Meditation 14" discusses a composite "table-pleasure" that one might call "mood." Table-pleasure is "the reflective sensation" (*la sensation réfléchie*) generated by the thoughtful assembling of foods and people in an appropriate setting. This manifold pleasure of the table is known only to the human race and is largely independent of the drive for food, he writes.

While Brillat-Savarin precludes from table-pleasure ravishments, ecstasies, or transports, the experience, as he sees it, gains in duration what it loses in intensity. Physically, a diner's brain awakens, face grows animated, color heightens, eyes shine, and a "gentle warmth" creeps over the whole body. Morally, the diner's spirit grows more perceptive, the imagination flowers, and clever phrases fly from the lips. At the end of good meal, "body and soul both enjoy a special well-being" (p. 189). Table-pleasure is so powerful that "all human industry" has concentrated on increasing its intensity and duration, he writes. Stomachs may have had limits, but people could improve the accessories. So, they ornamented goblets and vases, ate under the open sky and in gardens and woods, invented the charms of music, and sprayed exquisite perfumes. Dancers, clowns, and other entertainers amused the eyes of diners. To all of these ancient gratifications, his recent contemporaries had contributed exquisite food, dishes so delicate that people would never get up from table if other business did not intrude.

Preferring simplicity to embellishment, Brillat-Savarin asked only four necessities—at least passable food, good wine, agreeable companions, and plenty of time (p. 191). Passing on a recipe for fondue, he recommends memorably: serve the fondue on a gently heated platter, call for the best wine, "and you will see miracles" (p. 417).

At odds with Brillat-Savarin's suggestion that the many elements of a meal generate a composite pleasure is a modern tendency to associate mood with particular foods, drinks, or diets. This view represents a somewhat "medical model" of dining rather than a convivial model, and some food scientists even speak of "functional foods," with druglike uses.

The food and drink industries implicitly market many products as improving mood. Alcoholic drink advertisements appeal to an elevated, "party" mood. The soft drink Coca-Cola is named after two traditional drugs, coca and cola, revealing its origins as an early proprietary "functional food" that still contains caffeine. Cereals manufacturer Kellogg has sold its Strawberry Pop-Tarts—pastries heated in a toaster and aimed at preteens—as a "mood food" by linking the snack to a social setting and a color suggestive of a particular mood (*Brandweek* [18 March 2002], p. 6). Television commercials showed girls and boys dancing, and the color red predominating, such as a red garland of lights and a girl in a red dress. The product also received placement in the television series *Gilmore Girls*, in which characters are depicted regularly eating Pop-Tarts for breakfast, suggesting that a single item can summon up a complex social setting.

Meanwhile, other researchers seek to understand why young women in particular crave and binge on sweet snacks in attempts to improve depressed moods. Many get into bulimic cycles of binge-eating and compensating, with accompanying mood swings.

Researchers led by Wesley C. Lynch found in a survey, contrary to expectations, binge eating did not lift depressed and anxious feelings but worsened them. However, moods did improve immediately before and after "compensatory activities," which included not just vomiting, but also fasting, exercise, and the use of laxatives and diuretics that did not decrease, but instead increased significantly following binge episodes and decreased immediately before and after compensatory activities" (Lynch et al., pp. 310–311). One possible interpretation of these findings is that binge eating is not the "problem" except as the prelude to self-punishing or ascetic behavior.

As the advertisers of "mood food" implicitly accept, the product does not act alone but within wider circumstances. A positive mood results most often from a satisfying meal, rich in social interactions. The aim might be to avoid solitary snacking in favor of Brillat-Savarin's nineteenth-century formula of honest viands, good company, and reduced time pressures.

See also **Anorexia, Bulimia; Brillat-Savarin, Jean Anthelme; Coffee; Marketing of Food; Pleasure and Food; Presentation of Food; Sensation and the Senses**.

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Michael Symons

MOVIES AND FOOD. *See* **Art, Food in.**

MUSHROOMS. *See* **Fungi.**

MUSLIMS. *See* **Islam.**

MUSTARD. Mustard is the world's third most important spice after salt and pepper, and in temperate regions it is the most important native spice. The term "mustard" is believed to be derived from the practice of mixing the sweet must of old wine with crushed mustard seed to form a paste, *mustum ardeus* (hot must), hence mustard. The condiment is made from seeds of annual plants of the family Cruciferae, so named for the flower's four yellow petals, which form a cross. The mustard family includes the cole vegetables, radishes, turnips, cress, and horseradish, as well as many important weedy species, such as wild mustard or charlock (*Sinapis arvensis* L.).

Black mustard (*Brassica nigra* [L.] Koch), although later considered a weed, was likely the first mustard species harvested as a spice as it grew in the wild or was cocultivated with cereal crops. Its use predates recorded history with seeds, ready for sowing, found in a Bronze Age lake dwelling at the Bielersee (Lake of Bienne) in Switzerland and in vessels in northwest China dating to 5000–4000 B.C. The spice was well known to the earliest Egyptian dynasties and was spread by spice traders and conquering armies throughout Europe and Asia. The Spaniards introduced mustard to the Americas, and in California, Father Junipero Serra scattered black mustard seeds along the routes from monastery to monastery to mark the way in 1768. The bright yellow spring blooms, which mark the old trail, can be seen from the main north-south highway.

The Mustard Species

Black mustard plants are tall (up to 3 meters) and sparsely branched, and they produce many short pods (siliques). As the pod matures, the highly pungent, small (1.5 grams per 1,000 seeds), round dark brown seeds are shed, necessitating frequent hand harvesting or cutting and stacking immature plants on the threshing floor.

The characteristic seed shedding and seed dormancy of black mustard made it unsuited to monoculture and mechanized agriculture, and the spice trade turned to the production of a closely related species, *Brassica juncea* (L.) Czern and Coss. Plants of *B. juncea*, when compared to black mustard, are shorter (1 to 2 meters) and have many upright, heavily podded branches with longer pods that retain their seeds when ripe. The seed is larger (3 grams per 1,000 seeds) but produces the same pungency. The seed color is either brown (brown mustard) or yellow (Oriental mustard).

The species originated from a natural cross between *B. nigra* and *Brassica rapa* L. (turnip rape) followed by chromosome doubling to produce a vigorous and productive interspecific hybrid. This interspecific cross is believed to have occurred more than once where the two species occupied the same region. Possible centers of origin are believed to be North Africa, northern India and Pakistan, and western China.

The third condiment mustard species, *Sinapis alba* L., is called yellow or white mustard and produces a different pungency from both *B. nigra* and *B. juncea* seeds. From its Mediterranean center of origin, it has been widely disseminated throughout the temperate regions where day lengths (hours of sunshine) were sufficient to stimulate flowering. When moistened, the ripe seed will exude a mucilage from its yellow seed coat to form a whitish coating when dry. This may explain why white mustard is the common name in Europe, while in North America it is called yellow mustard.

Mustard flour and oil have strong antioxidant and antibacterial properties.

Plants of yellow mustard are shorter (0.6 meters) than either *B. nigra* or *B. juncea* and have deeply lobed leaves. The short, hairy pods, with flat beaks, contain and retain 5 to 6 seeds when ripe. The seed is significantly larger than the other mustard species (6 grams per 1,000 seeds), which aids in rapid seedling establishment. In Europe the crop is frequently sown and ploughed under as a green manure crop.

The Chemistry of Mustard

All three mustard species contain a significant amount of edible oil and high quality protein. Indeed on the Indian subcontinent *B. juncea* seeds are the second most important source of edible vegetable oil, and the residual high protein meal, after it is soaked in water, is fed to cattle. However, for the spice trade the important ingredient is the presence and concentration in the seeds of sulphur compounds called glucosinolates. Over forty such compounds are known, and their presence and quantity determines the flavor and odor of the cole vegetables as well as the taste and heat of the mustards. The glucosinolate that imparts the pungency and flavor to black and *B. juncea* mustards is called "sinigrin," while in *Sinapis alba* it is "sinalbin." When the seeds are stored whole and dry, they retain their quality for several years. However, when the cells of a mustard seed are broken and moisture is present, the enzyme myrosinase, also present in the seed, breaks down the glucosinolates to release sugar, sulphur, and the hot principles called isothiocynates. Black and *B. juncea* mustard seeds release the pungent, volatile, biting allyl isothiocynate found in powdered and Dijon mustards. Yellow mustard, on the other hand, releases the milder, nonvolatile para-hydroxybenzyl isothiocynate characteristic of hot dog or cream salad mustard.

Making Mustard

English powdered mustard is made from brown or Oriental (yellow seeded) *B. juncea* seeds using a dry milling

> In addition to the American-style hot dog mustard and the well-known Dijon style, there exists a multitude of “specialty” mustards as well as such variations as the Russian (hot and sweet), the Chinese (extra hot), the English (smooth and hot), the German (hot, smooth, and horseradishy), and the Italian *mostarda di frutla* (a thin, sweet, very hot mustard syrup containing large pieces of various fruits).

process in which the seeds are passed through a series of rollers and sieves to produce a fine flour. The seed coats, which are cracked off by the first roller, may be used in food preparation or sent to an oil extraction mill. The pure mustard flour is then blended with some yellow mustard flour, prepared separately in the same way, plus a certain amount of wheat flour to give the desired level of heat when mixed with water.

French or Dijon-style mustard is made with only brown mustard seeds using a wet milling process in which whole seeds are ground to a fine paste and the hulls or seed coats are separated with centrifuges. Some of the hulls may be added back to the paste along with vinegar, herbs, and spices. Since the hot principle allyl isothiocynate is volatile, much of the heat is lost in the process, resulting in less pungency than might be expected from *B. juncea* seeds.

Hot dog or cream salad mustard is made from yellow mustard seeds using a wet milling process that creates a fine paste. However, the hulls are usually separated from the embryos by passing the seeds through a set of break rollers prior to grinding. The paste is then mixed with cereal flours, spices, and vinegar according to the recipe being followed.

Mustard seeds and leaves have also been harvested as a food and for medicinal purposes. The medical applications, such as mustard plasters, baths, and treatments for chilblains, are largely a thing of the past, but mustard greens and mustard seed oil are still household staples in parts of China and on the Indian subcontinent.

> Four major mustard millers supply flour of various grades to processors the world over, largely replacing small local mustard millers.

Modern Mustard

Mustard was a common spice in ancient Greek and Egyptian civilizations, where it was often eaten raw, chewed with meat to mask off flavors, to aid digestion, and for its antimicrobial properties. However, the Romans recognized mustard’s potential by grinding and mixing mustard flours with unfermented grape juice, vinegar, and honey. They introduced mustard manufacture into Dijon and other regions of France and later into England. They recorded its application as a preservative and its use in sauces with meat, fish, and vegetables. In medieval times mustard making was primarily done by the monasteries, but by the thirteenth century French family firms supplied quality mustard to French royalty. In England large-scale mustard manufacture did not flourish until the sixteenth century, when large dried balls of mustard infused with horseradish were manufactured in Tewkesbury and were sold by peddlers throughout the country. Later Mrs. Clements in Durham began to mill and distribute mustard flour, a product later made famous by the competing firms of Keen’s and Colman’s. In the United States, R. T. French, seeking a milder mustard in the 1800s, introduced cream salad and hot dog mustard, thereby adding a new dimension to the mustard industry.

In the second half of the twentieth century, world usage of mustard more than doubled, from 75,000 tons to over 170,000 tons. Originally most countries grew their own supplies, but by the twenty-first century the predominant supplier was Canada. The United States and central Europe also are important producers. Yellow mustard has become more important with the popularity of fast-food outlets. In addition, a strong demand developed for deheated yellow mustard because of its high protein content and excellent emulsifying, water-holding, and stabilizing characteristics. It is also widely used as a meat extender in prepared meats. The hulls of yellow mustard are also in demand for the unique properties of the mucilage (vegetable gum) they contain.

Specialty mustards, which include almost every possible blend of added flavors and range of textures, have grown dramatically. Popular formulations include ingredients such as honey, beer, wines, whiskey, garlic, horseradish, lemon peel, ginger, onion, peppers, tarragon, and so forth (see Man and Weir for a more extensive list).The Mount Horeb Mustard Museum in Wisconsin boasts a collection of 3,341 different prepared mustards. The use of mustard in restaurants and in home cooking has expanded and become more subtle and more adventurous.

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MYTH AND LEGEND, FOOD IN. Food imagery appears in the myths and legends of many cultures worldwide; for example, in the concept of the earth as a life-giving mother and as an explanation for agricultural innovation. Gifts of food were thought proper to propitiate the gods and ensure success in food production.

Across cultures, the germination of plants and their ripening and dying are identified with the cycle of human life—the regeneration of the cosmos. The juxtaposition of life with death, fertility with infertility, and order with chaos is interwoven with the ideas of salvation and revival, of which woman is a symbol and the incarnation. For example, the Aztecs believed that the earth was female and called their goddess of fertility Tlazolteotl, Mother-Earth; similarly, other examples are the Celtic goddesses Aine and Anu (Danu, Dana), the Greek Demeter, the Hindu goddess Devi, and the Aboriginal deity Gunabibi, who was called the First Mother.

Egyptian myths about eternal forces of nature center on the male deity Osiris. His death at the hand of his brother Set and his resurrection, brought about by his wife Isis and his sister Nephtida, is associated with the cycle of plant vegetation and with the cereals that are sown after the harvest and regenerate with the coming of spring. The snake goddess Renenutet has custody over the harvest and field crops.

In ancient mythologies, everything is a gift of the gods' generosity, even the knowledge needed to improve food production. Examples appear cross-culturally: the Sumerian god Enlil makes a hoe and gives it to man so that he can cultivate land; the Chinese are taught how to cultivate land by the Divine Farmer, Shen-nung, who is the first to plow and sow grain, which rained from the sky or was dropped by the Purple Bird. A Hindu who sincerely worships goddess Devi is rewarded with rice by the household goddess, Annapurna; Indian bees make honey because of the divine intervention of the twin brothers Avins; and the Greek goddess Athena creates the olive tree from the depths of Attica's barren earth. The short poem in honor of Ninkasi, the Mesopotamian goddess of strong liquors, relates that it is due to her grace the dough rises when beer leaven is added to it, and that it is she who inspires bakers add sesame seed and herbs to bread.

In the epic of Gilgamesh, the goddess Ishtar asks her father, the god Anu, to use the heavenly bull to punish Gilgamesh. When Anu replies that the bull would not leave a single wheat grain on the earth for people, the goddess assures him that the grain reserves stored in the granaries of Uruk were sufficient to last for seven successive years of crop failure, and that they could sustain both people and cattle.

Many foods play a significant role in old myths and legends, such as the pomegranate in the Greek myth of Persephone. Other foods are themselves the subject of complex mythologies, and one of these is the pretzel. The commonly told story (at least in America) of the invention of the pretzel by an Italian priest to signify crossed arms in the act of blessing was created in the early 1900s to dilute the association of pretzels with beer drinking during Prohibition. In fact, the twisted pretzel traces to pre-Christian cult foods in the Rhine Valley, although its name derives from *bracellus* (an arm band or bracelet). The pretzels shown here were displayed in the Alsatian town of Wissembourg, France, during Christmas 1998. © DAVE BARTRUFF/CORBIS.

The association between humans and the gods endows food with a sacred quality, a mystical solidarity of man with plants and animals. When humans consume votive food they are in a way convinced that ultimately they consume a divine being. Offering food is a common practice in mythologies, and in order to prevent the wrath of the gods, priests were obliged to procure food for the sanctuaries.

TEA AND COFFEE IN MYTHOLOGY

In Chinese and Japanese cultures, tea is a frequent subject matter of legends. The tea plant was created from eyelids of a certain Buddhist monk, or sage, who, wanting to punish himself for falling asleep during meditation, cuts them off and discards them with contempt. Each eyelid gives rise to one tea shrub. According to the Japanese version of this legend, the eyelids belong to Bodhidharma (Daruma), who cuts them off as a preventive measure, since he wants to be unable to ever close his eyes.

The discovery of coffee is sometimes ascribed to goats. Coptic monks, who are compelled to observe a strict religious order of overnight prayers, notice that goats that had nibbled the leaves and fruit of wild coffee shrubs became excited and could not sleep at night. Thus, the monks follow the goats and, although they do not really like the taste of the leaves and bean, they are greatly satisfied with their unusual effect. Another, more poetic legend has Arabic origins: the first cup of this beverage was served to Muhammad by the Archangel Gabriel. The drink has an amazing effect. Right away Muhammad mounts his stallion, defeats forty knights in tournament, and lets forty Arabic ladies "taste the sweetness of love."

Each deity has a liking for a particular food; for example, lettuce is the favorite vegetable of the Egyptian god Set. In Hindu mythology, the god Dharmathakur accepts only white offerings (rice, milk, poultry), while the demonic and semi-divine female Dakini acquires strength from raw meat. As a child, Krishna goes into peasants' houses and pinches butter from them as he is very fond of it. The Hindu made offerings of boiled rice mixed with sesame seed, milk, ghee, and honey to their mystical ancestors residing in the other world.

Before any undertaking, a Greek promised the gods he would make some offering to them in order to gain their support. If someone could not afford to buy a sacrificial animal, he made a cake baked in the shape of an ox, a cow, or a sheep. Replacement offerings were made to gods when cities were besieged by enemies, or when meat was in short supply.

Beer is a food product most frequently referred to in mythologies of Mesopotamia, Egypt, and Scandinavia. Mesopotamian mythology in particular abounds in episodes with beer in the background. The goddess Inana makes the god Enki drunk with beer in order to steal the heavenly secrets away from him. In turn, in Greek mythology wine plays the most prominent role. On a holiday celebrated in December, when the new wine was stowed in granaries, the Greeks would kill a goat and sprinkle vine roots with its blood. Liquors were even thought to make the horrid existence in the underworld more pleasant; for example, in the Welsh underworld, in Annwn, there is a spring from which wine was flowing.

After his exhausting journey in search of the "herb of life" Gilgamesh falls into a deep sleep that lasts seven days. The host of that place, Ut-napishtim, says to his wife: "Start [to] bake bread and every day put one loaf next to his head and make a sign on wall so that you know how many times you have baked." The ritual meal in praise of Aboriginal deity Djanggawul was composed exclusively of fresh bread made of sago nut flour. Eating it formed a sacred bond of friendship between the participants of the feast.

In Greek mythology, ambrosia is the food that gives the Olympian gods eternal youth and beauty. Unlike nectar, which is a drink, ambrosia is probably a dish. It was believed to make even an ordinary person immortal. The Indian counterparts of ambrosia are *amryta*, the nectar found at the ocean bottom, and *soma*, a heavenly elixir that ensures immortality on earth. The Australian Aborigines told tales about an elixir of immortality, though this elixir had no name.

See also **Art, Food in: Literature; Ancient Mediterranean Religions; Australian Aborigines; Beer; Bible, Food in the; Buddhism; Christianity; Coffee; Folklore, Food in; Greece, Ancient; Herodotus; Hinduism; Inca Empire; Islam; Judaism; Mesopotamia, Ancient; Religion and Food; Symbol, Food as; Tea; Wine in the Ancient World**.

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Michael Abdalla

N

NAMING OF FOOD. Foods are named primarily according to their origins. Foods from the plant kingdom usually have the same name as the plant, such as *carrot*, *potato*, *peas*, and *spinach*. Sometimes the name of the food is from the fruit (the seed-bearing part of the plant), such as *apple*, from apple trees, and *raspberry* from raspberry bushes.

Food from animals usually has the same name as the animal: *lamb*, *chicken*, *rabbit*, *quail*, *salmon*, *Dungeness crab*, *snails.* The exceptions are words such as *calf* and *veal* or *pig* and *pork* or *sheep* and *mutton*, where the former word is of Anglo Saxon origin and the latter of French origin. A few remnants of Anglo-Saxon names remain, as in *oxtail soup* or *pigs' feet.* The names of animal parts when cooked and eaten often refer to the common anatomical names, such as *wing*, *breast*, or *leg* of birds and *rib* and *tongue* of mammals. However, most cuts of meat have their own special names: *sirloin*, *strip steak*, *lamb chop*. *Bacon* and *ham* denote that the meat is from a pig and that it is smoked. Innards like liver and kidneys are the same as the organ name. However, some interior parts have better-sounding food names, such as *sweetbreads* for *pancreas*, *tripe* for the *stomach* of a ruminant, *roe* or *caviar* for *fish eggs*, and *mountain oysters* for *testicles.*

Names of Dishes

Names for prepared foods follow several patterns. The commonest is a phrase with the main ingredients: *chicken almond*, *beef and mushrooms*, *creamed tuna casserole*, or with the cooking method as well as the food: *poached eggs on toast*, *pork and vegetable stir-fry*.

Another common pattern is to name foods after places. The meaning only indicates an origin and/or style. Sometimes the meaning is transparent, as in *Polish sausage*, *Belgian waffle*, or *Spanish omelet*, but often additional knowledge is required. *Florentine* (named for Florence, Italy) is for dishes with spinach, *Bolognese* (from Bologna) is with a meat sauce, and *Bologna* is a sausage. *Veal Milanese* (Milan) or *Wiener Schnitzel* (Vienna) is breaded and fried veal cutlet. *Provençal* (Provence) means made with tomato, garlic and olive oil, and *chicken Kiev* is chicken breast wrapped around butter, breaded, and fried, *Salad Niçoise* (Nice), *Mongolian hot pot*, *Peking duck*, *Buffalo wings*, and *baked Alaska* are other examples. *Chicken Maren*go was named in honor of Napoleon's victory at Marengo. Occasionally the name is misleading. French toast is an American dish, while *homard à l'americain* 'lobster American style' is a French dish. French-fried potatoes are common in France under the name *pommes frites* 'fried potatoes'.

A small number of words derived from place names have been resegmented and reanalyzed. Hamburger and Frankfurter were named after the German cities of Hamburg and Frankfurt, and Wiener is from Wien, the German name for Vienna. Hamburger was resegmented as ham + burger, although the food is made with chopped beef. Burger became a combining form to be added to any food served with ground beef (*cheeseburger*, *baconburger*) or some meat instead of beef (*chickenburger*, *fishburger*), or for a particular style (*California burger*). Vegetarian versions are *veggie burgers* or *garden burgers.* Subsequently, *burger* has become an independent word. *Frankfurter*, often shortened to *frank*, has also become a combining form, yielding new words like *turkeyfurter* or *turkeyfrank*, with each part of the word combining with new parts. *Hot dog*, an informal term for frankfurters, has generated *Tofu Pup*, a vegetarian sausage. It also illustrates the trendiness of wordplay.

Some dishes are named after people, either for the inventor or in honor of some famous person. *Sandwiches* were invented by the Earl of Sandwich, and *Beef Wellington* honors the Duke of Wellington. *Beef Stroganoff* is a French dish created to honor the Russian diplomat Stroganov. Other examples are *Oysters Rockefeller*, *Pavlova*, a meringue dessert created to honor the dancer Anna Pavlova, and the pastries named for Napoleon and Bismarck.

French has had an especially strong influence on English names for food and dishes. The phrase *à la* appears in several dishes. One phrase taken from French is *à la reine* 'to the queen' or 'in honor of the queen' for creamed foods often served on a puffed pastry. This has led to *à la king*, a mixture of French and English that violates French grammar, since "la" is the feminine definite article, and king by virtue of its meaning would be masculine (if English still had grammatical gender in its definite articles). Other examples are *riz à l'impératrice* 'rice pudding' literally 'to the empress' and *à la mode* 'with ice cream' (literally 'in the style').

English speakers have borrowed freely from other languages for hundreds of years, taking the original spelling (if that language uses Roman letters) as well as an anglicized pronunciation. (This phenomenon is part of the reason for the irregular spelling of English.) Food names have been heavily borrowed along with the dish: *sauerkraut* and *strudel* (German); *soufflé*, *mousse*, *crêpes*, *meringue*, and *fondue* (French); *spaghetti* and other pasta names as well as *pizza* and *spumoni* (Italian); *souvlaki* (Greek); *goulash* (Hungarian); *tortilla* (Spanish); *paella* (Catalan); *guacamole* (Nahuatl, a native Mexican language); *blini* (Russian); *cole slaw* (Dutch); *curry* (Tamil, a language of South India); *chutney* (Hindi); *shish kabob* and *baklava* (Turkish); *couscous* (Arabic); *sushi* and *tempura* (Japanese); *won ton* (Chinese); *succotash* (Narragansett, a North American Indian language); and *matzoh* (Hebrew).

Marketing Strategies

In selling foods, whether in stores or restaurants, attractive names are selected for the product or the dish. Often foreign-language equivalents are used, sometimes along with the English equivalent. For example, spaghetti in tomato sauce might be labeled pasta in marinara sauce. In addition to the euphemisms for innards described above, the names of pet foods are especially interesting since the names are intended to appeal to the owners. One popular brand of cat food has names like "country-style dinner," "mariner's catch," and "prime entree." The ingredients listed in small print on the label do not sound so nice.

Zwicky and Zwicky (1980) in their investigation of menus in American restaurants show that names both inform and advertise. Two examples they present are "Entrecôte au Poivre Madagascar–sirloin steak topped with green peppercorns, served with cream sauce and cognac" (Zwicky and Zwicky, p. 86) and "sautéed shrimp in garlic butter–the zesty garlic butter brings out the best in this epicurean treat from the sea" (Zwicky and Zwicky, p. 87). The first example describes and the second advertises. Zwicky and Zwicky observe that French is used on menus frequently because of the traditional association of French with fine food. The restaurant need not be French, and the French is often ungrammatical or mixed with English. Therefore, one finds *Cuisine de Holland* and *Stuffed Tomato aux Herbs, Shoreham Style* (Zwicky and Zwicky, pp. 89–90).

Since many people are on diets for reason of health and/or weight control, there is concern with calories and with fat. The food industry has responded by offering products with less fat and fewer calories. One word for referring to these products is "light," sometimes spelled "lite." The Miller Brewing Company used the word to denote a beer with fewer calories than regular beer. Since a light beer is ambiguous—it can be light in color (pale vs. amber or dark)—the spelling difference can disambiguate the two senses. Although other beer companies have been prevented from using this spelling, lite has spread to many other foods with fewer calories than the normal counterpart. More recently, "free," a clipping of "fat free," has emerged to denote foods without fat.

See also **Etymology of Food; Sandwich.**

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NATIONAL CUISINES, IDEA OF. Cuisines and nations are artifacts of human enterprise, will, and imagination. They refer ostensibly to material things: to the earth, to the natural world, to particular geographical locales and the products of these places. In this sense, cuisines tell one something about food, and nations tell one something about places. Cuisines, too, are made up of earthly products, such as butter, beef, saffron, and garlic, much as nations inhabit physical localities, whether protruding landmasses, landlocked mountains, or chains of islands. In the modern period, however, foods have become associated with cuisines and places with nations to such an extent that one does not perceive any difference between them. National cuisines are a product of the modern emphasis on nationalism and the nation-state.

In fact, the coining of "national cuisines" has become an almost exclusive means of organizing the link between food and place. One talks with ease of Germany and German cuisine and India and Indian cuisine, as if German cuisine and Indian cuisine have existed as long as the mountains, valleys, and lakes that define their namesakes' topographies. If the history of the subcontinent, and the food practices of people there, are reviewed, the limits of the term "Indian cuisine" will be fast apparent. The food habits of the Punjabi Sikh and the Kerala Christian, for instance, have little in common, though both groups occupy India and eat its food products. While a handy moniker to grasp onto the food habits of a group of people, "Indian cuisine" is not a product of nature. Classifying a cuisine helps mark a geographical locale as a nation; it allows people to imagine national unity and to create convenient categories for understanding food practices. The convenient shorthand of "German cuisine" and "Indian cuisine" belies the complex historical formation of national cuisines, and their link to nationalism, a way of speaking about place, identity, and sovereignty.

Because of the tangible and visceral nature of food, nationalists have long used food to help solidify claims and gain legitimacy. This can clearly be seen in the shift from food to cuisine as a way to mark ownership over ingredients and practices understood to come from a certain place. For at least two hundred years, France has been a geographical region where arguments have been made for the authenticity of national cuisines by citizens, the state, and culinary professionals. The arguments concern the natural, authentic nature of "French cuisine" as a national cuisine. The French also often argue for the superiority of French cuisine in general. A historical examination of cookbooks from this region reveals a shift in the assumptions about audience and organization away from noble patrons toward fellow citizens. This shift occurred from the sixteenth century to the early part of the nineteenth century. By the 1880s, almost all cookbooks were aimed toward national citizens.

More recently, newer nation-states such as Mexico and Israel have promoted their national cuisines as a means of legitimizing their claims to nationhood. But, according to anthropologist Sidney Mintz, "a national cuisine is a contradiction in terms. . . . for the most part, a national cuisine is simply a holistic artifice based on the foods of the people who live inside some political system, such as France or Spain" (Mintz, p. 104) Yet this "holistic artifice" has become a very successful enterprise. All manner of food ways, now packaged as "national cuisines," are promoted in restaurants, cookbooks, tourist guides, and television shows. In particular, cookbooks have been very effective at creating and promoting such assumptions; contemporary cookbooks include such titles as *A Taste of India*, *Mastering the Art of French Cooking*, and *The Art of Mexican Cooking.* The discourse of food writing has largely become bounded by the notion of national cuisines: National cuisines are seen as natural occurrences and the culinary discourse reflects that very assumption.

To really comprehend the tremendous complexity and diversity of human food practices, it is necessary to move beyond the discourse of national cuisines. Food—the raw ingredients, the cooking techniques, the ritual practices, the social significance—is ultimately more fluid, varied, meaningful, and powerful than the reliance on national cuisine as a category of explanation allows for in exploring it. Perhaps the twenty-first century, if significant in demonstrating the limited control of any sovereign nation-state, will be the period when food is removed from the nationalist agenda.

See also **Foodways; France: Tradition and Change in French Cuisine; Fusion Cuisine; Geography; United States: Ethnic Cuisines**.

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NATIVE AMERICANS. *See* **American Indians.**

NATURAL FOODS.

The concept of natural foods is obscure from many perspectives. Although international literature offers no clear definition, the term is used in food surveys, in the food industry, in the marketing of foods, and in modern discourses surrounding food choice. "Natural" is defined as 'produced by nature, that is, not produced artificially' in *Funk and Wagnalls Standard Dictionary.* Since all food can be said to be produced by nature, the term "natural foods" becomes even more unclear unless one considers the meaning Felipe Fernández-Armesto has proposed: "the oyster is eaten uncooked and unkilled. It is the nearest thing we have to 'natural' food—the only dish which deserves to be called 'au naturel' without irony" (p. 2).

If the concept of natural foods originates from the French phrase *au naturel*, that is, eating something uncooked and alive, it would relate first to modes of processing. An "unkilled" food like the oyster is a food uncooked and is, by that definition, a food that has not been altered by human hand. Thus natural foods are foods not deliberately altered in the course of production and processing. Asked in a study how they perceived naturalness in relation to food production, respondents in England and Denmark said they perceived organic food and free-range livestock products as the most natural foods and genetically modified foods as the most unnatural foods (Von Alvensleben).

Furthermore, natural foods can be interpreted in terms of connections to nostalgic rural life (Lupton). Yet regional foods, products that are not imported from exotic, faraway lands and not distributed in ways injurious to the environment are also representations of natural foods. Moreover, the concept of natural foods is related more to some groups in society than to others. Some associate natural foods with specific food choice ideologies, such as vegetarianism, and thus exclude certain animal products while including plants, cereals, fruits, and berries, preferably produced in an organic or ecological way (Lindeman and Sirelius).

The marketing strategies for natural foods may be understood on two levels. First: natural foods are considered unprocessed foods in the sense that they are not influenced by industry for mass production. Second: natural foods are seen as originating in the vegetable kingdom. Both dimensions are marketed as healthy for people and the environment.

Contradictions in Health and Purity

The marketing of natural foods actually refers to health issues. Natural foods are projected as guaranteeing a long, healthy life since they are portrayed as foods that can prevent diseases and aging. In this concept lies the belief that natural foods are pure and free from harmful and unwholesome components. Pure food is perceived as natural, simple, unspoiled, and earthy, but at the same time it is expected to be germ-free, biologically cleansed, and scientifically aseptic (Mintz).

Natural foods in fact can include more harmful and naturally occurring toxic substances than highly processed food. The latter, thanks to modern developments in biotechnology, (i.e., genetic manipulation) can be more "healthy" and can more effectively prevent diseases than the so-called natural foods (Coveney and Santich). Advances in biotechnology have produced foods that are much safer from a hygienic perspective with the same tastes, appearances, textures, and colors as foods produced in the conventional way. This is the ultimate goal for the modern food industry, and these are the foods modern consumers actually demand and look for even though they are not always aware of it.

Quality Aspects of Natural Food

The concept of natural foods is closely related to quality aspects of food. Adulteration of food has been evident since the growth of towns and the development of food distribution in medieval Europe. Adulteration became more prevalent in the late nineteenth century, a period also characterized by the food scientists' obsession with purity (Tannahill). This obsession was mainly a reaction to the development of the food industry and the loss of control over local food production, but it can also be linked to the development of food science per se. New scientific methods enabled scientists to measure and detect impurities in food. Thus the quality aspects of food were seen under the microscope, that is, scientists could actually see with their own eyes the bacteria, microorganisms, and chemical residues in the food; therefore, food was determined chemically clean or not. However, as Sidney W. Mintz emphasizes, this state is not the same as a natural one. Nature is not chemically clean.

At the same time a new genre of books with advice and guidelines on how to shop for safe, unaltered foods was published widely in Europe. The consumers, mostly women, were told what foods they should be suspicious of, what foods to avoid, how to detect adulterations in food, and so on. In these books and in the general debate in the newspapers, the development of food industries and fast-growing global trade was much criticized. Foods produced in the consumer's own country and sold by local, well-known salespeople were recommended (Fjellström). The debate continued in the twenty-first century within the European Union (EU) despite the fact that most states in the EU have effective measures to control quality in food production and distribution. Consumers in Europe and the United States fear unnatural foods produced outside national and regional borders.

The Ideology about Nature and Food

The vision of the foods eaten by humankind in prehistory is one of natural and healthy foods from a nutritional point of view (Jenkens et al.). This diet is perceived as plant-based; high in vegetable protein, dietary fiber, and antioxidants; and low in saturated fat. It is considered the best alternative for modern people forced to eat the food of the supermarket, which is characterized as bottled, canned, refined, preserved, and frozen.

The ideology and attitudes toward the wild and natural landscape on the one hand and the domesticated and cultivated landscape on the other shifted back and forth throughout the first millennium B.C.E. (Montanari). For example, in Greek and the Roman cultures the untilled, uncultivated landscape or nature was seen as something negative, the opposite of the civilized and human world. Only unfortunate people obtained food in wild nature. Although the vegetarian diet, as opposed to the animal one, appealed more to both the Greeks and the Romans, it had to derive from land cultivated by people. During the seventh and eighth centuries C.E. in Europe the preference for nature and for the wild landscape as a source of a daily food supply became more dominant among the lay nobility, while domestically produced foods were preferred by groups within the church and in monasteries. In the early part of the second millennium C.E., the dominant ideas supported an effective medieval agricultural system. Foods obtained from the wild or naturally grown were regarded as unsuitable for human consumption (Montanari).

In eighteenth-century Scotland the physician George Cheney won a reputation for his ideas on health and illness. Natural foods were once again in favor. Cheney saw natural foods as those that remained unaltered by strange preparation techniques and ingredients, although he was not a vegetarian (Beardsworth and Keil). The development of organicism in mid-twentieth-century England preceded the ideology of natural foods (Matless). Important symbols within this movement were the earth and the soil. Values such as nature and wholeness were seen as the right kind of values for the survival of humankind, just as production methods and geographies of foods were emphasized as important for people's health. Organicists were critical of the global food production and distribution industries, thus their approach can be understood as a critique of modernity.

Natural Foods and a Critique of Modernity

The choice of natural foods could be interpreted in terms of Anthony Giddens's theories about people's calculations of risk elements in modern everyday life. Health issues, fear of diseases, and ultimately existential questions, such as the fear of death, are the underlying reasons that people began to examine what foods they could trust in a global society, where multinational food industries control food production and distribution and where experts have commandeered the knowledge of what is safe and healthy food. In his well-known culinary triangle Claude Lévi-Strauss emphasized that raw food was related to nature, while cooked food handled in vessels made by people had become culture. At the beginning of the twenty-first century the discourses surrounding food, especially so-called natural foods, involve new and different meanings and symbols. In some groups, particularly those who favor natural foods, nature and rural living are favored before culture and urban living (Lupton). Thus Lévi-Strauss's ideas about the the raw and cooked have changed place. Raw food rather than processed and cooked food is considered culture among some groups.

See also **Green Revolution; Health Foods; Organic Agriculture; Organic Farming and Gardening; Organic Food.**

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Christina Maria Fjellström

NETHERLANDS. *See* **Low Countries.**

NEW ENGLAND. *See* **United States.**

NIACIN DEFICIENCY (PELLAGRA).

Deficiency of the vitamin niacin can result in the disease pellagra. This illness is characterized by the appearance of severe dermatitis on the parts of the skin that have been exposed to the sun, with deep cracking and flaking. Sufferers also have diarrhea and, in many cases, some kind of dementia. The condition typically flares up during spring, as sunshine becomes stronger. In practice, patients were often found to be deficient in the vitamin riboflavin in addition to niacin. Both in the Old and New Worlds, the condition has almost always been confined to people consuming corn (that is, maize) as their staple grain. The explanation is complex. We can synthesize niacin for ourselves to some extent if our diet contains a good supply of the amino acid tryptophan because we have enzymes that can, in a series of steps, turn a portion of any excess tryptophan molecules into niacin. The problem with corn is that the proteins that it contains have an unusually low proportion of tryptophan, and this is insufficient to provide a second source of the vitamin. Mature corn, like the mature grains of other cereals, does contain niacin, but it is mostly present in linkage with other compounds that make it essentially indigestible, because the digestive enzymes in the gut cannot break these linkages. In Central America and Mexico, where corn has been the staple grain for millennia, the populations have learned to soften the grains by soaking them with lime (calcium hydroxide) before grinding them to a paste. It is now realized that, in addition to its softening action, the alkaline lime liberates the niacin from its linkages, so that it is now nutritionally available. This is, at least, a partial explanation for the freedom of these peoples from pellagra. In addition, if a diet rich in maize is supplemented with a diet that also uses beans as a stable, as is the case among the traditional natives of Mexico, then the low level of tryptophan in maize is compensated by the higher tryptophan level in beans. Many types of long-established diets have this type of essential amino acid complementarity among the foods consumed.

However, when corn was brought back to the Old World, and gradually came to be adopted as a staple food in Southern Europe, but without the use of lime in its preparation, pellagra became a serious problem. In the nineteenth century it was suspected that corn developed toxic molds during storage. In France its use as a food crop was made illegal, and in Italy a special class of "pellagra hospitals" was established. In the southern regions of the United States, pellagra became a serious problem from about 1910 onward. There had been no obvious change in dietary habits to explain this, but it is now realized that corn processors had introduced a new method of milling corn that separated the germ. This was advantageous in reducing the oil content of the cornmeal and increasing its storage life, but it further halved the tryptophan content of the meal. The average consumer in the South was using approximately equal parts of cornmeal and of white wheaten flour that was somewhat richer in tryptophan. It appears that the change in milling was just enough to tip the balance toward the appearance of pellagra in those with only low intakes of good supplementary foods such as meat and milk. Niacin is now one of the synthetic vitamins included in the supplements routinely used to enrich flours in many Western countries.

See also **Assessment of Nutritional Status; Dietary Assessment; Dietary Guidelines; Food, Composition of; Maize; Malnutrition; Mexico; Nutrients; Nutrition; United States: The South; Vitamins: Overview.**

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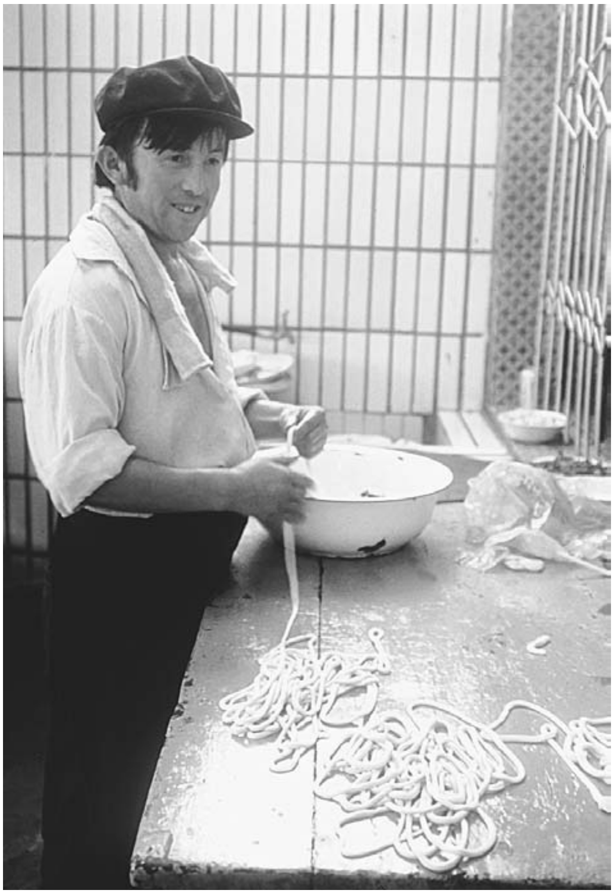
Kenneth John Carpenter

NOODLE IN ASIA, THE. Noodles originated in northern China during the last half of the Han Dynasty (206 B.C.E.–220 C.E.) when large-scale wheat grinding became available, providing flour to make *mian*, *mein*, or *mi*, the Chinese word for noodle. We learn about the earliest noodles from Shu Hsi, one of China's most learned men, who in 300 B.C.E. wrote a *fu* or rhapsody on noodles, in which he provided detailed recordings of noodle making. For centuries, *la mian* or hand-pulled or hand-swung noodles were popular. The chef grasped a length of dough between two hands, stretched it with a toss of several feet, and repeated the tossing and extending until the dough divided into thinner and thinner strands, resulting in soft, smooth, and chewy noodles.

In the centuries that followed, variations of noodle making were introduced. In the Tang Dynasty (618–907 C.E.), noodles were first cut into strips. Then, in the Yuan Dynasty (1271–1368 C.E.) the making of dried noodles began (Ang, p. 46).



Noodle maker in Turpan, Xinjiang, China. PHOTO BY GLENN MACK.

With travel and trade, noodles migrated into the rest of Asia. Noodles moved from China to Japan to Korea and to Southeast Asia. The Chinese influence is first evident in the name for noodle. The Chinese word for noodle, *mian* or *mien* or *mi* became *men* or *menrui* in Japan, *myun* in Korea, and *mee* in Thailand. It was even believed that Chinese noodles moved into Europe. According to legend, Marco Polo discovered pasta in China and took the idea home. But it was misinterpretation of his records that started this story because pasta was known to the ancient Greeks and Romans—a culinary evolution independent of China.

Asian noodles are distinctive because of the assortment of flours used. The notion that rice is the dietary staple in China is misleading as the majority of China eats wheat products. Southern China with its monsoon rains provides perfect rice-cultivating conditions while the large area north of the Yangtze River is excellent for wheat. Northern China, Korea, and Japan use wheat flour. Buckwheat noodles are found in Japan and Korea. Southern China uses wheat flour with the addition of egg as well as rice flour. Southeast Asia uses mostly rice flour, but also mung bean flour. Other Asian noodles are made from potato starch, sweet potato, soy bean, yam, and dried shrimp. They come dried, fresh, thin, thick, coarse, flat, round, and in broken sheets. Each country has similar yet distinctive ways of making noodles.

China

In China, the most popular noodle is the regular *gan mian* or *mian*, made of wheat flour and water. Salt is sometimes added, and cornstarch is sprinkled on fresh noodles to keep them from sticking together. Dried wheat noodles are either 12-inch lengths or, in the case of thinner noodles, nest-like swirls. Egg noodles or *dan mian*, occasionally flavored with shrimp and yellowish in color, are popular in southern China. *Chow mian*, or stir-fried noodles, is perhaps the most popular noodle dish.

Other noodles eaten in China are made with rice flour or mung bean flour. Dried rice noodles, *mi fen*, or rice sticks or rice vermicelli come in different widths, but in China, the thin, white opaque white noodles are most popular; they are softened in hot water or immediately puffed up when tossed in hot oil. *Sha He fen* or rice noodles from the southern village of Sha He, or vermicelli sheets, are wide, slippery, rice noodles sold in large squares. These fresh noodles made from rice flour, cornstarch, and potato starch are used in soups and stir-fried in a dish called *chow fen*. At other times, the sheets are filled with beef or shrimp and then rolled and steamed. Mung bean noodles or *fen si* (literally translated 'powdered silk') or cellophane noodles, bean threads, glass noodles, or vermicelli are from the starch of mung beans. They rehydrate in hot water to a slippery, translucent noodle, or puff up when fried in hot oil.

Japan and Korea

Japan is the most noodle- or *menrui*-consuming nation on earth. Japanese noodles include wheat-based noodles found in Osaka or southern Japan, and buckwheat-based noodles associated with old Edo, now Tokyo, and the north country. Wheat noodles include *udon*, which are thick round, square, or flat noodles; *kishimen*, which are also wide and flat; *hiyamugi*, which are round, very slender and served cold; *somen*, which are even more slender and slightly moistened with cottonseed or sesame oil, and also made with tea powder, *cha somen*; egg yolk, *tomago somen*; or tinted with red perilla oil, *ume somen*. Buckwheat-based noodles, or *soba*, are mixed with wheat flour. These noodles are long, thin, and gray-brown in color. A variation of this noodle, made with green tea, is *cha soba*.

Ramen, the most popular noodle in Japan, is of Chinese origin. These noodles are steamed and dried, making them easily rehydrated for quick eating. *Harusame* or 'spring rain' or cellophane noodles are made from Japanese potato starch or Chinese style from mung beans. Finally, *shirataki* or 'white waterfall' is made from the starch of the devil's tongue or *Amorphophalus konjac*.

TABLE 1

Asian Noodles

Name	Ingredients	Use
Chinese Noodles		
wheat noodles (mian, gan mian, mien, mi)	wheat flour and water	stir-fries, soups
egg noodles (dan mian)	wheat flour, egg, and water	stir-fries, soups
mung bean noodles (cellophane noodles, bean threads, glass noodles, fen si)	mung bean starch and water deep-fried	stir-fries, soups,
rice noodles (rice sticks, rice vermicelli, mi fen)	rice flour and water	stir-fries, soups, deep-fried
vermicelli sheets (Sha He fen)	rice flour, cornstarch, potato starch, and water	soups, stir-fries
Japanese Noodles		
ramen noodles	wheat flour, egg, and water	soups, stews, stir-fries
devil's tongue starch noodles (shirataki)	devil's tongue starch or Amorphophalus konjac starch with milk of lime	soups
soba noodles	buckwheat flour, wheat flour, and water	soups, stews, salads
somen noodles	wheat flour and water	soups, salads
udon noodles	wheat flour and water	soups, stews, salads
Korean Noodles		
buckwheat noodles (naeng myon)	buckwheat flour, wheat flour, and water	salads, soups
sweet potato noodles (vermicelli, tang myon)	sweet potato flour and cornstarch and water	salads, stir-fries
Thai Noodles		
thin rice noodles (rice sticks, rice vermicelli, sen mee)	rice flour and water	soups, stir-fries, salad
flat rice noodles (flat rice sticks, rice vermicelli, dried gway tio, banh pho)	rice flour and water	soups, stir-fries, salad
vermicelli sheets (Sha He fen, gway tio)	rice flour, cornstarch, potato starch, and water	soups, stir-fries
mung bean noodles (cellophane noodles, bean threads, glass noodles, woon sen)	mung bean starch and water salads	soups, stir-fries,
Vietnamese Noodles		
thin rice noodles fillings (rice sticks, rice vermicelli, bun)	rice flour and water	salads, soups,
flat rice noodles (flat rice sticks, rice vermicelli, banh pho)	rice flour and water	soups, stir-fries
mung bean noodles (cellophane noodles, bean threads, glass noodles, bun tau)	mung bean starch and water	salads, soups, fillings

Udon is usually served in broth with chopped scallions or *shichimi* or a seven-spice mixture consisting of red pepper, *sansho* or Japanese prickly ash pepper pods, dried mandarin orange peel, black hemp seeds, dark green nori seaweed bits, and white sesame seeds. *Soba* is traditionally served on bamboo slats inside a square wooden box with a dipping sauce made of *dashi* or a bonito flake-*kombu* seaweed broth. If the noodles are presented cold, then the dipping sauce may be accompianied by sliced scallions, wasabi or Japanese horseradish, and grated daikon or Japanese white turnip. *Somen* is usually served cold. *Shirataki* comes packed in lime water and needs to be parboiled before using in sukiyaki, a popular beef dish made in a shallow cast-iron pan.

Korea's proximity to Japan and China is reflected in the noodles eaten there. Koreans enjoy buckwheat noodles or *naeng myon* cold, much as the Japanese do, but with some unique variations. The Korean version of the Chinese mung bean noodle is *tang myon*, which is made with sweet potato and cornstarch. These grayish, rubbery noodles are used in stir-fries.

Southeast Asia

Vietnamese noodles come in various sizes and are prepared in different ways. *Bun* or rice vermicelli comes in small and thin sizes, and in much wider widths. Small or thin noodles are used in salads, *bun bo*, while the much wider noodles are found in soups. *Banh pho* is a flat rice noodle that looks like linguine and comes in widths of small, medium, and large, and is used in soups and stir-fries. Vietnam's most popular soup is *pho bac*, or rice noodles in beef soup served with slices of beef and fresh herbs. *Mi soi*, thin egg noodles, is of Chinese origin. *Bun tau* or mung bean noodles, cellophane noodles, bean threads, or glass noodles are made from mung bean starch. After these thin, wiry white sticks are softened in hot water, they are used in soups, stir-fries, and fillings.

In Thailand, noodles also come in every size and shape, from flat white rice noodles or *gway tio*, to brittle white rice stick noodles or *sen mee*, to glass-like bean thread noodles or *woon sen*. *Gway tio* can be served in stir-fries or soups. *Sen mee* is served fried, stir-fried, or in soups. *Woon sen* is used in soups and stuffings for its slippery texture. Popular dishes in Thailand are the *pad thai* noodle, which uses thicker-width rice noodles, and *mee krob*, which uses a thin rice vermicelli that is fried.

In other parts of Southeast Asia, variations of the noodles found in China, Vietnam, and Thailand are eaten. In Malaysia, rice vermicelli noodles are combined with a tamarind mackerel sauce for *laksa asam*. In the Phillipines, rice vermicelli is stir-fried with meats and vegetables to make *pancit*. In Singapore, *char kway teow* or flat white rice noodles are stir-fried with seafood, while egg noodles or *Hokkien*, yellow noodles, and rice vermicelli are stir-fried in the same dish with meat, seafood, and vegetables for *Hokkien mee*. Though there may be similarities in preparation of the noodle dishes, the flavors are distinctive of each region because of the indigenous ingredients used.

Ceremony and Symbolism

Noodles not only play an important role in Asian daily eating, but contribute to rituals in honoring the dead, celebrating birthdays of the living, and marking other special occasions. They are brought to the grave of a deceased family member or friend on the twenty-fourth day after the first of each lunar month. It was Emperor Chu Yuan-Chang of the Ming Dynasty (1368–1644) who built a *t'ai miao* or shrine to the imperial ancestors where he placed spiritual tablets of his paternal relatives for four generations. Offerings of foods, including noodles with sesame oil, were brought to the shrine on the appropriate day.

After the birth of a child, especially a son, the mother's family sends over gifts for the new mother of wheat flour or wheat flour noodles, chickens, and a basket of eggs. For the birthday celebrant, a plate of long thin noodles expresses a wish of long life. Long-life and happiness wishes with noodles continue with the New Year feast.

In Japan, *soba* is usually the final item eaten on New Year's Eve. This dish is called *toshi-koshi* which means 'year-passing' and symbolizes the old year passing. It is customary for a person who moves into a new neighborhood to make gifts of *soba* to households next to and in front of one's new house. The word for *soba* is a homonym of the word *soba* meaning 'near' or 'next to'.

Summary

One cannot think of Asia without thinking of noodles. Noodles, the symbol for longevity, play important roles in everyday eating as well as for special occasions and celebrations. Consumed at home or on the streets, noodles originated in China but are a permanent presence in all of Asia.

See also **China; Japan; Korea; Rice; Southeast Asia; Wheat.**

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Stella Fong

Three examples of a *Nudelholz,* an old tool for cutting pasta into thin strips by means of a ridged rolling pin. Made in southwest Germany, circa 1850 to 1870. This very ancient tool dating to Roman times was used in traditional culture to cut pasta or pastry into strands resembling modern linguini. Roughwood Collection. Photo Chew & Company.

NOODLE IN NORTHERN EUROPE, THE.

The word "noodle" is German in origin. By the mid-1400s, it appeared as *Nudel* in connection with *composita,* layered dishes employing cabbage, dried fruits, some form of meat (usually ham), and dumplings. There is no firm agreement among German food historians about the origin of the term *Nudel* even though it can be found in German- and Yiddish-speaking communities in Middle Europe by the 1500s. For example, in the 1581 cookbook of Hungarian-born Marcus Rumpolt, there is a recipe for *Nudeln aus der Grafschaft Tyrol* (Noodles from the county of Tyrol), evidence of the fact that, by the 1580s, there were already many regional variations in methods of preparation and serving contexts. Furthermore, the plural form of the word passed into French as *nouilles,* probably via Alsace. The original meaning, however, was *Teigwerk*, anything made of dough regardless of shape. Even to this day, the *Nudel* falls under the broad category of *Teigwerk* in most German-language cookbooks. The distinguishing difference between *Teigwerk* for pie crusts and doughs for noodles is that the latter are boiled or in some manner cooked with steam or water.

The most commonly accepted explanation for the origin of *Nudel* is that it derives from *Knödel,* or, as the word appeared in a number of old German dialects, *Nutel,* a dumpling (literally, a ball or turd). Recipes mentioning noodles appear in German as early as 1480, but at that time, the term applied to any sort of doughy addition to a boiled or baked dish, whether a shaped dumpling or thinly sliced noodles. The dough could be rolled, pressed, shredded, cut, chopped, stretched, or shaped into small "buttons"—all of this was included in the word *Nudel.* The oldest German lexicons define *Nudel* as a dough dish composed of wheat flour, butter, and milk. This paste is then boiled in water. There is no mention of eggs—eggs do not appear in noodle recipes until the 1600s. However, because the dough was made with white wheat flour (a luxury), the *Nudel* was at one time a food denoting high economic status.

Conceptually, the *Nudel* of Northern Europe differs from Italian pasta in that the enriched dough is not dried for later use, but rather cooked the same day it is made. The high fat content would probably preclude long storage because noodles are generally made with egg yolks, butter, and other unstable ingredients. Because of these rich ingredients, the German *Nudel* was not viewed as appropriate fasting food by strict Roman Catholics, although noodles of all sorts were indeed treated as meat substitutes. The cost of the ingredients alone set noodle dishes apart as special occasion or festive fare even in the late eighteenth century.

Earlier medieval sources are consistently clear in categorizing this type of food as something found in the invalid cookery of hospices operated by nunneries or monasteries. As a branch of invalid cookery, noodles were generally served with hot milk or cream depending on the patient's condition. Otherwise, noodles were a special-occasion food eaten only by the well-to-do as part of a larger menu, such as a side dish with a roast of meat. The concept of the noodle as health food survived in the once popular recipe for *Nürnberger Nudlen,* one of the most commonly cited sickroom recipes in old German medical literature.

By the seventeenth century, the noodle had evolved into three broad types in German cookery: flat noodles rolled thin and cut into various shapes (most often thin strips), shaped noodles or dumplings, and yeast-raised noodles as in the case of South German *Dampfnudeln*. This last dish is prepared by steam-baking balls of yeast-leavened dough in a heavy iron skillet.

There are also a large number of specialized terms associated with noodle making. Among these are *Nudelteig* (the dough from which any sort of noodle is made), *Nudelholz* (a special rolling pin for cutting the dough into strips), and *Nudelspritze* (a press for squeezing noodle dough into strips or strands, especially for *Nürnberger Nudeln*). Cristoforo Messisbugo illustrated a *Nudelholz* under the rubric *ferro da maccaroni* in his 1549 work on Italian Renaissance cookery. This tool was widespread in Europe, and its origin cannot be pinpointed.

The general presumption among German food scholars is that noodles (under a wide variety of names) were present in northern Europe during the early Middle Ages. Various methods of preparation, such as serving them with fried bread crumbs, may also be quite old. There is no evidence suggesting that the idea came from medieval Italy. In fact, the German noodle can be traced to the pre-Christian era, since pastry wheels and rolling pins for making noodles have been found in numerous Roman archeological sites north of the Alps. Yet the question remains whether these tools were used for making dried pasta as known to the Italians, or the richer noodle known later to German-speaking countries. It is quite possible that the Romans knew both types.

The *Nudel* appears to have entered English during the Georgian period, perhaps owing to the fact that the Hanoverian monarchs were German. The word was transliterated into English as *newdel* and noodle. The latter spelling is now the accepted form. In eighteenth-century England and America, the noodle was associated primarily with one dish: noodle soup. This is a preparation in which strands of freshly made noodles are boiled in meat stock, sometimes with the addition of small meat dumplings. This became a ubiquitous working-class dish by the nineteenth century.

The center of noodle cookery in America was the region settled by the Pennsylvania Dutch and the thickly settled German districts of the upper Midwest. In the German-American community, noodle dishes were generally reserved for Sunday dinners due to the amount of work required to make the dough. Additionally, the egg whites left over from noodle making were normally turned into sponge cakes—another special occasion dish. The Pennsylvania Dutch developed a number of interesting noodle recipes, including saffron noodles for boiled Sunday chicken, and a noodle dessert made with walnuts, sugar, and cinnamon.

By the mid-nineteenth century, noodle cookery became associated with regional peasant fare in Germany. German Romanticism elevated the noodle to an icon of German ethnicity, with the result that we see it everywhere today as a symbol of German cooking.

See also **Compote**; **Noodle in Asia**; **Pasta**; **United States: Pennsylvania Dutch Food**.

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William Woys Weaver

NORDIC COUNTRIES. The Nordic countries—members of the Nordic Council—are Finland, Iceland, and the Scandinavian countries (in a strict sense Norway and Sweden—the Scandinavian Peninsula—but generally this group includes Denmark as well). Finland is in many ways different from the other Nordic countries because its language is of the Finno-Ugric group (related to Estonian and Hungarian). The languages in the other countries belong to the Germanic group, and Swedes, Danes, and Norwegians understand each other when they talk together. The Icelandic language has closer ties with Old Norse. In the circumpolar areas there is an ethnic group of about around 50,000 people called Samis (often called Lapps, a designation they consider derogatory) who use a Uralic language, in addition to the language of their state (Norwegian, Swedish, and Finnish).

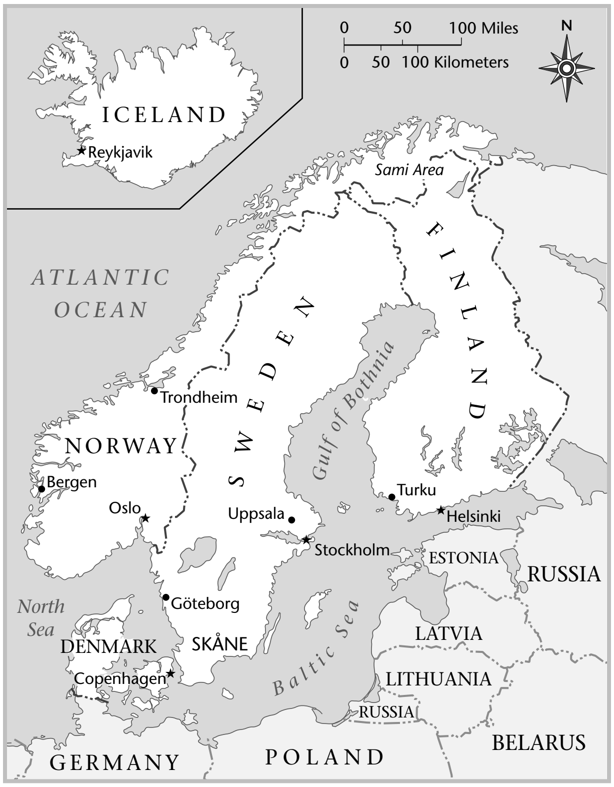
Many parts of Norway and Sweden consist of mountains, valleys, and enormous forests, while Denmark's highest point is less than two hundred meters above sea level. Denmark is smaller than Norway and Sweden, but comparatively it has much more cultivated land. Iceland, with its glaciers, hot springs, volcanoes, and large areas of barren land, is only populated along the coast, and fishing has always been important there. Finland, "the land of a thousand lakes," is a country of forests crisscrossed by rivers and lakes.

Sweden and Denmark are old independent kingdoms that historically have had strong aristocratic cultures. Both Norway (independent since 1905) and Iceland (independent since 1945) were ruled by Denmark for centuries, and the culture imposed by Danish or Danish-educated civil servants is still a part of the heritage in those countries. Finland, first under Swedish and then under Russian rule, gained its independence in 1919 and is also marked by the traditions of its former rulers.

The Nordic countries were mainly agricultural societies (although fishing was also important) until the last part of the nineteenth century, when industrialization marked a shift from rural to urban dominance.

The Lutheran religion was introduced in the middle of the sixteenth century, and this is still the religion of the majority of Nordic people, even though church attendance is relatively low and secular ideas dominate most fields. A Greek orthodox minority lives in Finland.

It is possible to draw a line between a northern area, which comprises Iceland, Norway, and the north of Sweden, and a southern area, including Denmark and the south of Sweden, which has ties to northern Germany and the Baltic. The west (in particular, the southwest) of Finland has strong ties to Sweden, while in parts of eastern Finland there are many similarities with Russian traditions.



Nordic Diet and Food Distribution—Sell the Best, Use the Rest

In general, diet in a region depends on what kind of food a region produces. For example, in the Nordic countries people along the coast eat more fish, people in the mountains eat more milk and cheese from sheep and goats, and people in the lowland plains eat more meat and bread. Yet a little more than one hundred years ago, many agricultural products were not only seen as food but also as money. Social conditions were such that much of what the farmers and peasants cultivated and caught was used in a barter economy to obtain other necessary goods (such as salt, spices, and special tools).

The Nordic elite had strong ties to their counterparts abroad. The aristocracy in Sweden and Denmark, the civil and ecclesiastic administrators in Norway, and merchants in the many ports along the Atlantic and Baltic coasts followed European habits and fashions and wanted fresh and exclusive food. Many of these people were rich landowners with lots of livestock; thus they could afford to have fresh meat at all times. They slaughtered animals regularly and had cooks to prepare different dishes at their request. The wealthy also had poultry, geese, turkeys, and sometimes fish ponds on their estates. They also had regular delivery of game, fish, and wild berries from the forests. Poor people picked lingonberries (*Vaccinium vitis-idaea*), bilberries (*Vaccinium myrtillus*), and in the north the yellow cloudberries (*Rubus chamaemorus*), which they sold to the upper classes, who used them for fruit drinks or for jams and jellies to go with roasts. Game was a privilege of the aristocracy in Denmark, as it was in most of Europe, but in the big forests of northern Scandinavia, hunting was free for everyone. Among the European nobility, the prestige of using wild animals as food was very high; this was also true in the upper classes in the Nordic countries, and very often the wealthy in these countries would buy game sold by poorer countrymen. When the smaller farmers and peasants slaughtered their domestic animals, they put aside the best cuts of meat and sold them to the manors, to the butchers in the towns, or to the ironworks where there were many foreign engineers and specialists who preferred this kind of food. In this way farmers received a certain amount of necessary cash. If a farmer had a goose or two, he would sell them, and if he had hens, he would sell the eggs. One of the most important dairy products, butter, was a means of payment as well as food.

The Food of the Elite—More European than Nordic

Even if the Nordic countries were sometimes considered the Ultima Thule (the northernmost part of the world fit for human habitation) by people farther south, they were never isolated from the European continent. The well-known Viking raids during the Middle Ages were quickly followed by diversified commerce. Luxury products began to be imported, and there are even two Danish cookbooks from about 1300, among the earliest manuscripts of this kind in Europe, that exhibit clear

A Swedish breakfast buffet at Grinda, Sweden, featuring a variety of flat breads, pickled fish, cold cuts, and cheeses. © BO ZAUNDERS/CORBIS.

influences from Mediterranean cuisine. German and French cookbooks were translated into Nordic languages in the seventeenth century: a Swedish edition of the famous *Le cuisinier françois* was published in 1664. This means that many of the dishes consumed in the Nordic countries were not too different from what was being eaten elsewhere in Europe. However, certain national specialities were still popular. In the eighteenth century, Swedes served the hors d'oeuvres at a so-called brandy table, which was often placed in a separate room from the dining room. Many foreign travelers in Sweden reported a habit of eating bread, butter, and salt fish before the meal and swallowing it down with glasses of brandy. The similarities with the Russian *zakuski* tradition seemed evident, but no one has resolved the issue of which tradition influenced the other.

Some of the game was unique to the Nordic region, particularly reindeer, but also elk, capercaillie, hazel hen, and black grouse. The upper classes valued fresh fish very highly, but they also consumed lots of dried, salted, and smoked fish. Salmon was considered a great delicacy, as were oysters, mussels, lobsters, and eels.

Fresh fruit and vegetables were granted much prestige in upper-class circles, and many different species of produce were imported or grown on experimental farms in the eighteenth century. Menus from that time indicate that asparagus, artichokes, and pineapples were popular items. In general, people stuck with cabbage, onion, carrots, and other roots, but they generally considered vegetables an "animal food" and not proper nourishment for manual workers. A study from the 1890s by Amund Helland that compared food habits in Norway with those in Paris showed that the Norwegians ate 10 kilograms of vegetables per head per year, while Parisians ate 118 kilograms.

The Food of the Lower Classes—"Humble Pie"

Since the best cuts were generally sold, offal and the less desirable parts of the animal were the most-used cuts of meat, especially among poor farmers. People always used the offal efficiently, for example, it was often minced and put into sausages or similar casings. Blood was used to make puddings, sausages, and other dishes. When making sausages, people also put grain or flour, salt and pepper, and sometimes onion in the casings. These blood dishes were in use in all the Nordic countries, but not in the eastern part of Finland, where many people belonged to the Orthodox Church.

Newborn calves were a special case. Calves were born at different times throughout the year, and the elite fattened them for some weeks and used them as roasts. However, there are accounts of a more popular and simple preparation dating from seventeenth- and eighteenth-century Norway. Ordinary people would not have the means to feed a calf in winter, so the whole newborn animal was boiled, the bones and hairs sifted away, and the remaining substance, a sort of jelly, eaten at once or kept for later use. The fat meat from the head of pigs and sheep was used in dishes such as *sylte*, which was more in keeping with the German tradition (*Sülze*) than in the French (*fromage de tête*) or English (brawn). *Sylte* was spiced with pepper and clove.

Different kinds of fat were also important ingredients in very simple, popular dishes. Some of them were dumplings, where the fat from the slaughtered animals and poultry was mixed with flour. They had many local names (*klubb*, *kams*, *klot*, *palt*, *kumle*, *kumpe*, *ball*) and corresponded roughly to the Central European *Knödeln* and *Klösse*. The flour was mixed with leaf fat from domestic animals, as well as with fat from seabirds, seal blubber, and roe and liver from fish. The fishermen in the north mixed cod liver and roe with flour, spices, and raisins and put this mixture into the cod's head or sound (air bladder) and boiled it in water. In some cases parts of the fish itself, fresh or salted, were added to this mixture, and potatoes were partly substituted for the flour. Before the use of forks and plates, slices of the ball were cut with a knife and placed between two bits of crisp flat bread, similar to the way one eats hamburgers today. A special type of ball was made from the blood of domestic animals, but more often this mixture of flour, blood, and some spices was made into sausages or baked into a soft flat bread.

Another way of combining fat and cereals was the *mölje* (jumble): crisp flat bread was broken into small pieces and put into a bowl with the liquid from boiling meat liver. Fishermen ate a *mölje* with crisp flat bread and cod liver. All these examples show an efficient use of all the parts of animal or fish products that were not sold or saved for important occasions.

In Finland there were and are examples of a special combination of flour with fish or meat, pies, and pasties. In the east they are called *piiras* or *piirakka* (Russian *pirog*) and *kukko*, which is a big pie with dough all around. *Pirog* is normally smaller than *kukko*, and if it is big, the filling is exposed with no crust on top. The filling in *kukko* may be meat, potatoes, cabbage, and turnips, but it was originally fish. In the west, along the coast, a similar pie had the name "herring cake."

Meat and Status

As in most societies, meat held more prestige than other food in Nordic countries, but there were also differences in the evaluation of different kinds of meat. The importance of pork in older times could be seen in the Swedish and Danish terms used for it, *fläsk/flaesk*, which are similar to the German *Fleisch*, which is a generic word for "meat." Today beef is more expensive than pork, but in the Middle Ages pork was much more expensive than beef and mutton if one calculated its average price by weight.

As a general rule, it is possible to say that swine dominated the meats of the south for a very long time, while cattle were more important in the north for several reasons, not least of which was that they provided hides and milk products. The tough meat from old and worn out cows and oxen was not used in steaks and roasts; rather, it was boiled in a pot with cabbage, groats, roots, and available herbs and spices. This meat was normally salted and put into water before it was boiled, so the salt could be extracted and the meat would soften. Mutton was also boiled this way. One common word for these dishes was *kål* (cabbage), which was used whether they contained cabbage or not. The Old Norse word, however, was *sodd*, which simply means "boiled." The use of this word is probably a sign of how old this dish is.

Mutton had played a very important role in Nordic countries, but the number of sheep—and goats, the even less prestigious domestic animals—has gradually diminished in Nordic countries during the last few centuries. Mutton was often eaten uncooked, since it had been dried, salted, and occasionally smoked. In general the meat was very seldom eaten fresh, except among the elite—a fact often commented upon by foreign visitors. This was, especially in the northern regions, a result of the climatic conditions. The summer season during which animals could graze was very short. During a winter with deep snow, feeding animals required a lot of fodder. Animals that were raised only for meat production were slaughtered after the summer, when they were at their fattest. In order to preserve the meat, the farmers had to dry, salt, or smoke it. Pork was often kept in brine.

This preserved meat could be kept for years: it was considered a symbol of wealth to have stocks of meat at the *stabbur*, a special storehouse built on pillars. From Denmark we know of the tradition of *gammelmadsfad* (plate of old food) or *saltmadsfad* (plate of salt food), which involved a big platter with all sorts of smoked and salted meat that could stand on the table for weeks. In Norway reports from wedding feasts in the eighteenth century tell about plates with old food that were put on the table but not eaten—they were only used as a decoration year after year.

Fish Consumption and Preservation

In the United States, especially in the Midwest, the Scandinavian population identifies with a peculiar dish: *lutefisk*. This dish has a jelly-like consistency and often a yellowish color. The dish is generally unpopular among people who have never tried it. The same holds true in Sweden, where *lutefisk* is considered a national dish.

The best raw material for *lutefisk* is the dried cod from the northern coast of Norway, where the air is rather cool. The *tørrfisk*, or stokfish, holds almost no humidity, lasts for years, and has been exported to Europe since before the year 1000. The fish had to be beaten or softened in water before they were cooked. In the late Middle Ages a special method emerged for the preparation of this dish: a potash lye or soda was put in the water to help soften the fish, and the result was *lutefisk* (lye fish). The oldest sources for this method are found in Sweden and Germany, but there are also recipes in early Spanish and French cookbooks, so the dish may have existed elsewhere.

Drying is probably the oldest method for fish preservation in Scandinavia, where all sorts of fish were cleaned and hung up to air dry. Even herring was dried, but it did not last as long as other fish because of its high fat content. In the north of Sweden and Finland, pike and other freshwater fish were dried. Salmon that could be dried, salted, and/or smoked held the most prestige.

Cod and other white fish were also salted in brine. This was the most common way to preserve herring, and salted herring has been an important part of Scandinavian diet for centuries. It was either eaten cold or grilled, normally with bread or porridge, and later with potatoes.

High-quality salt was expensive, but necessary for a good product. Among ordinary people who had little money for salt, a special method of preservation developed for herring and some freshwater fish. The Swedish term *gravlaks* (buried salmon) dates back to the Middle

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Fresh salmon on display in the fish market at Bergen, Norway. © WOLFGANG KAEHLER/CORBIS.

Ages, when the fish, sometimes lightly salted, was buried in the ground or in a barrel. It could be kept for months because of the slow fermentation that occurred. The result was soft flesh, but also a sour taste and a strong, unpleasant smell. In Sweden this method is still used to make the sour *strömming*, a herring from the north of the Baltic Sea (the Gulf of Bothnia). People in Norway also used herring, but today they mainly use trout from inland rivers and lakes. Icelanders use the flesh of the *hákarl*, a species of shark. The same fermentation technique exists in other circumpolar areas, and it is related to the old Roman *garum/liquamen* process.

In the modern version of *gravlaks*, the salmon has only gone through the early stage of the chemical process, where enzymes soften the flesh. Filets of salmon, with salt, sugar, pepper, and fresh dill spread between them, are placed under heavy weights for a couple of days in a cool place. This method of fermentation probably developed within the upper classes at a later time than the original method.

Milk—A Way of Life

Milk was extremely important in the northern part of Scandinavia, Iceland, and parts of Finland. In this area's tough climatic conditions, sheep and cattle were raised partly for hides, partly for food, but first and foremost for milk. In Iceland *skýr*, a curdled milk from sheep or cows, is considered a national dish.

One of the most important dairy products, butter, was so important in the northern countryside that it was used for hundreds of years as a symbol of wealth, particularly at weddings, where pyramids of sculptured butter were raised at each end of the table. The butter was formed in special wooden cases with patterns of flowers or animals. Folk museums display these butter sculptures as examples of popular art.

For the past several centuries, the elite of the Nordic countries have imported cheeses from Holland and Switzerland. These cheeses are made in the general European fashion by adding rennet to the milk. This was a different tradition from the one in the northern regions, where the milk was coagulated in a process caused by lactic acid. Some of these cheeses were sweet, a little like puddings or desserts, and others were made from sour milk, usually from a cow, but also from sheep and goats. One of the most famous and prestigious cheeses was the *gammalost* (old cheese), which was dark brown and rather hard with a grainy texture.

Milk was almost never drunk sweet; rather, it was made into different sour-milk varieties. A very special type was the "long milk" or "thick milk" that would stay fresh during the summer. It was also called *tettemjølk* in Norway and *tätmjölk* in Sweden after an herb (*Pinguicula vulgaris*) that was put into the milk that was said to cause the souring process. Today many people dispute the role of the herb: the process also starts when a little old milk, containing certain bacteria, is put in the kettle with the new milk.

In the northern areas, milk had to be substituted for beer as a common drink because of the low production of grains. The daily drink of ordinary people was *blanda*, which was sour whey blended with water. The inventive use of whey, the substance remaining after cheeses are made, is specific to the northern regions. It might be boiled into a sort of soup and eaten together with bread (sour milk was also used this way). Whey might also be boiled for hours until it became a thick substance. This was then put into wooden cases to cool and, when finished, looked like brown bricks. This "cheese" was either made from the whey of sweet or sour milk (the sour being the cheapest) and was spread on flat bread instead of butter by the poor and servants.

Bread—Flat, Soft, Hard, Sweet, Dark, White

The cold climate and the meager soil in the north made it difficult to grow grains other than oats and barley; since these do not contain gluten, they could not be used for leavened bread. The result was different sorts of flat, thin bread, specialties of the northern regions. These stood in contrast to the leavened rye bread in the southern part of Scandinavia, Denmark, and the Swedish region Skåne (which was part of Denmark until the seventeenth century). In Finland a dividing line can be drawn between the west and north, where different sorts of hard breads were baked, and the east, where soft rye bread was common.

The Danes, like the German and Dutch, had *smørrebrød* (butter bread), a dark rye bread served with butter and cheese, cold meat, sausage, liver paste, or other delicacies (internationally known as "open sandwiches"). While the flat bread in the north was baked on griddles (iron plates), bakery ovens were more widespread in the south, and the Danes often bought their bread from the baker. The Danish bakers, organized in guilds with strict rules, were obliged to have certain products ready at all times: white bread, coarse rye bread, and *skonrogger* (from sifted rye), in other words, alternatives for all classes of society. The status of bread had to do with the kind of flour used: for example, during festivals, the elite would eat only white bread made from wheat flour. This bread was best when fresh, but most people would let their bread dry out, which made it more economical since it would last longer.

The Swedes are especially known for their sweet and spiced breads. One French diplomat remarked as early as 1634: "The bread had a terrible taste, made as it was with wort and sweet fennel." This was the dark *vörtbröd*, made with beer wort, molasses, spices, citrus peel, and raisins. These sweet breads were earlier a luxury or used only for festive situations. The expression "sweet bread days" meant (and still means) good times.

Porridge—For Hunger and Luxury

Porridge is an old dish, perhaps more ancient than bread, and it has been used in many cultures. Flour mixed with water ("water porridge") was the simplest variety and was long thought to be a synonym for poverty. Scandinavians also mixed the grains with milk, cream, or whey. As was already mentioned, whey soup was eaten with bread. Milk made the porridge more attractive, and during annual festivals and rites of passage it turned into a luxury dish, *rømmegrøt* (sour cream porridge), with the addition of cream or butter. In modern times, porridge is more like a pudding made from rice and milk and is often sprinkled with sugar and cinnamon, but the *butterye* (a lump of butter in the middle) is still a relic from the past.

In early modern times and up until the nineteenth century, rice was a luxury that very few could enjoy. It was more common in Denmark, where they also ate porridge from *maiz* (corn), buckwheat, and pearl sago. Oats were not popular in Denmark unless they were made into groats, which were easier to digest. Danish porridges were often boiled with sweet milk, but in Skåne (southern Sweden) there is also a tradition of serving beer on porridge. In Denmark they have *øllebrød* (beer bread), which is rye bread that is diced and boiled in beer with sugar and lemon peel. In characteristically Norwegian style, when *øllebrød* was introduced there it was made with a mixture of beer and milk.

Nordic Drinks

Blanda, sour whey or milk mixed with water, was previously mentioned as a daily drink in northern regions. But beer production occurred everywhere: a very light and simple beer for daily use, and stronger brands for festivals and special occasions. Since the Middle Ages, more exclusive beers were imported from Germany, and the more affluent of society imported mead (made from honey). Grapes have never been grown in the Nordic countries, but wine has been imported since the time of the Vikings, especially after clergy with southern European roots established churches and monasteries in the region.

Ever since the eighteenth century, *akevitt*—brandy made from grain—has become more and more common. It is considered good for health and physical strength. Farm hands received a shot of *akevitt* when they started work at around 5:00 A.M. and when they began to tire in the afternoon. *Akevitt* was also used with sugar and spices in drinks, but imported brandy was preferred for this use. The introduction of potatoes in Nordic countries offered new and cheaper possibilities for *akevitt*, and the production and consumption led to widespread alcoholism in the countryside in the early nineteenth century. However, things began to change when popular temperance and abstinence movements emerged in the second half of the nineteenth century. The government introduced restrictions on distillation of alcohol, and coffee gradually replaced beer and brandy as the daily restorative drink.

The Sami Diet

A portion of the Sami people lived as nomads with their flocks of domesticated reindeer, but some also lived on the coast (the sea Samis) and were more residential in nature. Their diet placed an emphasis on meat and milk. The Samis ate meat from many wild animals: bear, otter, hare, marten, and wolverine, but never fox and wolf. Contrary to the rest of the Nordic population, they had no prejudice against horseflesh, which they ate dried. Their main source of food was reindeer, and they used every bit of it: the head, heart, and tongue were delicacies of great value. They never roasted fresh meat, but always boiled it. They preserved much meat for future use by drying—they never used brine. Dried meat was easier to transport. Also, blood was freeze-dried and then ground into a powder. Fat was appreciated, especially the rich rectum fat that was dried and used as cream in coffee, when this drink was introduced.

Among the Samis there were strict rules as to who could eat what. The heart and the genitals of the buck were reserved for men. Men also had the responsibility of preparing meals, particularly if the meal involved meat from reindeer and bear.

Fish was important for the Samis along the coast, but people also fished in the rivers of the great plains. The fish was boiled or dried for later use, and the roe was considered a special delicacy.

In general, bread has no tradition among the Samis, the exception being the sea Samis. For the nomads, carrying bread or flour and purchasing flour was no easy task. When bread finally was introduced, it was almost always unleavened.

Butter, cheese, and boiled dishes were made from milk. Herbs and berries were used instead of spices. The usual drink before coffee was water, sometimes mixed with male (sap from birch trees). The main meal was in the evening, and it always consisted of meat or fish. For lunch a lighter meal was common, such as soup or reindeer meat or, in summer, a cheese gruel.

A New Diet in an Urban Society

During the late nineteenth and the early twentieth centuries, the Nordic countries went through a process of urbanization, industrialization, democratization, and the emergence of stronger commercial links to the world outside. Many of the old traditions in meat preparation were changing. For example, the introduction of meat grinders made it possible for most social groups to mince meat. In earlier times, this was a privilege of rich houses, because it demanded servants who worked for hours with knives. Now everybody could make the meatballs that were and still are extremely popular national, everyday dishes in several of the Nordic countries, where they are referred to as "mother's meat balls."

A special dish that is less common today because it demands so much work to prepare is stuffed cabbage—minced meat in cabbage leaves (instead of the Mediterranean version with grape leaves). An unsubstantiated legend claims that the Swedish recipe, called *dolma* (a Turkish word), was brought to Sweden by King Charles XII, who spent several years in Turkey after his defeat at Poltava.

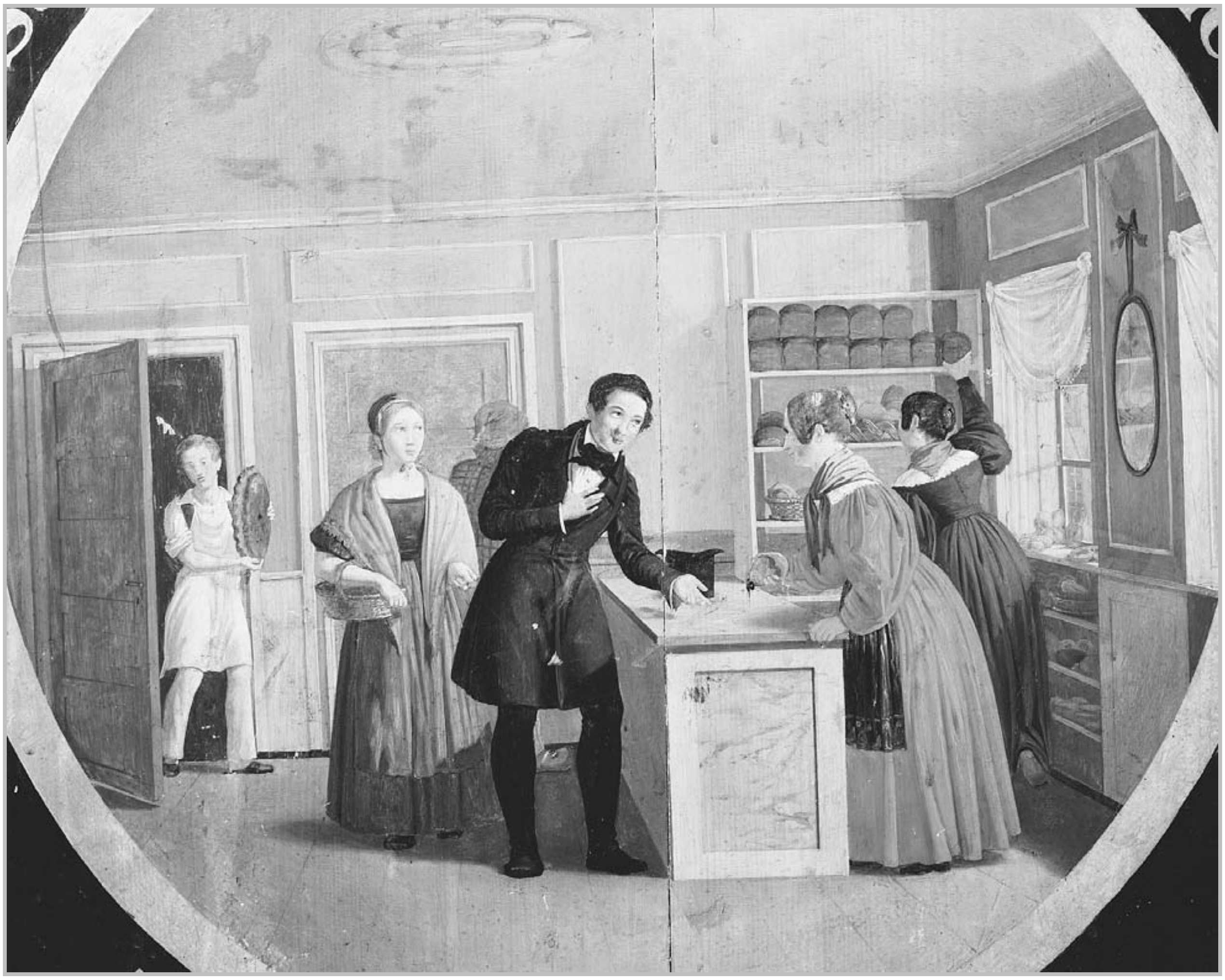
In general, with the advent of urbanization, the tendency went in the direction of more fresh food than before. In addition to the balls made of minced meat, cutlets of pork, sausages, chicken or veal fricassees, roasts, and steaks also became very popular. In Denmark the "old food platters" were replaced by "roast platters." The introduction of the kitchen stove was instrumental in this change.

In Norway, where there was no local tradition of leavened bread, the spread of bakeries and bakery ovens in the late nineteenth century led to the emergence of a great variety of breads. Apart from the wheat and rye bread known in Denmark, healthy new alternatives were offered, such as *kneippbrød* (after the German doctor Sebastian Kneipp), *grahambrød* (after the American dietician Sylvester Graham), and later whole-meal breads of different recipes.

As in so many countries, butter faced competition from the new artificial substitute, margarine. Many farmers replaced butter with margarine and received extra money to buy salt, spices, coffee, sugar, and other foreign products. This happened at about the same time that the entire system of dairy production went through a fundamental change. Instead of making different dairy products on the farm, farmers started to sell their milk to the new factories where butter and cheese were produced with modern techniques. This practice also followed a shift in cheese preferences. During the nineteenth century, Swiss and Dutch cheeses grew more popular, and the Nordic countries imported both cheese and dairy specialists from Gouda, Edam, Leiden, and Switzerland. The specialists trained local dairymen to make cheese a new way, and one of these cheeses, the Norwegian Jarlsberg, has been a success in the world market.

During the nineteenth century, coffee became the daily drink everywhere. It spread from the big cities to the countryside and from the elite down through all the other levels of society.

Potatoes represented the most extraordinary shift in food consumption, with a complete breakthrough occurring during the Napoleonic Wars. After that time, preparing the main hot meal was barely possible without boiled potatoes, the basis of Scandinavian cuisine. The nineteenth century was also a great time for herring catches, and the low price of these two products led to the expression "salted herring and potatoes," meaning a poor man's food or *husmannskost*. Also roast fresh herring was a very common dish among ordinary people. However, herring was also present in the *smörgåsbord*, which has been popular in Swedish restaurants and hotels since the late nineteenth century. Around a big brandy pot with taps for different brandies and *akevitts* were several sorts of cured herring, sardines, marinated sprats, smoked eel, grilled eel, eel in jelly, pig trotters, brawn, sausages, and later also *gravlaks* and smoked salmon. Today the *smörgåsbord* is not only an introduction to a meal, but it can be a full buffet lunch or din-



Danish painting on wood panels from 1836 showing the interior of a local bakery. Courtesy of the Københavns Bymuseum, Copenhagen. © ARCHIVO ICONOGRAFICO, S. A./CORBIS.

ner, complete with hot dishes (such as meatballs and steaks with onion). Dessert consists of different kinds of fruits, sweets, and cakes.

Food and Feast

Special occasions in life and rites of passage have always involved special dishes. The main objective has been to serve something special that sets that day apart from the rest. In rural societies, where resources were not always abundant and cash flow was low, a system of gifts emerged. Guests brought food to weddings and funerals, often butter and rich cheeses, which were all put on the table and then brought back if they were not finished. In the twentieth century, this custom changed with the advent of a more urban society and smaller families. New habits spread gradually from the aristocracy to the middle classes and then to the whole population. The *pièce de résistance* at special occasions, in most cases, was a roast.

Different regional traditions have developed around religious holidays. Among the many old traditions tied to the long Lenten period before Easter, only the sweet rolls with whipped cream still exist. A special Easter dish in Finland originated as a Lenten dish among Catholics in the southwest, but it has since spread to the whole country. *Mämmi*, a dark brown porridge-like substance made from malted rye and baked in the oven in boxes of birchbark (today cardboard), is served with thick cream and sugar.

Feasts for saints were much more important in earlier times, but the roast goose of St. Martinmas in November has survived in Denmark and in southern Sweden, where it is accompanied by *svartsoppa* (black soup) made from goose blood and giblets. On the thirteenth of December the Swedes celebrate Sancta Lucia with elements from an ancient regional feast. Young girls in white robes and candles on their heads march through the streets singing an Italian song and handing out *lussekatter* (Lucia cats), which are small saffron cakes. A special feast without any connection to religious traditions is held every August when crayfish are in season. Crayfish parties are merry events that involve paper hats, special plates, and lots of singing and drinking. The crayfish are boiled in dill and served cold. Swedes eat more crayfish than most people in the world. Most of the crayfish are wild, but there is an increasing farming industry in addition to the importation of about 3,000 tons of crayfish every year.

The Icelandic Thórablót in January is named after the Norse god Thor (Thunder). *Blót* was a religious ceremony that involved offerings to the gods and reputedly much eating and drinking. The food is *hákarl* (sour buck's balls), boiled sheepheads, and *hangikjöt* (smoked meat of lamb).

Christmas Celebrations

The one occasion in which the Nordic population as a whole still maintains traditions is Christmas. At this time people eat large quantities of meat. Many baked items are prepared exclusively for Christmas and are called Christmas cakes, of which there are seven required types.

The traditional Christmas meal is generally served on Christmas Eve, but the food is very different from country to country. In Denmark the traditional main dish was goose, as in Hans Christian Andersen's story "The Little Match Girl." In recent times, duck has been substituted for goose, but the stuffing is the same: apples and prunes. Dessert is a sweet rice pudding made from rice boiled in milk, with almonds and whipped cream added. Christmas Day in Denmark involves different traditions, but very often roast pork is served.

In Norway there are regional differences: roast rib of pork with sauerkraut is served on Christmas in the east, boiled cod is served in the south, and *lutefisk* is served in the north. The specialty of the west is *pinnekjøtt* (stick meat), a dried, salted, and sometimes smoked rib of lamb, which is put in water during the night so some of the salt is extracted and placed above steam for several hours. Tradition says that during the steaming process the long ribs should rest on sticks of birchwood. It is served with mashed turnips. Boiled potatoes accompany all the aforementioned dishes.

In Sweden *julskinka* (Christmas ham) is obligatory, but it is only one of the dishes served at an expanded *smörgåsbord*. Swedes eat *lutefisk* and rice porridge during the Christmas period. Another traditional element of this feast is the *vörtbröd*, which is dipped in the broth where the Christmas ham has been boiled, and a special hard Christmas bread that is a little softer than the crisp rye *knäkkebröd*.

Julskinka is also a main dish in Finland on Christmas Eve, but there it is often smoked in the sauna. In addition, the table holds sausages and the traditional oven-baked dishes in earthenware, called "boxes." These boxes contain liver, potatoes, turnips, and so forth. This kind of meal is also typical for weddings and other big events, although the *julskinka* is then often replaced by a roast of elk or other game. Dessert is a thick soup of dried fruits, also a very popular dish in Finland. Before this rich meal the Finns eat a hot lunch with *lutefisk* and rice porridge. In the southeastern part of the country, the *pirogs* will be on the table for Christmas.

On Christmas Day in Iceland the traditional dish *hangikjöt* is served and eaten cold. On Christmas Eve in Iceland people have no set tradition, but loin of pork and grouse are fairly common dishes.

Toward an International Cuisine?

Since the start of the twenty-first century, many old Nordic traditions have begun to change. Food consumption and food habits in Nordic countries today have been strongly influenced by international trends such as fast food, ethnic cuisine, and gourmet-restaurant culture. This development is a break from what was, until the late twentieth century, the general fare for the majority of the people in this region.

The use of minced meat is no longer limited to meatballs, as it is eaten with spaghetti, in lasagna, on pizzas, in tacos, and in pita breads. This trend also implies a reduction in the consumption of boiled potatoes. However, there has been an increase in consumption of *pommes frites* (fried potatoes) and potato-based snacks. This has partly to do with the strong increase in fast food (so-called "street kitchens"), where earlier only hot dogs were sold, but which now offer hamburgers, grilled chicken, and other dishes.

Different types of fast food or ready-made dishes are also being used for the main hot meal, served in the afternoon after parents come from work and children from school. In Sweden and Finland they also eat hot meals for lunch, either in cantinas, cafeterias, or street kitchens. Many Danes and Norwegians, who earlier enjoyed their lunches of open sandwiches, are now choosing hot fast food or cold salads for lunch. Open sandwiches are also being challenged by new varieties made from French baguettes or Italian ciabatta. Whereas the extravagant open sandwich had to be eaten on a plate with a fork and knife, the baguette and ciabatta sandwiches, with fillings of ham, cheese, or shrimp, can be taken away and eaten while standing or walking; at the same time, these sandwiches have more substance than the original, less substantial English sandwiches.

Drinking habits are changing in the direction of a more southern European style. Alcohol is still important for festive situations, but wine consumption is increasing rapidly compared to consumption of beer and strong liquor. Coffee is still brewed and drunk in the same way (what is often called American coffee), but new coffee bars are growing up all over, offering cappuccino, cafe latte, and espresso.

Important factors behind these changes are increased wealth and prosperity, travel by Nordic people to Mediterranean countries, an influx of new products from southern Europe, Africa, Asia, and the Americas, and the new urban lifestyle promoted through mass media. However, the break with tradition is not complete, because the new trends are mainly affecting smaller groups, such as urban, educated young people with relatively good financial freedom. This probably indicates that more pronounced changes will take place in coming generations.

See also **Germany, Austria, Switzerland**; **Lapps**; **Low Countries**; **Russia**.

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Henry Notaker

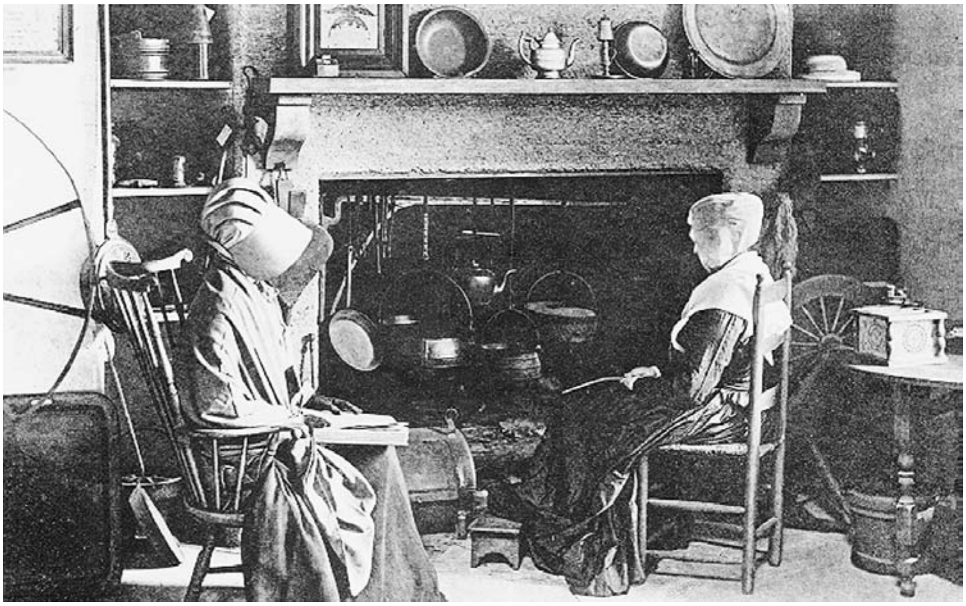
NOSTALGIA. The elusive word "nostalgia" is formed from two Greek roots: *nostos* ("return home") and *algia* ("pain"). The *Oxford English Dictionary* defines nostalgia as "a form of melancholia caused by prolonged absence from one's home or country; severe homesickness." In her remarkable book *The Future of Nostalgia*, Harvard professor Svetlana Boym says that the word was coined in 1688 by the Swiss doctor Johannes Hofer to identify the homesickness of Swiss soldiers who reacted physically to the hearing of certain folk melodies and the eating of rustic soups while on missions away from home. She centers her study on the effects of leaving one culture and residing in another, and of exploring cities rich in archaeological layers of memory. She also distinguishes nostalgia as either being restorative, as in recovering a lost home, or reflective, as in shaping a certain way of thinking about a particular time and place. In the latter, memory becomes a transformative and a reconstructive power.

The Idiom of Exile

In politics, art, music, literature, psychology, and even pop culture, nostalgia is the idiom of exile with, as Boym says, Adam and Eve as prototypes. While it may be a stretch to imagine their longing for the prelapserian apple after they left the Garden of Eden, it is certainly true that through the years the exiles and emigrants that followed their path from their native land to another country either tried to replicate the foods of their homeland or the taste sensations of their childhoods. Almost without exception French chefs, especially when transplanted to America, nostalgically craved the simple soups, daubes, and *pot-au-feux* of their childhood. The four-star chef Fernand Point believed that his mother's cooking was the best kind of cooking, and his disciples Paul Bocuse and Alain Chapel also went back to the simpler foods of the countryside in a movement called nouveau cuisine that captured immediate attention in France and abroad. Known as *cuisine de meres*, these ancestral cooking ideas perpetuated in their respective provinces fed their souls as well as their bodies. Nostalgia proved to be a powerful force.

Nostalgia in Literature

Literature, moreover, abounds with powerful nostalgic works like Jean Jacques Rousseau's *Confessions* and Henry David Thoreau's *Journal*—both motivated by early memories of a purer, more innocent, psychological, as well as physical, place to which there is no possible return except through memory. It was Marcel Proust, however, who irrevocably linked the subjective and often unreliable vagaries of memory with the particularity, sensory modality, and physical presence of food. In pursuit of vanished time, he found a transfiguring moment in the taste of a madeleine dipped in a cup of lime flower tea. Although he frequently had passed the golden shell-shaped French cookies in patisseries, it was not the sight or taste of the madeleine itself or even the tea, but the sensation, or Baudelairean correspondence, that immediately took him back to those Sunday mornings in Combray with his Aunt Leonie when he was a treasured child and not the world-weary adult he had become. The remembrance of



The old New England kitchen is evoked in this circa 1900 photograph of Quaker women gathered around a Nantucket hearth. Nostalgia for old-time foodways is everywhere evident in this picture, although distorted by Victorian notions about the past. A foot warmer is prominently displayed on the tea table instead of under the feet of the elderly woman facing the hearth. Spinning wheels abound, and the woman on the left is wearing a bonnet, which was only worn in public, not in the house. Finally, in spite of the clutter of utensils on the hearth, there is no fire. ROUGHWOOD COLLECTION.

food and, more specifically, the eating of a meal became a trigger point to his self-discovery.

Memories of a wistfully longed for earlier time exist not only in novels, but also in the various autobiographical forms. In *Memories of My Life*, Auguste Escoffier remembered his childhood in Villeneuve-Loubet and wrote about watching his grandfather toast bread and spread it with a particularly strong local cheese called *brousse.* One Sunday, when the young Escoffier tended the fire while his grandfather went to church, he prepared the same cheese toasts, which he then savored with a glass of sweet wine. Seen from the perspective of the mature and successful chef he had become, the incident was but one example of how easy it had been for him to satisfy both his curiosity and his gourmandise. In other personal narratives, odors rekindled memories of other kitchens. Writing about growing up in his mother's boarding house in a *Feast Made for Laughter*, Craig Claiborne described the smell of chopped onions, celery, green sweet peppers, and garlic sautéing together in butter or oil. The smell pervaded the kitchen and in his memory seemed the basis for seemingly hundreds of dishes his mother prepared and that he always identified with "southern cooking" and home. And in James Beard's *Delights and Prejudices*, beach breakfasts of sautéed razor clams gathered along the Oregon coast vie with the Welsh rabbit of the family's Chinese cook to epitomize all that was wonderful about his childhood in Portland.

The sights, smells, and tastes of the holidays almost without exception also evoke nostalgia. In his testament to childhood, *My Father's Glory; and*, *My Mother's Castle: Memories of Childhood*, Marcel Pagnol recreated his Provençal childhood through the eyes of an aging and successful filmmaker. In this autobiography there are scenes about a small boy exploring the streets of Marseille, and about the family's trips to their rented vacation home in the hills where the young Pagnol learned to hunt, trap, and explore the caves and the forest. Neither before nor since was the Christmas holiday in that place so exciting and memorable. Thrushes that he and his friend had trapped "tumbled from branch to spit," a small pine tree from the forest occupied the corner of the room, and on its branches hung hastily assembled presents, and after the Christmas Eve meal, the family feasted on dates, crystallized fruit, whipped cream, and the *marrons glaces* that his uncle had brought from the city. Seeing his father and uncle greet each other, Pagnol felt a new emotion and as a child recognized real friendship for the first time while savoring the *marrons glaces.*

Autobiographies and memoirs that are driven by taste, by memory, and by real life communicate reality in a basic way. When asked about why she wrote about food rather than love, war, sorrow, and death, M. F. K. Fisher simply said that our human hungers for security, warmth, love, and sustenance were inseparable. And she, more than any other American gastronomical writer, combined autobiography and her philosophy of the art of eating to create a hybrid genre called the culinary memoir. Whether she gently folded recipes into her narratives or simply explored the bliss or misfortune of family feasts, vegetable snobbism, the best oyster stew she ever ate, or learning to dine alone, she established the familiar "I myself" pattern that echoes through contemporary culinary food writing. The note of nostalgia or longing for an ideal past that can only be repossessed symbolically by familiar foods—a note that pervades the most memorable memoirs—has been given a voice in her distinctive first-person style. And the unremitting use of gastronomy as a kind of surrogate to ease all human longings has found a varied expression in her narratives.

M. F. K. Fisher has had many imitators because the act of remembering has become a dominant part of how writers—especially cookbook authors—thought about food in the last decade of the twentieth century and continue to do so. Some memoirs have been straightforward records of the author's life and his experience of memorable meals, and recipes have been either abundant or completely absent. In the best of these memoirs, however, the recipes have become an extension of the text. They function as a kind of chart of the emotions evoked by meals or certain moments frozen in time. Other memory-plus-recipe books have been plainly cookbooks in which nostalgia functions as a stylistic devise. Headers tout Aunt Tillie's doughnuts and Uncle Jerry's barbecue, or evoke quaint breadboxes lined along Formica counters or that exciting aperitif sipped in a café along the Boulevard St. Germaine. Unfortunately, their authors often lack the authentic voice of M. F. K. Fisher, and their work does not resonate with the depth of continuous reminiscence.

Whether it is a once-in-a-lifetime Reine de Saba, a comforting Toad-in-the Hole, or an ordinary macaroni and cheese meal, the pleasures of the table need a writer to transcribe them, and a writer needs a sensibility that is shaped by empathy with the conditions of time past as well as time present. Nostalgia is a powerful motivator.

See also **Art, Food in,** *subentries on* **Literature** *and* **Poetry**; **Beard, James**; **Comfort Food**; **Cookbooks**; **Escoffier, Georges-Auguste**; **Fisher, M. F. K.**; **Sensation and the Senses**.

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Joan Reardon

NOUVELLE CUISINE.

The expression "nouvelle cuisine" has been used several times in the course of the history of cooking, particularly in France in the middle of the eighteenth century. It was introduced to subordinate the practice of cooking to principles of chemistry that were to be established by Lavoisier later on. People had mixed feelings about it: for instance, Voltaire wrote "I must say that my stomach does not at all agree with the 'nouvelle cuisine.'"

Origin

Today nouvelle cuisine refers to a trend of opinion that appeared in France in the 1960s. At the time, it caught on rapidly and was a great international success. Yet, as it got tangled up in its contradiction, it stopped being fashionable, and nowadays it has a negative connotation. In spite of that, it was an innovative and quite important movement, which brought about a revolution within the "grande cuisine" whose lessons are still present in the grand chefs' minds.

Among the precursors of the movement were Fernand Point, Alex Humbert (who first made the *petits legumes*), André Guillot, and Jean Delaveyne, former chef at Buckingham Palace; they were those who questioned Auguste Escoffier's heavy heritage. They rejected the overused *fonds de sauce* as well as the so-called Allemande (German) sauce, a light one, and Espagnole sauce (Spanish), a dark one, gravies that were the basis of all kinds of rich and little refined dishes whose taste was almost always the same, since the products lost their specificity when cooked. They made their sauces less rich, highlighting the freshness and the quality of the products, thus paving the way for a revolutionary generation who was to shake up the tradition.

One has to bear in mind that at the beginning, the chefs of the nouvelle cuisine were not outsiders to French cooking. On the contrary, they were the brilliant pupils of the greatest traditional chefs. The revolution in cooking came from within the Michelin-starred restaurants. Paul Bocuse, Alain Senderens, Jean and Pierre Troigros, Alain Chapel, Michel Guerard, when very young, all started studying the traditional way, a painstaking, difficult time of apprenticeship, moving from one place to another almost in the same way as the students who graduate from different universities. An important characteristic of the movement was friendship. Although French chefs are usually individualistic, even selfish, these young chefs were always in contact, telling one another of their discoveries, discussing their problems, and so on. Today, they still do it, although they themselves have become the symbols of a new tradition.

Characteristics of Nouvelle Cuisine

Nouvelle cuisine has several characteristics. Most important were the quality and the freshness of the products chefs used. They went shopping to the market every morning and looked for the best products, and never used any preservatives, deep-frozen food, or any product that was not absolutely fresh. They did not offer a menu card with a long list of dishes that never changed, the reason being that such a long list required having a great quantity of products available. As a result the leftovers would necessarily lose their freshness and thus could not be used. Instead, they offered a reduced number of recipes that kept changing every day according to their market shopping. At the time, in Paris, this was made easier thanks to Les Halles, a huge market right in the heart of the city, within walking distance of every restaurant. Because they were looking for quality, the chefs became more and more attracted by unusual, exotic products. Foreign influences prevailed, particularly those of North Africa (Morocco, especially), Italy, China, and Japan. In 1960 Shizuo Tsujui opened the first school of French cuisine in Japan, which multiplied the cultural exchanges between the two countries. So much so that in 2000, Alain Senderens remarked "the nouvelle cuisine is now Japanese."

In the new style of preparations, there were no *fonds de sauces* used in the dishes any more. Sometimes, short juices, quickly made, were turned into a small quantity of sauce, which was to be served on fresh, only lightly cooked products.

The spices banished from the French cuisine since the seventeenth century were now back in use; contrary to the Middle Ages, they were no longer used in large quantities, but in small touches and only to rouse the flavors that would blend with those of the products. The effect they aimed at was to enhance the quintessence of the product, that is to say that sauces or spices were only used to bring out the product's taste and qualities, not as a substitute for them.

The approach was similar to that of previous cuisine movements. The new chefs stressed the importance of nutrition and its consequence for people's health. They wanted to change the image of an obese gastronome into that of the slim, smart dilettante so much in vogue in the magazines of the 1960s. For their female clients, always anxious to watch their figures, the chefs felt urged to contrive new recipes that could be delightful without being rich. Indeed, it is significant to note that the first book written in 1976 by Michel Guerard was *La cuisine minceur*.

As a result, less food was served; of course what each dish lacked in quantity had to be replaced by better quality and a better esthetic presentation. It is true that the grande cuisine had always included an element of display and ceremony: As the dishes were prepared for all the guests present, the dinners were organized as a ceremony for the whole party, to such an extent that, at the beginning of the nineteenth century, Antonin Carême defined the *patisserie* (pastry cooking) as a branch of architecture. Instead, the new chefs replaced the presentation of entire dishes with that of individual plates; what was considered beautiful and attractive was not the whole chicken, the whole *pate en croute*, or *baba*, but the layout of the food on each plate that the guest was about to eat. To serve the dishes, the chefs no longer enacted their ritual at the pedestal tables on which they used to carve the meat or flambé the basses. They brought each guest their own plates, with the food previously prepared. Sometimes, it was hidden under shining dish covers the waiter would take off as a surprise, once the plate was set in front of the guest. Then the guests would appraise the esthetic aspect of the layout and enjoy the all-pervading fragrances of the food.

The chefs were always in search of new products and new aromas. Similarly they also kept looking for new techniques. As they were the best technicians of their generation, they began using all the new tools available:

cutter blenders, food processors, nonstick materials, and so forth. The relationship between food and fire had become a central problem, so they started experimenting with new methods such as cooking under vacuum, microwave ovens, and steam ovens. Yet this did not mean that they ignored some of the old methods; in fact quite a number of them were brought back into fashion, for instance, the *cuisson en croute de sel* and steam cooking. Moreover the fact that they had learned how to control the use of refrigeration enabled them to use new ways of preparing the food or carving the meats, which otherwise would not have been possible.

A Cultural Phenomenon

First and foremost, the nouvelle cuisine was a genuine revolution accomplished by the chefs themselves, more precisely the best of them. However, the newspapers and other media played an important part in the overall outcome. Raymond Oliver was the first to appear on a weekly TV show, which lasted for fourteen years and made him a star. Other chefs also became stars, which was seldom the case before that.

The expression "nouvelle cuisine" owes a great part of its success to two journalists, Henri Gault and Christian Millau (who for the first time in 1969 published the *Nouveau Guide*, followed in 1971 by the *Guide Gault et Millau*, a monthly magazine which soon became popular and had a great influence on the chefs as well as on their clients). Besides, at the time, the expression itself fitted nicely into a whole set of new trends of thought, of things or events which had appeared after World War II, for instance *la nouvelle critique litteraire* (the new literacy criticism), *le nouveau roman* (the new novel, with Alain Robbe-Grillet, Nathalie Sarraute, and Nobel Prize winner Claude Simon), and *la nouvelle vague* (the new wave) in the cinema with Alain Resnais, Jean-Luc Godard, François Truffaut, and Claude Chabrol. Traditional guides, the *Michelin* in particular, had already acknowledged the worthy chefs by giving them one to three stars: for example, Paul Bocuse was awarded three stars in 1965, Haberlin, in 1967, and Troigros and Barrier, in 1968. The new *Gault et Millau Guide* quite cleverly introduced a new distinction between the nouvelle cuisine chefs and the traditional ones. Later on the distinction was noted by a printed symbol, the former having a red one and the latter a black one.

Heyday and Demise

In 1973, in number fifty-four of their guide, Gaut and Millau published the ten commandants of nouvelle cuisine, among which they advocated that one should reduce cooking time, use best-quality products and products fresh from the market, offer a shorter menu, limit the use of modern technical tools, while keeping open to new developments, do away with marinades and game hanging, cook sauces that were less rich, respect dietary rules, use a simple estheticism, and be creative. To these commandments, they added another one: friendship.

Nouvelle cuisine has been described as a blending of Japanese food presentation with French cooking techniques. The concept has taken on a life of its own in the hands of its imitators. In this interpretive study, a tiny piece of meat is served with miniature vegetables ("bonsai" vegetables to food critics), while an upended pastry serves as a vertical element topped with sprigs of blooming thyme. Is it art, or campy novelty? PHOTO BY ANDRÉ BARANOWSKI.

From then on, nouvelle cuisine became quite fashionable. It was everywhere, on television, on the radio, in the newspapers; people talked about it and held controversial discussions. The chefs who had become real stars were rich enough to purchase their own restaurants and become their own masters. The economic boom of the 1960s and the 1970s boosted the careers of the chefs, providing them with much money, which of course incited other less-gifted chefs to follow suit. Unfortunately for several of them, what ought to have been simple, original, or healthy food became approximate, ridiculous, meager food. The journalists who had praised the best chefs, now did the same with drudges, and gave the seal of quality to poor, ridiculous, and botched dishes. As a result, the movement was quite discredited though the greatest chefs were never criticized by those who blamed their imitators. By the 1980s, nouvelle cuisine had lost its appeal and today it is no longer used; it even has turned into a pejorative connotation.

The concepts used by the chefs who inspired them predominate within today's grande cuisine, not only in France, but the world over. Products must be selected with a ruthless eye on quality, wines and dishes matched with flair, cooking times short and accurate, and sauces lighter. Judicious blending of foreign trends and customs is a major element. An attractive plate is served, the food displayed simply and esthetically. An open mindedness and a concern for nutrition and diet are the essential ingredients binding the whole approach. Today, there cannot be a grand chef in the world who has not in some way or other been influenced by the nouvelle cuisine ethos.

See also **Carême, Marie Antoine; Cuisine, Evolution of; Escoffier, Georges-Auguste; Fads in Food; France; Icon Foods.**

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NUTRACEUTICALS. There are many ways to think about food. In the simplest sense, food is fuel. Food provides the energy needed to perform daily functions and maintain normal metabolic processes. But we all know that food is more than fuel. Food contains nutrients that are essential to prevent diseases. For example, scurvy will occur if vitamin C is not continually present in the human diet. Similarly, blindness can occur where diets are deficient in vitamin A. The "essential nutrients"—those that are needed to prevent specific diseases—have been a major focus of human nutrition research for the past century. Through this research we have determined the amount of each essential nutrient required to prevent disease in populations of various ages, cultures, and genetic predispositions. What is interesting, however, is that the link between diet and disease, or more important, diet and health, cannot be entirely explained by the absence or presence of the various essential nutrients in our diets. And so today, a multitude of components that are found in foods are being investigated to determine what, if any, role they play in maintaining health and reducing the risk of disease. Numerous phytochemicals (plant chemicals) that occur in fruits and vegetables are taking center stage in this research, as more evidence accumulates regarding their health-promoting properties (Beecher, 1999).

Human Nutrition Research

Concurrent with these new activities in nutrition research is a reevaluation of the medicinal practices of past and present cultures. These traditional medicines are based largely on the use of plant materials. Chinese medicine, which predates modern medicine by thousands of years, employs a vast array of botanical materials for the treatment of disease and the maintenance of health. Similarly, East Indian Ayurvedic medicine, early European folk medicine, and native North American medicine are based largely on the use of plant materials.

Health-Promoting Foods

Today the exploration and exploitation of the disease-fighting properties of a multitude of phytochemicals found in both food and nonfood plants have created a renaissance in human health and nutrition research. At the same time, many opportunities for the development of novel dietary products have been created. With all new fields of study come new terms. "Nutraceuticals" and "functional foods" are two new terms used to describe health-promoting foods or their extracted components. Although debate continues regarding the exact meaning of these terms, it is convenient to consider nutraceuticals as healthful products that are formulated and taken in dosage form (for example, capsules, tinctures, or tablets). Functional foods, on the other hand, are products that are consumed as foods, and not in dosage form.

The beneficial role of many nutraceuticals and functional foods may relate to their protective effects against degenerative diseases, such as cancer and cardiovascular disease. Typically the active ingredient(s) in the food or supplement is believed to help the body combat metabolic processes that lead to degenerative conditions. In this way, supplementing the diet with beneficial phytonutrients may reduce the risk of degenerative diseases

NEURODEGENERATIVE PROCESSES

Foods and supplements are also being examined for their effects on neurodegenerative processes. Blueberries have recently been shown to reverse some of the losses in memory and motor skills that occur during aging (Joseph et al., 1999). Gingko biloba supplementation may be effective in the prevention and treatment of Alzheimer's disease.

ANTICANCER AND CARDIOPROTECTIVE PROPERTIES

The anticancer and cardioprotective properties of plant flavonoids and isoflavonoids are being investigated in human health and nutrition research. In the field of biotechnology, genetic techniques are being developed to control the synthesis of flavonoids and isoflavonoids in various food crops (Dixon and Steele, 1999).

during aging. These concepts are well illustrated by the example of dietary antioxidants.

There is overwhelming evidence to suggest that oxygen and its highly reactive by-products are responsible for oxidative damage ("rust") to biomolecules in our bodies. Oxidative damage to biomolecules is believed by many to be a significant factor in the etiology of many degenerative diseases and the aging process itself. Oxidative damage to cellular DNA is an underlying element in the initiation of cancer. Similarly, oxidative damage to low-density lipoprotein in the blood is a causal agent in the development of atherosclerotic plaque in cardiovascular disease. It has been suggested and supported by various types of evidence that consuming antioxidants may provide greater protection against the deleterious effects of oxidative damage (Ames et al., 1993).

Several groups of plant phytochemicals, including carotenoids, tocopherols, and polyphenolics, are extremely effective antioxidants; these antioxidants are found at various levels in fruits, vegetables, and nonfood plants. Thus, with respect to the terms "nutraceutical" and "functional foods," a fresh or processed fruit or vegetable that is particularly high in antioxidant phytochemicals could be considered a functional food. The high antioxidant level may be a normal characteristic of the plant, or may be due to phytochemical fortification during manufacture of a processed food product. A nutraceutical may be an antioxidant phytochemical concentrate, having been extracted from raw materials and formulated as a standardized capsule or tablet (Hasler, 1998).

Challenges and Opportunities

The field of nutraceuticals and functional foods is new, and many gaps exist in the knowledge base. For example, it is widely accepted that the health-promoting properties of foods are not necessarily due to single components, but rather a few or several active ingredients. This creates a significant paradigm shift from the pharmaceutical model, which is based on the efficacy of single agents. Many of the bioactive phytochemicals under investigation have long been ignored, thus methods for their handling and measurement are lacking. Manufacturers wish to make specific claims of health benefits on their product labels. Clearly such claims must be based on solid scientific evidence, which to date is often lacking. Government regulatory bodies also face challenges in this new category of health products, which lies between foods and drugs. However, all parties share the desire to improve personal and public health through diet modification, to reap the consequent social and economic benefits.

The field of nutraceuticals and functional foods is at times confused, or at least lumped together with the field of biotechnology and genetic modification. The two areas are distinctly different, although there is some potential for overlap. Techniques in genetic modification may be applied to enhance the phytochemical content of food and nonfood plants. Although the complex series of biochemical reactions used by plants to synthesize specific phytochemicals is often not well understood, there is tremendous potential to harness the plant's sophisticated biochemical machinery to synthesize valuable compounds and ultimately enhance human health.

See also **Antioxidants; Biotechnology; Crop Improvement; Dietary Assessment; Dietary Guidelines; Ethnobotany; Ethnopharmacology; Functional Foods; Genetic Engineering; Vitamins.**

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Wilhelmina Kalt

NUTRIENT BIOAVAILABILITY. The chemical analysis of a food gives us values for the total amounts of particular nutrients that are present. Commonly, when a food is to be analyzed, it is first treated with a strong acid, or an enzyme, that breaks up complex materials into simpler, soluble products. Thus, the starch content of a food may be measured as the amount of additional sugar found after the treatment of the food with an enzyme that acts specifically on starch, and nothing else, to break the large molecules down to glucose. Usually, if different analytical methods are compared, the one giving the highest values is chosen, on the grounds that it has extracted the nutrient in question most completely.

However, from a nutritional point of view our interest is in how much our digestive system will be able to extract in a form that can be absorbed into the bloodstream. The term "digestibility" was formerly used to designate this, but nowadays it is becoming more common to use the term "bioavailability." It must be remembered that, after a period of preliminary storage and preparatory digestion in the stomach, ingested food passes into the small intestine and it is there that final digestion occurs and the smaller, digestible molecules are absorbed. The residual gut contents are then passed into the large intestine, whose major function is the removal of water, though the presence of a large bacterial population ferments some of the otherwise indigestible components of food. Since the fermented material is not recovered in the feces it may, wrongly, be considered to have been digested, even though it is not "bioavailable."

The final measure of bioavailability must therefore be some overall response of the subject to a test dose of the food in question. If the subject is a human "guinea pig," this might be the increased level in the blood of the nutrient in question; if young, growing animals are used, it could be their rate of growth when receiving a supplement of the test food, compared with that of other animals receiving the pure nutrient. We will cite some examples below to illustrate why the subject has some importance, and how it can be studied with different nutrients.

Protein

Proteins are enormous molecules composed of chains of hundreds of amino acids. Our bodies can only build up their own proteins from single amino acids, and the absorptive system of the gut will only allow single amino acids to pass into the bloodstream. This breakdown, which is very efficient for most of the protein in ordinary foods, requires a complex series of enzymes, beginning with pepsin, which is secreted into the stomach. It is only very resistant proteins, like those in hair, that fail to be digested by the combined attacks of digestive enzymes.

In general, cooking makes proteins more digestible by loosening and breaking up some of their natural coatings. However, there is one exception—the so-called Maillard (or Browning) reaction, which occurs when a reducing sugar is heated in contact with protein under conditions of relatively low moisture. These reactions are limited to a subset of amino groups. This reaction is not very common but can occur, for example, if dried skim milk is used to fortify cookies intended for undernourished toddlers. During the baking the reactive group of the lactose in the dried milk combines with reactive groups on the surface of the protein molecules present. One of these reactive groups is attached to the essential amino acid lysine and the resulting compound is resistant to digestion, so that the protein has lost much of its nutritional value.

Niacin

The disease associated with a deficiency of the vitamin niacin (also called nicotinic acid) is pellagra, which is characterized by terrible dermatitis on parts of the skin exposed to the sun and by mental deterioration. The disease has nearly always been associated with poor people eating a diet based on corn (that is, maize) and little in the way of meat or milk. It is now known that, as the grain matures, the niacin combines with structural materials to form a complex that is not readily broken down by digestive enzymes. This gives the vitamin a very low bioavailabilty, and ordinary cooking in boiling water does not liberate it. Corn is also lower in the amino acid tryptophan than are other grains (and also lower in tryptophan than meat and milk). By means of a series of chemical reactions in the body, tryptophan can provide an indirect source of niacin.

These two characteristics of corn serve to explain its association with pellagra, which began to be seen in southern Europe when corn first became the staple food of many low-income peasant communities. However, this seemed inconsistent with the fact that pellagra was not a problem among low-income communities in Central America where corn had been the staple food for very long periods. It is now realized that a difference in the way that corn is prepared for cooking in the two geographic areas was at least partly responsible for the differing rates of pellagra. In Central America, corn is traditionally soaked in lime water, which is strongly alkaline, before being cooked and made into tortillas. This treatment, which softens the hard grains, also has the effect of releasing the niacin from its B vitamin complex and making it bioavailable. This is an interesting example of a traditional folk custom having a beneficial effect in addition to the obvious one of softening the grain. It has also been recorded that Native American groups in North America who relied on corn as their staple food, but did not have access to lime, used infusions of wood ash, which is also alkaline, for the same purpose.

Maize came from the New World. One could say, therefore, that the thousands of Europeans who suffered and died from pellagra in the 1800s did so because the first explorers who brought maize to Europe failed to bring with them the cooking instructions that had been adopted from long experience where it had been a staple food for many centuries. Furthermore, people of European origin and habits, but living in the American South, were again subject to the disease in the early 1900s.

Other Vitamins

Pernicious anemia results from a long-term deficiency of vitamin B_{12}. A normal mixed diet provides enough of this vitamin. However, its absorption requires the secretion of a specific "intrinsic factor" by cells in the stomach wall. These cells may atrophy, particularly in some older people, and then the vitamin in the food remains unabsorbed so that, when the tissue reserves are used up, the result is a macrocytic (large cell) anemia and progressive neurological damage. After the problem has been detected, the vitamin can be supplied by intramuscular injection.

Vitamin A is found naturally only in animal products. Many people, for lack of purchasing power or other reasons, eat little or no animal products and meet their need for vitamin A by ingesting carotene and related compounds (carotenoids) that provide the coloring of carrots and are present in all green leafy material. Carotene can be hydrolyzed by enzymes within the gut wall to form active vitamin A. However, it has very limited solubility and can be absorbed only in conjunction with fats. Unfortunately, low-income children in Third World countries who rely on carotenoids as their source of vitamin A also commonly have diets that are very low in fat, so that even a reasonable intake of carotenoids does not save them from blindness and other effects of vitamin deficiency.

Iron

Deficiency of iron and the resulting anemia is a major nutritional problem in many parts of the world. This metallic element is, of course, an essential component of hemoglobin, the oxygen-carrying chemical in our red blood corpuscles, as well as having other functions. However, iron can also be toxic if the body absorbs much more than it needs, because we have no mechanism for excreting the excess. Our bodies therefore have to regulate the absorption of iron so that very little is absorbed when we already have enough, but that we do absorb more after blood loss, or during pregnancy when the growing fetus has to be provided with its hemoglobin. It appears that there is a feedback system that informs the cells on the inner surface of the small intestine how much iron is required to be absorbed.

However, there are limits to this control, and children may die from acute iron poisoning as a result of finding iron pills and eating them as candy. A small proportion of people also absorb more iron than they need even from a normal diet and suffer from a serious disease (hemachromatosis) as a consequence. Iron, therefore, is a nutrient for which a relative low bioavailability is normal, and in fact essential.

It is estimated that adult men need to absorb about 1 milligram of iron per day to replace their losses from rubbed-off skin, and so forth, and that premenopausal women need to absorb some 50 percent more in order to compensate for losses of menstrual blood. It is commonly recommended that people consume 10 times these levels each day, on the assumption that there will be about 10 percent bioavailability. In general, "heme iron" from meat is best absorbed, with a typical value of about 20 percent. The absorption of the iron compounds present in vegetable foods is lower and variable, but is increased if vitamin C is present in the same meal. It is particularly low from green vegetables like spinach that are relatively rich in iron but also in another compound called phytic acid or phytate. This compound can form insoluble salts with iron that inhibit its absorption. Legumes (that is, beans, lentils, and peas) are generally richer sources than the grains, but the iron compounds they contain are also less well absorbed than those in meat.

Wheat fully milled to "white flour," and used to make white bread, is particularly low in iron, and yet it can form a large portion of the diet of many people. Because of this, many technically developed countries legally required that millers add a source of iron, as part of a micronutrient supplement, to all the white flour that they produce. This is a problem for millers because the addition of ferrous sulfate, the common iron salt with relatively high availability, can catalyze the oxidation of fat in foods, producing rancid off-flavors. That can be avoided by adding the actual metal in very fine form. On chemical analysis, this form of iron is fully measured and meets the legislative standard for the iron content of white flour. However, its bioavailability is more doubtful and depends on whether the gastric acid, which it meets in the stomach, is sufficient to react with it to produce soluble salts. Even iron with the finest particle size seems to have only 20 percent of the bioavailability of the iron in ferrous sulfate.

Other Trace Minerals

Zinc provides the best example of deficiency of a trace mineral occurring in practice as the result of low bioavailability, rather than as a result of an absolute deficiency of the mineral in the diet. In the Middle East, cases were observed of young men who had failed both to grow to normal height and to reach puberty. Tests showed that these subjects did respond to dietary supplements of zinc; even though their diet was low in zinc they were not really deficient in the element. The traditional diet in the area was based on wheat, but it was not customary there when cooking wheat flour to first "raise," or leaven the dough by fermenting the flour with yeast, as in Western baking. We now realize that yeast, in addition to producing bubbles of carbon dioxide that "raise" the dough, secretes enzymes that hydrolyze the phytate present in the flour. Unfermented products, like "falafel," still contain a significant amount of phytate and, when they are eaten, the phytate binds with zinc present in the same meal to make it largely unavailable. When a diet includes more meat or fish, which are richer sources of zinc, enough remains uncombined to provide what is required for normal functions; but the young men who had failed to mature and grow were typically from poor families who ate little in the way of animal products.

Another problem with trace minerals is that they share absorption pathways and are, in a sense, in competition with each other. As a consequence, very high intakes of one element can reduce the bioavailability of another. Thus, if one were to take a high supplement of an iron salt, in order to avoid any risk of an iron deficiency, one could precipitate a deficiency of zinc since that element would no longer be so well absorbed. Equally, a particularly high intake of zinc could reduce one's absorption of copper, and so on.

There is no one "ideal diet." Our bodies can tolerate and adapt to considerable differences in the intake of nutrients, but there are limits, and it is clearly dangerous to supplement the diet with a very large amount of a single nutrient. The simplest way to maintain a reasonable balance in one's diet is to follow the traditional advice of eating a wide variety of foods.

See also **Assessment of Nutritional Status; Cooking; Disease: Metabolic Diseases; Dietary Guidelines; Ecology and Food; Functional Foods; Iron; Maize: Maize as a Food; Nutraceuticals; Nutrition; Nutritional Biochemistry; Trace Elements; Vitamins.**

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NUTRIENT–DRUG INTERACTIONS. The terms "nutrient-drug interaction" and "diet-drug interaction" refer to the process whereby the consumption of a food affects the absorption, metabolism, action, retention, and/or excretion of a drug, or conversely the process whereby taking a drug affects the absorption, metabolism, action, retention, and/or excretion of a nutrient.

Adverse consequences of nutrient-drug and diet-drug interactions are so common that in their 1996 accreditation standards, the Joint Commission on Accreditation of Healthcare Organizations began requiring hospitals to ensure that "patients are educated about the potential for drug-food interactions" by "[i]nstruction on potential drug-food interactions and counseling on nutrition intervention and/or modified diets, as appropriate" before they are discharged.

In the following discussion, we will first address the effects of diet and nutritional status on drug absorption, disposition, metabolism, and action; thereafter, we will address the effects of drugs on nutrient absorption, disposition, metabolism, and action, with attention to certain specific food/nutrient/drug interactions.

Terminology Used in Describing Nutrient-Drug Interactions

The following terms are useful when discussing nutrient-drug interactions:

- *Pharmacokinetics:* the characteristics of a drug's absorption, distribution, metabolic transformation (biotransformation), and excretion. Interactions affecting pharmacokinetics are the most common form of nutrient-drug interactions.
- *Pharmacodynamics:* the mechanisms of drug action and the relationships between a drug's concentration at the active site and its pharmacological effects. Interactions affecting pharmacodynamics are less common, and certainly less well-studied, forms of nutrient-drug interaction.
- *Absorption:* the rate at which, and the extent to which, a drug leaves its site of administration. Sites of drug absorption can include all surfaces of the body, and for drugs given by injection, the bloodstream. Specifically, drugs taken orally are absorbed to some extent in the mouth and stomach (if the formulation is designed for this purpose), but predominantly in the small intestine, the organ that is specifically designed for absorption. In order to be absorbed, drug particles must be broken down and dissolved in liquid, for example, by both stomach juices and the fluid you swallow when taking the pill, so that they can reach the cells of their absorption site successfully. Note, however, that there are some drugs that may be destroyed in the stomach—therefore many preparations are coated in order to pass through the stomach intact, and only be broken down when they reach the small intestine.
- *Bioavailability:* the extent to which a drug reaches its site of pharmacological action. In practice, bioavailability is measured as the extent to which the drug reaches the bodily fluid that bathes the tissue site where the drug should act. The bioavailability of a drug increases with increased absorption and distribution of the drug to its site of action, and decreases with increased metabolism and excretion of the drug before it can reach the site of action.
- *Biotransformation:* the process through which drugs, nutrients, and hormones can be metabolized, and thereby either activated or inactivated.

Host Factors Affecting the Development of Adverse Interactions between Foods and Drugs

The likelihood of adverse interactions between foods and drugs is affected by the following factors: (1) age, because older people have less metabolic reserve; (2) medical conditions, such as diabetes mellitus, that lead to abnormalities in both food and drug handling; (3) conditions, such as arthritis, that increase the likelihood that the person will be taking over-the-counter medications; (4) sex; (5) size and fat mass, which are related to a person's diet and nutritional status; (6) exclusionary diets, for example, diets from which all animal products are excluded (vegan diets); (7) the use of substances of abuse, such as alcohol, which alter the handling of both drugs and nutrients; and finally, (8) medical conditions that require the care of different specialists and multiple medications.

Effects of Foods and Food Components on Drug Absorption and Bioavailability

There are at least four ways in which foods and their components can affect the absorption and bioavailability of a drug:

- *Physicochemical binding:* The food component and the drug can bind to each other physicochemically, so that neither the drug nor the component can be absorbed. For example, the antibiotic tetracycline binds with calcium, magnesium, iron, and zinc; once bound, the antibiotic becomes unavailable—that is why this drug should not be taken with dairy products, which contain high amounts of these minerals.
- *Stability:* The food can alter the stability of the drug preparation in the stomach, so that it breaks down before it can be absorbed.
- *Gastric emptying:* The drug or food can change the rate at which the stomach empties, and therefore the rate at which the drug arrives in the small intestine. Gastric emptying is normally a three-phase process. When you begin to eat, a small amount of food mixed with stomach juices enters the small intestine. The presence of this mixture makes the small intestine send a signal to slow down gastric emptying. This slow-down allows the stomach time to thoroughly mix the food with the stomach juices, and to break down the food into small particles. Fatty foods are highly effective in slowing stomach emptying, while erythromycin, an antibiotic, increases the speed of gastric emptying.

A drug taken on an empty stomach is likely to be dumped rapidly into the small intestine. As a result, there will be only one peak in the curve describing the concentration of the drug in the blood across time. By contrast, a drug taken with food will arrive in the small intestine more slowly, and in small spurts (via the second phase of gastric emptying), so that there may be two or more peaks in this curve. Remember, though, that one job of the stomach is to break down pills into particles. If you take a pill on an empty stomach, it may arrive in the small intestine more quickly, but it may not be absorbed if the pill is not sufficiently broken up. Furthermore, a drug taken on an empty stomach will pass more rapidly through the small intestine, with the result that the time for absorption is shorter and less of the drug may be absorbed. Finally, in the third phase of gastric emptying, approximately every 24 hours, the normal stomach has a massive series of contractions that propel larger particles and any remaining material in the stomach into the small intestine. If there are any large drug particles left behind in the stomach, this "housekeeping" emptying may lead to a sudden dumping of a large quantity of the drug into the small intestine, with a corresponding sharp peak in the blood concentration of the drug. The duration and extent of the phases of gastric emptying in response to food vary considerably from individual to individual, but is longer in women than in men, and is much longer in chronic alcoholics. Smoking while eating also delays stomach emptying.

The fourth way in which foods can affect the absorption and bioavailability of a drug is by:

- *Competition for absorption:* Many drugs use the intestine's natural transport systems—which normally transport food components—to cross the intestinal wall. They therefore compete with food components for transport. For example, L-dopa and methyldopa (drugs used to control Parkinson's disease) use the same transporter mechanism as aromatic amino acids from proteins, so absorption of these drugs is decreased if you eat a high-protein meal at the same time you take the drug.

In general, we can divide drugs into those that are best absorbed on an empty stomach (for example, most but not all antibiotics, digitalis preparations, captopril, and sucralfate); those absorbed best with food (for example, some hypertension medications such as chlorothiazide and spironolactone, and drugs for blood lipid abnormalities such as lovastatin and gemfibrozil), and those for which absorption varies by the type of preparation or formulation. For example, drugs that are enterically coated (so that they are not destroyed by stomach acid) may be more easily absorbed if they are taken with food, because a long stay in the stomach may weaken the coating just enough that it disintegrates more easily in the small intestine.

The examples given above are general rules and may not be true for the specific preparation you may be taking. Therefore, it is critical to check the package insert for your drug and to consult with your pharmacist. For example, theophylline, a commonly used asthma drug, comes in several different formulations, depending on the manufacturer. One version of theophylline is best absorbed when accompanied by a high-fat meal, while another is poorly absorbed. The rate of absorption of theophylline is extremely important because it is one of the many drugs that has a narrow therapeutic window; in other words, there is a very small difference between the concentration of drug that you need in your bloodstream for it to be effective, and the concentration at which the drug becomes toxic. For the drug to work properly, it is critical to maintain a steady level of the drug in the bloodstream—neither too little nor too much. Therefore, switching from one formulation to another has to be done carefully.

Effects of Foods and Food Components on Drug Biotransformation

Biotransformation can be divided into two phases: Phase I, in which compounds are transformed by enzymes (proteins that transform the structure of other molecules such as drugs to make them either inactive or more active), and Phase II, in which compounds are prepared for excretion in the urine by attaching a molecule that makes them soluble in water. The small intestine has some capacity for drug biotransformation, but the major site of biotransformation is the liver. Because blood from the small intestine must pass through the liver before it goes on to the rest of the body, some drugs that are readily absorbed may not be bioavailable, because they are inactivated by the liver before they can get to the site of action. Blood flow through the liver, and the size of the liver itself, decrease as people age, so some drugs may be effective at lower doses in the elderly than in the young.

The dietary factors that activate the liver enzymes are just beginning to be elucidated. These include both nutritive factors (protein, carbohydrate, and fat) and nonnutritive factors, compounds in charbroiled meat, in cruciferous vegetables such as cabbage, turnip, and broccoli, and in citrus fruits, especially grapefruit. If you are taking a drug that is activated or inactivated by liver enzymes, it is important to maintain a diet that does not vary much from day to day in order to assure a steady level of the active drug in your bloodstream. Note that large changes in macronutrient composition of your diet, for example, adoption of a low-protein diet, can also affect Phase II biotransformation, and therefore drug excretion.

Effects of Drugs on Food and Nutrient Intake and Function

Drugs can affect food and nutrient intake, either as a desired effect or as a side effect. They can alter appetite; cause nausea and vomiting; cause food aversions; alter the taste of food, decrease taste sensations, or cause the mouth to be painful; cause gastric irritation; and alter intestinal function. One class of drugs that can cause all of these problems consists of the anticancer drugs, which can potentially cause malnutrition because they can decrease food intake dramatically.

Specific Diet/Food-Drug Interactions

There is a large number of well-known food-drug interactions in which the drug's action is altered by specific dietary components. Common examples are diuretics used for hypertension, digoxin used for cardiovascular disease, coumarin anticoagulants used for blood thinning, and monoamine oxidase (MAO) inhibitors used for depression. Similarly, there are a number of drugs, such as the drugs designed to reduce stomach acidity, that affect vitamin and mineral status, requirements, and activity.

Drugs can inhibit enzymes that may be critical for the metabolism of toxic substances in food. In the case of disulfiram, a drug used to curb alcohol consumption, the enzyme inhibition is the desired therapeutic effect. This drug inhibits aldehyde dehydrogenase, the enzyme that breaks down the aldehyde derived from alcohol consumption. As a result, people taking the drug become ill when they drink alcohol, and thus learn to avoid alcohol. For most drugs, however, food-drug incompatibility is an undesirable side effect.

General Principles

The considerations we have discussed bring us to enunciate two important general principles:

1. First, if you are taking any drug, either prescription or over-the-counter, be sure to consult your pharmacist concerning any nutrient-drug interaction for that drug.
2. Second, be sure to take both drug and food on a regular basis, so that drug absorption, action, metabolism, and excretion are consistent and predictable.

See also **Assessment of Nutritional Status; Disease: Metabolic Diseases; Enteral and Parenteral Nutrition; Health and Disease; Immune System Regulation and Nutrients; Intestinal Flora; Nutrients; Nutrition.**

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NUTRIENTS.

Nutrients are those organic and inorganic compounds that a living organism must acquire from the environment to support essential life processes, including basal metabolism, growth and maintenance of body tissues, activity, reproduction, and maintenance of general health. Nutrients are normally obtained by the ingestion of foods. Organic nutrients include carbohydrates, proteins or amino acids, lipids, and vitamins. Inorganic nutrients include minerals. Water is sometimes included in a listing of nutrients.

Classification of Nutrients

Nutrients often are classified as essential or nonessential. Essential nutrients are those that cannot be synthesized in the body at all or in sufficient amounts to meet needs and, thus, must be obtained preformed in the diet. These include the essential (indispensable) amino acids, the essential fatty acids, the vitamins, and the minerals. Two amino acids are classified as semi-essential because, although they can be synthesized in sufficient quantities in the body, their synthesis depends upon a supply of an essential amino acid. Other nutrients are considered conditionally essential, meaning that they are not normally required by a healthy adult but may be required in certain disease states or at certain stages of life because of increased demand or impaired synthesis. Nonessential nutrients include those that are oxidized as fuels and those that provide carbon skeletons and amino groups for endogenous synthesis of body constituents. The term "dispensable" is sometimes used to describe these nutrients, as the nutrients are not truly nonessential: an adequate amount of carbohydrate, protein, and fat must be taken in to supply the substrates required for maintenance of blood glucose, as fuel for oxidative metabolism and synthesis of ATP, and as substrate for synthesis of body components. They are "nonessential" only in the sense that carbohydrate, fat, or protein, as well as ethanol, can be used as fuels; in that either carbohydrate or protein or even the glycerol backbone of triacylglycerols (fat) can be a source of glucose; in that any fuel potentially can be used for synthesis of most lipids; and in that amino groups from most amino acids can be used for synthesis of indispensable amino acids. Also, some food components that have health benefits and are considered important parts of healthy diets, such as fiber and phytochemicals, are not required and are not considered nutrients per se.

The following table summarizes the nutrient classes, the essential compounds in each class, and the basic functions of these nutrients in the body.

Additional information about some of these nutrients can be found below. Additional information for the other nutrients can be found under separate entries in this volume.

Niacin

The term "niacin" is used to refer to either nicotinic acid (pyridine-3-carboxylic acid) or nicotinamide (pyridine-3-carboxamide). Niacin is widely distributed in foods of both plant and animal origin. Good sources of niacin include meats, poultry, fish, legumes, peanuts, some cereals (mainly in the bran), and enriched or whole grain products. Much of the niacin in cereals is not readily available because it is esterified to complex carbohydrates or peptides.

The amino acid tryptophan also is an important precursor for synthesis of pyridine nucleotide coenzymes (see below). The estimated conversion factor for adults is 60 mg of tryptophan to 1 mg of niacin. The term "niacin equivalent" (NE) is used for expression of niacin intakes and requirements, with either 1 mg of nicotinic acid, 1 mg of nicotinamide, or 60 mg of tryptophan equal to 1 NE.

The adult recommended daily (or dietary) allowance (RDA) for NEs is 14 mg per day for females and 16 mg per day for males (Institute of Medicine, 1998). Most mixed diets in the United States provide more than 5 mg of preformed niacin. However, for individuals consuming typical Western diets, most NEs are derived from tryptophan rather than from preformed niacin. The tryptophan content of proteins ranges from about 0.6 percent for corn to 1.5 percent for animal products. Assuming that the average tryptophan content of protein is about 1 percent, a diet for adults that contains 100 g or more of protein provides about 16 mg NEs and would by itself meet the RDA for niacin. One should note that food composition tables do not take into account the bioavailability of niacin (from plant foods) and do not include an estimate of the NE available from tryptophan in the food. The adult male RDA for NEs would be supplied by ¼ cup peanut butter, 3½ slices roast beef, 4½ cups green peas, or 15 slices enriched wheat bread.

Nicotinic acid and nicotinamide are actively absorbed from the small intestine as well as from the renal filtrate. Niacin metabolites are excreted in the urine. Defects in tryptophan absorption or reabsorption from the renal filtrate have been associated with cases of niacin deficiency (pellagra).

Niacin is essential for the formation of the pyridine nucleotide coenzymes, nicotinamide adenine dinucleotide (NAD), and nicotinamide adenine dinucleotide phosphate (NADP). Reduced forms of these coenzymes are indicated as NADH and NADPH. NAD and NADP function in oxidation-reduction reactions that are involved in the catabolism of glucose, fatty acids, ketone bodies, and amino acids. These coenzymes ultimately funnel electrons to electron-to-oxygen transfer systems, including the mitochondrial electron transport chain. These coenzymes also are essential for reductive biosynthetic reactions. In addition, NAD has a non-coenzyme function: NAD serves as the donor of adenosine diphosphate-ribose moieties for ADP-ribosylation reactions. Poly-ADP-ribosylated proteins appear to function in DNA repair, DNA replication, and cell differentiation.

Symptoms of pellagra, or niacin deficiency, include functional changes in the gastrointestinal tract and nonspecific lesions of the central nervous system. Early symptoms include weakness, lassitude, anorexia, and indigestion. Later symptoms include various gastrointestinal and mental symptoms and a bilaterally symmetrical dermatitis that affects parts of the body exposed to sunlight, heat, or mild trauma. Pharmaceutical doses of nicotinic acid cause vasodilation, and long-term use can cause gastrointestinal irritation and possibly liver damage. The tolerable upper intake level (UL) set by the Institute of Medicine (1997) is 35 mg of niacin per day for adults.

Riboflavin

Riboflavin is the common name for 7,8-dimethyl-10-(1′-D-ribityl)isoalloxazine, which also is known as vitamin B_2. Much of the riboflavin in the American diet is supplied by dairy products. Meats, especially organ meats,

TABLE 1

Summary of nutrients and their functions ***(See Appendix for complete chart of vitamins.)***

Nutrient class	Essential compounds in class	Function in body
Carbohydrates (composed of glucose, galactose, fructose, and other sugars)	None	Fuel—oxidation or storage as glycogen; Source of carbon skeletons for synthesis of various organic compounds
Proteins (composed of amino acids)	Histidine Isoleucine Leucine Lysine Methionine (and Cysteine) Phenylalanine (and Tyrosine) Threonine Tryptophan Valine	Protein synthesis; Substrate for synthesis of essential nonprotein compounds; Source of amino groups for synthesis of nonessential amino acids; Source of carbon skeletons for synthesis of various organic compounds including glucose and nonessential amino acids; Fuel—oxidation or conversion to carbohydrate or fat for storage
	Sufficient total amino acids to supply amino groups for synthesis of nonessential amino acids	
Lipids	n-6 Essential fatty acids (e.g., linoleic acid) n-3 Essential fatty acids (e.g., α-linolenicacid)	Fuel—oxidation or storage; Carbon skeletons for synthesis of various organic compounds in body; Polyunsaturated (n-6 and n-3) fatty acids are required for synthesis of eicosanoids, inositol phosphoglycerides, sphingolipids, and membrane phospholipids
	Sufficient dietary lipids to ensure adequate absorption of fat-soluble vitamins	
Vitamins		
B vitamins	Niacin	Synthesis of coenzymes NAD(H) and NADP(H) that participate in oxidation-reduction reactions; Substrate for ADP-ribosylation of macromolecules
	Thiamin	Synthesis of coenzyme thiamin pyrophosphate (TPP) that is required by transketolase and α-ketoacid dehydrogenase complexes
	Riboflavin	Synthesis of coenzymes FAD and FMN that participate in oxidation-reduction reactions
	Vitamin B_{12}	Synthesis of coenzymes deoxyadenosylcobalamin and methylcobalamin that participate in the metabolism of methionine and of propionyl/methylmalonyl CoA, respectively
	Folate	Synthesis of folate coenzymes, including tetrahydrofolate, methyl-tetrahydrofolate, methylene-tetrahydrofolate, and 10-formyl-tetrahydrofolate; the coenzymes are required for the metabolism of glycine, serine, methionine, and histidine, and the synthesis of purines and dTMP
	Vitamin B_6	Synthesis of coenzymes pyridoxal 5'-phosphate (PLP) and pyridoximine 5'-phosphate (PMP) that are involved in amino acid metabolism
	Pantothenic Acid	Synthesis of coenzyme A; Synthesis of acyl carrier protein domain of fatty acid synthase
	Biotin	Coenzyme for synthesis of holocarboxylases
Other Vitamins	Vitamin C	Electron donor for enzymatic and nonenzymatic reactions
	Vitamin A	Precursor of 11-*cis*-retinal required for visual function; Precursor of all-*trans* retinoic acid and other metabolites that bind retinoid nuclear receptors
	Vitamin D	Precursor of vitamin D hormone
	Vitamin E	Lipid-soluble antioxidant
	Vitamin K	Substrate for γ-glutamylcarboxylase

[continued]

TABLE 1 (CONTINUED)

Summary of nutrients and their functions

Nutrient class	Essential compounds in class	Function in body
Minerals		
Macroelements	Calcium	Regulation of cellular activities by intracellular Ca^{2+} (2^d messenger function); Activation of certain proteins; Effects on excitability of nerve and muscle tissues; Component of mineralized tissue
	Phosphorus	Substrate for synthesis of nucleotides, DNA and RNA, phospholipids, signaling molecules, creatine phosphate, and other phosphoesters; Regulation of protein function via phosphorylation of tyrosyl, seryl, or threonyl residues of proteins; Substrate for oxidative phosphorylation (ATP synthesis); Component of mineralized tissue; Acid-base buffer system
	Magnesium	Anion charge neutralization (e.g., $Mg^{2+}\cdot ATP^{4-}$); Essential for function of certain proteins; Stabilization of DNA and RNA structures
	Sodium	Membrane potentials of all cells and excitability of nerve and muscle tissues; Major extracellular cation; Generation and maintenance of electrical and osmotic gradients; Nutrient transport
	Potassium	Major intracellular cation; Membrane potential and excitability of nerve and muscle tissues
	Chloride	Major inorganic anion in body fluids
	(Sulfur)	Not essential as sulfur because sufficient inorganic sulfur is formed from catabolism of methionine and cysteine; Synthesis of Fe-S cluster proteins, various sulfoesters, including those in glycosaminoglycans
Microelements		
	Iron	Synthesis of heme proteins, iron-sulfur cluster proteins, Fe-containing metalloenzymes
	Zinc	Conformation of zinc-finger proteins; Metalloenzymes—catalytic and noncatalytic roles
	Copper	Metalloenzymes—catalytic role
	Manganese	Metalloenzymes—catalytic and regulatory roles
	Iodine	Synthesis of thyroid hormone
	Molybdenum	Synthesis of Mo-containing coenyzme
	Selenium	Synthesis of selenocysteinyl residues of selenoproteins
	Boron and Chromium?	Probably are essential
	Nickel, Vanadium, Silicon, Arsenic, and Fluorine?	Possibly are essential (Although fluorine is not known to be nutritionally essential, its health benefits in prevention of dental caries are significant and fluoride intake, mainly from water, is recommended.)
	(Cobalt)	Vitamin B_{12} contains cobalt, but inorganic cobalt is not required

eggs, and vegetables such as broccoli, spinach, and mushrooms are also good sources. Enriched flour and enriched breakfast cereals also contribute significantly to riboflavin intakes. The RDA for riboflavin is 1.3 mg for men and 1.1 mg for women (Institute of Medicine, 1998). Some amounts of common foods that would need to be consumed to supply 1.3 mg of riboflavin (assuming they were the sole dietary source of this vitamin) are 3 cups milk, 1¼ pounds beef round, 8 large eggs, 4⅓ cups broccoli, or 65 slices whole wheat bread. Daily intakes of riboflavin in the United States average about 1.5 to 2 mg for adults (Institute of Medicine, 1998).

Following ingestion, flavin coenzymes are released from noncovalent attachment to proteins by gastric acidification and subsequent proteolysis. Nonspecific pyrophosphatases and phosphatases act on coenzyme forms to release riboflavin. Covalently bound flavin coenzymes make up about 5 percent to 10 percent of the riboflavin naturally occurring in foods, and the 8α-(amino acid)-riboflavins obtained from their digestion cannot by used for resynthesis of coenzymes. Free riboflavin is actively taken up from the small intestine. Riboflavin and small amounts of riboflavin catabolites are excreted in urine.

Riboflavin is required for synthesis of flavin mononucleotide (FMN), which is riboflavin 5′-phosphate, and flavin-adenine dinucleotide (FAD). Fully reduced forms of these coenzymes are indicated by $FMNH_2$ and $FADH_2$. Riboflavin coenzymes are involved in oxidation-reduction reactions in which the ring portion of the coenzyme undergoes sequential addition or loss of hydrogens and electrons. Flavoproteins function in either one- or two-electron transfer reactions.

The flavin coenyzmes, FAD and FMN, function indispensably in oxidation-reduction reactions involved in the catabolism of glucose, fatty acids, ketone bodies, and amino acids, as well as in energy production via the respiratory chain and in reductive biosynthetic reactions.

Inadequate dietary intake of riboflavin can result in stunting of growth, a variety of lesions involving the skin and the epithelium of the gastrointestinal tract, anemia, and neuropathy. Riboflavin has a low toxicity, perhaps because of its low solubility or ready excretion in the urine. No tolerable upper intake level has been established because of a lack of suitable data.

Thiamin

Thiamin, also known as vitamin B_1, is 3-(2-methyl-4-aminopyrimidinyl)methyl-4-methyl-5-(β-hydroxyethyl)thiazole. Excellent sources of thiamin include unrefined cereal germs and whole grains, meats (especially pork), nuts, and legumes. Enriched flours and grain products in the United States contain thiamin, as well as niacin, riboflavin, iron, and folic acid.

The RDAs for thiamin are 1.2 mg of thiamin for men and 1.1 mg for women (Institute of Medicine, 1998). Typical intakes of thiamin in the United States average 1.2 to 2.0 mg per day for adults (Institute of Medicine, 1998). The recommended 1.2 mg of thiamin per day is provided by a 3½-ounce pork chop, 20 slices of whole wheat bread, 1⅔ cups of pecan halves, or 17 ounces of roasted peanuts.

Thiamin is released from its phosphate ester forms in which it is found in most natural foods by the action of pyrophosphatases and phosphatases in the small intestine. Free thiamin is absorbed by an active transport process that is probably carrier mediated. Trapping of thiamin as thiamin pyrophosphate in the mucosal cells appears to facilitate the uptake by metabolic trapping. Excess thiamin is excreted in the urine as various metabolites.

Raw fish may contain microbial thiaminases, which hydrolyze and, thus, destroy thiamin in the gastrointestinal tract. Certain thiamin antagonists that are found in coffee, tea, rice bran, and heme-containing animal products can impair thiamin uptake or utilization. Chronic alcoholism results in impaired thiamin absorption, which may be secondary to a folate deficiency. Thiamin requirements also appear to be elevated in individuals with high caloric intakes, especially when calories are derived primarily from carbohydrates, in renal patients undergoing long-term dialysis, in patients fed intravenously for long periods, and in patients with chronic febrile infections.

Thiamin is required for synthesis of thiamin pyrophosphate (TPP), which is also known as thiamin diphosphate (TDP); this may be the sole coenzyme form of thiamin. However, monophosphate and triphosphate esters occur naturally, and thiamin triphosphate has been implicated in nerve function. TPP functions in two general types of reactions in which TPP functions as a Mg^{2+}-coordinated coenzyme for "active aldehyde transfers." First, TTP is a coenzyme for the oxidative decarboxylation of α-keto acids (catalyzed by the pyruvate, α-ketoglutarate, and branched-chain keto acid dehydrogenase complexes). Second, TPP is required as a coenzyme for transketolase, which catalyzes sugar rearrangements in the pentose phosphate pathway of glucose metabolism.

Thiamin deficiency, or beriberi, affects the nervous and cardiovascular systems. Clinical symptoms include mental confusion, anorexia, muscular weakness, ataxia, peripheral paralysis, paralysis of the motor nerves of the eye, edema, muscle wasting, tachycardia, and an enlarged heart. In Western countries, symptomatic thiamin deficiency is usually observed only in association with alcoholism.

No toxic effects of thiamin administered by mouth have been reported in humans, and thiamin is readily cleared by the kidneys. Injection of doses of thiamin that are more than 200 times those required for optimal nutrition produces a variety of pharmacological effects and can even induce death because of depression of the respiratory center. No tolerable upper intake level has been established for thiamin because of a lack of sufficient data.

Vitamin B_{12}

Vitamin B_{12}, or cobalamin, consists of a central cobalt atom coordinately linked to the four pyrrole nitrogens of a heme-like planar corrin ring structure. The 5th coordinate bond of cobalt is to one of the nitrogens in a phosphoribo-5,6-dimethylbenzimidazolyl side group of the corrin ring structure, and the 6th coordinate bond of cobalt can be occupied by a number of ligands. In vitamin B_{12} preparations, this ligand is typically a cyano group that is formed by trace amounts of cyanide during purification of the vitamin from natural sources.

Vitamin B_{12} is synthesized by some anaerobic microorganisms and by some algae, such as seaweed. Most plants and higher organisms do not use vitamin B_{12} as a coenzyme, and they do not synthesize it. Vitamin B_{12} is found in meat, dairy products, some seafoods, and in fortified cereals. A strictly vegetarian diet contains low levels of vitamin B_{12}, most of which come from algal sources or possibly microbial contamination associated with plant roots.

The RDA for vitamin B_{12} is 2.4 micrograms for adults (Institute of Medicine, 1998). This amount of vitamin B_{12} can be obtained from ⅒ ounce of beef liver, 1 egg, or 2⅔ ounces of canned tuna. Typical intake of vitamin B_{12} in the United States averages 3.3 to 5.6 micrograms per day for adults (Institute of Medicine, 1998).

Absorption of vitamin B_{12} is a complex process. Vitamin B_{12} in food must be released from proteins to which it is naturally bound; this is accomplished in the stomach by the acid environment and by proteolysis of proteins by pepsin. The vitamin B_{12} then binds to other proteins that have affinity for vitamin B_{12}, but these binding proteins are hydrolyzed by pancreatic proteases in the small intestine. The free vitamin B_{12} then binds to an intrinsic factor, which is a high-affinity vitamin B_{12}-binding protein secreted by the gastric glands. The vitamin B_{12}-intrinsic factor complex binds to receptors located near the end of the small intestine, and the complex is taken up by endocytosis. The intrinsic factor is degraded by lysosomal enzymes, and free vitamin B_{12} is released into the cytosol of the mucosal cells. The vitamin B_{12} is released from the intestinal mucosal cells into the plasma as a complex with another protein, transcobalamin II. The transcobalamin II-B_{12} complex is transported into tissues by receptor-mediated endocytosis; the complex is degraded in the lysosome, and the free vitamin B_{12} is transported out of the lysosome into the cytosol.

Vitamin B_{12} is excreted from the body in the urine. It is also secreted in the bile, but vitamin B_{12} secreted in the bile is normally reabsorbed via the enterohepatic circulation. Vitamin B_{12} is needed for synthesis of two coenzymes: methylcobalamin, which is a cofactor for cytosolic methionine synthase, and 5′-deoxyadenosylcobalamin, which is a cofactor for mitochondrial methylmalonyl CoA mutase.

Vitamin B_{12} deficiency seldom is caused by a dietary lack of the vitamin and most commonly is because of a defect in vitamin B_{12} absorption. Malabsorption of vitamin B_{12} can result from a lack of intrinsic factor secretion, decreased gastric acid production, or pancreatic enzyme insufficiency. Food vitamin B_{12} is malabsorbed by many elderly individuals, and it is recommended that adults older than 50 years ingest adequate vitamin B_{12} from supplements or fortified foods. Symptoms of vitamin B_{12} deficiency include megaloblastic anemia and a severe, and often irreversible, neurological disease called subacute combined degeneration.

No toxicity of vitamin B_{12} has been reported. Absorption is limited by the amount of intrinsic factor secreted. No tolerable upper intake level has been established for vitamin B_{12} because of lack of suitable data.

Vitamin B_6

Vitamin B_6 refers to several 4-substituted 2-methyl-3-hydroxyl-5-hydroxymethylpyridine compounds, which include pyridoxal, pyridoxine, pyridoxamine, and their respective 5′-phosphate derivatives. Good sources of vitamin B_6 include cereals, meat, especially organ meats, poultry, fish, starchy vegetables, and noncitrus fruits and juices.

The RDA for vitamin B_6 is 1.3 mg for adults (Institute of Medicine, 1998). The median intake of vitamin B_6 from food sources (i.e., not including supplements) is about 2 mg for men and about 1.5 mg for women. Amounts of some foods that would by themselves supply the daily RDA for vitamin B_6 include 1⅓ whole chicken breasts, 2 bananas, 1⅓ cups of oatmeal, 12 cups of milk, or 22 large eggs.

Phosphate derivatives of vitamin B_6 are hydrolyzed by phosphatase prior to uptake from the small intestine. Some plants contain pyridoxine as a glucoside derivative; these normally are deconjugated by a mucosal glucosidase before the pyridoxine is absorbed. Vitamin B_6 in a mixed diet is about 75 percent bioavailable, whereas the vitamin B_6 in supplements is about 90 percent bioavailable. Vitamin B_6 is absorbed by a nonsaturable passive diffusion mechanism with metabolic trapping of the vitamers by formation of the phosphate derivatives. Excess vitamin B_6 is excreted in the urine. The major excretory form of vitamin B_6 is the 4-carboxylate derivative 4-pyridoxic acid, but unmetabolized vitamin also is excreted and may be the major excretory form when very high doses of vitamin B_6 are ingested.

Vitamin B_6 is used to form pyridoxal phosphate (PLP), this vitamin's major coenzyme form. PLP binds to proteins and PLP-dependent enzymes via Schiff base formation with the ε-amino group of specific lysyl residues in the proteins. PLP serves as a coenzyme for many enzymes involved in amino acid metabolism, including aminotransferases, decarboxylases, aldolases, racemases, and dehydratases. Aminotransferase reactions convert the coenzyme between the PLP and pyridoxamine phosphate forms.

Vitamin B_6 deficiency can result in seborrheic dermatitis, microcytic anemia (because of decreased hemoglobin synthesis), convulsions, depression, and confusion. Low vitamin B_6, folate, or vitamin B_{12} intakes can lead to an elevated plasma homocysteine level. Alcoholics tend to have low vitamin B_6 status.

Some subjects taking very large pharmaceutical doses of pyridoxine have developed severe sensory neuropathy. There is some evidence for toxicity at daily doses of 500 mg or more, and a safe upper level of intake is thought to be 100 mg/day. The tolerable upper intake level set for vitamin B_6 by the Institute of Medicine (1998) is 100 mg/day for adults.

Pantothenic Acid

Pantothenic acid, also known as vitamin B_5, consists of a β-alanine moiety condensed with pantoic acid. Pantothenic acid is distributed widely in plant and animal sources. Meat (especially liver), fish, poultry, milk, yogurt, legumes, and whole-grain cereals are good sources of pantothenic acid. Pantothenic acid is present in foods in the free form and in various bound forms, including coenzyme A, coenzyme A esters, acyl carrier protein, and glucosides.

The Adequate Intake established for pantothenic acid by the Institute of Medicine (1998) is 5 mg per day for adults. This amount of pantothenic acid can be obtained by eating 2½ cups of peanuts, 6 eggs, 3 whole chicken breasts, 6½ cups of milk, or 19 slices of whole wheat bread. The average dietary intake of pantothenic acid in the United States is about 5 to 6 mg, with somewhat lower average intakes in the elderly and young children.

Dietary coenzyme A, coenzyme A esters, and acyl carrier protein are degraded enzymatically in the small intestine to release free pantothenic acid. Pantothenic acid is taken up by active transport. Approximately 50 percent of dietary pantothenic acid is available. Pantothenic acid is excreted unchanged in the urine. The kidneys regulate excretion of pantothenic acid, secreting it when plasma concentrations are high and largely reabsorbing it when plasma concentrations are in the physiological range.

Cells use pantothenic acid to synthesize coenzyme A, which consists of pantothenate linked to cysteamine by a peptide bond and to a 3′-phospho-ADP moiety via a phosphoester linkage. Coenzyme A contains a reactive sulfhydryl group that is involved in the formation of thioesters with fatty acids and other carboxylic acids. Coenzyme A plays a major role in fatty acid metabolism and in the final oxidative steps in the catabolism of all fuels. Much of the metabolism of fatty acids and certain amino acid derivatives, as well as a numerous amphibolic steps in metabolism, use coenzyme A thioester substrates and produce coenzyme A thioester products. Coenzyme A also is used for the synthesis of the acyl carrier protein domain of fatty acid synthase, a multifunctional enzyme that catalyzes palmitate synthesis. Coenzyme A is involved in oxidative decarboxylation reactions catalyzed by α-keto acid dehydrogenase complexes, β-oxidation of fatty acids, ketone body synthesis, fatty acid and triacylglycerol synthesis, amino acid and organic acid catabolism, and in synthesis of isoprenoids, cholesterol, and steroids.

A naturally occurring deficiency of pantothenic acid has not been documented reliably and is undoubtedly rare because of the wide distribution of pantothenic acid in foods. Pantothenic acid deficiency has been produced experimentally in a small number of volunteers via a pantothenic acid-free diet; these volunteers appeared listless and complained of fatigue after nine weeks on the pantothenic acid-free diet. A "burning feet" syndrome that was observed among prisoners of war and among malnourished individuals in Asia may have been because of pantothenic acid deficiency, as symptoms appeared to be reduced by pantothenic acid.

Pantothenic acid is relatively nontoxic. Doses below 10 g of pantothenic acid per day do not seem to be associated with any toxic symptoms. No tolerable upper intake limit was set by the Institute of Medicine (1998) because of insufficient data.

Biotin

Biotin contains a ureido group attached to a tetrahydrothiophene ring and has a valeric acid side chain extending from the tetrahydrothiophene ring. Biotin is synthesized by bacteria, yeast, algae, and some plant species. Biotin is distributed widely in foods, existing both as free biotin and as biotin covalently bound to lysyl residues in biotinyl-proteins. Liver, whole-grain cereals, nuts, legumes, yeast, and egg yolks are relatively high in biotin. Biotin is synthesized by microflora in the large intestine, but biotin produced at that site appears to be excreted mainly in the feces.

The Adequate Intake for biotin, as set by the Institute of Medicine (1998), is 30 micrograms per day for adults. About 3 ounces roasted peanuts, 3 medium eggs, 5 cups of milk, ⅓ cup of peanut butter, or 1⅓ cups of oatmeal will provide 30 micrograms of biotin. The daily intake of biotin in Western countries is estimated to be about 60 micrograms per day.

Digestion of proteins releases biotinyl-lysine (biocytin) and small lysine-containing peptides with biotin attached covalently. These are hydrolyzed to release free biotin by a specific hydrolase called biotinidase that is present in the pancreatic digestive secretions. Free biotin is transported into the mucosal cells of the small intestine by a carrier-mediated, sodium-dependent process.

Biotin is excreted as such and as several degradation products. Degradation products include bisnorbiotin, in which the 5-carbon valerate side chain has been shortened by two carbons, and biotin sulfoxide, in which the thiophene ring sulfur has been oxidized to a sulfoxide.

The only known function of biotin in humans and other mammals is as a prosthetic group for four carboxylases: pyruvate carboxylase, acetyl CoA carboxylase, propionyl CoA carboxylase, and 3-methylcrotonyl CoA carboxylase (in the pathway of leucine catabolism). Holocarboxylase synthetase attaches biotin to the apocarboxylases in an ATP-requiring reaction; the biotin is attached by an amide bond to an ε-amino group of a specific lysyl residue in the enzyme protein. In the holocarboxylases, biotin serves as a CO_2 carrier and carboxyl donor to substrates.

A dietary deficiency of biotin is very rare because of the wide distribution of biotin in foods. Biotin deficiency with clinical symptoms of hair loss, dermatitis, and neurological symptoms has occurred in individuals consuming an abnormal diet that is low in biotin and high in raw egg white. Raw egg white contains avidin, a protein that binds biotin with a very high affinity and prevents its uptake from the intestine. Biotin deficiency may occur in individuals who routinely take certain anticonvulsants or in individuals with severe protein-energy malnutrition. 3-Hydroxyisovalerate is elevated in the urine of biotin-deficient subjects.

Intakes of biotin up to 10 mg per day have not been reported to be associated with toxicity. No tolerable upper intake level has been set for biotin because of lack of data. Inborn errors of biotin metabolism, biotinidase deficiency and holocarboxylase synthetase deficiency, can both be treated with pharmacological doses of biotin.

Vitamin C

Ascorbic acid or vitamin C is a 6-carbon lactone synthesized from glucose by plants and many animals. Humans, as well as nonhuman primates and several other species, are unable to synthesize ascorbic acid because of a lack of gulonolactone oxidase, the terminal enzyme in the biosynthetic pathway.

Ascorbic acid is found in many fruits and vegetables. Some dietary vitamin C is present as an oxidized form, dehydroascorbic acid. Cantaloupe, kiwi, oranges, lemons, strawberries, and watermelon are especially high in vitamin C. Vegetables that are rich sources of vitamin C include broccoli, red peppers, cauliflower, brussels sprouts, asparagus, potatoes, cabbage, spinach, collard greens, green peas, and carrots. Citrus juices and tomato juice are good sources of vitamin C. Many foods, such as fruit drinks and breakfast cereals, are fortified with vitamin C.

The current RDA for vitamin C is 75 mg for women and 90 mg for men (Institute of Medicine, 2000). An additional 35 mg per day is recommended for smokers. The adult female RDA is contained in ¾ cup orange juice, 1 orange, 1 kiwi, ⅓ cantaloupe, 1 small sweet pepper, 2 cups broccoli, or 3 baked potatoes. Typical intake of vitamin C by adults is 70 to 100 micrograms per day.

Ascorbic acid absorption probably occurs by a Na^+-dependent system in the intestine. Bioavailability is close to 100 percent for vitamin C at doses between 15 and 200 mg but declines at higher doses. Ascorbic acid and its metabolites are excreted mainly in the urine.

Ascorbic acid acts as an electron donor, or reducing agent. Two electrons are lost, probably sequentially, with formation of semidehydroascorbic acid (free radical) and dehydroascorbic acid. Dehydroascorbic acid can be enzymatically or nonenzymatically reduced back to ascorbate or hydrolyzed irreversibly to 2,3-diketogulonic acid, which is converted to other products, including oxalate.

Vitamin C acts as an electron donor for eight mammalian enzymes: three dioxygenases that are involved in collagen hydroxylation (prolyl 4-hydroxylase, prolyl 3-hydroxylase, and lysyl hydroxylase), two dioxygenases that are involved in carnitine synthesis (6-N-trimethyl-L-lysine hydroxylase and γ-butyrobetaine hydroxylase), 4-hydroxyphenylpyruvate dioxygenase, dopamine β-hydroxylase, and peptidylglycine α-amidating monooxygenase. Ascorbic acid may also function in nonenzymatic reduction reactions and thus acts as a water-soluble antioxidant.

An early sign of vitamin C deficiency is fatigue. With more severe deficiency, petechial hemorrhage, coiled hairs, ecchymoses, bleeding and tenderness of the gums, hyperkeratosis, joint pain, and shortness of breath may occur.

Vitamin C is relatively nontoxic. Excess vitamin C may promote the formation of oxalate kidney stones. The tolerable upper intake level, or maximum intake level likely to pose no risk of adverse health effects in most individuals, was set at 2000 mg ascorbic acid per day from food plus supplements (Institute of Medicine, 1998).

Vitamin K

Vitamin K refers to a group of compounds that are 2-methyl-1,4-napthoquinones with a hydrophobic substituent at the 3-position. Phylloquinone (vitamin K_1), which is synthesized by plants, has a 20-carbon phytyl substituent at the 3-position of the napthoquinone ring. Menaquinones (vitamin K_2) are synthesized by bacteria and have an unsaturated side chain, made up of four to thirteen isoprenyl units, instead of the saturated phytyl chain present in phylloquinone. Animal tissues contain both phylloquinone and menaquinones. In addition to these naturally occurring compounds with vitamin K activity, a synthetic form of vitamin K called menadione can be alkylated to an active form in the liver and is used in animal feeds. Human vitamin K supplements are phylloquinone.

Green vegetables are the major dietary source of phylloquinone: kale, spinach, broccoli, brussels sprouts, cabbage, and lettuce are rich sources. Some vegetable oils, especially soybean oil and rapeseed (canola) oil, are good sources. Menaquinones, which are obtained especially from liver, provide only a minor portion of the vitamin K needed to meet the requirement. The nutritional significance of menaquinones synthesized by bacteria in the lower bowel is uncertain.

The RDA for vitamin K for adults who are age twenty-five years and older is 65 and 80 micrograms for women and men, respectively (National Research Council, 1989). The RDA for males is provided by ⅓ ounce of spinach or kale, ⅓ cup of broccoli, ⅔ cup of shredded cabbage, or 2¼ ounces of lettuce. Typical intake of vitamin K by adults is 70 to 100 micrograms per day.

Absorption of dietary vitamin K depends upon adequate lipid absorption. Vitamin K is incorporated into chylomicrons, along with other lipids, and ultimately is taken up by the liver as part of the chylomicron remnants. Vitamin K is stored in liver; the hepatic phylloquinone pool turns over more rapidly than that of menaquinones. Vitamin K is excreted predominantly as metabolites and glucuronides; these are excreted primarily in feces via the bile, but significant amounts are also excreted in urine.

The hydroquinone form of vitamin K is required for the posttranslational modification (γ-glutamylcarboxylation) of a group of proteins (referred to as Gla proteins or vitamin K-dependent proteins) during their synthesis. Vitamin K serves as substrate, or coenzyme, for an enzyme that converts targeted glutamyl residues to γ-carboxyglutamyl (Gla) residues in these proteins. This posttranslational modification of glutamyl residues is essential for the normal physiological function of vitamin K-dependent proteins. Continued function of vitamin K in γ-glutamylcarboxylation reactions is dependent upon the recycling of oxidized vitamin K (vitamin K epoxide) back to the hydroquinone form (vitamin KH_2).

Vitamin K-dependent proteins include four plasma clotting proteins (prothrombin, factor VII, Factor IX, and factor X), two plasma proteins involved in thrombin-initiated inactivation of factor V (protein C and protein S), plasma protein Z of uncertain function, and two bone proteins (osteocalcin, or bone Gla protein, and matrix Gla protein). At physiological pH, both carboxyl groups of each Gla residue are negatively charged, and these anionic residues are involved in the association of Gla proteins with Ca^{2+}.

Primary vitamin K deficiency is rare. Vitamin K-responsive hemorrhagic disease of the newborn can occur because of low vitamin K stores in the liver of the newborn and the low vitamin K content of human milk, along with other factors. In developed countries, commercial infant formulas are supplemented routinely with phylloquinone, and the practice of oral or intramuscular administration of phylloquinone to the newborn is almost universal. Vitamin K deficiency also has been reported in adults with low intakes of vitamin K who are receiving antibiotics and in patients subjected to long-term total parenteral nutrition without vitamin K supplementation. Vitamin K status should be of concern in disorders of lipid digestion or absorption and in persons treated with anticoagulant drugs that act by blocking reduction of oxidized vitamin K.

Toxic manifestations from ingestion of large amounts of vitamin K have not been reported. Menadione administration to infants has been associated with hemolytic anemia and liver toxicity, and should not be used for human supplements.

Vitamin E

Vitamin E is the term used for all tocopherols and tocotrienols and their derivatives that exhibit vitamin E activity. Tocopherols are more important sources of vitamin E. Both the tocopherols and tocotrienols consist of a chromanol head and a phytyl tail. The side chain of tocopherols is saturated, whereas that of tocotrienols contains double bonds at the 3′, 7′, and 11′ positions. Four tocopherols and four tocotrienols occur naturally; they differ in the number and position of the methyl groups on the chromanol ring. The naturally occurring isomer of α-tocopherol is the 2′R, 4′R, 8′R isomer, whereas synthetic tocopherols are mixtures of all eight possible stereoisomers.

Tocopherols in foods exist primarily as the free or unesterified forms. Ester forms (e.g., α-tocopheryl acetate or α-tocopheryl succinate) are less susceptible to oxidation and are used for food fortification and for supplements. The 6-hydroxyl group on the phenolic ring is the site for esterification of fatty acids.

A variety of naturally occurring RRR-α-tocopherols and tocotrienols are supplied by foods. Tocopherols differ in their antioxidant and biological activities. Currently, the biological activity of various forms of vitamin E are expressed as units of activity in relation to that of all-*rac*-α-tocopheryl acetate, which is a common pharmaceutical or synthetic form of vitamin E. The unit used to express vitamin E activity is the α-tocopherol equivalent (α-TE) with 1 equivalent equal to 1.49 mg of all-*rac*-α-tocopheryl acetate or 1.0 mg of RRR-α-tocopherol. The majority of the tocopherols consumed in the diet are not α-tocopherol, and γ-tocopherol accounts for more than half the estimated total tocopherol intake. Rich sources of vitamin E include vegetable oils, vegetable shortenings, margarines, mayonnaise, salad dressings, wheat germ, rice bran, nuts, seeds, peanut butter, eggs, potato chips, whole milk, and tomato products.

The RDA for vitamin E is 15 mg α-TEs for adults. This amount of vitamin E could be provided by 4 teaspoons of soybean oil, ⅔ cup of margarine, 2 cups of whole milk, 4½ cups of green peas, or 2 pounds of salmon. The average intake of vitamin E from American diets is 11 to 13 mg α-TEs daily in adults not taking vitamin E supplements.

Tocopheryl esters are hydrolyzed to free tocopherol in the small intestinal lumen, presumably by pancreatic esterases. Vitamin E is absorbed with other lipids, and the majority of the vitamin E is incorporated into chylomicrons in the mucosal cells of the small intestine. The chylomicrons are secreted into the lymph and then enter the circulation. Vitamin E is taken up by the liver in the chylomicron remnants and is then either stored in the parenchymal cells of the liver, incorporated into nascent very low density lipoproteins (VLDL) that are secreted into the blood stream, or excreted via the bile. Both vitamin E and its metabolites are primarily excreted in the feces via biliary secretion from the liver. Some metabolites are excreted in the urine.

Vitamin E is the major lipid-soluble, chain-breaking antioxidant found in plasma, red cells, and tissues, and it plays an essential role in maintaining the integrity of biological membranes. Among the biological functions proposed for vitamin E, the reaction of α-tocopherol with lipid peroxyl radicals to prevent uncontrolled free radical-initiated lipid peroxidaion is the best understood. Whether other tocopherols have other roles is uncertain.

Patients with familial isolated vitamin E deficiency have clear signs of vitamin E deficiency (extremely low plasma vitamin E levels and neurological abnormalities—spinocerebellar dysfunction with progressive ataxia) but do not have fat malabsorption or lipoprotein abnormalities. Absence of hepatic α-tocopherol transfer protein impairs secretion of α-tocopherol into hepatic lipoproteins (VLDL) and appears to be responsible for the low plasma vitamin E status of patients with familial isolated vitamin E deficiency and the low delivery of vitamin E to tissues. In humans, low plasma levels of vitamin E are associated with shorter lifespans of red blood cells because of their increased susceptibility to hemolysis. Vitamin E deficiency is rarely associated with lipid malabsorption syndromes or lipoprotein abnormalities. Neurological symptoms occur in individuals with malabsorption syndromes as well as in individuals with familial isolated vitamin E deficiency.

Vitamin E is relatively nontoxic when taken by mouth. The upper tolerable intake level set by the Institute of Medicine (2000) is 1000 mg of α-TEs per day from vitamin E supplements in addition to dietary intake. Consumption of more than this increases risk of hemorrhagic damage because vitamin E can act as an anticoagulant.

Potassium

Potassium (K^+) is distributed widely in the body and is the principal cation in intracellular fluids. Like sodium and chloride ions, potassium ions exist as free hydrated ions that bind only weakly to organic molecules. Potassium functions in the maintenance of electrolytic and osmotic balances or gradients. The distribution of potassium between the intracellular and extracellular fluids is the result of ion pumps and of the permeability characteristics of cell membranes. The Na^+, K^+-ATPase pump, which moves 3 Na^+ out of the cell in exchange for 2 K^+ that are moved into the cell, is of particular importance.

Potassium is widely distributed in foods, especially in fruits and vegetables. Rich sources of potassium include fruits such as avocado, banana, cantaloupe, orange juice, and watermelon; vegetables such as lima beans, potatoes, tomatoes, spinach, and winter squash; and fresh meats.

Obligatory losses of potassium, which must be replaced, average about 800 mg of potassium per day. The estimated minimum requirement for potassium established by the National Research Council (1989) is 2 g per day for adults. Two grams of potassium are provided by 4 cups of fresh orange juice, 5½ small bananas, 5 medium potatoes, or 9⁄10 pound of beef chuck. Typical Western diets provide about 3 g of potassium per day.

Over 90 percent of the potassium in the diet is absorbed from the gut into the circulation. However, although nearly all of the dietary K^+ is absorbed in the small intestine, there is normally some net secretion of K^+ in the colon that results in loss of potassium in the feces. Absorption of dietary K^+ causes a rise in the concentration of K^+ in the plasma, and this immediately stimulates physiological mechanisms to promote rapid entry of K^+ into cells so that a rapid rise in the plasma K^+ concentration is prevented. Uptake of K^+ by cells is essential in preventing life-threatening hyperkalemia. Nevertheless, in the long-term, to maintain K^+ balance, the excess K^+ from the diet must be excreted by the kidneys.

At typical potassium intakes, renal tubular secretion of K^+ is required to maintain potassium balance. Renal secretion of K^+ is under the control of various homeostatic regulatory mechanisms. The most important hormone regulating secretion of K^+ is aldosterone, the release of which is triggered by a high concentration of K^+ in plasma (or a low concentration of Na^+ or by angiotensin II). When potassium intake is high, secretion of K^+ by the colon as well as the kidney is increased to eliminate the excess potassium.

During potassium depletion, the kidney reabsorbs most of the filtered K^+, and essentially no K^+ is secreted. The small amount of K^+ excreted in the urine under these circumstances comes from the filtered K^+ that escaped reabsorption.

The high concentration gradient of K^+ between the intracellular fluid and the extracellular fluid is important for generation and maintenance of the normal resting membrane potentials across cell membranes and for excitability of nerves and muscles. Higher intakes of potassium may have beneficial effects in preventing hypertension.

Dietary deficiency of potassium does not occur under normal circumstances. Large losses can occur, by either gastrointestinal or renal routes, in cases of prolonged vomiting, chronic diarrhea, use of diuretic agents, some forms of chronic renal disease, and in some metabolic disturbances such as metabolic acidosis. Hypokalemia causes membrane hyperpolarization, and this can interfere with the normal functioning of nerves and muscles, resulting in muscle weakness and decreased smooth muscle contractility. Deficiency symptoms include weakness, anorexia, nausea, drowsiness, and irrational behavior.

Acute hyperkalemia can result from sudden enteral or parenteral increases in potassium intake to amounts of about 18 g per day for an adult. Hyperkalemia causes membrane depolarization, causing muscular weakness, flaccid paralysis, and cardiac arrhythmias. Severe hyperkalemia can cause cardiac arrest and death.

Chloride

Chloride is the principal inorganic anion in the extracellular fluids of the body. Dietary chloride comes almost entirely from sodium chloride, and a small amount comes from potassium chloride. Thus, table salt and foods or beverages that contain NaCl added during food processing or preparation are the major sources of chloride in the diet. The amount of chloride contributed by water is low compared to that contributed by salt.

The estimated minimum requirement for chloride is 750 mg/day for adults, which corresponds to about 1.3 g of sodium chloride per ¼ teaspoon of table salt). Typical salt intake in the United States is higher than this. It is recommended that daily salt intake should not exceed 6 g because of the association of high intake with hypertension.

Loss of fluids through the skin, feces, and urine cause loss of both sodium and chloride. Chloride movement tends to parallel that of sodium, and loss of sodium usually is accompanied by a similar molar loss of chloride. Thus, conditions that cause loss of sodium (e.g., heavy losses through sweating, chronic diarrhea or vomiting, trauma, or renal disease) also cause loss of chloride and can result in hypochloremic metabolic alkalosis.

Chloride is essential for maintenance of fluid and electrolyte balance. Hydrochloric acid is an essential component of the gastric juice secreted by the stomach.

Deficiency of chloride does not occur under normal circumstances. Toxicity from excess intake of chloride is not known to occur, but water-deficiency dehydration can cause hyperchloremia.

See also **Choline, Inositol, and Related Nutrients; Gene Expression, Nutrient Regulation of; Immune System Regulation and Nutrients; Malnutrition; Malnutrition: Protein-Energy Malnutrition; Nutrition; Vitamin C; Vitamins**; **Appendix**.

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NUTRITION. Food is comprised of nutrients that are classified by their role in the body: the energy-yielding macronutrients (carbohydrates, protein, and fat), the essential micronutrients (vitamins, minerals, and water), and numerous other components. Although micronutrients do not supply energy to fuel the body, they are indispensable for the proper functioning of the metabolic and regulatory activities in the body. Other nonessential nutrients, such as flavonoids, phytoestrogens, carotenoids, and probiotics, also may have important health-promoting properties, and investigations are ongoing. The daily intake of a variety of foods provides energy and nutrients that are essential to the health and well-being of an individual. The relationships among food intake, nutrition, and health define the field of nutrition. More fully, nutrition is the study of food, its nutrients and chemical components, and how these constituents act and interact within the body to affect health and disease.

The scope of the field has grown in recent years and the boundaries between the science of nutrition and many other biological sciences have blurred. For example, the science of nutrition includes chemistry to study how food ingredients interact with each other; physiology to investigate how nutrients within food are assimilated into body tissues; engineering to design new fortified foods; anthropology to explore why we chose to eat certain foods in centuries past; and psychology to determine what attitudes and behaviors influence our dietary patterns today. Nutritionists often have either a college or advanced degree in nutrition or a related field, whereas clinical (human) nutrition specialists will have graduate degrees, which may include medicine, and have completed an examination for certification. Registered dietitians are nutrition professionals who are often responsible for applying nutritional science to clinical practice to promote health and treat disease. Dietitians frequently work in hospitals but also may be employed in universities, public health departments, restaurants, the food industry, and exercise facilities. Similarly, given the broad

PROFESSIONAL NUTRITION CREDENTIALS IN THE UNITED STATES

Certification Board	Type of Certification*
Commission on Dietetic Registration	*DTR:* Dietetic Technician (A.A., B.S., B.A.)
	RD: Registered dietitian (B.S.)
	CSP or *CRD:* Board certified specialist in pediatric or renal nutrition
	FADA: Fellow of the ADA (R.D. and Ph.D., M.S.)
American Board of Nutrition	Clinical Nutrition Specialist (M.D.)
	Human Nutrition Specialist (Ph.D.)
National Board of Nutrition Support Certification	*CNSP:* Certified Nutrition Support Physician (M.D.)
	CNSD: Certified Nutrition Support Dietitian (R.D.)
Certification Board for Nutrition Specialists	*CNS:* Certified Nutrition Specialist (Ph.D., M.S.)

* Type of education required for certification indicated in parentheses.
Italicized acronyms denote the professional credentials required for certification.

scope of the field, other nutrition professionals include but are not limited to physicians, biochemists, anthropologists, epidemiologists, geneticists, food scientists, and engineers.

For this review, the field of nutrition is divided into three major categories: (1) nutrition in research, (2) nutrition in clinical practice, and (3) nutrition in policy and education. An overview of nutritional research is presented, from how nutrients interact within the body and among themselves (nutritional biochemistry), to the investigation of the relationships between specific foods or food groups and the health status of populations (nutritional epidemiology). Research findings in the field provide the information needed to guide nutrition practice for the care of individuals as well as large groups of people. The development of nutrition policy comes from both research and clinical practice advances. Concise descriptions of each are given and a brief history of the field and projected directions of the future of the field are offered.

Nutrition: A Historical Perspective

Numerous advances in the field of nutrition have occurred within the last century. The major focus of nutrition research and practice shifted from concern over which foods are required to avoid nutritional deficiencies and overt illness, to what foods and supplements may be consumed to promote optimal health. Functional foods are a part of the vocabulary, and energy bars, herbal remedies, and nutritional supplement products are now widely available.

In biblical times certain foods were understood to have special healing properties; however, the concept of nutrients as essential for health is relatively new. Recent discoveries in the field have been dependent on the development of scientific methods to analyze nutrient content and interactions. Therefore, though some vitamins were understood to be essential in the early part of the twentieth century, trace elements such as zinc and selenium were not considered essential for humans until the 1970s.

As the field of nutrition has developed, it has also expanded. In 1950 the history of nutrition science during the two previous centuries was summarized by Dr. Elmer McCollum in just under five hundred pages. It would likely take ten volumes of such texts to encapsulate the nutrition-related findings and proceedings from the latter half of the twentieth century. Accomplishments in the field of nutrition over the last century are highlighted in five major eras: (1) food as energy, (2) micronutrient deficiency diseases, (3) nutrition in public policy, (4) nutrition and chronic disease, and (5) nutrition for optimal health.

Food as energy (1880–1920). By the end of the nineteenth century the major, energy-yielding components of food—protein, fat, and carbohydrate—had been identified, and nutrition research, especially concerning the metabolism of proteins and the energy composition of foods, was flourishing. Much of this work had been conducted in animals; therefore, the human nutrition experiments performed by Dr. W. O. Atwater (1844–1907) and colleagues were particularly novel. From their studies, the energy yield of carbohydrate, protein, and fat was derived (4, 4, and 9 kcal per gram, respectively), values that are still used today. Dr. Atwater also developed the first human calorimeter in the United States to measure energy expenditure. However, it was a pair of medical doctors, James Harris and Francis Gano Benedict, who perfected this methodology to establish standards for the energy needs of healthy individuals. Energy expenditure was measured in approximately 250 healthy men and women at the Carnegie Institute Laboratory in Washington, D.C., and equations were derived from the data. The Harris-Benedict energy expenditure prediction equations for men and women, published in 1919, remain some of the most useful tools in clinical nutrition assessment today.

Micronutrient deficiency diseases (1920–1940). The period between 1920 and 1940 brought about a paradigm shift in the understanding of the etiology of some common diseases. Until this time it was thought that all disease resulted from poor sanitation and hygiene; therefore, bacteria, mold, and toxins were identified as the likely cause of disease. As Alfred Harper has suggested, "the concept that a disease might be caused by a deficit of a substance that was nutritionally essential was beyond the grasp even of most nineteenth-century physicians and scientists" (p. 217). In order to combat disease as well as increase shelf life, food was sterilized, milled, and polished to reduce the danger of ingesting bacteria, mold, and toxins. Despite these efforts, pellagra, beriberi, and infantile scurvy actually increased in prevalence. In a number of studies conducted by Dr. Joseph Goldberger from 1914 to the 1920s, where the diets of individuals suffering from pellagra were compared to those of healthy individuals, foods that decreased the presence of diarrhea and dementia in pellagrous individuals were identified. From his work it was later determined that pellagra was due to a diet poor in the vitamin niacin and not infection. At approximately the same time, Dr. Christiaan Eijkman (1858–1930) won a Nobel Prize in medicine (1929) for the discovery of the "antineuritic" vitamin thought to be responsible for curing beriberi. Through his experiments, in which chickens were fed human hospital diets, combined with studies of beriberi in prisoners who survived on polished rice, he hypothesized that the hull of the rice grain contained an antidote to the neurological disorder. Although not completely correct, his observations led to the discovery of the essential vitamin thiamin.

As Kenneth J. Carpenter summarized, "new technologies of food processing that have obvious advantages may also have a downside" (p. 227). While technology decreased infectious disease and increased the shelf life of food products, it inadvertently led to nutritional deficiencies. The heat-sterilization of cow's milk, which destroyed vitamin C, was related to the outbreak of infantile scurvy in well-to-do families. The practices of polishing rice and degerming corn to increase grain stability also led to increased prevalence of beriberi (thiamin deficiency) and pellagra (niacin deficiency), respectively.

Nutrition in public policy (1920–1964). One of the most fruitful periods in the history of public health nutrition followed on the coattails of World War I. It became possible to manufacture the micronutrients that had been identified by chemists as essential for health cheaply and efficiently. In 1922 the first of a series of public health efforts at eradicating nutrient deficiency in the United States was initiated by the voluntary addition of iodine to salt (see Table 1). The fortification of other foods was used to address rampant public health problems such as rickets (vitamin D), beriberi (thiamin), pellagra (niacin), and dental caries (fluoride). Since the initiation of fortification policies in the United States, clinically evident nutritional deficiencies have been virtually eliminated.

The first attempt at defining nutritional requirements was directed toward the prevention of nutrient deficiencies in military personnel during World War II. In the early 1940s the Food and Nutrition Board of the National Academy of Sciences reviewed the scientific evidence and developed the Recommended Dietary Allowances for energy, protein, and eight essential vitamins and minerals. The first national food supplementation program was initiated in 1946 (National School Lunch Act) to improve the dietary intake of children from economically disadvantaged families. Other national food assistance programs were added over the next fifty years.

Nutrition and chronic disease (1960–1990). The last forty years of the twentieth century saw continued discovery in the field of nutritional biochemistry and a new research emphasis on the role of nutrition in the cause of and treatment for chronic disease. Disease patterns shifted from infectious and nutrient deficiency diseases to increasing rates of cardiovascular disease, diabetes, cancer, and osteoporosis. Nutrient deficiencies, when present, were often secondary to restrictive dietary habits, economic deprivation, or the presence of another disease that altered nutrient metabolism. The more pressing problem now was the change in the American lifestyle and a dietary shift from too little to too much. Modern household technologies increased productivity in housework but decreased physical activity, and the home-cooked family meal became a thing of the past. Varied diets consisting of whole grains, fruits, and vegetables gave way to convenience foods resulting in a much higher consumption of fat and sugar. Results from the Framingham Heart Study were perhaps the first glimpse into the relationship between fat intake and cardiovascular disease and the realization that each type of fat plays a specific role in health and disease. During this era, links among fat intake, serum cholesterol, and cardiovascular disease were studied thoroughly, and the reasons for the increasing prevalence of obesity in the United States were explored. In 1985 Michael Brown and Joseph Goldstein were awarded the Nobel Prize in medicine for their work on the regulation of cholesterol metabolism and its influence on arteriosclerosis.

The essentiality of macrominerals (e.g., calcium, phosphorus, sodium) was understood in the 1850s. However, it was not until technological advances triggered an explosion of new research that trace and ultra-trace elements were identified as essential for humans. Working together, nutritionists, biochemists, biologists, immunologists, geneticists, and epidemiologists uncovered the mysteries behind minerals such as zinc, selenium,

TABLE 1

Significant policies and recommendations in nutrition (1901–2001)

Date	Nutrition policies and recommendations	Description
1917	Food Guide, "5 Food Groups"	Food groups included flesh foods, breads/cereals, butter/fats, fruits and vegetables, and sweets (USDA).
1922	Iodine fortification	Iodized salt was initially added to salt (60 mg/g salt) in Michigan, goiter virtually eradicated by 1927.
1932	Vitamin D fortification	Vitamin D was added to milk at a minimum of 400 IU/quart. Was also added to some margarine.
1941	Enrichment with iron, niacin, riboflavin, and thiamin	Iron, niacin, riboflavin, and thiamin were added to refined wheat flour, and eventually to bread, pasta, rice, and cereal grain products.
1943	Recommended Dietary Allowances, 1st edition (United States)	Purpose: "To serve as a guide for planning an adequate diet for every normal person." (FNB/NRC)
1945	Fluoride fortification	Voluntary artificial fluoridation of municipal water supply in the United States; currently, 62 percent of U.S. population drinks fluoridated water.
1946	Food Guide, "Basic 7"	Food groups included milk, meat, green/yellow vegetables, citrus fruits, potatoes/other vegetables, bread/cereal, and butter/margarine (USDA).
1946	National School Lunch Act	It provides nutritionally balanced, low-cost, or free lunches to nearly 27 million children each school day. The program was established under the National School Lunch Act, signed by President Harry S Truman.
1958	Daily Food Guide, "Basic 4"	Food groups included meat/eggs/fish, milk/dairy, fruit/vegetables, and bread/cereals (USDA).
1964	Food Stamp Act	The first Food Stamp Act was started as a pilot project in 1961. The current law was enacted in 1977 and is amended regularly by the Congress. Purpose is to end hunger and improve nutrition and health. It helps low-income households buy food for a nutritionally adequate diet.
1975	National School Breakfast Program	The School Breakfast program began as a pilot project in 1966 under the Child Nutrition Act. The purpose was to ensure that all children have access to a healthy breakfast at school to promote learning readiness and healthy eating behaviors. It provides nutritionally balanced, low-cost, or free breakfasts to 7.4 million children each school day.
1971–1974	National Health and Nutrition Examination Survey (NHANES)	The first of a series of surveys to assess the health and nutritional status of the U.S. population (NCHS/CDC).
1974	Special Supplementary Nutrition Program for Women, Infants, and Children (WIC)	Nonentitlement program designed to improve the intake of protein, vitamins A and C, calcium, and iron, to low-income, pregnant, and lactating women and children less than 5 years old.
1980	Dietary Guidelines for Americans: Nutrition and Your Health	First set of recommendations for individuals to guide food choices without specifying amounts (USDA/DHHS).
1985	Continuing Survey of Food Intakes of Individuals (CSFII)	The first of a series of surveys to provide information on the dietary status of the U.S. population and monitor changes in dietary intakes (ARS).
1988–1994	NHANES III	National Health and Nutrition Examination Survey, noted the significant increase in obesity in the United States (NCHS/CDC).
1989	RDA, 10th edition	Definition: the level of intake of essential nutrients that . . . meet the known nutrient needs of practically all healthy persons.
1989	VI. Diet and Health: Implications for Reducing Chronic Disease Risk	Thorough review of the evidence on which dietary guidelines are based. Specific evidence provided on intake of fat, fruit and vegetables, protein, salt, alcohol, calcium, fluoride, and physical activity (FNB).
1990	VII. Nutrition Labeling and Education Act (NLEA)	This act made standardized nutrition labeling on food products in the United States mandatory. There are now 11 health-related claims that are approved to be used in advertising on food packages (FDA).
1992	Food Guide Pyramid	Eating guide based on the RDA that also considered salt, fat, and sugar intake (USDA/HNIS).
1994	Dietary Supplement Health and Education Act (DSHEA)	Exempts any product labeled as a dietary supplement from FDA regulatory approval. Permits structure/function claims without prior FDA authorization.
1997	Dietary Reference Intakes (DRI)	This was the first in a series of revised recommendations now called DRI, which replaces the RDA. This report included recommendations for calcium, phosphorus, magnesium, vitamin D, and fluoride.
1998	Folate fortification	Fortification of all breads, pasta, rice, flour, and breakfast cereals with folate to decrease the risk of neural tube defects in women of childbearing age. Program initiated in United States, Mexico, and Canada.
1998	Dietary Reference Intakes (DRI)	Second series of the DRI for thiamin, riboflavin, niacin, vitamins B_6 and B_{12}, folate, pantothenic acid, biotin, and choline.
2000	Dietary Guidelines for Americans, 4th edition	The dietary guidelines are updated about every 5 years. They provide nontechnical suggestions for healthy dietary patterns and activity (USDA/DHHS).
2001	Dietary Reference Intakes (DRI)	Third series of the DRI for vitamins A and K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdemum, nickel, silicon, vanadium, and zinc.

copper, molybdenum, and chromium. Scientists first recognized human zinc deficiency in the mid-1960s. Severely growth-retarded, young Middle Eastern men were anemic, extremely lethargic, and hypogonadal. Their diet consisted mainly of wheat bread with little animal protein. When their diets were supplemented with zinc, their lethargy, growth, and genital development improved.

Nutrition for optimal health (1990–present). In the understanding of nutrition, the American public experienced yet another paradigm shift in the 1990s. They wondered if all nutrients that provided a health benefit needed to fit the traditional definition of "essential nutrient." As a result of this question, herbal and botanical extracts, phytochemicals, and other alternative nutritional therapies to promote optimum health were explored. In 1999 the U.S. market for functional foods alone was estimated to be $6 billion (Hasler, p. 504) and it continues to grow by approximately 12 percent each year. The explosion of this market is likely due to the increase in social acceptance, changes in regulations, the booming economy of the 1990s, and the targeting of products to particular populations. The scientific validation of some therapies also is of increasing interest.

Pharmacological uses (larger amounts than required to prevent deficiencies) of essential nutrients are being explored. Although much of the current interest in megavitamin supplementation began in the 1990s, the work of Dr. Linus Pauling in the 1970s initiated the movement. Pauling was the only individual to be awarded two unshared Nobel prizes for his work in chemistry (1954) and peace (1962). In the field of nutrition, however, he is noted most for his unproven theories regarding the potential protective role of vitamin C on the common cold, cancer, and heart disease. Pauling himself reportedly took up to six hundred times the recommended daily amount of vitamin C. Given that many individuals also practice a "more must be better" approach, the national recommendations for nutrient intake now include guidelines for safe upper limits for individual nutrient intakes.

Nutrition in Research

Experimental nutrition research is one aspect of the science of nutrition. Nutrition research is conducted to answer questions raised both in clinical practice and policy. Research in nutrition can focus on individual cells, whole animals or humans, or entire populations, and often overlaps with research in genetics, biochemistry, molecular biology, toxicology, immunology, physiology, and pharmacology.

Nutritional biochemistry. Nutritional biochemistry is the backbone to the understanding of the structure and function of nutrients within food and the body. Nutrients serve as cofactors for enzymes, components of hormones, and participants in oxidation/reduction reactions through metabolic processes. Though required in small amounts, nutrients are essential for body growth, sexual development and reproduction, psychological well-being, energy level, and the normal functioning of most organ systems in the body. Nutritional biochemists study the functional roles of vitamins and minerals in the body, metabolic blocks that occur from deficiencies, the effects of hormones on nutrient metabolism, and interactions among nutrients within the body. In the 1990s a whole new area of research emerged that focuses on relationships between nutrition and genetics. An example of this type of study includes the identification of a genetic defect in folate metabolism (C677T), which increases a woman's risk of delivering a baby with a neural tube defect.

Food science. Food science is the study of the composition of food materials and the reaction of food to processing, cooking, packaging, and storage. Food science integrates knowledge of the chemical composition of food materials; their physical, biological, and biochemical behavior; the interaction of food components with each other and their environment; pharmacology and toxicology of food materials, additives, and contaminants; and the effects of manufacturing operations, processes, and storage conditions.

The potential beneficial role of functional foods in the American diet has gained attention and recent food science research focuses on the development of such foods. Functional foods are generally defined as those that provide health benefits beyond basic nutrition, and include fortified, enriched, or enhanced foods, and whole foods, which have high levels of protective nutrient components. Examples of these foods include orange juice with added calcium or echinacea, or snack foods with antioxidants, fruit-flavored candy with vitamin C, various soy products, and margarine with added plant sterols. Factors that drive the market for such foods include a growing general public interest in nutrition and its impact on health, an aging population that is more concerned with health, research findings receiving media attention, and an increasingly unregulated consumer food market.

Human nutrition. Human nutrition, or clinical nutrition, research is that which focuses on the study of nutrients within the living human body. Although biochemical studies are extremely informative, until the nutrient is added to or depleted from the diet, the effects on individuals can only be hypothesized. Human nutrition research includes the study of individual nutrient requirements (e.g., nutrient intake assessment, energy expenditure assessment, nutrient turnover balance studies, and nutrient bioavailability), the effects of nutrients on body growth (e.g., body composition techniques, anthropometry, pubertal assessment), and the dietary, physiological, or disease factors that influence nutrient requirements. In the 1990s one important human nutrition study found that increasing folic acid intake in young women reduces the incidence of neural tube defects (spina bifida) in their babies.

Nutritional epidemiology. Nutritional epidemiology is the science of systematically studying the relationships between food choices and health status. Epidemiological studies are particularly valuable in understanding complex relationships between food intake (dietary exposure) and determinants of diseases with multiple etiologies and long latent periods. Examples of such studies include the relationships between low folic acid intake and increased incidence of spina bifida, and elevated saturated fat intake and elevated risk of arteriosclerosis. There are, however, limitations to these studies in that they describe relationships rather than prove cause and effect. Frequently, clinical trials and intervention studies are used as follow-up studies to evaluate more fully the questions raised by epidemiological evidence.

Nutrition in Clinical Practice

Scientific evidence continues to mount regarding the key roles that nutrients and their metabolism play in the prevention of the most common chronic diseases. Half of the leading causes of death in the United States (heart disease, cancer, stroke, and diabetes) are associated strongly with unhealthy eating habits. Clinical nutrition is the practice of applying research evidence to aid in the care of individuals with or at risk for diet-related diseases. These principles are used to develop individualized nutrition care plans. Generally, diseases may affect nutritional status by (a) decreasing the intake of nutrients, (b) altering the metabolism of nutrients (or unusual losses), or (c) altering energy expenditure. Alternatively, as mentioned briefly above, poor nutritional status can lead to disease. For example, zinc deficiency can decrease the function of the immune system that in turn leads to increased risk for diarrhea and infectious diseases.

Assessment of nutritional status is essential for identifying undernourished and overnourished states (obesity is now a major health problem) and estimating the optimum intake to promote normal growth and well-being. Nutritional assessment has several components, including the evaluation of dietary intake, growth status, body composition, energy expenditure, and biochemical measures of nutritional status in the context of a medical history, diagnoses, and current therapy. These data are used to develop individualized nutritional care plans, which may include recommendations for total energy intake, adjustments in the diet to increase or decrease the consumption of certain foods, and possibly the inclusion of nutrient supplements. For patients who cannot be fed orally, more technology-based nutritional support is used to maintain or improve nutrient intakes and nutritional status. This involves either feeding the patient through a tube directly into the stomach or intestine (enteral) or through an intravenous line directly into the bloodstream (parenteral). Because malnutrition will add to complications of illness and prolong the illnesses and hospitalization, appropriate assessment of the patient is extremely important. In the complex and rapidly changing context of critical illness, individualized nutrition assessments are crucial and require the sequential monitoring of all patients to maintain appropriate nutritional care plans.

Definition of Terms

Nutrition: the study of foods, their nutrients, and other chemical components; their actions and interactions in the body; and their influence on health and disease.

Nutritional Science: the body of scientific knowledge that relates to the processes involved in nutrition.

Health: a state of optimal well-being—physical, mental, and social; relative freedom from disease.

Functional Foods: foods that provide a health benefit beyond basic nutrition.

Essential Nutrient: a substance that must be obtained from the diet because the body either cannot make it or cannot make adequate amounts.

Enteral Nutrition: nutrient solutions delivered into the gastrointestinal tract (e.g., stomach, small intestine) through a tube inserted through the nose or directly into the stomach.

Parenteral Nutrition: nutrient solutions delivered directly into the bloodstream through an intravenous catheter.

It is unlikely that individuals who have not been seriously ill have had the opportunity to seek the counsel of a trained nutritional professional for developing an individualized diet plan. The average American displays a keen interest in how nutrition affects his or her health, and is disappointed with the information physicians are able to provide because traditional medical training has limited nutrition content. Therefore, greater numbers of individuals are seeking nutrition information for themselves, and using the information to self-diagnose and self-prescribe. The advances in communications technology, particularly the explosion of information on the World Wide Web, allow the ready accessibility of sound nutritional advice, and substantial amounts of quackery. Without training and a significant amount of time dedicated to the task, it is difficult to decipher truth from fraud. Future directions in nutritional education likely will include tools to aid Americans in deciphering information, particularly from the Internet, in order to make educated choices to optimize their diets and live healthier lives (see Table 2).

Nutrition in Public Policy: Monitoring and Education

Nutrition in public health or nutrition policy generally is regarded as the combined efforts taken toward im-

TABLE 2

Credible sources of nutrition information on the World Wide Web

Professional Organizations
American Dietetic Association: www.eatright.org
American Society for Clinical Nutrition: www.faseb.org/ascn
Society for Nutrition Education: www.sne.org
American College of Sports Medicine: www.acsm.org
Institute of Food Technologists: www.ift.org

Government Organizations
Centers for Disease Control: www.cdc.org
Office of Food Labeling: www.cfsan.gda.gov
Center of Food Safety and Applied Nutrition: www.vm.cfsan.fda.gov/list.html
Food and Nutrition Information Center: www.nal.usda.gov/fnic
Center for Nutrition Policy and Promotion: www.usda.gov/fcs/cnpp.htm
International Food Information Council: www.ificinfo.health.org
National Center for Complementary and Alternative Medicine: http://nccam.nih.gov/
Office of Dietary Supplements of NIH: http://odp.od.nih.gov/ods/

Private Organizations
Quack Watch: http://www.quackwatch.com/
Gatorade Sports Science Institute: www.gssiweb.com
National Dairy Council: www.dairyinfo.com
The Dannon Company: www.dannon.com
United Fresh Fruit and Vegetable Association: www.uffva.org

proving nutrition and health status of populations. With increasing emphasis on health promotion and disease prevention, there is a proliferation of nutrition-related disease prevention, screening, and education programs targeted at increasing fiber, fruit, and vegetable intake, and reducing saturated fat intake. Additionally, a number of food assistance programs and mandated food fortification programs have been instituted, all promoting a healthy diet and lifestyle.

Nutrition research, public policy programs, and nutrition surveillance systems work synergistically like spokes on a wheel. Evidence obtained from scientific research is used to set nutritional recommendations such as the Dietary Reference Intakes and the Dietary Guidelines for Americans. These standards are used to judge the adequacy of the American diet, provide the basis for nutrition labeling of foods, formulate special diets, and guide the development of food fortification and nutrition policy developed to assist those who are at nutritional risk. Specific food assistance programs (such as, food stamps, Special Supplementary Nutrition Program for Women, Infants, and Children) are targeted at specific economically disadvantaged and nutritionally at-risk populations. Fortification programs generally are less specific, but some target at-risk populations through specific foods, for example, vitamin D–fortified milk to prevent rickets in young children. Finally, the wheel is completed by nutrition monitoring programs that are used to evaluate the effectiveness of instituted policies. The National Health and Nutrition Examination Survey (NHANES) and the Continuing Survey of Food Intake of Individuals (CSFII) are ongoing monitoring tools used to assess the population's nutrient intakes, nutrition and health status, and knowledge and attitudes about health.

Perhaps most important, public health nutrition includes the dissemination of scientific findings, the explanation of dietary recommendations, and outreach of federal assistance programs. The responsibility of communicating experimental findings in an understandable form falls on nutrition scientists, journalists, educators, and the public. The scientists are responsible for interpreting the research findings into a form that is understandable to the general public. Journalists are responsible for communicating the scientific message in an objective way, and the public is responsible for pursuing an accurate understanding of the issues. Various government agencies have the responsibility to organize and administrate the myriad of nutritional policies and programs, and to communicate information regarding these programs to the public.

The Future of Nutrition and Food Science

In the twentieth century nutrition research, practice, and public policy shifted from a focus on the quantitative aspects—to ensure food security and eradicate nutritional deficiencies—to a greater attention on the qualitative aspects—to achieve optimal, balanced, dietary intakes. In the twenty-first century nutrition research, practice, and policy will likely explore the following areas:

relationships between human genetics and nutrition,
the role of genetically modified foods in human health,
the relationship of nonfood substances in the promotion of health and the bioengineering of functional foods,
the promotion of economic growth and food security in developing nations to prevent or delay the undesirable health effects of malnutrition, and
the prevention and treatment of the obesity epidemic in children and adults.

Relationships between food intake and human health will continue to be of great public interest, and nutrition and food scientists will face new challenges in a faster-changing environment.

See also **Assessment of Nutritional Status; Dietary Assessment; Dietary Guidelines; Dietary Systems: A Historical Perspective; Dietetics; Enteral and Parenteral Nutrition; Food Stamps; Functional Foods; Malnutrition; Nutrients; Nutritionists; Nutrition Transition: Worldwide Diet Change; Obesity; Physical Activity and Nutrition; Vitamins; WIC (Women, Infants, and Children's) Program**.

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NUTRITIONAL ANTHROPOLOGY. Many cultural anthropologists and sociologists who are interested in food and food systems examine the interrelationships of social, cultural, and economic factors as they relate to food use. In contrast, nutritional anthropology refers to a field of study at the interface of anthropology and nutritional sciences focused particularly on understanding how the interactions of social and biological factors affect the nutritional status of individuals and populations. This does not mean that all research in nutritional anthropology involves measurement of nutritional status, and many studies in this field do not include biological outcomes in their research design. However, they differ from studies in the "anthropology of food" because their basic aim is to understand how the physical well-being of humans is affected by their food systems, while cultural anthropologists and sociologists analyze food use in order to understand how social and cultural systems work.

In their investigations, nutritional anthropologists use methods from both the social and biological sciences, which they also draw on in developing theories and testing hypotheses. Occasionally, they turn to humanistic scholarship as a source of insights into the cultural and historical aspects of food. The field can be characterized, therefore, as a biocultural discipline, which emphasizes the importance of integrating multiple perspectives on human behavior and experience in explaining nutrition.

The types of research undertaken by nutritional anthropologists can be classified into the following main categories: (1) sociocultural processes and nutrition; (2) social epidemiology of nutrition; (3) cultural and ideational systems and nutrition; (4) physiological adaptation, population genetics, and nutrition; and (5) applied research for nutrition programs.

Investigations in the category of sociocultural processes and nutrition are often focused on large-scale processes of change, such as globalization, modernization, urbanization, changing women's roles, and technological change in order to understand how these processes affect food and nutrition. While many investigators conduct studies in which they examine the effects in a specific location of a particular manifestation of change (for example, rural to urban migration in a particular developing country), others are concerned with understanding how large-scale changes have affected nutritional conditions across many populations. For example, nutritional anthropologists have studied the consequences for nutrition of a shift from foraging-hunting to agriculture. Studies of the effects on nutrition of a shift from subsistence farming to cash cropping are another example.

Nutritional anthropological research that falls into the category of social epidemiology and nutrition includes a range of topics, for example, describing how particular social and cultural factors place people at risk for nutritional problems or identifying health problems related to nutrition. Among the topics that have attracted attention are the social and ecological determinants of vitamin A deficiency and other micronutrient deficiencies, interactions of socioeconomic and cultural factors that adversely affect growth in infants and young children, and the functional consequences of malnutrition in childhood and adulthood.

Studies in the area of cultural and ideational systems and nutrition are often aimed at understanding how particular beliefs relate to food selection, including food prescriptions and proscriptions. Among the topics investigated by nutritional anthropologists who link their work to public health issues are the ways culturally structured food avoidances during pregnancy or childhood illness affect health outcomes. For example, studies have been conducted on how beliefs about illness and food affect the treatment and household management of children with diarrhea.

There has been a long-standing interest among biocultural anthropologists in the interactions of cultural, physiological, and genetic adaptations in relation to food systems and nutritional patterns. One type of research that falls within this general category includes studies of behavioral adaptations that permit people to create and sustain diets that, over the long run, would be untenable biologically without such adaptations. For example, in Central America, ancient cultures developed the technique of soaking maize kernels in an alkaline solution, which improves its amino acid composition and the bioavailability of the B vitamin, niacin. Without these improvements, a population that subsisted on maize as its primary staple food would be at risk of serious malnutrition.

Another area of research in nutritional anthropology is the relationship between genetic variability in populations and food consumption patterns. A specific topic that falls within this area is the matter of lactose tolerance. Anthropologists have sought to understand how it is possible for adults in some populations to consume milk when the common pattern is for humans to lose their capacity to digest lactose after childhood. The role of this genetic trait has been explored in relation to the development of dairy-based food economies in northern Europe and some regions in Africa. It is likely that there will be an expansion of this type of research with the development of new techniques and knowledge in nutritional genomics.

In addition to conducting basic research, some nutritional anthropologists also engage in applied research, undertaken in direct support of public health activities. Often, investigations in this category involve community-level investigations, although applied nutritional anthropology may also be carried out for the purpose of informing national or international nutrition policy and planning. Studies at the community level may focus on identifying the sociocultural factors to be taken into account in instituting intervention activities (formative research) or in process evaluations to see how these factors are affecting the utilization of programs.

Applied anthropological studies in nutrition and health have been facilitated by the development of manuals for Rapid Assessment Procedures (RAP) or Focused Ethnographic Studies (FES). For example, with the aid of manuals, short-term qualitative studies have been conducted in planning interventions to improve vitamin A status in deficient populations and for interventions intended to improve the feeding of infants and young children.

As would be anticipated for a field that cuts across the disciplinary boundaries of the biological and social sciences, nutritional anthropology is eclectic in the scope of its theories and methods. Within that broad scope, however, one can identify a number of commonalities, including: (1) a focus on populations rather than studying individuals without consideration of the larger group of which they are a part; (2) a focus on communities and households as key social units that affect nutrition; and (3) a mixed method approach that utilizes both qualitative and quantitative techniques for data collection and analysis.

See also **Anthropology and Food; Food Archaeology; Nutrition; Prehistoric Societies.**

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NUTRITIONAL BIOCHEMISTRY.

Nutritional biochemistry is one of the academic foundations that make up nutritional sciences, a discipline that encompasses the knowledge of nutrients and other food components with emphasis on their range of function and influence on mammalian physiology, health, and behavior. Nutritional biochemistry is a subdiscipline that is made up of the core knowledge, concepts, and methodology related to the chemical properties of nutrients and other dietary constituents and to their biochemical, metabolic, physiological, and epigenetic functions. A primary focus of research in nutritional biochemistry is the scientific establishment of optimal dietary intakes (Dietary Reference Intakes or DRIs) for every nutrient and food component throughout the life cycle (Thomas and Earl, 1994; Standing Committee, 1998).

Nutritional biochemistry is an integrative science whose foundation is derived from knowledge of other biological, chemical, and physical sciences, but it is distinguished in its application of this knowledge to understanding the interactive relationships among diet, health, and disease susceptibility. For example, nutritional biochemistry is rooted in analytical methodology that permits the purification of individual nutrients and the determination of their structures, as well as in classical biochemical approaches that identify metabolic pathways and elucidate the role of dietary components in regulating metabolism and gene expression. Additionally, human genetic studies of inherited inborn errors of metabolism, such as phenylketonuria, have contributed to core nutritional biochemical knowledge by revealing important interrelationships among nutrition, metabolism, and genotype and their interactions during normal and abnormal human development.

Knowledge generated from nutritional biochemistry research forms the foundation upon which nutrition-based public health interventions are designed and implemented. Many common diseases and disabilities afflicting human populations in both developing and developed countries result from general malnutrition, deficiencies of specific nutrients, or overnutrition. Inadequate diets or poor dietary habits are associated with increased risk for morbidity and mortality, including birth defects, diabetes, cardiovascular disease, obesity, and certain cancers. Specific nutrients, food components, or metabolites, singularly or in combination, can contribute to risk for disease or, alternatively, can be protective by preventing disease. Furthermore, associations among dietary components and diseases are strongly influenced by subtle genetic variation, such as single nucleotide polymorphisms, which are prevalent in all human populations. Research-based diet therapies and strategies to decrease the incidence of nutrition-related diseases have a successful history of improving public health and individual quality of life. Such strategies include (1) the fortification of grain products with folic acid to decrease the incidence of common birth defects (spina bifida), (2) the iodinization of table salt to prevent cretinism, a developmental disorder associated with severe neurological and cognitive deficits in children, and (3) the promotion of diets low in cholesterol to prevent and to manage cardiovascular disease. These nutrition-based interventions have impacted the quality of life for individuals, and the monetary effects associated with the amelioration of these disorders have significantly benefited health care systems and national economies.

CORE KNOWLEDGE THAT DEFINES NUTRITIONAL BIOCHEMISTRY

- Structure and function of nutrients and other dietary constituents
- Chemical structure and metabolic functions of essential and nonessential nutrients
- Physiological and biochemical basis for nutrient requirements
- Motifs of absorption and transport of nutrients
- Integration, coordination, and regulation of macro- and micronutrient metabolism
- Regulation of nutrient metabolism and nutritional needs by hormones and growth factors
- Interaction of nutrients with the genome; nutrient control of gene expression; DNA stability
- Dietary bioactive components (functional foods)—nontraditional roles of nutrients
- Food, diets, and supplements
- Food sources of nutrients and factors affecting nutrient bioavailability
- Effect of food processing and handling on nutrient content and bioavailability
- Nutritional toxicology—upper limits of intake; nutrient–nutrient and drug–nutrient interactions
- Dietary Reference Intakes (DRIs); Food Guide Pyramid
- Nutrient supplements—risks/benefits, life stage, bioavailability
- Molecular markers of nutrient intake—gene arrays and analytical chips
- Nutrition and disease
- Impact of disease and genetics on nutrient function and requirements
- Genetic basis of inherited metabolic disease

SOURCE: Allen, Lindsay H., Margaret E. Bentley, Sharon M. Donovan, Denise M. Ney, and Patrick J. Stover, "Securing the Future of Nutritional Sciences through Integrative Graduate Education." *Journal of Nutrition* 132 (2002): 779–784.

Current research and discovery in nutritional biochemistry is focused broadly in several areas, including nutritional genomics and metabolomics. Nutritional genomics is the study of genome–nutrient interactions and includes (1) the role of nutrients and dietary components in regulating genome structure, expression, and stability, and (2) the role of genetic variation on individual nutrient requirements. Nutritional metabolomics is the study of metabolic pathways and networks and includes (1) the regulation of metabolic pathways and networks, by nutrients and other food components, and (2) the establishment of analytical methods that "profile" human serum and urinary metabolites to assess nutritional imbalances and disease risk. It is anticipated that knowledge derived from these new approaches will enable nutrient requirements to be tailored to an individual's genetic profile for optimal health throughout the life cycle. In addition, information obtained from these new technologies will inform efforts (1) to improve or to enhance the food supply through the targeted introduction of traditional or novel foods, (2) to fortify food chemically with specific nutrients, or (3) to enhance crops genetically for higher nutrient content or quality.

Nutritional sciences academic training programs with a strong emphasis in nutritional biochemistry reside in medical colleges (e.g., Columbia University), schools of public health (e.g., Harvard University), and land grant universities (e.g., Cornell University). Nutritional sciences training programs can be independent units, jointly administered or affiliated with programs of toxicology, biochemistry, animal sciences, food sciences, and various medical programs. Academic faculty in nutritional biochemistry can be expert in many disciplines, including chemistry, biochemistry, genetics, and physiology. Therefore, individual nutritional sciences programs with distinct nutritional biochemistry concentrations are highly unique. Nutritional biochemists establish careers in teaching and research within universities, governmental and regulatory agencies, and the food, pharmaceutical, or biotechnology industries. Nutritional biochemists may also work in fields related to public policy, health care, or product development and marketing in the food industry.

See also **Dietary Guidelines; Nutraceuticals; Nutrient Bioavailability; Nutrients.**

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NUTRITIONISTS. The field of nutrition is a broad one and has a wide variety of individuals working in it. Self-styled experts abound—based on the premise that they have eaten all of their lives, have grown, and are healthy adults, they regard themselves as nutrition experts. Unfortunately, it is not quite this easy to become a nutritionist. Cooks, chefs, science teachers, and many allied health professionals may have taken a course or two in nutrition during their training, but this does not qualify them as nutritionists either. Nutritionists have undergone rigorous educational programs in the sciences and have studied nutrients and other components of food in depth.

For the purpose of this discussion, four different types of nutritionists will be described along with the educational pathways needed to qualify for each position. These include the nutrition scientist, the public health nutritionist, the dietitian (known in the United States as the registered dietitian or RD) and the dietetic technician (known as the dietetic technician, registered, or DTR in the United States). Each of these groups develops different skill sets, and each group is responsible for carrying out different functions in the broader field that is nutrition.

Nutrition Scientists

Nutrition scientists are those individuals who use the scientific method to study nutrients, both as individual compounds and as they interact in food and nutrition. The role of the nutrition scientist is to develop new knowledge related to nutrients or nutrition or to develop new processes or techniques to apply existing knowledge. For example, nutrition scientists have been involved in developing food preservation processes, determining nutrient requirements for various animal species, describing how individual nutrients function within the cells of the human body, and identifying nutrition-related problems in various populations.

Nutritionist scientists may have their basic training in nutrition or in a related field such as biochemistry, microbiology, cell biology, epidemiology, toxicology, agriculture, or food science. In most cases, they hold a PhD in their respective field of study. Sometimes, they hold another terminal degree such as an MD or a doctorate in public health (DrPH). Other nutrition scientists do not hold a terminal degree but are trained at the master's degree level and may assist in laboratories or in fieldwork. The characteristic that defines the nutrition scientist is not the field in which the training occurred, but the area in which the person is working. If scientists are conducting research with food, nutrients, or the nutritional status of groups, individuals, or animals, it is appropriate for them to be known as nutrition scientists. In the United States, the universities that train individuals to be nutrition scientists are regionally accredited, but the discipline-specific programs are not.

Public Health Nutritionists

Public health nutritionists are professionals who view the community as their client. They specialize in diagnosing the nutritional problems of communities and in finding solutions to those problems. Some classic examples of public health nutrition interventions include the fortification of salt with iodine to prevent goiter or the enrichment of grain products with B vitamins to prevent deficiency diseases like pellegra or beriberi.

Public health nutritionists are often dietitians who hold a bachelor's degree in applied nutrition. In addition, they study public health theory and practice at the master's degree level, earning a master's degree in public health (MPH). The curriculum for the MPH includes coursework in epidemiology, advocacy, public policy, program management, grant writing, and social marketing. Programs in public health nutrition may accept students whose bachelor's degree is in a field other than nutrition; in that case, they also do graduate work in nutrition. In the United States, there is an organization known as the Association of Graduate Programs in Public Health Nutrition, Inc. that establishes voluntary guidelines for knowledge, skills, and competencies for public health nutritionists.

Dietitians

Dietitians, RDs in the United States, are practitioners who translate the science of nutrition into practice for individuals and groups. Though dietitians may work in a variety of settings, they traditionally practice in the areas of clinical nutrition, food service, or community nutrition. RDs hold bachelor's degrees and have completed a supervised practice program known as a dietetic internship.

The profession of dietetics is self-regulating. Undergraduate dietetics programs in the United States are known as didactic programs in dietetics (DPDs) and are accredited by the Commission on Accreditation for Dietetics Education (CADE). DPDs are required to provide a curriculum that includes "foundation knowledge and skills" which are mandated by CADE for entry-level dietetic education programs.

Students who successfully complete a DPD may apply for entry into a supervised practice program. These dietetic internships, also accredited by CADE, are designed to meet the "competency statements" for the supervised practice component of entry-level dietetic education programs. Dietetic internships provide a minimum of 900 hours of supervised practice experience. Curricula for these programs include core competencies but also allow programs to train generalists or specialists in a particular practice area, such as nutrition therapy or foodservice systems management.

An alternate training route for dietitians is the Coordinated Program in Dietetics (CP). Coordinated programs provide the student with both the didactic and the supervised practice components of dietetics education in a single program. CPs may be offered in conjunction with either a bachelor's or master's degree.

After completion of both the didactic and supervised practice components of dietetics education, graduates sit for a national registration examination, which is administered under the auspices of the Commission on Dietitics Registration (CDR). Individuals who pass the examination may practice as RDs. Licensing is also required in some states; the same examination may be used for both purposes.

Dietitians who have completed their education in other countries may sit for the RD examination in the United States if their country has established reciprocity with CDR. Reciprocity requires that the course of study include both didactic and practice components. Some of the countries that have reciprocal agreements with the United States include Canada, Denmark, and the Philippines.

The RD credential is used to protect the public from practitioners whose educational and professional credentials are below published and accepted standards. In addition, that credential must be maintained to ensure that dietetics practitioners do not allow their knowledge base to become outdated. Every five years, the RD credential must be renewed by demonstrating that a program of planned learning activities has been undertaken to allow for continued competence. Dietitians who allow their credentials to lapse must retake the registration examination in order to reestablish their level of competence.

Dietetic Technicians

Dietetic technicians, DTRs in the United States, are dietetics practitioners who work with dietitians in all three areas of dietetics practice, clinical, foodservice, and community. They may work independently, if the expertise of a dietitian is not required for the specific task that is being done. For example, the dietetic technician could counsel a new mother on infant feeding practices but would not recommend a parenteral formula for the recipient of an organ transplant. DTRs hold at least an associate's degree and have attended a program that includes a supervised practice component.

In the United States, CADE accredits dietetic technician programs (DTs). The curriculum for these programs must include didactic content in the eight "foundation knowledge and skills." The specific requirements for DTs differ from those for DPDs in the depth involved. DTs include a supervised practice component of at least 450 hours, during which students develop the practice competencies set by CADE for DTRs.

Like RDs, DTRs are required to pass a national registration examination established by CDR. Passing the examination provides them with the credential to practice as dietetics professionals. DTRs are also required to demonstrate continued competence by engaging in planned learning activities and renewing their credential every five years.

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NUTRITION TRANSITION: WORLDWIDE DIET CHANGE. The world is witnessing rapid shifts in diet and body composition, with resultant important changes in health profiles. In many ways, these shifts are a continuation of large-scale changes that have occurred repeatedly over time; the changes facing low- and moderate-income countries today, however, appear to be occurring very rapidly. Broad shifts in population size and its age composition; in disease patterns; and in dietary and physical-activity patterns are occurring around the world. The former two sets of dynamic shifts are termed the demographic and epidemiological transitions. Dietary and physical-activity changes, reflected in nutritional outcomes such as changes in average stature and body composition, are referred to as the nutrition transition.

Historical Nutrition Patterns

Human diet and activity patterns and nutritional status have undergone a sequence of major shifts, which can be defined as broad patterns of food use and of corresponding nutrition-related diseases. Since the eighteenth century, the pace of dietary and activity change appears to have accelerated, albeit to varying degrees in different regions of the world. Dietary and activity changes have been paralleled by major changes in health status, as well as by major demographic and socioeconomic changes. Obesity emerges early among these shifting conditions, as does the level and age composition of morbidity and mortality. Five broad nutrition patterns have been identified, going back to the origins of modern man. The two "earlier" patterns continue to characterize certain geographic and socioeconomic subpopulations, but much of the modern world is experiencing one or more of three later patterns: receding famine; the appearance of nutrition-related noncommunicable diseases (NR–NCDs); and, in response to these, behavioral change.

Receding famine. In this stage, the consumption of fruits, vegetables, and animal protein increases, and starchy staples become less important in the diet. Many earlier civilizations had made great progress in reducing chronic hunger and famines, but only in the last third of the last millennium did these changes become widespread, leading to marked shifts in diet. Famines continued well into the eighteenth century in parts of Europe, however, and they remain common in some regions of the world. Activity patterns start to shift in this stage, and inactivity and leisure become a part of the lives of more people.

Nutrition-related noncommunicable diseases (NR–NCDs). A diet high in total fat, cholesterol, sugar, and other refined carbohydrates, and low in polyunsaturated fatty acids and fiber, and often accompanied by an increasingly sedentary life, is characteristic of most richer societies (and of increasing portions of the population in poorer societies) in this stage. These characteristics result in increased prevalence of obesity and degenerative diseases that characterize Omran's final epidemiological stage.

Behavioral change. A new pattern appears to be emerging in this stage as a result of changes in diet, evidently associated with the desire to prevent or delay degenerative diseases and prolong health. Whether these changes, instituted in some countries by consumers and prodded in others by government policy, will constitute a large-scale transition in dietary structure and body composition remains to be seen.

Nutrition science is increasingly focusing on these three later stages, in particular on the rapid shift in much of the world's low- and moderate-income countries from the stage of receding famine to the stage of nutrition-related noncommunicable diseases. The concern about this change is so great that, for many, the term "the nutrition transition" is synonymous with it.

Apparent Increasing Rapidity of Shifts in Dietary and Activity Patterns and Body Composition

The pace of nutrition-transition shifts from the receding-famine period to that dominated by nutrition-related noncommunicable diseases seems to be accelerating in poor and developing countries. As use of the term "nutrition" rather than "diet" suggests, the category "nutriton-related noncommunicable disease" incorporates the effects of diet, physical activity, and body composition, rather than dietary patterns and their effects alone. This usage is based partly on incomplete information, which seems to indicate that the prevalence of obesity and a number of other NR–NCDs is increasing much faster in the poor and developing world than it has in the West. Rapid growth in urban populations there is much greater than that experienced less than a century ago in the West. Another element is the shift in occupation structure and the rapid introduction of mass media.

Clearly, there are both quantitative and qualitative dimensions to these changes. On the one hand, changes toward a high-density diet with reduced complex carbohydrates and other important elements, and toward increasing inactivity, may be proceeding faster than in the past. The shift from labor-intensive occupations and physically demanding leisure activities toward less strenuous work and leisure is also occurring faster. On the other hand, qualitative dimensions related to multidimensional aspects of the diet, activity, body composition, and disease shifts may exist. For example, the human diet and every one of these other factors are composed of many components, each of which will affect a person in a range of ways. Eating meat, for instance, will provide humans with many valuable nutrients such as bioavailable iron and vitamin B_{12} or B_6 not found in plant foods, but also with others such as saturated fat that, when consumed in excess, may harm human health. Social and economic stresses people face and feel as these changes occur might also be included.

At the start of the new millennium, the pace and complexity of life seem to be increasing exponentially. While the penetration and influence of modern communications, technology, and economic systems (related to what is termed "globalization") have been a dominant theme since the late twentieth century, there seems to have been a confluence of changes in these factors that have led to a major global concern about the rapid globalization of the world economy and its impact on various subpopulations.

Increasing access to Western media and the removal of communication barriers enhanced by the World Wide Web, cable television, mobile telephone systems, and other technology are important. The accelerated introduction of Western technology into manufacturing, basic sectors of agriculture, mining, and services is also a key element.

Globalization and China: an example. The types of changes the developing world is facing can be seen in considering life in China in two different periods. During the 1970s food-supply concerns still existed. There was no television, limited bus and other mass transportation, and little food trade. Minimal processed food existed, and most rural and urban occupations were very labor-intensive.

By the end of the twentieth century, work and life in China had changed. Small gas-powered tractors were available, modern industrial techniques were multiplying, offices were quite automated, soft drinks and processed foods were consumed everywhere, televisions were found in about 89 percent of households (at least a fifth of whom received Hong Kong and Western advertising and programming), younger children did not ride bicycles, and mass transit had become heavily used.

Add to such changes similar ones occurring in much of Asia, North Africa, the Middle East, Latin America, and many areas (particularly cities) in sub-Saharan Africa, and it is evident that the shift from a subsistence economy to a modern, industrialized one occurred in a span of ten to twenty years, whereas in Europe and other richer industrialized societies, it took place over many decades or centuries.

To effectively examine the nutrition aspects of these changes, one would need to compare changes in poorer countries in the period from 1980 to 2000 with changes that occurred a half century earlier in the developed world. However, data on diet and activity patterns are not available, and there is only minimal data on nutrition-related noncommunicable diseases and on obesity.

The negative elements of the nutrition transition known to be linked with nutrition-related noncommunicable diseases are obesity, adverse dietary changes (for example, shifts in the structure of diet toward a greater role for higher fat and added sugar contents, reduced fruit and vegetable intake, reduced fiber intake, greater energy density, and greater saturated fat intake), and reduced physical activity in work and leisure. The causes of these elements are not as well understood as are the trends in each of them. In fact, there are few studies attempting to examine the causes of such changes, and there are only a few data sets that are equipped to allow such crucial policy analyses to be undertaken.

Obesity Trends

The most commonly measured health outcome due to shifts in the structure of diet is obesity. Increases in overweight and obese adults in the developing world since the 1970s have occurred much faster than in richer countries. Shifts in body composition among Chinese adults have been examined (Bell et al., 2001) over an eight-year period. Not only did the average BMI (body mass index, which is the common measure for overweight status and measures weight in kilograms divided by height in square meters) level increase, but the shape of the BMI distribution curve changed over the eight-year period of the study so that there was a large proportion of high BMI adults. From 1989 to 1997 the proportion of underweight men and women dropped considerably, and the prevalence of both overweight and obesity increased greatly, the proportion of overweight or obese men more than doubling and the proportion of overweight or obese women increasing by 50 percent.

China's changes are not unique. Annual increases in the prevalence of overweight and obese adults in selected poor and middle-income countries can be compared with those in the United States. Elsewhere we present data that illustrate the annualized increases from richer countries with comparable data from poorer countries (Popkin, 2002). We also show how quickly overweight status and obesity have emerged in Mexico as a major public-health problem. Compared with the United States and European countries, where annual prevalence increases in overweight and obesity are about 0.25 percent each, rates of change are very high in Latin America. Similar shifts in the prevalence of obesity are found for North Africa and the Middle East and Asia. In each of these countries the annual rate of increase in the prevalence of overweight plus obesity is between 1 and 2.5 (Popkin, 2002).

What is important to note is that increases in the proportion of the adult population who are overweight are far greater in all of these poorer countries than in the United States or most European countries. Only Spain, with its large growth in overweight population in the last decade, is similar, in speed of change, to these countries.

Dietary Changes: Shift in the Overall Structure over Time

The diets of the developing world are shifting rapidly. Good data for most countries on total energy intake are not available, but shifts in the structure of the diet can be examined. Thus, the shift in diet, over time, in the proportion of energy derived from fat has been explored (Guo et al., 2000).

The dramatic changes in the aggregate income–fat relationship from 1962 to 1990 are found in China. Most significantly, by 1990 even poor nations (having a gross national product [GNP] of only $750 per capita) had access to a relatively high-fat diet, which derived 20 percent of its energy from fat; in 1962 the same diet was associated with countries having a GNP of $1,475 (both GNP values in 1993 dollars). This dramatic change arose from a major increase (from 10 to 13 percent) in the consumption of vegetable fats by poor and rich nations alike. Increases (of 3 to 6 percent) also occurred in middle- and high-income nations.

At the same time, there were decreases in the consumption of fat from animal sources for all except the low-income countries. The availability of animal fats continued to be linked to income, though less strongly in 1990 than in 1962. These decreases, combined with the increase in vegetable-fat intake for countries rich and poor, resulted in an overall decrease in fat intake for moderate-income countries of about 3 percent, but an increase of about 4 to 5 percent for low- and high-income countries.

In 1990 vegetable fats accounted for a greater proportion of dietary energy than animal fats for the poorest 75 percent of countries (all of whom had incomes below approximately $5,800 per capita). The absolute level of vegetable-fat consumption increased, but there remained, at most, a weak association of GNP and vegetable-fat intake. Changes in vegetable-fat prices, supply, and consumption equally affected rich and poor countries, but the net impact was much greater on lower-income countries.

There has been an equally large and important shift in the proportion of energy from added sugar in the diets of lower-income countries (Drewnowski and Popkin, 1997).

Examination of the combined effect of these various shifts in the structure of rural and urban Chinese diets reveals an upward shift in the energy density of the foods consumed. Energy intake from foods and alcohol in both urban and rural Chinese adult diets increased over 10 percent between 1989 and 1997. These numbers represent a very rapid shift in energy density. (It is important to note that the Chinese Food Composition Table, from which these data were extracted, measures only a few beverages [milk, coconut juice, sugarcane juice, spirits, beer, wine, champagne, and brandy] and excludes many beverages, in particular tea and coffee, included in normal measures.) Other clinical studies have found that the consumption of higher-density diets is associated with increased total energy intake. Energy density changes in the diet of China, and most likely in other developing countries, are critical components to be monitored.

The Importance of Rapid Social Change, Including Urbanization, Demographic Change, and Behavioral Changes

Diets have shifted far more dramatically in urban than in rural areas. Some critical sociodemographic issues include:

- rapid reductions in fertility that have speeded shifts in age distribution;
- unabated urbanization in Asia and Africa that will leave more of the poor residing in urban than rural areas in future decades;
- economic changes, in particular increased income and income inequality, that appear to define changes in many regions of the developing world;
- globalization of mass media that faces countries at an earlier stage of economic development than in the past.

Urbanization. The structure of diet has shifted markedly as populations have urbanized (Drewnowski and Popkin, 1997). This relationship will, by itself, shift the structure of national diets significantly as the proportion of the population in urban areas grows.

Structural shifts in income-diet relationships. Economists speak of two types of behavioral change. One relates to shifts in the "population composition" of society toward the educated, rich, or urban. The other is "behavioral" and relates to the way people with different characteristics behave, particularly their economic behavior. At the same level of education or income, a person might buy different amounts or types of commodities at different points in time. Research conducted in China shows there have been profound behavioral shifts since the 1980s. For each extra dollar of income, additional high-fat foods are being purchased, when compared with previous years (Guo et al., 2000). This suggests that the demand pattern for food has changed, so that for the same income level patterns of demand are significantly different from those in earlier periods. The explosion in access to goods and exposure to mass media may well have created this situation.

Mass media. There is no doubt that access to modern mass media has grown very rapidly. It is most useful to look at the proportion of households in a country that own television sets. Overall, 88.5 percent of Chinese households owned televisions in 1997. Not only the proportion of people with access to television but also the types of programs and access to Western influences were shifting. In the 1980s cable systems in China did not provide outside programming; by 1997 many provinces provided access to China Star, a Hong Kong system that relies heavily on U.S. and British programming and modern advertising.

While there are not extensive data on the proportions of Chinese households with access to mass media more than thirty years ago, research has shown a marked increase in television ownership and viewing and indicates that media's penetration into Chinese households in 1997 is far greater than into American households fifty years ago, when television was in its infancy.

Health effects. The BMI-disease relationships have been found to vary between major Asian and other subpopulation groups and those of European background. Are these related to differences in the distribution of fat in a body (e.g. fat distributed around the heart and livers in the abdomen versus in the hips and buttocks), or are there underlying equally important genetic factors that account for these differences?

There are a number of different ways these questions could be answered in the affirmative. One is if body composition and other unmeasured racial and ethnic factors affect susceptibility to nutrition-related noncommunicable diseases. Another might be if previous disease patterns (such as the presence of malaria or other tropical diseases) have predisposed the population to certain problems. One component of this might be the fetal insult syndrome hypothesized and popularized by Barker.

A growing body of research shows that international standards used to delineate who is overweight and obese are not appropriate for many large subpopulations. For instance, a BMI of 25 appears to have a far greater adverse metabolic effect in an Asian adult than in a Caucasian adult (Deurenberg et al., 1998). In fact, the World Health Organization (WHO) and the International Obesity Task Force (IOTF) have formed a group of scientists and agencies in Asia to review this topic. This group has held international meetings and has proposed a lower BMI cutoff for Asians, of 23 for overweight and 25 for obesity (International Diabetes Institute, 2000). In one paper comparing China, the Philippines, and U.S. Hispanics, African Americans, and whites, the odds of being hypertensive were higher for Chinese men and women in the 23–25 BMI range than for other subpopulation groups (Bell et al., 2001). Ethnic differences in the strength of the association between BMI and disease outcomes warrant further consideration.

Zimmet and others who have focused on this issue as it relates to lower-income countries have felt that the highest genetic susceptibility for adult-onset diabetes was for Pacific Islanders, American Indians, Mexican Americans and other Hispanics, and Asian Indians. Those groups with modest genetic susceptibility include Africans, Japanese, and Chinese. The age of onset (usually after fifty) of non-insulin-dependent diabetes mellitus (NIDDM) is much lower for these susceptible populations, and it appears that the prevalence is higher for a given level of obesity and waist-hip ratio.

What is not clear is how much of this difference between subpopulations' BMI-diabetes or other BMI-morbidity relationships is a function of differences of body composition, of metabolic or genetic factors, or of social causes. Part of the apparent race-hypertension relationship may also be explained by socioeconomic status (Bell et al., 2001).

There is possibly another factor related to the role of exposure to poor health in this population, for which there is less understanding and no real documentation of its impact (e.g., malnutrition that causes a virus to mutate, parasitic infections that affect long-term absorption patterns, or a parasite that is linked with an unknown genotype—comparable to sickle-cell anemia and its evolutionary linkage with malaria). There is no basis for speculation about the importance of this factor.

The effect of fetal and infant insults on subsequent metabolic function, however, appears to be a critical area. If rapid shifts toward obesity are occurring among those who earlier faced higher levels of low birthweight in a population, then this becomes a much more salient aspect of this argument. In the developing world, where intrauterine malnutrition rates have been and continue to remain high, and nutrition insults during infancy are highly prevalent, research suggests important potential effects on the prevalence of nutrition-related noncommunicable diseases in coming decades (Barker, 2001; Adair et al., 2001). There is an emerging consensus that fetal insults, in particular with regard to thin, low-birthweight infants who subsequently become overweight, are linked with increased risk of these diseases. Infancy itself, however, may equally be a period of high vulnerability. Three further studies by Hoffman and collaborators (2000) suggest that fat metabolism of stunted infants is impaired to the extent that it could lead to increased obesity and other metabolic shifts. Other work on the role of stunting and obesity (Popkin et al., 1996) had suggested such an effect; Hoffman's work offers the mechanism.

The Coming Cardiovascular Disease Epidemic

Evidence from many developing countries shows that nutrition-related chronic diseases prematurely disable and even kill a large number of economically productive people, a preventable loss of precious human capital. Four out of five deaths from nutrition-related chronic diseases occur in middle- and low-income countries. Reddy (2002) has pointed out that these low- and middle-income countries now account for over three-quarters of global mortality and over 40 percent of the global burden of disease, measured as disability adjusted life years (DALYs) lost, that is attributable to noncommunicable diseases. Among the low- and moderate-income developing countries, the burden of cardiovascular disease alone is now far greater in India and China. Together these two countries account for over half of all new cases of diabetes in the world. Lower-income communities are especially vulnerable to nutrition-related chronic diseases, which are not only diseases of affluence. Such nutrition-related chronic diseases as cardiovascular diseases (CVDs), cancers, and diabetes are becoming major contributors to the burden of disease, even as infections and nutritional deficiencies are receding as leading contributors to death and disability.

Furthermore, cardiovascular diseases in the developing world emerge at an earlier age. Over 45 percent of heart disease–related deaths in low- and moderate-income countries occur under the age of 70 (compared with about 20 percent in high-income countries) (Reddy, 2002).

There are large differences in the profiles of the CVD epidemic across the developing world. Hypertension and stroke, for instance, are more likely to emerge in East Asia, whereas diabetes comes earlier in South Asia.

As would be expected from the dietary and obesity data noted above, CVD levels are far greater in urban areas of the developing world; the opposite is often true in the higher-income developed countries.

The Social Burden of Changes in Diet, Body Composition, and Health

In the richer countries of the world, higher-income groups increasingly follow a more healthful lifestyle when compared to poorer groups. Higher-income Americans consume a more healthful diet, exercise more, and smoke less; similar patterns are found in other high-income countries (Popkin et al., 1996). The prevailing opinion has been that the opposite is found in the developing world, namely, that the poor are less likely to have a heavy burden of nutrition-related noncommunicable diseases than the rich. This statistic is changing rapidly. Monteiro and his collaborators have shown that obesity has gone down among the better-educated, and increased among the less-well-educated, in southeastern Brazil. Soowon Kim and collaborators have shown that not only are less healthful dietary patterns common among higher-income Chinese; so are other harmful dimensions of lifestyle (inactivity, smoking, drinking). Other Chinese scholars have shown a rapid shift in food-consumption patterns among different income groups, which seems to indicate a shift in the burden of unhealthy diets toward poor Chinese (Guo et al., 2000).

The Future

Consuming a more tasteful and richer diet is a goal of most of the world's population. Dietary change is universal; rapid change, though, is now seen especially in the poorest areas of the world. The challenge is to learn how to continue to improve the palatability and quality of our diet, while discovering ways to accomplish this task in a more healthful manner.

See also **Food Politics: United States; Food Supply and the Global Food Market; Health and Disease; Nutrients; Nutrition; Obesity; Political Economy**.

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NUTS. Botanically, a nut is a hard, one-seeded fruit that is indehiscent, which means it does not split open on its own at maturity. Many commercial nuts, however, do not meet the strict botanical definition. One common characteristic of nuts is a hard outer covering or shell. The shell is a natural package that protects the inner seed, usually very high in food value, from animal predation. To overcome thick nutshells, humans (and other primates) developed tools. The most primitive tools are rocks used by chimpanzees for cracking nuts. Some scientists speculate that the shards broken from such primitive nutcrackers may have been the first scraping and cutting tools used by early humans as they gradually developed and improved technology.

Nuts may have helped spark early humans' technological creativity by coupling a challenge with a nutritious reward. The hard nutshell is a challenge that must be overcome to gain the reward of the kernel and has become a metaphor for a challenging puzzle, "a hard nut to crack." The names given to nuts by indigenous people sometimes reflect the effort of cracking. The word *pacan*, for example, was used by Native Americans to refer to all hard-shelled nuts that required an instrument (stone or hammer) to crack. The folds, wrinkles, and lobes of walnut kernels bear a resemblance to the brain, and are similarly encased in a skull-like protective case. Under the "Doctrine of Signatures," a medical system used in the sixteenth and seventeenth centuries, that similarity was considered meaningful so walnuts were prescribed for maladies related to the head. It may be from such visual, verbal, and historical connections that the term "nut" came to be associated with the head, as well as with an idiosyncratic personality.

Modern technology has provided global access to a wide range of nut crops, at the same time threatening the maintenance of the genetic and ethnobotanical diversity that produced them. Perhaps exploring the variety of nut crops within the context of their usefulness to humanity will contribute to improved stewardship.

Almonds (*Prunus dulcis* [Miller] D. A. Webb)

Plant biology. The almond is a deciduous tree of the arid temperate zone. It grows to a height of twenty-five to thirty feet and has white to pink solitary flowers, 1–1.5 inches across, that develop with or before the early foliage. The flowers of most almond cultivars are self-incompatible, although there is selection for self-compatibility, especially in Europe. Honeybees typically transfer the heavy pollen. The flower has a single pistil with two ovules. If both develop, an undesirable "double kernel" is produced. The fruit is a compressed, pubescent, oblong-ovoid drupe that splits at maturity to reveal the shallow pitted stone containing the seed (the edible kernel).

Almonds are a concentrated source of energy, being relatively high in fat (54 percent, see Table 1). The fatty acid in highest concentration is oleic acid (70–78 percent), a monounsaturated fatty acid that can contribute to lowered cholesterol levels. Kernels are also relatively

TABLE 1

Nutritive value and composition of major nut crops

				fat composition					
Crop	% water	% protein	% fat	% sat	% oleic	% linoleic	% carb	minerals	cal/g
almond	4.70	18.59	54.23	8.05	67.01	20.00	19.51	0.48	5.98
brazil nuts	4.60	14.30	66.85	20.00	48.01	26.00	10.88	1.60	6.54
cashews	5.20	17.18	45.66	16.98	70.00	6.99	29.27	0.90	5.61
chestnuts	52.50	2.91	1.50				42.07	0.60	1.94
coconut	50.90	3.56	35.33	86.16	6.92	.	9.33	0.04	3.47
hazelnuts	5.80	12.60	62.33	4.99	54.04	16.03	16.70	1.25	6.33
peanuts	1.80	26.18	48.68	21.97	43.08	28.96	20.63	0.38	5.82
pecans	3.40	9.19	71.15	7.00	63.00	20.00	14.58	0.97	6.86
pine nuts	3.10	13.21	61.43				20.71	0.04	6.43
pistachios	5.30	19.27	53.66	10.02	64.98	19.01	18.99	1.61	5.93
walnuts	3.50	14.78	63.94	6.99	14.98	62.00	15.79	0.93	6.50

high in protein (18 percent). Seedlings vary in kernel quality, with some producing bitter kernels due to high levels of the glucoside amygdalin. Amygdalin is hydrolyzed by the enzyme emulsin to form benzaldehyde and cyanide, which cause the bitter taste. Substrate and enzyme are both present in the seed and are united when cells are injured, as occurs during consumption. The trait has adaptive value as a protection against predation.

History. Almonds originated in Asia and moved with the migrations of peoples, which were often impelled by the upheavals of famine and warfare. In Genesis 43:11, the patriarch Jacob instructed his sons to carry almonds and pistachio nuts from their home in Palestine to Egypt when the family had to relocate during a period of extreme famine (c. nineteenth century B.C.E.).

The almond may have been introduced in Greece during the conquests of Alexander the Great (c.320 B.C.E.). From Greece, almonds spread into Italy and the Mediterranean region, a movement that can be traced in the etymology of the English word. "Almond" is derived from the French *amande*, from the Latin *amygdala*, which came from the Greek.

The Arab conquest of North Africa in the sixth and seventh centuries started another wave of almond introductions. The Moors took almonds with them when they conquered southern Spain. Almonds were then transported from Spain to California during the Spanish Mission Period (1800). The warm, dry climate of California, coupled with intensive agricultural systems, led to the preeminence of California in world almond production.

Almonds are currently grown in regions characterized by a subtropical Mediterranean climate. Primary production centers are the central valleys of California, the Mediterranean region, and Central to Southwestern Asia.

Procurement. In California, culture is intensive. Cultivars are selected for high production of soft-shelled kernels. Grafted trees of improved cultivars are propagated on rootstocks selected for the constraints of particular sites. Trees are planted in irrigated orchard configurations with densities of up to 134 per acre. Two rows of the main cultivar to one row of a pollinizer are planted and hives of bees are maintained to aid pollination. Trees are heavily fertilized and protected with chemical pesticides, and yields of over 3,000 pounds of kernels per acre are achieved. Harvest operations are heavily mechanized, with specialized machines to shake nuts from the tree and others to collect them from the orchard floor.

In the Mediterranean region of production, culture is not as intensive, and many orchards are composed of selected seedlings rather than grafted trees. Furthermore, most classes and cultivars are hard- or semi-hard-shelled. Orchards contain fewer trees than in California, with only fifty to seventy trees per acre being typical. Selection has occurred within particular regions that have become identifiable for the class of almonds produced, despite heterogeneity. For instance, the Spanish island Majorca is known for the Farmer Majorca class, composed of a multitude of related seedling trees. Recent selection has been for late-blooming cultivars that avoid frost damage, for self-compatibility, and for adaptation to the environmental stresses that are not as completely controlled as in California.

Global and contemporary issues. Standardization accompanying globalization puts pressure on diversity. Increased uniformity allows increased mechanization, and may contribute to marketability and even profitability, but at the cost of genetic diversity. Small areas in the Mediterranean once comprised distinct land races of selected seedlings. The diversity of those local populations is being reduced as grafted culture increases. Maintenance of ex situ germ plasm collections cannot substitute for the continued selection of desirable seedlings by multiple local growers.

Brazil Nuts (*Bertholletia excelsa* Humbl. & Bonpl.)

Plant biology. Brazil nuts are produced by giant evergreen trees indigenous to the Amazon forest of South America. Trees may reach heights of over 160 feet, and form part of the upper forest canopy. Cream-colored flowers are borne in racemes at the ends of shoots, and have both male and female parts. Female *Euglossine* bees accomplish pollination, while males of that species primarily visit orchids. Flowers mature and drop quickly, within a single day. Fruit matures in fourteen months, falling from the tree from January to June. The fruit is a four- to six-inch spherical pod with a thick outer shell encasing twelve to twenty-four wedge-shaped nuts, each in its own dark brown rough shell. Each nut is two inches long or more and has a single solid kernel. Kernels are about 66 percent fat, 20 percent of which is saturated (see Table 1). The high oil content makes the nuts valuable as a source of oil for cosmetics and soap making, as well as for consumption. The nuts are about 14 percent protein and are a concentrated source of selenium, which is being studied for its role in preventing some forms of cancer.

History. Although Brazil nuts have been used by indigenous people of the Amazon for millennia, they were "discovered" by the outside world in 1569 when Juan Alvarez Maldonado was directed to the nuts by the Cayanpuxes Indians on the Madre de Dios River. The Spanish called the nuts "almendras de los Andes" or "almonds of the Andes." Dutch merchants began trading for Brazil nuts in the early 1600s, but it was not until the beginning of the nineteenth century that the tree was given its botanical name. The German botanist Alexander von Humboldt and his French colleague Aime Bonpland went on an expedition to Brazil in 1799; following their return to Paris about five years later, the men named the nut after von Humboldt's friend Claude Louis Berthollet.

Brazil nuts became a traditional Christmas delicacy in England in the nineteenth century, and the market for the nuts soared as rubber exports increased in the last half of the century: the settlers who ventured into the forest to harvest rubber also harvested the Brazil nuts. When the market for rubber dropped, the demand for Brazil nuts remained consistent and has continued to support the *castaneros* who make their living harvesting the wild trees. The value of the nuts is dependable enough to serve as a type of currency in the area where they are grown.

Procurement. Brazil nuts are the only globally distributed nut crop produced almost entirely from wild trees. The long time required to establish a bearing tree, and low yields related to problems with pollination in established orchards, have made plantations of the trees economically unattractive. Most nuts come from the Brazilian states of Para, Amazonas, and Acre. Brazil nuts are also produced in Bolivia, Peru, Colombia, the Guianas, and Venezuela. A single tree may produce over 300 of the heavy, nut-filled pods. *Castaneros* do not stand under the trees in windy conditions to avoid being hit and possibly killed by the falling pods. Most collecting is done in the morning, and an experienced worker can collect close to a thousand pods in a day. Pods are opened with a machete, and nuts are carried to the river in sacks often weighing over one hundred pounds. They are taken by canoe or raft to marketing centers, where a few exporters accumulate and market the crop and receive the majority of the profit.

Global and contemporary issues. Increased attention has focused on Brazil nuts as a "keystone species," a species critical to the intricately interwoven web of life for many organisms. Studies in the wild have revealed the role of specialized bees for pollination, a factor that may be missing in planted orchards. The agouti, a large rodent, is unique in its ability to open the pods and to scatter-hoard the nuts, contributing to seedling establishment. Other organisms rely on the empty pods as a substrate for development. In recognition of their value to local people, laws in several countries prevent cutting down Brazil nut trees. Creative efforts are being made by local people to market the valuable crop directly and establish a sustainable ecological and economic system centered on this valuable nut tree.

Cashew Nuts (*Anacardium occidentale* L.)

Plant biology. The cashew tree is a medium-sized (up to forty feet tall), spreading evergreen tree that originated on the dry, salty coastal beaches of northeast Brazil. Trees have a deep taproot and extensive lateral roots that adapt them to their habitat. Leaves are simple and alternate, with entire margins. Flowers may be unisexual or perfect and are borne in terminal-branching panicles. The fruit is composed of a greatly enlarged receptacle, sometimes called the "cashew apple," at the base of which develops a thick-shelled, single-seeded, kidney-shaped nut. Inside the nut is the edible kernel, covered with another, thinner shell. Between the outer and inner shells is a thick, caustic oil called "cardol" that can cause blisters and must be removed. The kernels are roasted to remove toxins. Cashews are lower in oil than many nuts, having only 45 percent. The primary oil is oleic acid. Kernels are relatively high in carbohydrates (see Table 1). In addition to the edible nuts, the peduncle (or apple) can be eaten, pressed for juice, or used to make wine. The caustic nutshell liquid (CNSL) has heat-absorbing properties that make it useful in several industrial applications, from clutch facings to waterproof paints. Other plant parts are also useful: sap is used as insect repellent and varnish, and leaves and bark are used medicinally.

History. Indigenous people of Brazil were using cashew nuts and apples when the first Europeans visited in the mid-1500s. The Portuguese introduced trees to India in the 1560s, from which the species spread to other tropical parts of Asia. India was the source of the first international trade in cashews in 1907, exporting 430 tons of kernels to Britain and importing unshelled nuts from East Africa.

Procurement. The World Bank estimates that 97 percent of world cashew production is from "wild trees" (self-sown rather than systematically planted in orchards), although research on crop improvement is proceeding in Brazil, India, and Africa. Seedlings are capable of producing nuts only three years after planting. The vast majority of the very perishable cashew apples are allowed to rot rather than being processed. Yield from a mature cashew tree is estimated at between 100 and 150 pounds of fruit (apples and nuts), from which twenty pounds of hulled, unshelled nuts can be obtained, yielding about six pounds of kernels. Nuts are dried immediately after harvest, and then must be roasted to remove the caustic nutshell liquid, which complicates processing. Traditional methods of roasting result in the loss of the CNSL, as well as causing hazardous working conditions due to spurting oils and toxic smoke. More modern extraction methods salvage the CNSL, but require expensive solvents and technical expertise.

Chestnuts (*Castanea* spp.)

Plant biology. Chestnuts are deciduous trees with simple, alternate leaves that have serrate to dentate margins. Chestnuts are monoecious, with separate male and female flowers on the same tree. Male flowers are borne as unisexual catkins at the terminal end of shoots and as bisexual catkins on the lower shoots. Female flowers appear singly or in clusters of two or three at the base of the bisexual catkins and become the nut-bearing burrs. Male flowers tend to shed pollen prior to female receptivity, creating a tendency to cross-pollination. Pollen is primarily wind disseminated. The fruit is a spiny burr that dehisces into four valves at maturity to reveal three nuts. Chestnuts are rich reddish brown with a conspicuous pale oval scar at the base. The shell is relatively thin and is not as protective as the burr is. When the shell is removed, a hairy pellicle (seed coat) covers the embryo and two irregular cotyledons. Chestnuts have the highest water content, the lowest fat content, and the highest carbohydrate (starch) content of any nut crop (see Table 1). If chestnuts dry after harvesting, some of the starch converts to sugar and viability of the seed is lost. As a result, postharvest handling dramatically affects both the edible quality of the product as well as its viability for seed.

Three species account for the majority of world production: the Chinese chestnut (*Castanea mollissima* [Bl.]), the European chestnut (*C. sativa* [Mill.]), and the Japanese chestnut (*C. crenata* [Sieb & Zucc.]). All species have a somatic chromosome number of 2n=24 and hybridize freely.

History. Seven species of *Castanea* are found around the world in the temperate zone, and each has a long history of utilization. The Japanese chestnut is native to the Japanese islands and Korea and has been cultivated for over 2,000 years, with some cultivars being maintained since 750 C.E. The species is considered the most domesticated, with the largest fruit, the most precocious seedlings, and the smallest mature tree size. Unfortunately, some of them produce nuts that are not very palatable until they have been cooked.

Most chestnuts consumed in Europe and the United States are derived from the European chestnut, which has been cultivated in southern Europe and Asia Minor since the Roman Empire. Increasingly, hybrids between the European and Japanese chestnuts are grown commercially because the latter species is resistant to ink disease.

American chestnuts (*C. dentata* [Marsh.] Borkh) were a dominant tree in the eastern forests of North America until ink disease (*Phytophthora cinnamomi*) eliminated them from the Gulf states in the early 1800s, and chestnut blight disease (*Cryphonectria parasitica* [Murr.] Barr) developed in the United States in the late 1800s. Ink disease probably came in on cork oak trees from Portugal, which were planted in the south before 1823. Blight disease was introduced in the 1880s, with Japanese chestnut planting stock. It spread up and down the eastern seaboard with nursery stock, and then moved into the forest by other vectors, until by 1950 almost all large chestnut trees were infected. Ink disease is lethal to chestnuts, but the blight fungus does not kill roots, so trees continue to sprout, are reinfected, and die back. There is good evidence that, in the southern United States, heavy shading, competition, grazing, and continued infections often kill the trees completely, but this is not the case in northern forests, where canopy type, competition, and predation are quite different.

In addition to the two diseases, chestnuts in the United States are also threatened by the Oriental Chestnut Gall Wasp (*Dryocosmus kuriphilus*), another introduced pest that has become established and is damaging native chestnut species. The Gall Wasp is believed to have been introduced from Asia into Georgia in 1974 on scion wood that did not pass through proper quarantine. It infested orchards of Chinese chestnuts in Georgia and has also been found in wild trees of the American chestnut along the Appalachian Trail.

Procurement. Chestnuts are exported in large numbers from Italy, Spain, Australia, China, and Korea. Japan and the United States are primarily importers, although these markets are partially satisfied by locally grown chestnuts. New cultivars are being registered at an increasing rate, and interest in the crop is increasing.

Global and contemporary issues. The chestnut exemplifies both the dangers and benefits of globalization. The devastation of the North American forest by introduced diseases and insects argues in favor of the careful regulation of genetic materials moving between countries. Breeding programs are succeeding in developing resistance to these pests by the use of interspecific hybrids that were created using introduced germ plasm, illustrating the value of carefully sharing genetic resources.

Coconut (*Cocos nucifera* L.)

Plant biology. The coconut is a tall, tropical palm tree that reaches reproductive maturity six to ten years from planting and may live one hundred years. Tall varieties may reach heights of one hundred feet and have a single, usually curved or leaning, trunk with smooth gray bark marked by the ringed scars left by fallen leaf bases. A many-leafed crown tops the trunk, with each pinnately compound leaf being fifteen to twenty feet long. Male and female flowers are borne on a fleshy spike (spadix) enclosed within a leaflike sheath (spathe) arising from the leaf axils. Female flowers are in the basal position and male flowers are at the apex. Pollination may be either anemophilous (wind-distributed) or entomophilous (insect-distributed). The fruit is a large drupe eight to nine inches in diameter. The coconut has a thin, smooth, grayish brown epicarp, a one-to-three-inch-thick, fibrous mesocarp (yielding coir, a fiber used in thatching), and a woody endocarp (the shell). Inside the shell the endosperm comprises the single seed. A portion of the endosperm is solid (the flesh) and a portion is liquid (the milk). The coconut is light in relation to its volume, which allows it to float and be transported by water for long distances. Eventually it washes up on sandy, saline, tropical beaches where it is well adapted to survive. When the embryo germinates, the radicle emerges through one of three germinating pores visible on the outside of the shell. The three pores give the head-sized coconut the appearance of a monkey face. The genus name *Cocos* is derived from the Portuguese word for "monkey."

Coconut oil is extracted from the dried flesh, or copra, and is rich in lauric acid, a valuable antifungal, antiviral, and antiprotozoal compound. As a food, coconut oil is very high (86 percent) in saturated fats, which occur as medium-chain triglycerides that do not raise serum cholesterol or contribute to heart disease as much as long-chain triglycerides. Coconut oil is also a component of soaps and other health products.

History. Coconut fossils from the Tertiary period have been found in the Indo-Pacific Ocean region where the plant originated, and charred coconuts have been found in Western Melanesian archeological sites dated to 3000 B.C.E. The plant is a valuable source of food (the flesh), drink (the milk), and shelter (leaves, shell fibers, and trunk). In Sanskrit, the coconut palm is called "the tree which provides all the necessities of life." As a valued source of life's requirements, the coconut was spread by seafaring people throughout the Pacific, possibly as far as the Pacific coast of Central America, and west to India and East Africa. The first written mention of the tree was by an Egyptian monk in 545 C.E., and Marco Polo described coconuts growing in Sumatra, India, in 1280 C.E.

Procurement. Coconuts were first established in large-scale commercial plantations in the mid-nineteenth century, many from the seeds of local wild palms along the seashore. Planted coconuts now greatly outnumber wild palms, and coconut products form the main export of Ceylon, the Philippines, and other Indian and Pacific Ocean islands.

Hazelnuts (*Corylus avellana* L.)

Plant biology. Hazelnuts, also known as filberts, are produced on small, shrubby, often multitrunked trees that usually grow to heights of fifteen to twenty-four feet. They have simple, alternate, round-oval leaves with toothed margins. Hazelnuts are monoecious, with both male and female flowers on the same plant, but they are not self-fruitful. Flowers appear before the leaves. Male flowers are borne in catkins at nodes on one-year-old wood, and their wind-disseminated pollen is shed in midwinter. Female flowers are inconspicuous clusters of tiny flowers enclosed within bud scales, visible at the time of pollination as bright red stigmas extending from buds. Fruit matures from early September to October, with the ovoid or oblong nut inside a leafy husk. There is wide diversity in fruit and husk shape, and that diversity is reflected in the common names: "hazel" is from the Old English word for hood or bonnet (*hæsel*), which referred to a nut whose husk was shorter than the nut. "Filbert" is probably derived from the name of St. Philibert, a Frankish abbot whose feast day falls in the season when the nuts ripen; it has also been said that the name comes from "full beard," which referred to a long husk. In some countries long nuts are called "filberts," while shorter, round nuts are called "hazels."

The nuts are composed of a shell that has variable amounts of pubescence, especially at the tip. Inside the shell, the kernel is encased in a more-or-less-fibrous seed coat (pellicle) that is usually removed by blanching. Kernels are high in fat (62 percent), with the predominant being oleic acid (see Table 1). Hazelnut kernels are also high in Vitamin E, averaging 400 mg/100 g.

History. The European hazelnut was the first plant of the temperate deciduous forest to move into areas vacated by receding glaciers at the close of the last ice age, due primarily to its great climatic tolerance. Nuts are recovered at European archeological sites in conjunction with prehistoric human settlements, indicating a long history of food usage. Hazelnuts are one of Europe's oldest cultivated plants. They have been grown for centuries in Turkey, Italy, Spain, France, Germany, and England, although different conventions have arisen for their culture in each country. Hazelnuts were introduced in North America by shipments of seed sent in 1629 to the Massachusetts Company. Due to the eastern filbert blight (*Anisogramma anomala* [Peck] E. Muller), the culture of hazelnuts in the United States is concentrated in the coastal valleys of Oregon and Washington.

Procurement. In Turkey, the leader in world hazelnut production (65 percent), hazelnuts are cultured in traditional systems that rely on hand labor. Multitrunk seedling trees are planted in clumps of four or five bushes, often arranged irregularly on steep hillsides. Stems are progressively removed as they grow too old, allowing younger shoots to come into production. Nuts in the husk are hand harvested before the crop drops.

Italy follows Turkey in hazelnut production, accounting for about 23 percent of world production. Hazelnut culture in Italy is similar to that in Turkey, using clumps of multitrunk seedling trees, but with more uniform spacing. In Spain, where about 5 percent of world production originates, orchards are planted in still more regular rows, with a single bush at each location rather than a clump of separate bushes as in Turkey and Italy.

The United States produces about 3 percent of the world hazelnuts. In the United States, hazelnuts are grown in systems that facilitate mechanization and maximize nut size and yield per acre. Grafted trees of selected cultivars (mostly "Barcelona") are grown as single-trunk trees in evenly spaced rows, with about 200 trees per acre. Trees are sprayed with chemicals to accelerate and concentrate ripening. Nuts fall to the ground and are mechanically windrowed and harvested.

Global and contemporary issues. The European hazelnut, *Corylus avellana*, hybridizes with other species of *Corylus* that occur from China to the United States and that are largely untapped resources. The genetic diversity of the European hazelnut is well established, based on diverse seedling culture in the primary production centers. The potential is excellent for continued genetic improvement of hazelnuts through selection and breeding.

Peanuts (*Arachis hypogaea* L.)

Plant biology. The peanut (or groundnut) probably originated in South America although it was also cultivated in ancient China. It is a low-growing annual legume with subterranean fruits. Its leaves are stipulate and even-pinnate, mostly with two pairs of oval leaflets and no tendril. Flowers are formed in the axils of leaves and have a very long pedicel. Flowers are self-pollinated and usually do not open. After pollination, cell division in the pedicel drives the pod below ground, where it ripens. The fruit is an indehiscent, fibrous, constricted pod containing one to three dry edible seeds, each encased in a papery integument. The seeds are 20 to 25 percent carbohydrate, 25 to 30 percent protein, and 45 to 50 percent oil (see Table 1).

History. Peanuts may have been domesticated by selection from the related species *Arachis monticola*, found in northwest Argentina, and the only other member of the genus with the same chromosome number ($4x = 40$), although other candidates are possible. Peanuts have been found in archeological sites in Peruvian desert oases dated to 2000 B.C.E. and were mentioned in Spanish historical records in 1550. Four major varieties of peanut form the foundations of world trade. "Virginia" prostrate peanuts were reported in the West Indies by the Spanish, and introduced from there into Mexico, as well as to West Africa via slaving ships. This variety was introduced to eastern North America from both the West Indies and West Africa in the seventeenth century. The Spanish took "Peruvian" prostrate peanuts from Peru to the Philippines and into southeastern China before 1600, with subsequent transport by Chinese traders. "Spanish" peanuts are an erect variety that is very high in oil. They were taken from Brazil to Africa in early introductions, and were established in Spain in the late eighteenth century. From Spain the "Spanish" peanuts were taken to southern France and were introduced in the United States in 1871. The "Valencia" was named for a location in Spain and introduced in the United States from that region about 1910. However, it had been introduced in Spain from Cordoba, Argentina, about 1900.

Procurement. Peanuts are grown worldwide in areas that have hot summers, alternating wet and dry seasons, and sandy soils. The plant is capable of fixing nitrogen in root nodules via symbiosis with the *Rhizobium* bacterium. Plants are harvested by digging and are piled to dry. In the United States, yields of over two tons per acre are often achieved. The major world producers of peanuts are China, India, and the United States (USDA–National Agricultural Statistics Service, 2001). The primary use for peanuts is as a source of edible oil, but they are also eaten as a food either boiled or dried. The tops of plants, as well as the residual protein-rich cake from oil extraction, can be fed to cattle.

Pecans (*Carya illinoinensis* [Wangenh.] K. Koch)

Plant biology. The pecan is a deciduous, temperate tree species native to North America. It is found in well-drained alluvial soils of the Mississippi River and its tributaries from Illinois and Iowa south to the Gulf Coast of Louisiana and west to the Edwards Plateau of Texas. Isolated populations are found as far east as southwestern Ohio, as far west as Chihuahua, Mexico, and as far south as Oaxaca, Mexico. In modern times, the distribution of pecans has been extended from the Atlantic seaboard west to California, with major commercial production in the non-native states of Georgia and New Mexico.

Trees are long-lived (to 300 years) and grow to heights of over 120 feet. Leaves are alternate, odd-pinnately compound, with nine to fifteen serrate leaflets. Trees are monoecious (male and female flowers are borne on the same tree) and dichogamous (male and female flowers mature at different times), a system that encourages out-crossing with other trees of a complementary bloom period. Male flowers are borne on pairs of three stalked catkins that arise from buds of the previous season. Female flowers are borne as spikes at the tip of the current season's shoots, usually with two to four flowers per spike. Pollen is disseminated by wind (anemophily). The fruit is a "drupelike nut," with the dehiscent husk splitting at maturity (usually September to December) to expose the elongated, relatively thin-shelled nut. Kernels are two-lobed, separated in the shell by an internal partition or septum. Kernels are high in oil (70 percent), with the predominant oil being oleic acid (60 to 70 percent).

History. Some scientists think that early people carried pecan nuts north as the Laurentide ice sheet retreated at the close of the last ice age. Nuts have been found in Illinois in association with the artifacts of early people dated to around 8900 B.C.E. There is a rich history of pecan use by Native American tribes recorded in the writings of Hernando de Soto, Cabeza de Vaca, and Oviedo. Dense groves of native pecan trees growing along the Guadalupe River of Texas were visited every other year, due to the alternate-bearing cycle. In years of heavy production, pecans were a major component of people's diet.

Shell thickness and nut size were probably the two most important criteria of selection by early foragers, just as they are for modern pecan collectors. Trees producing large, thin-shelled nuts are more highly valued, more regularly visited, more extensively harvested, and (probably) more widely dispersed over time. About 1882, Edwin E. Risien of San Saba, Texas, offered a prize for the best native pecan. His intention was to obtain nuts from the prize-winning tree and plant them to establish an orchard of superior seedlings. The tree that won the competition came to be known as the "San Saba" pecan. Seedlings of that tree were selected and propagated, producing the "Western," "San Saba Improved," and "Onliwon" pecans, among others.

The first report of successful asexual propagation was by Abner Landrum in 1822. However, it was the gardener Antoine, a slave, who first established a commercially viable orchard by asexual propagation by grafting "Centennial" pecan on the Oak Alley Plantation in

Nuts have always provided a dimension of humor in cookery. From left to right: Folk art serving basket for walnuts constructed of sliced walnut shells and wire, American circa 1870. Cast-iron nutcracker in the form of a dog, American, circa 1930 (press the tail and crack the nut). Austrian marzipan mold of carved boxwood, circa 1840. Marzipan (almond paste) is used here to make faux walnuts and walnut shells. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Louisiana in 1846. In the late 1800s several nurseries sold grafted trees, providing material for the first great boom in pecan orchard establishment, which occurred in Georgia in the early 1900s. The extensive acreage established at that time, largely using the "Stuart" cultivar, quickly moved Georgia to the lead in production of improved pecans.

Procurement. Native pecans are harvested from wild trees. Trees are often unmanaged except at harvest and yield less per acre and have lower-quality pecans than improved orchards. As a result, native pecans sell for less on the market. Land clearing for other crops greatly reduced native pecans during the last quarter of the twentieth century. Efforts to characterize and conserve the diversity of native pecans are being pursued.

Commercial pecans are grown in orchards of variable numbers of selected cultivars, grafted onto regionally adapted seedling rootstocks, in configurations that vary by geographic region. Tree density tends to increase from the East to the West, with many orchards planted on 50′ × 50′ spacings in the East, with 35′ × 35′ spacings common in Texas, and 30′ × 30′ spacing common in New Mexico and farther west. Cultivar diversity tends to be greatest in the Southeast, while many western orchards contain large blocks of a single cultivar, usually "Western." Grafted trees begin to bear between the fourth to eighth leaf, but may not achieve a positive cash flow until the twelfth to fifteenth leaf. Cost of culture varies by region, with increased cost for pesticide application in the Southeast, but increased irrigation expense in the arid West.

Pecans are the most important nut crop in Mexico, which has native as well as grafted orchards. Pecans are also grown to some extent in Israel, South Africa, Australia, Egypt, Peru, Argentina, Brazil, and China.

Global and contemporary issues. The United States is the world center of diversity for the pecan. As native trees are cleared, much of that diversity may be lost. Efforts are being made to collect and characterize the diversity of the pecan across its range and to establish appropriate in situ reserves.

Pine Nuts (*Pinus cembroides* Zucc.)

Plant biology. Pine nuts are produced by the *piñon* pine tree, a small- to medium-sized tree found at high elevations in the arid North American Southwest. *Piñon* is found from west Texas to California, north to Wyoming, and south into Chihuahua, Baja California, and Hidalgo, Mexico. Trees form broad pyramidal crowns and become round-topped with age. Trunks are often twisted and gnarled, with rough, irregularly furrowed bark. Typically there are two needles per fascicle, with needles being one to two inches long, sharp-pointed, and fragrant. Trees are monoecious, with male flowers produced as short staminate cones. Female cones are lateral or subterminal, about one to two inches long and almost as wide, and brown at maturity. Cones mature the second year, in August to September. The brown to black edible seeds are one-half to three-quarters of an inch long, triangular to ovate in shape, and often rounded at the base. They have a thin, brittle shell. The kernels are aromatic and flavorful, are rich in fat (61 percent), and have about 13 percent protein (see Table 1).

History. Pine nuts have been found in excavations at Gatecliff Shelter, Nevada, and dated at 6,000 years B.C.E. Nuts were used by Native Americans in the Southwest as an important component of their diet, both medicinally and ritualistically. The terminal buds, inner bark, and the core of green cones can be eaten in the spring. Several parts of the plant were used medicinally: crushed nuts for treatment of burns; pitch for treatment of wounds; smoke from burning branches for treatment of coughs, colds, and rheumatism; fumes of burning pitch for head colds, coughs, and earaches. Wood was used as fuel and in construction. Pitch was used for waterproofing, as a black dye, and as an adhesive. Ritualistically, the pitch was used by the Navajo to prepare corpses for burial, and by the Hopi, who painted it on their foreheads to protect them from sorcery.

Procurement. Most nuts are harvested from wild trees when the crop presents itself, which is irregularly. Traditionally, nuts are collected from the ground after the cones have opened. Piñon nuts have become regionally popular as an ingredient in specialty recipes, and the demand for nuts has been met by harvest practices that damage the tree, such as breaking off cone-bearing limbs. Once harvested, nuts store well and may be kept for up to three years without becoming rancid.

Pistachios (*Pistacia vera* L.)

Plant biology. Pistachios are members of the same family as the cashew nut, the Anacardiaceae (which also includes mango and poison ivy). Commercial pistachio nuts are produced by *Pistacia vera*, a deciduous tree that grows to a height of twenty-five to thirty feet, with alternate, pinnately compound leaves, each with three to five leaflets. Trees are dioecious, producing male flowers on some trees and female flowers on others. Both male and female flowers are borne on panicles in the axils of the previous year's growth. Pollen is spread by the wind to the apetalous female flowers. The fruit is a dry drupe with an outer hull and a dry, thin shell that splits upon drying to expose the greenish kernels, each usually about one inch long by one-half inch wide. Kernels have about 20 percent protein and over 50 percent fat, 65 percent of which is the monounsaturated fat oleic acid.

History. The pistachio tree probably originated in western Asia and Asia Minor, but grows wild eastward to Pakistan and India. Pistachios have been recovered from archeological excavations in Jordan, dated to 6760 B.C.E. The Jewish patriarch Jacob instructed his sons to carry pistachio nuts and almonds with them from their home in Palestine to Egypt, as gifts for their brother Joseph, when the family had to move during a period of extreme famine (*New International Version Study Bible*, Genesis 43:11). Pliny reported that pistachios were introduced to Italy from Syria during the first century B.C.E., and spread from there throughout the Mediterranean area.

Pistachios were first introduced to the United States around 1853–1854 by the commissioner of patents, who distributed seed for experimental purposes. The crop did not gain much interest until later introductions began to fruit, in about 1881. The cultivar "Kerman" was introduced in Chico, California, by USDA (United States Department of Agriculture) plant explorer W. E. Whitehouse in 1929, from collections made near Kerman, Iran. That cultivar is the basis of the California pistachio industry.

Procurement. The major pistachio-producing areas are Iran, Turkey, and the San Joaquin Valley of California. In Iran and Turkey, nuts are harvested from trees of improved cultivars growing in established orchards, but harvesting and processing methods are primitive. Nuts are harvested by hand and many are allowed to dry in the hull, which can stain portions of the shell red, making them unattractive. As a result, many imported nuts are dyed with a red vegetable dye to camouflage the stains. Pistachios produced in California are mechanically harvested, hulled, and dried, and are unstained. Technology ensures that they can usually be marketed in natural condition. Small, wild nuts with desirable green color are still harvested in Afghanistan, although destruction of forests by clearing, overgrazing, and producing charcoal has reduced wild populations.

Global and contemporary issues. International political issues have resulted in barriers to marketing pistachios, which has influenced domestic crop value and acreage planted.

Walnuts (*Juglans regia* L.)

Plant biology. Nuts from several species of the genus *Juglans* are consumed worldwide, but the most horticulturally important is the Persian walnut. Persian walnut trees grow to heights of seventy-five feet and have trunks with tight, silvery bark. Shoots have chambered pith, distinguishing *Juglans* from its sister genus *Carya* (which has a solid pith). Leaves are odd pinnately compound, with five to nine elliptic-ovate to long elliptic leaflets with entire margins, while black walnuts have more leaflets (fifteen to nineteen) that have serrate margins. Male flowers are borne laterally as single catkins on shoots of the previous season. Female flowers are borne terminally on current season shoots and usually have one to three nuts.

Flowers are wind pollinated, and male and female flowers mature at different times of the season, promoting cross-pollination, which results in increased heterozygosity. Despite the predisposition to cross-pollinate, walnuts are self-fruitful. The fruit is a drupelike nut with a thick, irregularly dehiscent husk covering a shallowly fissured shell that encases the two kernels, each of which is deeply divided at the base.

Walnut kernels are rich in oils (64 percent), making them a high-energy food. The primary fatty acid is linoleic (62 percent), a polyunsaturated oil (see Table 1).

History. Progenitor trees were originally distributed across mountainous regions of central Asia, from eastern Turkey to Xin-jiang Province of western China. Walnuts have a long association with humans and have been found in archeological excavations of caves inhabited by prehistoric groups in China and the United States. Initial selection for large nut size and thin shell could have been unconscious, as seeds from unconsumed caches of preferred seed germinated and established seedlings near habitations. Over time, and in association with people, walnuts having large, relatively thin-shelled nuts were developed.

Improved walnuts were sent to Greece from Persia "by the kings," according to the Roman historian Pliny. From Greece, walnuts were introduced to Rome, where they were given the Latin name *Jovis glans* ('nut of Jupiter'), which was contracted to provide the genus name *Juglans*. The connection to Persian royalty is reflected in the specific epithet *regia*, meaning 'royal'. Romans spread walnuts throughout the Mediterranean, where the trees readily adapted to the warm, dry climate. The trees spread across Europe and into England where they became known in Old English as *wealhhnutu* (*wealh* means 'foreign' or 'strange', and *hnutu* means 'nut'). Although the tree is not capable of bearing profitable crops in the cool, wet English climate, it was esteemed for its high-quality wood. Walnuts were carried around the world in English ships, and came to be known in commerce as "English walnuts." Walnuts came to the United States with the first settlers in New England, although the first established production was from Spanish materials introduced in California.

Procurement. Walnuts are intensively cultured in California, with improved cultivars selected for high production and quality grafted onto hybrid rootstocks. Pollinizer cultivars are included to provide adequate cross-pollination. Orchards are irrigated, with up to five acre-feet of water per acre being required to mature a crop. Trees are chemically protected from pests, and mechanically harvested and processed.

In Europe and Asia, much production comes from seedling trees, with use of grafted cultivars increasing in Western Europe. Over centuries of cultivation, the selection of horticulturally valuable individuals and continued propagation by seed have resulted in distinct landraces in different regions.

Global and contemporary issues. In Europe, the economic incentive to increase production and quality by establishing monocultures of a few genotypes is being balanced by the awareness that regionally distinct land races provide a valuable source of genetic diversity. As more seedling trees are harvested for their valuable lumber, the need for conservation by in situ reserves has increased.

See also **Fruit; Horticulture; Legumes; Vegetables.**

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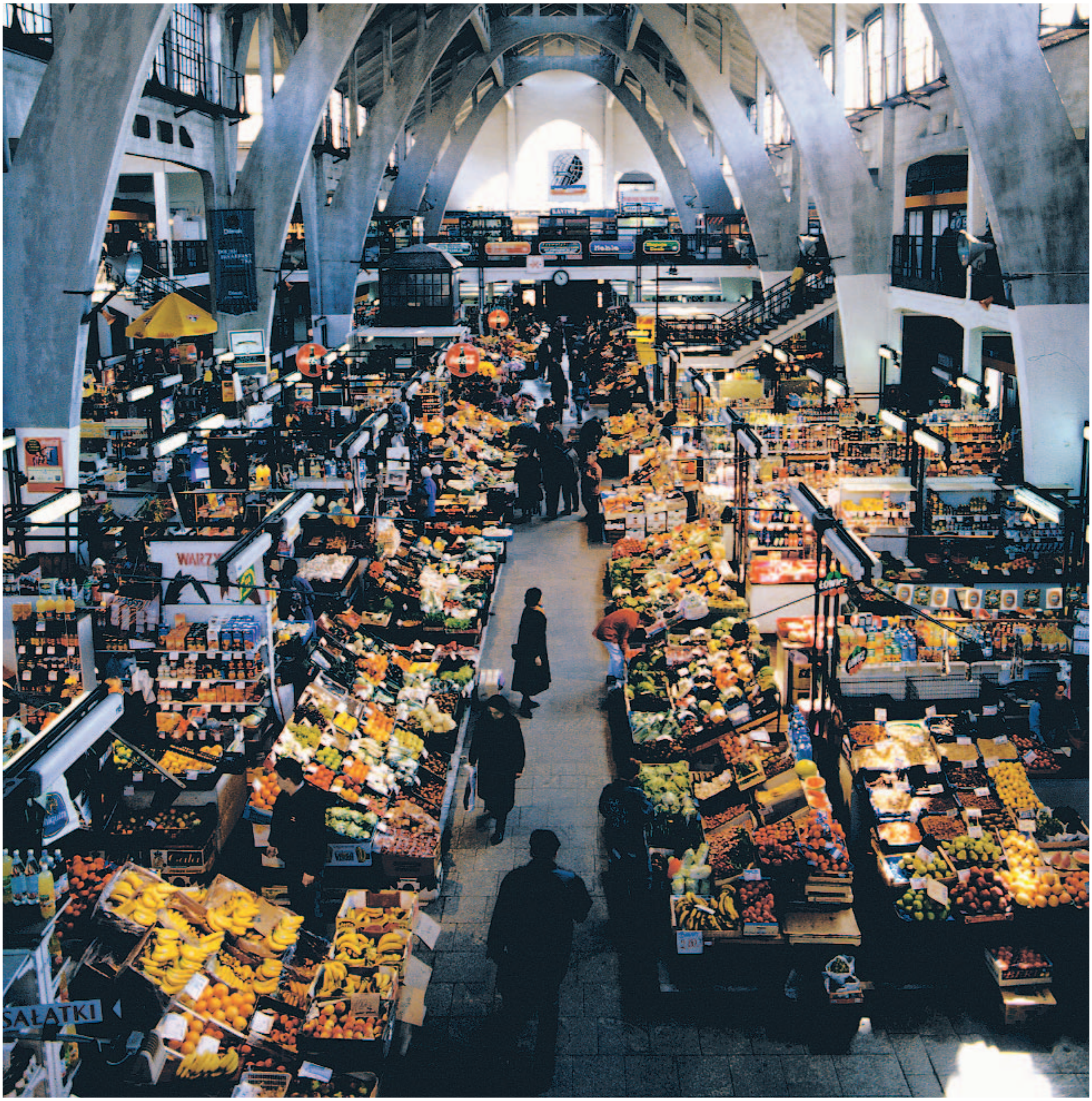
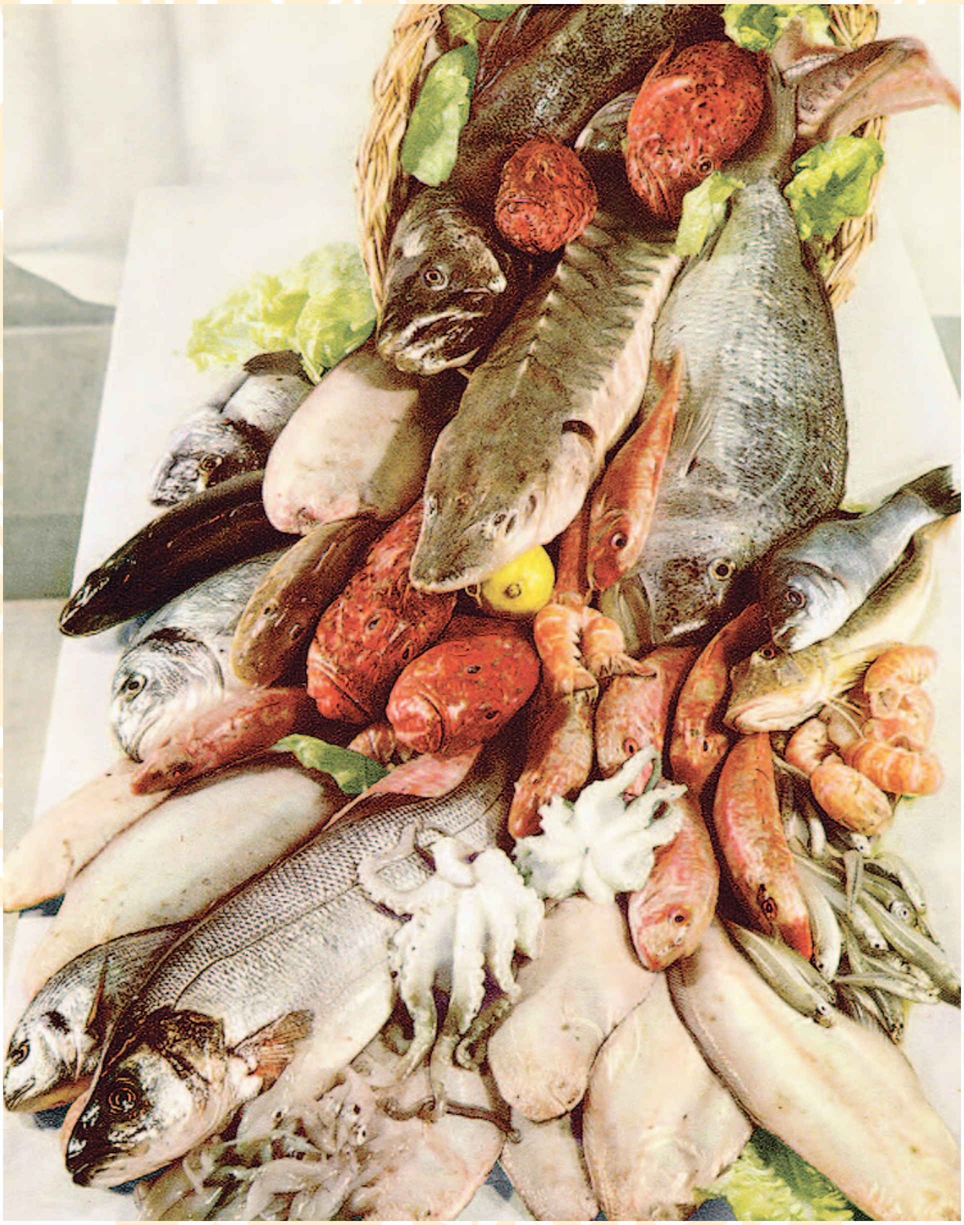
L. J. Grauke



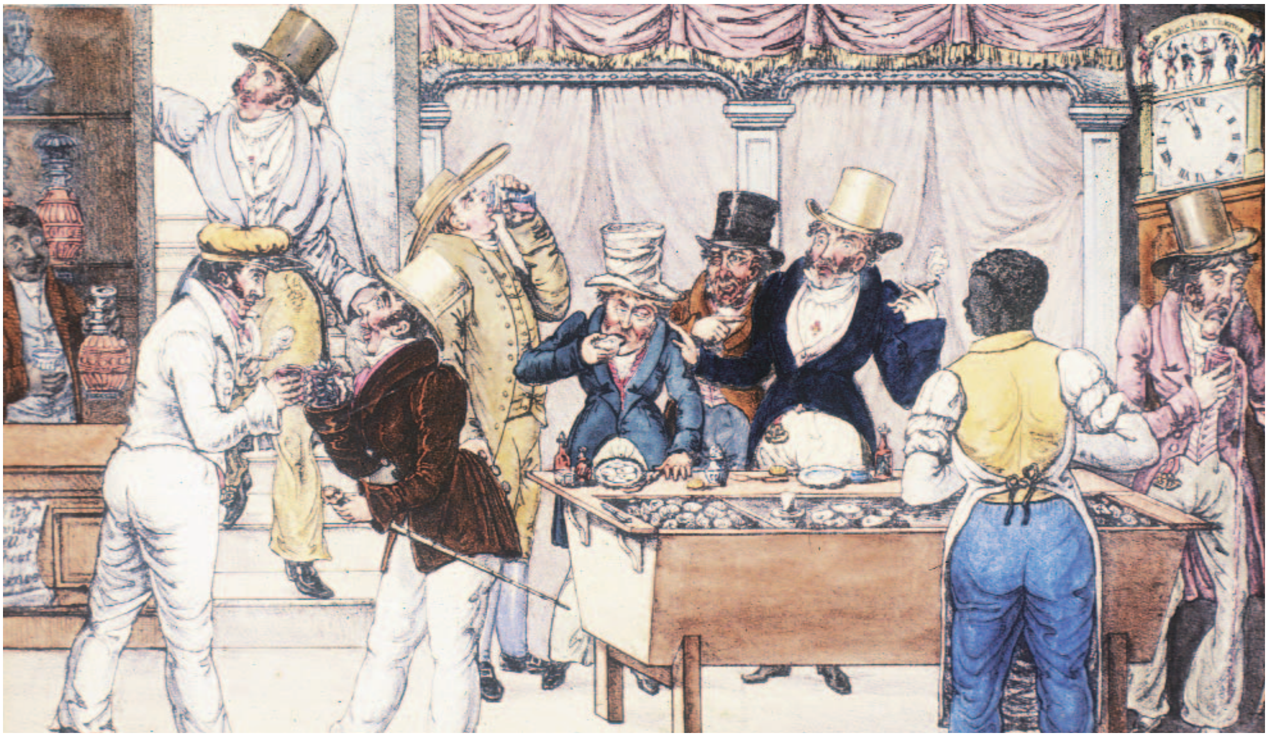
Central Europe Market hall in Wrocław, Poland. The new market hall, shown here, replaced the old hall, which was destroyed during World War II. Photo by André Baranowski.

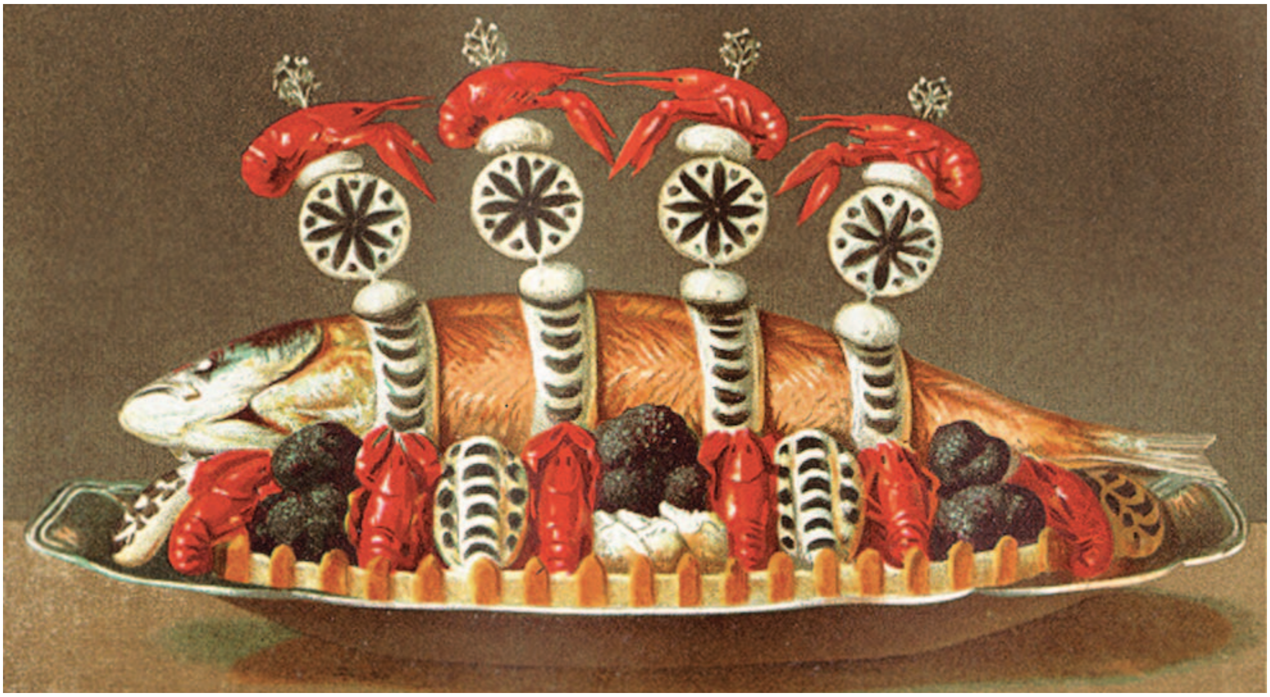


Fish Fish in the Giannino Restaurant, Milan, Italy, 1949. Such enticing displays of high-quality ingredients are far more common in European restaurants than in those in the United States. The photograph itself is a study in period food styling. Roughwood Collection.

Top: **Fish** This hand-tinted engraving called *Philadelphia Taste Displayed* shows the interior of an 1830s American oyster cellar with its private booths, its black owner James Prosser, and the complete absence of women. City ordinances in early America forbade women and children from entering these establishments, which specialized in turtle soup, pepperpot, and seafood. Roughwood Collection.

Bottom: **Fish/Sea Fish** Food styling in the Victorian period relied heavily on an abundance of garnishes, as in the case of this poached salmon from Alphonse Gouffeé's *Royal Cookery Book* (London, 1868). Roughwood Collection.





***Top:* Flowers** Nasturtiums were introduced from Peru in the 1500s. Both the leaves and the flowers were used in cooking and are still popular today as salad garnishes. Photo by William Woys Weaver.

***Below:* France/Southern French Cuisines** Fried fish at Chez Fonfon, Marseille, France. © Owen Franken/CORBIS.

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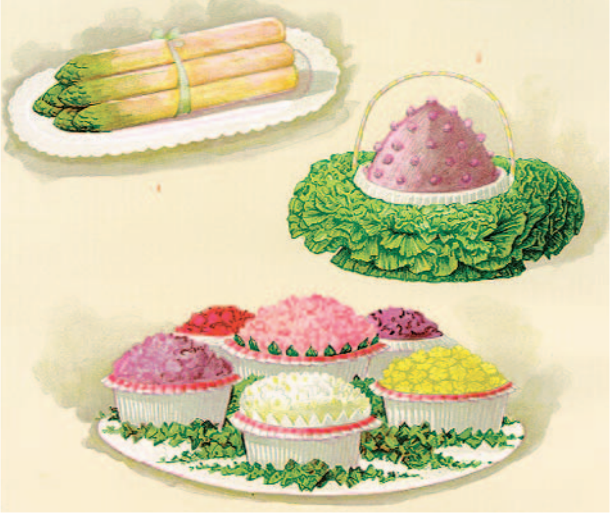
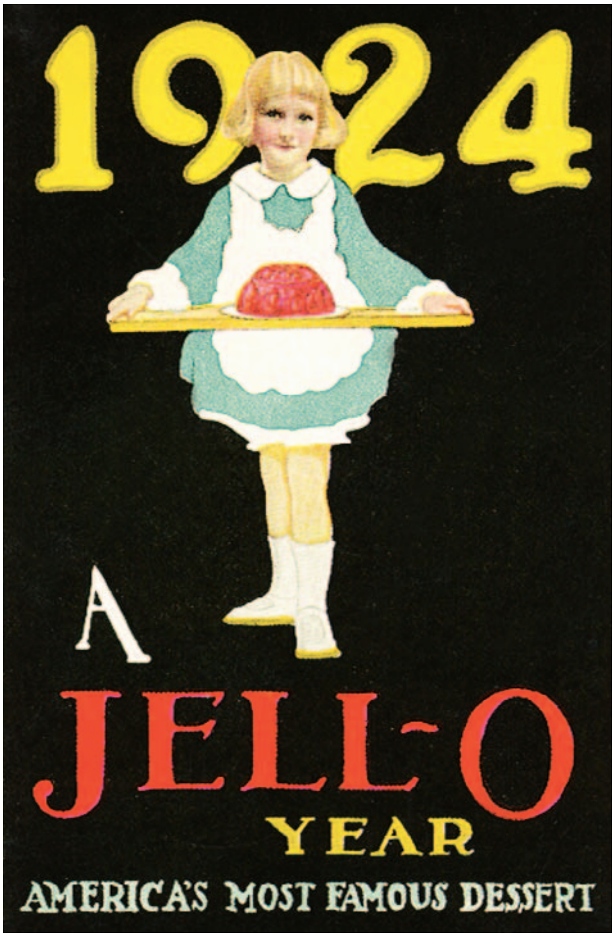
Herbs and Spices The Egyptian Market in modern Istanbul evokes the culinary riches of the former Ottoman and Byzantine empires. Ground herbs and spices are arranged in neat hills. © Paul Hardy/CORBIS.

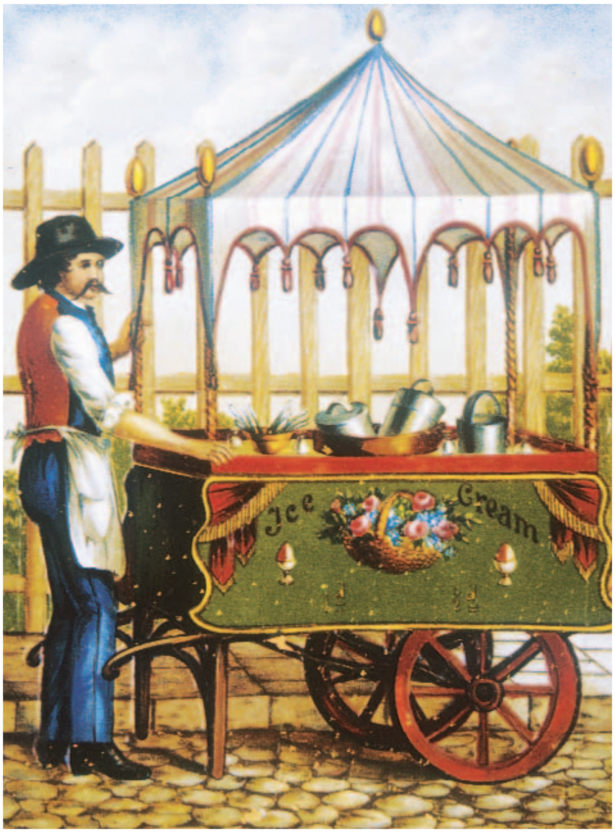
***Bottom, left:* Gelatin** One of the keys to the early success of Jell-O was its pitch to children and the use of children in its advertising campaigns. The "Jell-O girl" is featured on the cover of this 1924 booklet containing recipes and pictures of her on every page. Roughwood Collection.

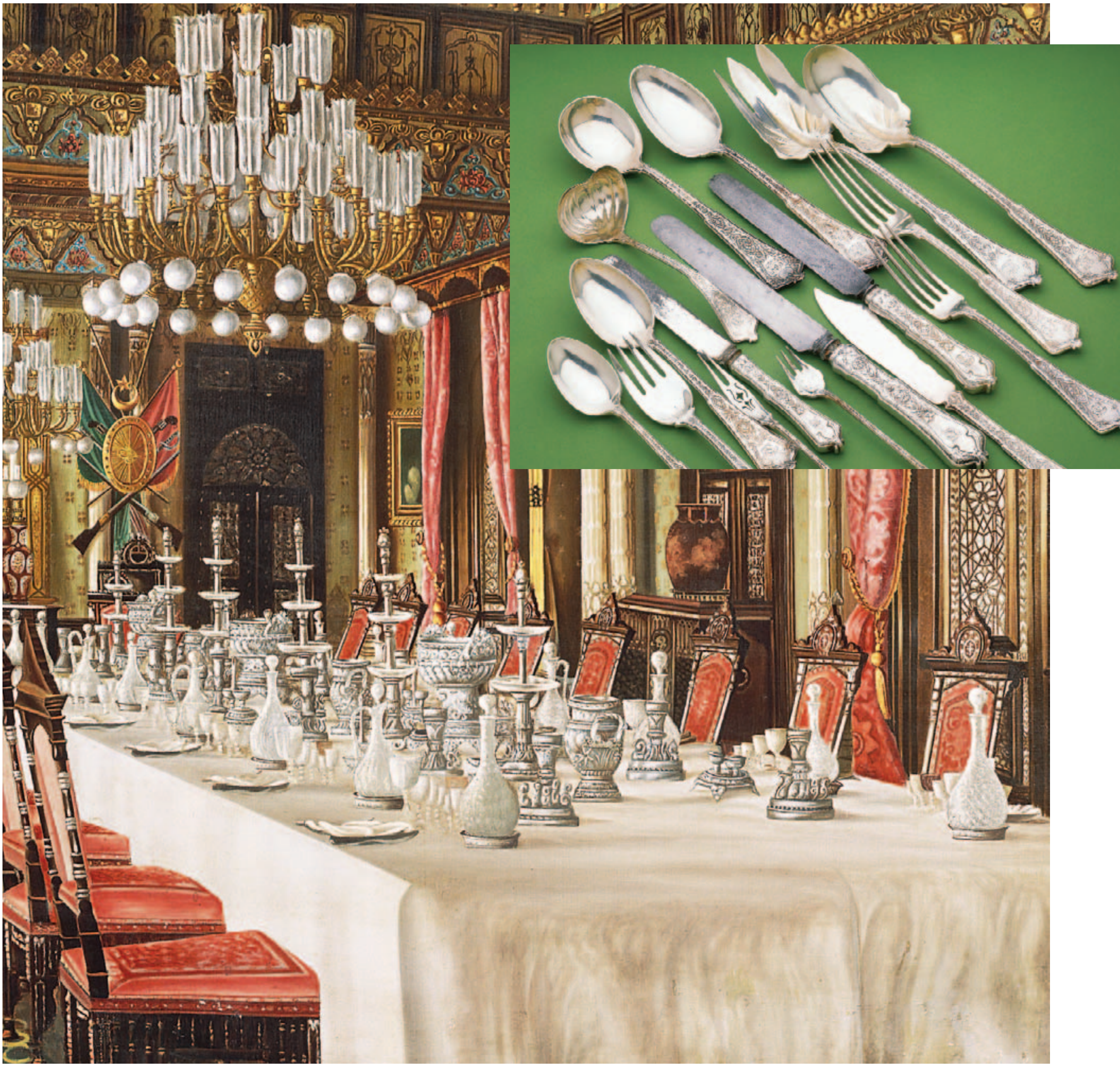
***Top, right:* Ice Cream** Victorian ice creams achieved elaborate designs and flavor combinations. This chromolithograph plate from Garrett's *Encyclopedia of Practical Cookery* (London, circa 1880) proves that Victorian confectioners also possessed a sense of playful whimsy. Roughwood Collection.

***Bottom, right:* Ice Cream** The hokey-pokey man was once a familiar figure in American cities with large Italian populations. He was a street vendor who sold ice creams, water ices, and a variety of light foods. This circa 1890 chromolithograph "scrap" picture was meant to be pasted to a gingerbread cookie and thus serve as a Christmas tree ornament. Roughwood Collection.



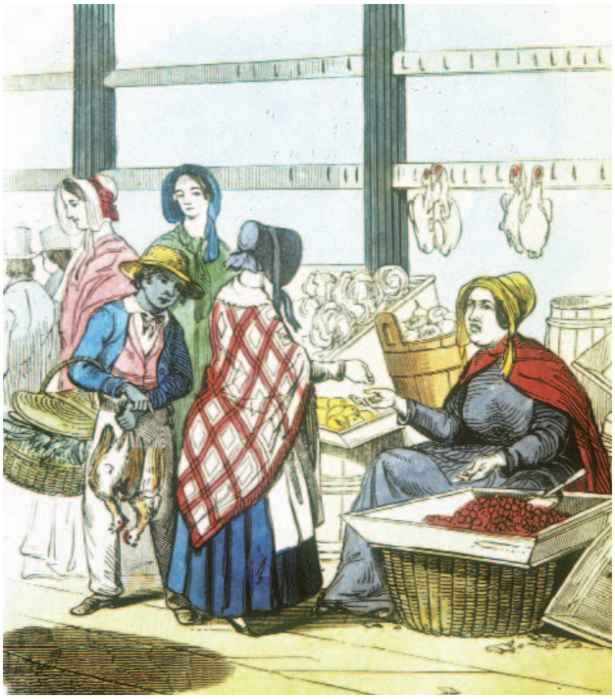






Luxury Nineteenth-century opulence is depicted in this contemporary painting of the banquet hall in Yildiz Palace, Istanbul. Courtesy of The Museum of Fine Arts, Istanbul. © Archivo Iconografico, S.A./CORBIS.

***Inset:* Luxury** Oriental opulence was also a popular theme in Victorian table design, as in the case of this Persian pattern silver by Tiffany & Company of New York. © Peter Hartholdt/CORBIS.



***Top:* Markets** Cherry vendor in the old Philadelphia market shambles. Produce was formerly sold loose, which necessitated both an array of baskets and an assistant to carry them. From *The Useful and the Beautiful* (Philadelphia, 1850). Roughwood Collection.

***Below:* Markets** Fresh vegetable and fruit stand in Quebec City, Canada. © Philip Gould/CORBIS.

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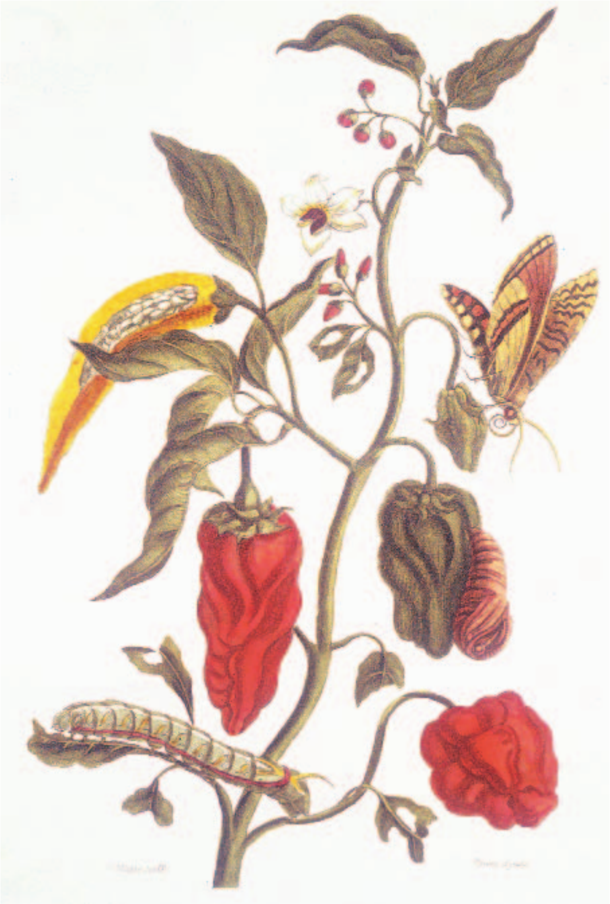
***Left:* Mexico** Tortilla vendor in Yucatán, Mexico. © Liba Taylor/CORBIS.

***Top right:* Mexico** Peppers and a tomato worm from Maria Sibylla Merian's *Metamorphosis Insectorum Surinamensium* (The Hague, 1705). Merian's primary interest was insects, but she used plant and vegetable props in all of her renderings. Unlike Raphaelle Peale, whose paintings are botanically correct, Merian's pepper plant is actually a collage of different species and varieties all growing from the same branch. (See Peale's still life with tomato in volume 3, color insert page 5.) Roughwood Collection.

***Bottom right:* Mexico** Cactus pears *(Opuntia ficus-indica)* are generally harvested in the summer. Fruits with red pulp are prized in the United States and Europe, whereas Mexicans generally prefer fruit with green pulp. Photo courtesy of Park S. Noble.



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ENCYCLOPEDIA OF FOOD AND CULTURE

VOLUME 3:
Obesity to Zoroastrianism,
Index

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OATS. *See* **Cereal Grains and Pseudo-Cereals.**

OBESITY. Obesity and overweight now affect more than 50 percent of adult Americans. Diabetes mellitus, hypertension, heart disease, gallbladder disease, and some forms of cancer result from obesity. Whether these diseases are yet present or not, the obese individual should be encouraged to lose weight by appropriate methods to reduce the future likelihood that they will develop. Methods of weight loss include diet, nutritional education, self-help groups, and behavioral change. Under some circumstances drugs or surgery may be considered.

Definition and Measurement of Obesity

Obesity and overweight are best defined using the body mass index (BMI). This index is determined by dividing body weight in kilograms by the square of the height in meters: BMI = W/H^2. The normal rate for BMI is 18.5 to 25. A BMI between 25 and 30 kg/m^2 is defined as overweight and a BMI above 30 kg/m^2 is defined as obesity (Table 1). Visceral fat can be used as an index of central adiposity. An increase in visceral fat reflects central obesity and increases health risks. The waist circumference is used to assess the amount of visceral obesity. A waist circumference in men of 40 inches (102 cm) or more, and in women, of 35 inches (88 cm) or more, is the threshold for defining central obesity (Table 1).

Prevalence of Overweight

More females than males are overweight at any age. The frequency of overweight increases with age to reach a peak at forty-five to fifty-four years in men and at age fifty-five to sixty-four in women. The National Health and Nutrition Examination Survey (NHANES) conducted by the U.S. government (published in 1993) found a BMI of 25 or more in 59.4 percent of men age twenty years or older and in 50.7 percent of women over the age of twenty years. The prevalence of obesity (BMI 30 or more) was 19.5 percent in men and 25.0 percent in women. The incidence of obesity continues to increase dramatically in the United States and elsewhere. A number of factors including age, sex, and physical inactivity influence the amount of body fat.

At birth, the human infant contains about 12 percent body fat. During the first years of life, body fat rises rapidly to reach a peak of about 25 percent by six months of age and then declines to 18 percent over the next ten years. At puberty, there is a significant increase in the percentage of body fat in females and a decrease in males. By age eighteen, males have approximately 15 to 18 percent body fat, and females have 25 to 28 percent. Be-

TABLE 1

Classification of overweight and obesity by BMI, waist circumference, and associated disease risk

			Disease risk* relative to normal weight and waist circumference	
	BMI kg/m^2	Obesity class	Men = 102 cm (= 40 in) Women = 88 cm (= 35 in)	>102 cm (>40 in) >88 cm (>35 in)
Underweight	18.5		–	–
Normal +	18.5–24.9		–	–
Overweight	25.0–29.9		Increased	High
Obesity	30.0–34.9	I	High	Very High
	35.0–39.9	II	Very High	Very High
Extreme Obesity	= 40	III	Extremely High	Extremely High

*Disease risk for type 2 diabetes, hypertension, and CVD.
+Increased waist circumference can also be a marker for increased risk even in persons of normal weight.
Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults—The Evidence Report. National Institutes of Health. Obes Res 1998;6 Suppl 2:51S–209S.

Due to his enormous size, Frank Williams, age 16, weight 442 pounds, was placed on display at the St. Louis Exposition in 1893. Obese teenagers are now a much more common sight. Photo by McKnight, Paducah, Kentucky, circa 1893. ROUGHWOOD COLLECTION.

tween ages twenty and fifty, the fat content of males approximately doubles and that of females increases by about 50 percent. Total body weight, however, rises by only 10 to 15 percent: fat now accounts for a larger part of the body weight and lean body mass decreases.

Risks Related to Obesity

As the BMI increases, there is a curvilinear rise in excess mortality. This excess mortality rises more rapidly when the BMI is above 30 kg/m^2. A BMI over 40 kg/m^2 is associated with a further increase in overall risk and for the risk of sudden death. The principal causes of the excess mortality associated with overweight include hypertension, stroke, and other cardiovascular diseases, diabetes mellitus, certain cancers, reproductive disorders, gallbladder disease, and sudden death.

The insulin-resistant state or metabolic syndrome is strongly associated with visceral fat. It may include consequences such as glucose intolerance or type 2 diabetes mellitus, hypertension, polycystic ovarian syndrome, dyslipidemia (the state of abnormal—either higher or lower—values for blood fats), and other disorders. These are often responsive to weight loss, especially when this is achieved early and the loss is maintained.

Development of Obesity

Several mechanisms lead to obesity, including neuroendocrine imbalances, particular drugs, diet, reduced energy expenditure, and genetic factors that lead to certain syndromes and predisposition to obesity. Obesity can follow damage to the hypothalamus in the brain, but this is rare. Cushing's disease is somewhat more common and can result in obesity. Treatment should be directed at the cause of the increased formation of adrenal corticosteroids.

Treatment of diabetics with insulin, sulfonylureas, or thiazolidinediones (but not metformin) can increase hunger and food intake, resulting in weight gain. Treatment with some antidepressants, anti-epileptics, and neuroleptics can also increase body weight, as can cyproheptadine (a serotonin antagonist that produces weight gain), probably through effects on the monoamines (including norepinephrine, epinephrine, dopamine, histamine, and serotonin) in the central nervous system.

Eating a high-fat diet and excessive consumption of sugar-sweetened beverages and the prevalence of abundant varieties of food in cafeterias or supermarkets are dietary factors in the development of obesity. Reduced energy expenditure relative to energy intake is another major component. Energy expenditure can be divided into four parts.

An inactive individual at rest burns between 800 and 900 kilocalories during a twenty-four hour period. This rate is lower in females than in males, and declines with age, and could account for much of the increase in fat stores if food intake does not decline similarly. The effect of physical exercise on metabolism is variable but on average is responsible for about one-third of the daily energy expenditure. From a therapeutic point of view this component of energy expenditure is most easily manipulated. Dietary thermogenesis is the energy expenditure that follows the ingestion of a meal. Heat produced by eating may dissipate up to 10 percent of the ingested calories. These thermic effects of food are one type of metabolic "inefficiency" in the body, that is, where dietary calories are not available for "useful" work. In the obese, the thermic effects of food are reduced particularly in individuals with impaired glucose tolerance or diabetes. Acute over- or underfeeding will produce corresponding shifts in overall metabolism, which can be as large as 15 to 20 percent.

Genetic factors can produce some types of obesity that are easily recognized. Among these types of obesity are: (1) the Bardet-Biel syndrome, characterized by retinal degeneration, mental retardation, obesity, polydactyly, and hypogonadism; (2) the Alstrom syndrome, characterized by pigmentary retinopathy, nerve deafness, obesity, and diabetes mellitus; (3) Carpenter syndrome, characterized by acrocephaly (abnormalities in the facial and head bones), mental retardation, hypogonadism, obesity, and preaxial syndactyly (extra fingers or toes on one hand or foot); (4) the Cohen syndrome, characterized by mental retardation, obesity, hypotonia (reduced tone of the muscles, resulting in a “floppy” muscle mass), and characteristic facies (an appearance of the face that is typical of specific genetic diseases); (5) the Prader-Willi syndrome, characterized by hypotonia, mental retardation, hypogonadism, and obesity; and (6) the pro-opiomelanocortin (POMC) syndrome, characterized by defective production of POMC that is recognized as a red-headed fat child with a low plasma cortisol (a value that is below the normal range).

If both parents are obese, about 80 percent of their offspring will be obese. If only one parent is obese, the likelihood of obesity in the offspring falls to less than 10 percent. Studies with identical twins suggest that inheritance accounts for about 70 percent and environmental factors (diet, physical inactivity, or both) account for 30 percent of the variation in body weight. Deficiency of the gene leptin and deficiency of the leptin receptor are rare, but are associated with massive human obesity. Absence of convertase I has also been associated with obesity in one family. The most common defects associated with massive obesity are abnormalities in the melanocortin receptor system—up to 4 percent of massively obese people may have this type of defect.

Evaluation of the Obese Patient

A medical evaluation should include the expected medical history, family history, personal and social history, and review of the systems of the body with a particular focus on the medications that can cause weight gain. A physical examination should include an assessment of the patient’s height, weight, waist circumference, blood pressure, and level of health risk due to obesity. Laboratory tests should include a lipid panel, glucose level, chemistry panel for hepatic (liver) function and uric acid, thyroid function testing, and, if indicated a cortisol level.

Evaluating Risk Using the Body Mass Index (BMI)

Individuals with a normal BMI (20–25 kg/m^2) have little or no risk from obesity. Any individual in this weight range who wishes to lose weight for cosmetic reasons should do so only with conservative methods. Individuals with a BMI of greater than 25 to 29.9 kg/m^2 are in the low-risk group for developing heart disease, hypertension, gallbladder disease, and diabetes mellitus associated with obesity. They too should be encouraged to use low-risk treatments, such as caloric restriction and exercise. Individuals with a BMI of 27 to 30 kg/m^2 or more who have diseases related to obesity may use adjunctive pharmacotherapy for weight loss.

Individuals with a BMI of 30 to 40 kg/m^2, have moderate risk for developing diseases associated with obesity. Diet, drugs, and exercise would all appear to be appropriate forms of treatment. Individuals with significant degrees of excess weight often find exercise difficult. However, exercise is very important in helping to maintain weight loss. The use of weight loss medications, as an adjunct to treatment, may also be useful in this group. Individuals who have a BMI above 40 kg/m^2 have a high risk of developing diseases associated with their obesity. Moderate to severe restriction of calories is the first line of treatment, but for some of these patients surgery may be advisable.

Treatment of Obesity

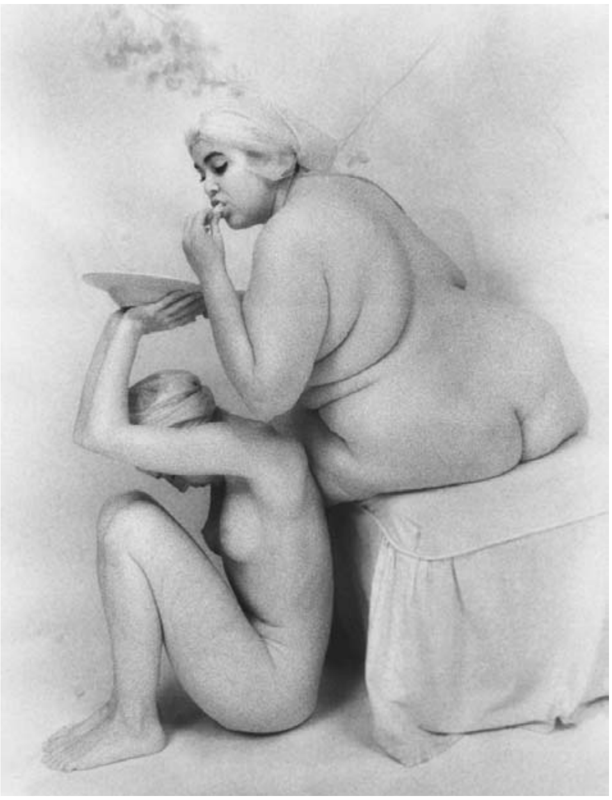
Any diet must reduce an individual’s caloric intake below daily caloric expenditure if it is to be successful. This requires an assessment of caloric requirements, by estimating caloric expenditure from desirable weight tables; for men, multiply desirable weight by 30 to 35 kilocalories/kilogram, (14–16 kilocalories/lb.); for women, multiply desirable weight by 25 to 30 kilocalories/kilogram (12–14 kilocalories/lb.). After assessing caloric requirements, a reasonable calorie deficit can be prescribed. A caloric deficit of 500 kilocalories/day (3,500 kilocalories/week) will produce the loss of approximately one lb. (0.45 kilograms) of fat tissue each week. Table 2 gives a list of diets divided into different levels of energy.

The very low calorie diet (below 800 kilocalories) was developed to facilitate the rate of weight loss since lower energy intake should lead to greater energy deficit. In free living people, however, diets with 400 kilocalories/day have not produced greater weight loss than those with 800 kilocalories/day, suggesting either that they are harder to adhere to or that there is an adaptation in energy expenditure. In either case, these diets should only be used under appropriate medical supervision.

TABLE 2

Characterization of diets by composition

Type of diet	Calories	Fat g (%)	Carbohydrate g (%)	Protein g (%)
Typical American	2,200	85 (35)	274 (50)	82 (15)
High-fat, low carbohydrate	1,400	94 (60)	35 (10)	105 (30)
Moderate-fat	1,450	40 (25)	218 (60)	54 (15)
Low & very low fat	1,450	16–24 (10–15)	235–271 (65–75)	54–72 (15–20)



Obesity is a highly charged subject that has assumed broad sociological implications. In this 1998 photographic study called "Servitude I" by American artist Lynn Bianchi, several issues are exposed through novel inversions of female roles: body image, incessant snacking, and anorexia, to name three. Here it is the overly thin female who acts the role of caryatid-slave to an Earth Mother figure who never stops eating. PHOTO COURTESY OF THE ARTIST AND THE RALLS COLLECTION, INC., WASHINGTON, D.C.

Types of diets. There are several types of diets with more than 800 kilocalories/day that usually have more than 1,200 kilocalories/day. They can be divided into several categories. These categories are based on the relative proportion of macronutrients included in the diet and whether they use special foods. For all diets it must be true that they reduce the calorie intake to produce a negative energy balance. Low-carbohydrate diets are touted because they produce ketosis (a state of increased ketones associated with diabetes and fasting) and allow you to eat all of the protein and fat you want. This ends up reducing total calorie intake to about 1,500 kilocalories/day. Since these diets generally have carbohydrate levels below 50 g./day they are ketogenic and can be monitored clinically by the appearance of ketones in the urine. They vary in the level of fiber that is employed. The Atkins diet has low fiber levels, the Sugar Busters diet higher fiber levels.

Low-fat diets recommend fat intake in the range of 10 to 20 percent of calories. The higher carbohydrate increases fiber intake. These diets were developed in a setting designed to reverse the atherosclerotic plaques associated with risks for heart disease, but because of the high fiber content they were often associated with weight loss. Moderate fat levels with higher carbohydrates are characteristic of many widely recommended "healthy diets." For weight loss, the New York Health Department recommends the Prudent Diet, which has stood the test of time.

The portion-controlled diet makes use of prepared foods that have a narrow range of calories. This includes liquid or powdered drinks as well as frozen or canned entrees that have about 300 kilocalories/meal. These can be combined conveniently and thus removes the problem of counting calories from the individual. A number of popular diets focus on a single food, and although nutritionally unbalanced, they are simple to follow and the monotony of single items tends to limit food intake.

Food Guide Pyramid. The Food Guide Pyramid provides an approach to evaluating the quality of your diet. At the bottom of the pyramid are the grains, beans, and starchy vegetables that provide vitamins, minerals, fiber, and energy; six or more servings are recommended. On the next level are the vegetables (3–5 servings) and the fruits (3–4 servings). On the third level are the meats, fish, poultry, and nuts (2–3 servings) along with the milk and yogurt (2–3 servings). At the top are the fats, sweets, and alcohol. Reducing the number of servings proportionally will provide you with a calorie-reduced diet. Most important for the dieter, however, is to sharply reduce the fats and sugar at the top of the pyramid and to reduce or eliminate alcoholic beverages. Not only do alcoholic beverages have calories, their consumption tends to reduce the individual's control in selecting the quality and quantity of foods to eat.

Changing behavioral patterns of eating. The basic principles of behavioral approaches for obesity can be summarized under the ABCs of eating.

- The A stands for antecedent. If one looks at eating as the response to events in the environment, then the antecedent events are those that trigger eating.
- The B stands for the behavior of eating. This includes among other things the place, the rate, and the frequency with which an individual eats. If the act of eating can be focused at one place with one plate and place setting it can help to provide control over eating.
- The C is the consequence of the eating. The feelings an individual has about eating can be altered, and rewards for changing eating patterns can be instituted.

Exercise and physical activity. The only part of energy expenditure that is amenable to significant manipulation is physical activity. During sleep, the lowest level of activity, approximately 0.8 kilocalories/minute is consumed. Thus, if an individual sleeps for an entire 24 hours, approximately 1,150 calories will be expended. Reclining increases this level to approximately 1.0-1.4 kilocalories/minute. Obese and diabetic patients should be encouraged to increase their physical activity for two reasons: First, it consumes calories, but second, and more important, exercise increases glucose utilization and may improve insulin sensitivity.

Drug treatment of obesity. Only a few drugs have been approved by the Food and Drug Administration for treatment of obesity. Studies following individuals who have used these drugs for two years have been published for sibutramine (Meridia) and orlistat (Xenical). Weight-loss drugs should be reserved for patients with moderate- or high-risk obesity (BMI > 30 kg/m^2) or a BMI above 27 if they have other significant diseases related to obesity. They should be considered for the patient who has failed to lose weight with other methods. Herbal products containing ephedra and an herbal source of caffeine can also produce weight loss when used in accordance with the package instructions.

Surgery. Gastric operations reduce the size of or bypass the stomach, but should be reserved for people with a BMI above 40 or when recommended by a physician.

The Obese Child

Estimates of the prevalence of obesity in children range from 3 to 15 percent. This figure has been rising more rapidly than in the rest of the population. The appearance of obesity in childhood and particularly adolescence is important because it most often persists into adult life. It may be a precursor to the appearance of type 2 diabetes in adolescents. The possibility of treatment should be considered for children who are above the seventy-fifth percentile of weight for height, and might be encouraged for those who are above the ninety-fifth percentile of weight for height. The treatment of prepubertal children should probably involve both parents and child since at this age the principal control of food availability is in the hands of the parents. For adolescents, however, it may be better to separate patient and parents, since the interaction between these groups may be part of the problem. Where growth has not reached its fullest extent, dietary restriction should attempt to reduce further weight gain. Severe caloric restriction and the use of appetite-suppressing drugs may slow height growth. For both children and adolescents, involvement in a regular exercise program is probably the first line of treatment.

See also **Anorexia, Bulimia; Body; Body Composition; Caloric Intake; Eating: Anatomy and Physiology of Eating; Fasting and Abstinence; Fats; Fiber, Dietary; Hunger, Physiology of.**

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George Bray

OCTOPUS. *See* **Mollusks.**

OIL.

Oil is liquid fat, usually plant-derived, used as a cooking medium, as a lubricant to keep food from sticking to pans, and as a source of flavor. Oil from animal sources, particularly fish oil, is also used as a nutritional supplement. Oil is also ubiquitous in processed foods.

The difference between oil and fat is that oil is liquid at room temperature while fat is solid. Chemically, both are composed of hydrocarbon chains and are potent sources of energy. The strong molecular bonds of fats and oils make them relatively resistant to heat and thus suitable for high-heat cooking methods such as deep-frying. Oil can be used in conjunction with other fats, such as butter, to raise the temperature of the other fat at which it would otherwise begin to break down and smoke.

History of Oil

Olive oil and sesame oils are among the most ancient oils in the Western world, dating back to 4,000 years or more. Olive trees are relatively simple to cultivate and, once the olives are prepared, the oil can be obtained by pressing. Both olive oil and sesame oil were used in southern Europe, while northern countries typically used animal fats such as lard or goose fat.

In the Orient, oil was pressed from soybeans, while sesame, mustard seed, and safflower oils were used in India and ancient Egypt. Peanuts, corn, and sunflower seeds were available in the New World, but oil was generally extracted only from squash seeds, especially squash belonging to the species *Cucurbita pepo*.

The nineteenth century saw the rise of international trade in tropical oils, particularly palm and coconut oil. The raw materials, which included hearts of palm and dried coconut meat (copra), were exported from Africa and the Pacific islands to industrial countries to be pressed for oil. The vast production of corn in the United States provided a source of oil to be used in cooking and in the manufacture of oleomargarine.

Olive oil is one of the major culinary oils employed in the Mediterranean region. This home-pressed oil is being bottled for private use at Dolcedo, Italy. © OWEN FRANKEN/CORBIS.

In nineteenth-century Africa, both the French and British introduced larger-scale peanut farming specifically for peanut oil, which was used as an adulterant in cheap grades of olive oil, and as a base ingredient in soap.

Composition of Oils

Oils, like other fats, consist mostly of triglycerides, which are three fatty acids attached to a molecule of glycerol (an alcohol built around three atoms of carbon). A fatty acid consists of a carboxyl group (carbon, oxygen, and hydrogen linked together), which in turn is linked to a hydrocarbon chain. The more the hydrocarbon chain is filled with hydrogen atoms, the more chemically stable it will be. A fatty acid fully loaded with hydrogen is said to be "saturated," while a less hydrogen-rich acid is "monounsaturated" or "polyunsaturated," depending on its structure. Oleic acid is a common monounsaturated fat, while linoleic acid is the most common polyunsaturated fatty acid.

The more saturated a fat is, the more likely it is to be solid at room temperature (such as lard or shortening). Oils are liquid because they are less saturated than fats. They are also less shelf-stable because their chemical structures are more likely to be affected by exposure to oxygen, causing them to become rancid or develop off-flavors. To make the product more stable, food processors pump hydrogen through the oil to fill in the gaps in its chemical structure, a process known as "hydrogenation." Highly hydrogenated oil is creamy or solid at room temperature, useful for making oleomargarine or other processed food products.

Oils generally have about the same caloric value of approximately 120 calories per tablespoon whether the fatty acids are saturated or not. More important to health-conscious consumers is the role of fatty acids in raising or lowering the presence in the bloodstream of the high-density lipoprotein (HDL) or low-density lipoprotein (LDL) associated with cholesterol. HDL (the "good cholesterol") is a beneficial substance that helps the body get rid of excess cholesterol, while LDL (the "bad cholesterol") builds up in the arteries and can increase the risk of heart disease. Eating foods high in monounsaturated fatty acids is believed to help lower LDL cholesterol levels and decrease the risk of heart disease, while the consumption of saturated fats may increase levels of LDL and total cholesterol. The consumption of polyunsaturated fats in place of saturated fats decreases LDL cholesterol levels. The American Heart Association recommends the consumption of oils that have no more than two grams of saturated fat per tablespoon.

Unsaturated fat content is a major selling point for household oils. One of the major oils on the market, canola oil, was developed specifically to appeal to consumers concerned about fat content. Canola—short for "Canadian oil"—is a variety of the rapeseed plant developed in Canada with less fatty acid than the traditional variety and thus a lower level of saturated fat than most other oils.

The chemical structure of oils makes them relatively stable at high temperatures, but at some point oil begins to break down and give off smoke; beyond this point there is danger of fire. The smoke point for most oils is around 410°F (210°C), although some oils have even higher smoke points. The smoke point gets lower as oil is re-used due to degradation of chemical bonds and contamination of the oil with food particles. Commercial operations that re-use oil will pass it through a filter to take out the contaminants.

Sources of Oil

In addition to olives, oil is obtained from legumes such as peanuts and soybeans; from the seeds of many plants, including corn, rapeseed (canola), sesame, cottonseed, sunflower, palm, safflower, coconut, grapeseed, mustard, pumpkin, and avocado; and from tree nuts such as wal-

TABLE 1

Smoke Points of Common Oils

Oil	Smoke point (degrees F)
Sunflower	392
Olive	410
Corn	410
Peanut	410
Soybean	410
Cottonseed	435
Avocado	435
Canola	437
Grapeseed	446

SOURCE: *The Simon and Schuster Pocket Guide to Oils, Vinegars, and Seasonings*

TABLE 2

Fat Content of Major Household Oils

Oil	Calories per tablespoon	Saturated fatty acids (grams per tablespoon)	Polyunsaturated fatty acids (grams per tablespoon	Monounsaturated fatty acids (grams per tablespoon)
Olive	119.3	1.8	1.1	9.9
Corn	120.2	1.7	8.0	3.3
Canola	123.8	1.0	4.1	8.2
Peanut	119.3	2.3	4.3	6.2
Sesame	120.2	1.9	5.7	5.4
Soybean	120.2	2.0	8.0	3.2
Soybean, hydrogenated	120.2	2.0	5.1	5.8
Sunflower, 70% oleic and over	123.8	1.4	0.5	11.7
Sunflower, less than 60% linoleic	120.2	1.4	5.5	5.5
Sunflower, 60% linoleic and over	120.2	1.4	8.9	2.6
Sunflower, linoleic, hydrogenated	120.2	1.8	4.9	6.3
Grapeseed	120.2	1.3	9.5	2.2
Cottonseed	120.2	3.5	7.1	2.4
Safflower, over 70% linoleic	120.2	0.8	10.1	1.9
Almond	120.2	1.1	2.4	9.5
Rice bran	120.2	2.7	4.8	5.3
Avocado	123.8	1.6	1.9	9.9
Palm	120.2	6.7	1.3	5.0
Fish oil, menhaden, fully hydrogenated *	112.7	11.9	0.00	0.00

Unlike oils from plant sources, fish oil contains cholesterol. Fully hydrogenated menhaden oil contains 62.5 milligrams of cholesterol per tablespoon.

SOURCE: U.S. Department of Agriculture, Agricultural Research Service. 2001. USDA Nutrient Database for Standard Reference, Release 14. Nutrient Data Laboratory Home Page, http://www.nal.usda.gov/fnic/foodcomp.

nuts, almonds, hazelnuts, and pistachios. Tree nut oils are usually expensive and do not respond well to high heat, so they are used primarily to dress salads or to add flavor to baked goods.

The finest oils are simply extracted from the raw material (such as olives or nuts) by pressure. This is called "cold pressed" or "first pressed" oil. Oil that remains bound up in the raw material can be extracted by heat or chemical solvents.

Oils labeled by specific names, such as peanut oil, are obtained from those particular plants; a product labeled merely "vegetable oil" is a blend of various oils. In the production of vegetable oils, seeds are cracked, cooked, and run through a press to extract readily obtainable oil. The pulp is further processed to obtain the rest of the oil, which is neutral and tasteless; if flavor is desired, the oil can be mixed with the product of the first pressing to restore flavor and color.

Uses of Oil

Oil has a variety of uses in cooking, most of them based on its ability to transfer heat to the food while remaining stable itself. Asian food is often stir-fried in a little hot oil, just enough to keep the food from sticking to the pan. Chicken can be sautéed or fricasseed in a few tablespoons of oil, while pieces of breaded fish can be fried in shallow oil—perhaps a quarter of an inch deep.

Frying large pieces of food in deep oil requires a temperature of 350° to 375°F (177° to 191°C). At that temperature, the hot oil will sear the surface of the food being fried, trapping moisture within the food. The food thus cooks in its own moisture rather than in the oil, which is why properly fried food is not greasy. Greasiness results from frying at a temperature lower than optimal.

In Italy, olive oil is used as a dipping sauce for bread at the table. Olive oil is preferred as a salad dressing because it has its own flavor to contribute to the dish.

In food manufacturing, oils are used in a host of products, ranging from soups and gravies, salad dressings, bread and rolls, and fried foods to nondairy toppings and frozen desserts, coffee creamers and cocoa mixes, candy bars and cakes, and in most processed snack foods.

Fish Oil

Some species of fish such as Atlantic menhaden have high levels of certain essential fatty acids, called omega-3 fatty acids, which the human body is not able to synthesize by itself and must obtain from food. Oil made from these fish is sold as a nutritional supplement. Menhaden oil is used in the production of margarine and shortening in Europe and has been approved for use in the United States.

See also **Butter**; **Cooking**; **Fats**; **Fish**; **Frying**; **Snacks**.

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Richard L. Lobb

ONIONS AND OTHER *ALLIUM* PLANTS.

Allium crops have been cultivated for millennia by people worldwide for sustenance, flavor, and medicinal purposes. Each of these three properties is closely connected to a suite of unique organosulfur compounds present in *Allium* crops that make them distinct from other wild and cultivated food plants. These compounds impart the characteristic flavors and odors of edible alliums. A substantial body of scientific literature suggests that these organosulfur compounds likely arose through natural selection for pest resistance. In a fortuitous circumstance, humans find these odors and flavors appealing, thus what confers functional significance to the *Allium* crop for its survival also confers culinary significance to the *Allium* consumer for gastronomic pleasure.

Seven major allium crop complexes are recognized, five of which contain a single allium crop (Table 1). These five are bunching onion (*fistulosum*), chives (*schoenoprasum*), Chinese chives (*tuberosum*), garlic (*sativum*), and rakkyo (*chinense*). The remaining two complexes contain four separate crops (leek, kurrat, great-headed garlic, and pearl onion) in the case of *ampeloprasum* and two different crops (onion and shallot) in the case of *cepa*. Each of these crops represents a unique modification of the leaf. In the allium crops where bulbs are prominent, leaf bases are swollen due to the accumulation of carbohydrates from photosynthesis. In those crops where pseudostems are the edible portion, overlapping leaf bases form a hollow column that has the appearance of a stem, such as the base of the leek. For other allium crops the edible portion is the leaf blade, which also serves as the primary photosynthetic organ. These seven crop complexes are grown and consumed worldwide for a multiplicity of uses.

TABLE 1

The seven primary edible allium crop complexes

Species Complex	Crop	Variety	Storage Organs
cepa	bulb onion shallot	*cepa* *ascolonicum*	foliage leaf bases and bladeless leaf sheaths
fistulosum	bunching onion	NA	foliage leaf bases, bulbs absent
schoenoprasum	chives	NA	foliage leaf bases, bulbs absent
tuberosum	Chinese chives	NA	rhizomes, bulbs absent
ampeloprasum	leek kurrat great-headed garlic pearl onion	*porrum* *kurrat* *holmense* *sectivum*	bulbs generally absent, cloves like garlic in great-headed garlic and pearl onion; pseudostem in leek and kurrat
sativum	garlic	*sativum*	swollen, bladeless sheaths (cloves)
chinense	rakkyo	NA	swollen, foliage leaf bases, bulbs prominent

NA = not applicable

SOURCE: Brewster, 1994, as redrawn from Jones and Mann, 1963

Taxonomic History

The genus *Allium* contains more than five hundred species, including many ornamental and edible plants. The genus has been assigned to the family Alliaceae, although for many years it was classified with both the Amarylidaceae and the Liliaceae. Edible alliums are important staples in the diets of many of the world's cultures. Most of the edible alliums are native to the mountains of central Asia, and a number of alliums are still collected from the wild in this region. Distribution of *Allium* crops ranges widely throughout the Northern Hemisphere and in mountainous regions of the tropics. The area of greatest diversity is the mountains of central Asia, including Afghanistan, Tajikistan, Pakistan, and parts of Siberia and China.

Many edible alliums are classified into two subgenera, *Rhizirideum* and *Allium*. In subgenus *Rhizirideum* the sections Cepa, Schoenoprasum, and Rhizirideum are comprised of the species *cepa*, *fistulosum*, *schoenoprasum*, and *tuberosum*. In the subgenus *Allium* the section Allium is comprised of the species *ampeloprasum*, *sativum*, and *chinense* (Hanelt, 1990; Brewster, 1994). Together these seven species contain the primary edible alliums consumed throughout the world. G. R. Fenwick and A. B. Hanley (1985) also describe a number of other minor alliums consumed as vegetables or herbs, including the topset onion, the tree onion, the Wakegi onion, and others. These minor alliums are primarily from the *Allium cepa* group and are discussed in some detail in Henry A. Jones and Louis K. Mann's *Onions and Their Allies* (1963).

The topset onion, tree onion, and Egyptian topset onion (*A. cepa* subvarieties *viviparum*, *bulbiferum*, and *proliferum* respectively) form bulbils in their inflorescences. Bulbils are small, bulblike structures used as vegetative propagules for these alliums.

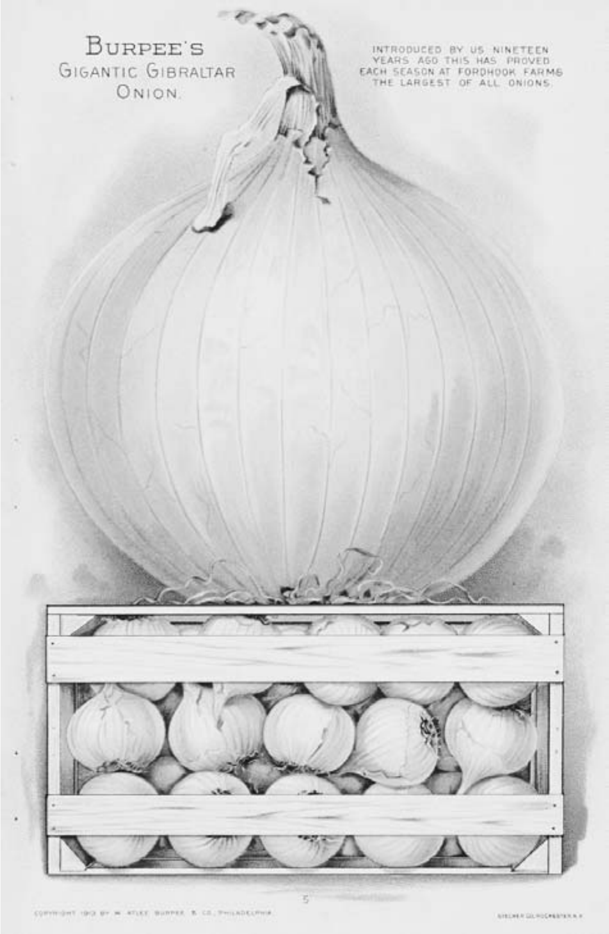
Crop Histories

Onion and shallot. The wild progenitor of onion is not known, although P. Hanelt (1990) and M. J. Havey (1995) have suggested it may be *Allium vavilovii*. Bulb onion was domesticated from a plant that likely had a long juvenile phase and grew as a perennial. Selection pressure during domestication was for larger bulbs that grew more rapidly, a biennial life cycle that concentrated vegetative growth into one season, and barriers to crossing with other wild species (Brewster, 1994). The cultivated *Allium cepa* has been placed into two horticultural groups by Hanelt (1990), the Common Onion group and the Aggregatum group. The Common Onion group includes the typical bulb onion, while the Aggregatum group consists of those subspecies or varieties of *A. cepa* whose lateral buds have been active, thereby forming clusters of smaller bulbs. These types of *A. cepa* have been further subdivided into multiplier or potato onions and shallots. Multiplier onions may possess as many as twenty small bulbs that are short and wide, whereas shallots form clusters of smaller, narrow separate bulbs (Jones and Mann, 1963). Most of the plants in the Aggregatum group are vegetatively propagated for horticultural use. Aggregatum group crops are found at extreme northern latitudes, such as Finland and Russia, and also in the tropics, but for different reasons. The short life cycle of Aggregatum group crops favors the short growing season in northern latitudes, whereas the intense pest pressure of tropical environments favors a short-season crop that can be grown from a vegetative propagule rather than from seed (Brewster, 1994).

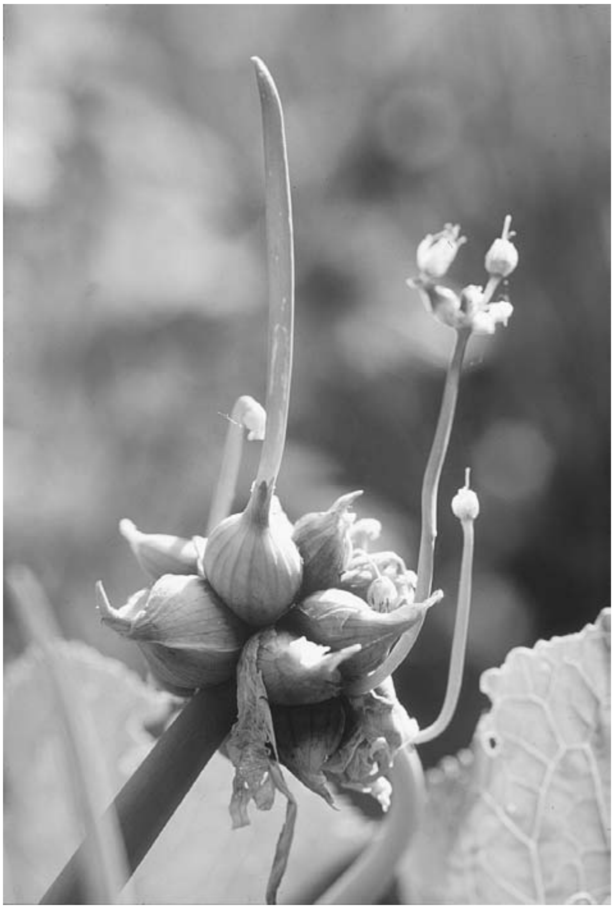
Onion plants form bulbs in response to specific day lengths and temperatures. This photoperiodic response includes two primary categories, long day and short day. The long-day onion plant requires a day length of at least fourteen hours (actually a night length of less than ten hours) to initiate bulb formation, while short day onion plants require between twelve and fourteen hours of day length to form bulbs. Long-day onions are grown in the northern latitudes, often from seed or transplants sown in early spring. Bulb formation takes place during the summer months, and bulb harvest is during the later summer and the fall. The short-day onion is grown in warmer climates, where it may be sown in the fall and overwintered in the field. Bulb formation is in the spring, and harvest is in early summer.

Long-day onions were cultivated in Europe for many centuries and adapted to northern latitudes. Like many root vegetables developed for consumption during winter months in cold climates, these long-day onions were harvested in late summer and fall and stored at cold temperatures. For this reason these cultivars or landraces became known as storage onions. Populations of storage onions developed in England and other parts of northern Europe and in the early seventeenth century were taken to the New World, where they were planted in the area around Salem, Massachusetts (Goldman et al., 2000). Selection for proper bulb formation and storability led to the development of popular cultivars, such as the Danvers Yellow Globe, which became a progenitor population for virtually all long-day storage onions in the United States during the nineteenth and twentieth centuries.

Short-day onions were cultivated in the Middle East and in many southern European countries for centuries, and immigrants from Italy and Spain brought these cultivars and landraces to the United States in the late nineteenth century (Goldman et al., 2000). The first southern European onions in the United States were likely the


BURPEE'S GIGANTIC GIBRALTAR ONION.
INTRODUCED BY US NINETEEN YEARS AGO THIS HAS PROVED EACH SEASON AT FORDHOOK FARMS THE LARGEST OF ALL ONIONS.

Giant-sized onions became popular toward the end of the nineteenth century, due in part to the fame of the Giant Zittau onion of Germany. Burpee's Giant Gibraltar onion was an attempt to breed an American counterpart to that highly successful variety. Chromolithographic advertisement from a Burpee seed catalog. © CYNTHIA HART DESIGNER/CORBIS.



Topsetting onions are also called Egyptian onions, tree onions, and Catawissa onions. Contrary to popular belief, they are not from Egypt, and began to appear in English and American kitchen gardens only in the 1790s. They were highly valued for their early spring greens and for the bulbils shown here, which were used like pearl onions in pickles. Zammit-Havermann Garden, Toronto, Canada. PHOTO ROB CARDILLO.

Bermuda types, which originated in Italy and were first grown in the United States in southern Texas. The second type of onion introduced from southern Europe was the Babosa onion from Valencia, Spain, which was likely introduced early in the twentieth century. Fabian Garcia's early breeding work at the New Mexico Agricultural Experiment Station developed the Early Grano onion, an important progenitor of many of the sweet, mild onions grown in the southern United States (Brewster, 1994; Goldman et al., 2000). These onions were further selected into a number of important populations, including the Texas Early Grano and Granex series, which are important short-day onions in the U.S. market.

Garlic. Garlic almost certainly originated in the mountains of central Asia. Although its exact progenitor is unknown, it may be *A. longicuspis*. For thousands of years garlic has been propagated by asexual means because fertile flowers were extremely rare. At the end of the twentieth century several reports of fertile garlic clones, both in the wild and in cultivation, initiated intense interest in seed propagation of garlic, which appears to be a realistic proposition (Pooler and Simon, 1994). Seed production is important for several reasons, including the possibility of reducing the spread of viral diseases by going through a reproductive phase and the potential for breeding garlic for improved characteristics. Despite the fact that little to no sexual reproduction of garlic has taken place under cultivation, much phenotypic variation exists among cultivars, likely due to the selection of interesting and favorable mutants.

Leek, kurrat, great-headed garlic, and pearl onion. The *ampeloprasum* group includes four primary crops, all of which can be freely crossed and interbred. Wild *A. ampeloprasum* is found in a broad geographic range that includes western Iran through the Mediterranean to Portugal (Brewster, 1994).

The leek group is characterized by the development of a pseudostem, which is actually the edible part of the leek plant. The pseudostem is so called because the concentric overlapping leaf bases fold over each other to create a hollow stemlike structure, although botanically the edible portion of the leek is not a stem. Leeks are well adapted to cool climates and are grown throughout northern Europe. Unlike bulb onions, leeks do not have specific photoperiodic requirements for pseudostem formation and can thus be grown in a wide range of latitudes.

The kurrat group includes those *A. ampeloprasum* selected for edible leaves and short pseudostems. The crop is popular in Egypt, where the leaves are repeatedly cut and harvested every three to four weeks over an eighteen-month period (Brewster, 1994).

The great-headed garlic group includes plants that form large cloves similar to garlic cloves, however the inflorescence is large and leeklike. Called elephant garlic by many commercial growers, it typically is much larger than a garlic plant and can produce up to six large cloves at the base of the flower stalk. When the plant does not flower, only a single large clove, known as a "round," is produced.

Pearl onion is a minor *Allium* crop grown in certain parts of Europe. The plant forms a cluster of small, spherical, white-skinned bulbs. In the United States, products marketed as pearl onion may in fact be small bulbs of *A. cepa* rather than the true pearl onion. Among U.S. horticulturists, the true pearl onion is often called Portuguese leek.

Bunching onion. The bunching onion has been the primary *Allium* crop in many parts of Asia for millennia and is still a major component in the diet in China and Japan. Bunching onions appear similar to bulb onions during early growth stages, but bunching onions do not form bulbs and instead are harvested for their green foliage.

Allium fistulosum may derive from the wild *Allium altaicum*, which grows in the mountains of southern Siberia and Mongolia and is interfertile with *A. fistulosum*.

In the U.S. market the consumer is usually presented with green onions or scallions that are likely the bulb onion *A. cepa* harvested for its green foliage. It is also possible that these green onions were produced from an interspecific hybrid between *A. cepa* and *A. fistulosum* known as "Beltsville Bunching" that has been a mainstay of bunching onion production in the United States for more than fifty years. Thus the green onions or bunching onions in the U.S. market may be of several different genetic backgrounds.

Bunching onion cultivars have been developed for a variety of market classes. These classes are primarily separated by the geographic areas in which the plants can be grown and by the quality of the foliage. Certain consumers prefer blanched pseudostems instead of green pseudostems. Cultivation of the former is accomplished by mounding soil on the developing plants, thereby reducing the amount of chlorophyll and producing a more tender, lighter-colored pseudostem.

Rakkyo. This allium crop is grown mainly in Japan and China, where it produces small bulbs that are mostly consumed pickled. The plants resemble chives but develop elongated bulbs in the summer.

Chives. Chives, which grows wild in Eurasia and in America, is the most widely distributed allium species. It is extremely cold hardy and is winter dormant, and it can grow in latitudes as high as 70° (Brewster, 1994). Chives form a cluster of low-growing, narrow, hollow leaves. After every two or three leaves have formed, axillary buds form side shoots that then allow for the development of a cluster of shoots (Brewster, 1994). The shoots are attached to each other on a rhizome.

Chinese chives. *Allium tuberosum* grows wild in East Asia and is cultivated for its garlic-flavored leaves and immature flowers. It forms rhizomes similar to those of chives, and the leaves arise as dense clumps from these rhizomes (Brewster, 1994). Unlike true chives, which has a hollow stem, the leaves of Chinese chives are flat.

Chemical Constituents and Culinary Significance

The word "allium" derived from the Greek phrase "to leap out," thereby suggesting a strong interaction between the crop and its consumer. Worldwide the edible alliums are prized for their unique flavors. These flavors are derived from a suite of unique organosulfur compounds that likely have their origin as a defense strategy, protecting allium plants from pests. Although they possess some toxicity for insect and microbial pests, their levels of toxicity for humans and larger animals is far less and in most cases nonexistent. Several exceptions exist, however, and these are discussed under the pharmacological properties of allium crops below.

Like all plants, alliums uptake the necessary element sulfur as sulfate from the soil. Sulfate is then used to form the amino acids cysteine and glutathione, which in turn form the gamma glutamyl peptides. These peptides serve as building blocks for the allium flavor precursors, known collectively as the alk(en)yl-L-cysteine sulfoxides or ACSOs. The ACSOs are present in the mesophyll storage cells, inside the cell's cytoplasm. Each allium crop is characterized by a different number and ratio of these ACSOs, which ultimately determine its flavor. For example, onion contains three ACSOs, while garlic contains four. The balance of these ACSOs in onion and garlic are different, resulting in flavor differences between the vegetables. Knowing the ACSO profile can help predict the flavor of an allium, because they are directly responsible for the flavor components as described below.

The ACSOs are considered flavor precursors because they do not impart flavors directly. Rather, it is only upon tissue disruption that allium crops yield their unique flavors and odors. This is accomplished through a chemical reaction that begins when the enzyme alliinase, stored in the bundle sheath cells and protected from the ACSOs by a membrane, comes into contact with the ACSOs after tissues are cut. Thus the scent of an unchopped onion bulb is completely different from the scent after tissues have been chopped, because the enzymatic lysis of the ACSOs initiates the development of the thiosulfinates, which are actually responsible for allium flavors.

As soon as allium tissues are disrupted, such as by a kitchen knife, the transient sulfenic acids are formed as well as the by-product pyruvic acid. Pyruvic acid has been used extensively as an indirect measure of onion pungency because the amount of enzymatically formed pyruvate is positively correlated significantly with a taste perception of pungency (Wall and Corgan, 1992). In all alliums except onions the sulfenic acids are rapidly converted into thiosulfinates, which are the compounds responsible for the flavors of allium vegetables. This conversion also takes place in onions, however, immediately prior to thiosulfinate formation, the compound propanethiol sulfoxide is formed. Propanethiol sulfoxide, also known as the lachrymatory factor, is responsible for the formation of tears in the eyes of those close enough to the chopped onion to intercept the airborne compound. Presumably the formation of tears is caused by the interaction of this sulfur compound with the eye's nerve cell membrane, causing the formation of sulfuric acid.

Thiosulfinate accumulation in crushed or cut allium tissues is perceived by the nose, the eyes, the tongue, and the skin. Because allium crops contain different ACSOs, they also contain different kinds and amounts of thiosulfinates, which in turn leads to different flavors. Thiosulfinate formation at room temperature is complete after thirty minutes (Thomas and Parkin, 1994). Chopped allium tissues therefore have differential thiosulfinate profiles depending upon the length of time they have been allowed to sit and the temperature at which they have been prepared.

Typically most consumers process cut alliums by boiling or by frying or sautéing in oil. These two processes yield different by-products. Boiling chopped garlic results in the formation of various sulfides, including diallyl disulfide and diallyl trisulfide. Sautéing in oil produces the vinyl dithiins and ajoene (Lawson, 1998). The transformation of sulfur compounds into thiosulfinates and downstream reactions that transform the thiosulfinates into sulfides and dithiins is an area of great interest and investigation in the allium research community.

Biology of Vegetable Alliums

Most of the edible alliums possess some variation of the leaf that creates their vegetable form. Those that form bulbs do so because the base of the leaf begins to swell with carbohydrates from photosynthesis. The concentric swollen leaf bases make up the structure of the onion bulb. Similarly the swollen leaf base and its protective leaf sheath make up the clove that is a part of the garlic bulb. Thus the bulb is nothing more than fleshy leaves or leaf bases on top of a short, flattened stem. Those alliums that form a pseudostem, such as leek, do so because the overlapping leaf bases form a hollow stemlike structure. These leaf bases do not swell but make up the edible portion of the crop just the same. And of course those vegetable alliums that are consumed for their leaf blades typically do not form swollen structures such as bulbs. In all cases a short, flattened stem is found under these leaf bases. It is likely that this stem has been shortened during the evolution of these allium crops, resulting in larger and more-prominent leaf bases and storage tissues.

These many variations on leaf morphology illustrate an important principle of crop domestication. Many of our most important crop plants occur in complexes where multiple morphological forms of a single species have been selected by humans to serve a variety of different needs. For example, the crop species in the *Brassica oleracea* complex, including cabbage, broccoli, cauliflower, kale, collards, and Brussels sprouts, all possess variations that partition their photosynthate into different storage organs. In the case of cabbage the photosynthate is stored in leaf tissue packed into a compact rosette. In the case of Brussels sprouts the axillary buds are activated, and smaller headlike structures become the item of commerce. In the case of broccoli photosynthates are partitioned into the thickened stem and immature inflorescence. Similar to allium crops, the variations in morphology serve the purpose of producing different crops for different uses. Among cultivated plants the alliums are unique in that their multiplicity of forms is based on how and where the photosynthate is partitioned in the leaf.

Another unique biological feature of the alliums is the presence of bulbils in the inflorescence. Bulbils are simply small bulblike structures that form in leaf axils, particularly in the inflorescence, of many allium crops. Bulbils are also comprised of leaf tissue but are not formed from swollen leaf bases as onion and garlic bulbs are. Rather, they represent a unique form of propagule from which alliums can be vegetatively propagated in a clonal fashion. The presence of bulbils in the inflorescence can also be a diagnostic character for differentiating alliums. They are common in garlic, are not present at all in Chinese chives and rakkyo, and occasionally are present in leek and kurrat.

Pharmacological Properties

> And if the boy have not a woman's gift to rain
> a shower of commanded tears,
> An onion will do for such a shift,
> which in a napkin being close conveyed,
> Shall in despite enforce a watery eye.
>
> (William Shakespeare, *The Taming of the Shrew*, cited in Block, 1992)

Alliums may have been cultivated originally for their medicinal properties and only later developed into flavorants, although it is possible these two discoveries occurred simultaneously or in close proximity. Many of the most common vegetable crops, such as lettuce, tomato, and others, were originally used as medicinal plants prior to their widespread use as food (Rubatzky and Yamaguchi, 1997).

The Egyptians made extensive use of alliums to treat a variety of ailments, many of which are recorded in the Codex Ebers, a document at least 3,500 years old (Block, 1985). Documentation of their use in ayurvedic medicine in India, Western-style medicine in Greece, and Eastern-style medicine in China abounds (Lawson, 1998). Evidence also indicates that early Olympic athletes were fed alliums to promote blood circulation and to attain peak performance and that Europeans have used alliums to treat blood clots in horses and other domestic animals for many centuries (Block, 1985, 1992). Alliums were important in warding off plague and other microbial infections over the centuries (Lawson, 1998) and in treating dysentery, smallpox, and many other maladies during the twentieth century. Indeed edible alliums have been more widely used than many synthetic medicines for an incredibly diverse array of conditions.

The rising importance of synthetic, mono-molecular drugs during the twentieth century, particularly in the United States, resulted in a dearth of interest in naturally derived whole foods as medicines during that period. However, in the last decade of the century many people in the West became increasingly interested in the potential health functionality of food. In fact many consumers began to purchase food for these very properties (Sloan, 2000). The folkloric documentation of these crops as curatives is highly informative with respect to the potential health functionality of alliums in the diet. Many properties mentioned in this way have been partially confirmed by modern medical investigation.

Historically allium crops have been used to treat a wide range of ailments, but the most prominent has been cardiovascular disease. Within the rubric of this disease, allium intake has been associated with significant reductions in blood pressure, cholesterol, and platelet aggregation (Block, 1992). Reductions in each of these parameters have been measured in clinically relevant feeding trials (Lawson, 1998), suggesting the potential for dietary intervention with edible alliums for cardiovascular disease. The antiplatelet, or antiothrombotic, potential of onions appears to be quite potent in vivo following onion administration in canines (Briggs et al., 2000).

Significant applications also have been noted for the antimicrobial property of allium extracts, which extends to bacteria, fungi, and viruses; reductions in carcinogenesis; reductions in blood sugar and increases in insulin; and general antioxidant activity (Lawson, 1998). For many of these properties the thiosulfinates have been implicated as the suspected causal agents, although much work is required to determine the involvement of other compounds with significant potential for biological activity. One such example is the flavonoids, which are present in high concentrations in colored onion tissues and have significant potential as antioxidants, show reductions in tumorigenesis, and remain at relatively high levels following thermal processing. Among the most prominent flavonoid in onions is the flavonol known as quercetin, which has shown great promise as an in vivo antioxidant and platelet inhibitor but less promising results when studied in vivo (Janssen et al., 1998).

It is important that the conversion of the ACSOs into thiosulfinates is enzymatically controlled. Therefore this reaction may be significantly hindered by cooking. Furthermore the thiosulfinates are volatile compounds that are likely altered and possibly reduced in concentration with thermal processing. For these reasons evaluation of the above-mentioned medicinal properties in feeding studies with cooked alliums are important in determining the extent of the health implications of dietary alliums.

Nutritional Components and Utilization

The dry matter content of many allium vegetables is in the range of 7 to 15 percent, with the exception of the 35 to 50 percent dry matter found in garlic (Brewster, 1994). Approximately 1 to 2 percent is protein, 0.2 percent is fat, and 5 to 12 percent is carbohydrates. Garlic bulbs may contain up to 6 percent protein. The caloric value is approximately 35 calories per 100 grams but is much higher for garlic. Onion contains a variety of secondary compounds, such as flavonols, anthocyanin pigments, sterols, and saponins (Brewster, 1994).

Just as in ancient times, onion growing is still a specialized branch of farming. This onion farmer in Costa Rica is grading the onions in her barn. © CARL & ANN PURCELL/CORBIS.

A large number of processed products are made from vegetable alliums, and these find their way into a wide array of processed foods. Concentrated oils are produced from steam distillation of fresh onion and garlic, and these are used to deliver onion or garlic flavor to processed foods. Dehydrated products make up a sizable portion of the onion and garlic processing industry. Dehydration requires fairly low temperatures due to the potential for carmelization under high heat. The fresh product is ultimately dried to 4 percent moisture. The resultant dried flakes can be further ground into powder and mixed with salt and calcium stearate to produce onion or garlic salt. In a number of countries, particularly in Asia, pickled allium bulbs are consumed. These are produced in a fermentation process and then bottled in vinegar and salt to make a sour pickle or vinegar and sugar to make a sweet pickle.

During the late twentieth century the popularity of mild, sweet onion bulbs rose dramatically in many markets around the world, indicating a desire for a less-pungent onion. Reduced pungency can be obtained through a combination of genetic backgrounds and favorable environments, in particular those soils where sulfur supply is low or is deliberately reduced. As discussed above, since the flavor pathway in alliums begins with the uptake of sulfate, high levels of soil sulfur can result in the production of more pungent onion bulbs (Randle et al., 1995). Only certain short-day onion cultivars grown in the southern United States have made significant inroads into the consumer market as a sweet or mild product, and these are not available year round in many markets. Since the accumulation and partitioning of sulfur and organosulfur compounds in alliums is not fully understood, it is difficult to predict the potential for mild onion cultivars in other market classes.

See also **Vegetables**.

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Irwin L. Goldman

ORGANIC AGRICULTURE. Organic agriculture originated as a response to a growing awareness that the health of the land is linked to the health and future of the people. It is a holistic and philosophical approach to agriculture, which has as its goals the protection and conservation of the land for future generations, the production of high-quality food, the return to many traditional agricultural methods, and the harmonious balance with a complex series of ecosystems. Land, water, plants, animals, and people are all seen as interlinked and interdependent.

Definition

The final rule of the United States Department of Agriculture (USDA), which implements the Organic Foods Production Act of 1990, describes organic production as one which will "respond to site-specific conditions by integrating cultural, biological and mechanical practices that foster cycling of resources, promote ecological balance and conserve biodiversity." Organic agriculture promotes linkages and connections between land and water, plants and people. Soil fertility is enhanced through the use of composted waste to be generated at the farm site and recycled into it, multiple crops and rotations, a belief in the beneficial results of encouraging biodiversity through numerous species, and no use of synthetic fertilizers or pesticides. Further, stringent inspections, record keeping, and certifications are required to verify and maintain the organic status of the land and the food produced.

The terms "alternative," "sustainable," and "ecological" agriculture are also sometimes used, in place of organic, although not everyone believes that these terms are interchangeable. The European Union protects three terms: "organic," "ecological," and "biological" and abbreviations like "bio" and "eco" in all European Union languages. This is to prevent their use in a misleading or false manner. In the United States, the definition of organic agriculture by the National Organic Standards

Board is "an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on the minimal use of off-farm inputs and on management practices that restore, maintain, and enhance ecological harmony."

Today, organic agriculture is practiced in almost every country in the world, and the amount of certified organic land is growing as well. The total area is more than 42 million acres worldwide. The bulk of the organic land (45 percent) is in Oceania; Europe has 25 percent; North America, almost 8 percent; and Latin America, 22 percent. The emphasis in organic agriculture is on sustainability, local resources, and the stewardship of the environment, as well as expanding its global impact beyond food supply and into ecological health. Economically, the International Trade Center estimates the world retail market for organic food and beverages increased from $10 billion in 1997 to $17.5 billion in 2000. Revenue distribution by 2001 is estimated to be at 46 percent in Europe and 37 percent in the United States.

History

At the beginning of the twentieth century, 39 percent of the United States population lived on farms, compared with less than 2 percent in 1990. Large land holdings were designed as federal lands to protect the natural environment and provide public access. Food quality, adequacy of supply, and public health were concerns. Issues with food quality led to the Pure Food and Drug Act of 1906. Extensive research was carried out to make plants disease resistant, and to improve yield. In the 1920s Rudolf Steiner, an extremely charismatic and complex individual, gave a series of eight lectures about agriculture that were the foundation of biodynamics, a concept in which all life forms and the land are in balance and combine with agriculture to address the health of the land with a spiritual dimension. By the 1930s hybrid seed corn had became common, and the devastation of the dust storms destroyed millions of acres of farmland in the Plains states. Two world wars had decimated farms and farmlands in much of Europe. Food supply for present and future populations was becoming a global concern. The vitality of the soil was seen by many as the key to a healthy future population.

Sir Albert Howard of England was one of the visionary leaders, if not the founder, of the organic agricultural movement in Europe. Philosophically, he linked the health of the land to the health of the people. Howard believed that agriculture as mainly practiced, with chemical fertilizers and a single crop, was out of balance with the environment and that many traditional agricultural practices should be revived. His major concern was for the health of the soil, which he felt could be maintained by a diversity of plant and animal crops, recycling of waste to enrich the soil, minimal depth in plowing, natural pest control, and smaller labor-intensive farms, emulating traditional methods.

Rows of parsnips, carrots, beets, and spinach are shown in these organic vegetable plots at Ryton, near Coventry, England. © Michael Boys/CORBIS.

By the 1940s, chemical fertilizers and pesticide and insecticide use had increased. However, a USDA report from the same time warned that insecticides were present in food and advocated the use of naturally occurring products as insecticides. Some believed that conservation practices like cover crops, crop rotation, strip planting, and contouring of the planting were critical to preserve the soil both by keeping it in place and by maintaining its fertility. At the same time, conventional farming was stressing yields, mechanization, and modern practices. In 1949, official guidance was issued from the U.S. government on how to appraise the toxicity of chemicals in foods.

In America, J. I. Rodale had founded *Organic Gardening Magazine* and the Soil and Health Foundation (now the Rodale Institute). Many credit him from the mid-1940s onward with promoting and supporting organic agriculture in America. He went on to create numerous publications and with his research and publishing delivered his core message of "healthy soil = healthy food = healthy people."

In 1959, the cranberry crop in the United States was recalled due to the presence of a cancer-causing chemical used to kill weeds. In 1962, Rachel Carson's work

Silent Spring had a massive impact: Many Americans, for the first time, saw the link between the loss of plant and animal populations and the use of pesticides. By that time organic farming was well established as an alternative approach. Further environmental activism in the 1970s made many aware of organic agriculture and organic foods.

Alice Waters opened her restaurant Chez Panisse in Berkeley in 1971 and has been a promoter and champion of quality ingredients, supporting growers who farm organically. Her influence in turn promoted and sustained many other organic growers. The fame and growing impact of Chez Panisse have affected chefs and the public alike. Numerous chefs today provide details about ingredients on their menu, and many base their entire approach to food on organic products.

Likewise, vegetarians have long focused on the quality of the ingredients in their diet. John and Karen Hess in their landmark book *The Taste of America* decried the quality of food in America in the 1970s, stating that "[t]he health food and organic movements and the counterculture generally, have made some small but enormously promising steps toward reviving the taste of our food. . . . They are our hope" (p. 298). Organic agriculture has slowly grown, spurred by various scares but hampered by the counterculture label. Reports and findings in the 1990s with regard to the effect of pesticides and chemicals in food on humans, particularly children (for example, the use of alar on apples), drove the increasing demand for organically produced food, which in turn spurred the growth of organic farms.

Application of Principles

Although many people associate organic agriculture primarily with fruits and vegetables, organic agricultural practices are applied effectively to all crops and animals. All crops—grains, citrus, nuts, fruits, herbs, vegetables, oilseeds like flax and sunflower, beans, cotton, grasses for pastureland—can reinforce a basic organic tenet: grow a variety of crops in a rotation system. Many people prefer organic agriculture because of its systemic approach that ties food production to ecology, and connects land, people, plants, and animals to a common goal, a healthy vital environment for all. Food produced organically is thought to be more flavorful, have higher nutritional values, be safer to eat, and be ecologically sound. Each food safety crisis, environmental scare, and dietary concern has increased the steadily growing pool of organic farmers and consumers.

The founders of the organic agricultural movement—Rodale, Balfour, and Howard, to name a few—passionately shared the belief that the health and vitality of the soil were key to the future of the land and food production. A fundamental principle of organic agriculture is that no synthetic fertilizers or pesticides are permitted. Complex ecosystems that encourage a rich diversity of plants, animals, and insects are considered necessary for a viable and living soil. Composting, worms and beneficial insects in the environment, recycled farm wastes, use of manures, composts, ash, and crop residues contribute to the vitality of the soil, which in turn leads to healthy plants and animals. Further, organic agriculture addresses the broader environmental issues of pesticide and fertilizer residues, run-offs, and concentrations, which affect, not just the health of the organic farm system, but the ecosystems around it. The concept of balance between nature and human actions and stewardship of the land is integral to organic agriculture; in fact, it cannot be maintained otherwise. The inspection process leading to organic certification usually requires a minimum of three years in the United States (two years in the United Kingdom) to allow all traces of past land use practices to disappear. The first usable harvest follows the third year, assuming all other criteria are met for organic certification. This sizable commitment of resources is economically difficult and is one reason that many countries, although not the United States, have subsidies to help farmers certify their land for organic production.

Many feel strongly that organic foods, which are grown without synthetic pesticides, eliminate the concern for ingesting the residues or additives.

Organic Foods

Most consumers believe, and some studies have shown, that there are more nutrients and flavor in organic products. Generally, organic products are more costly than foods grown by conventional agriculture. They are more labor intensive and must meet much stricter regulation, and therefore the cost of organic foods reflects the cost of production. Organic agricultural practices, which utilize local resources and eliminate outside needs as much as possible, fit developing countries' needs very well as well as countries with food supply issues, for example, Cuba.

Cuba is considered one of the success stories of organic agriculture. Heavily dependent upon the Soviets for food and agricultural support, the collapse of the former USSR in 1989 left Cuba desperate for food. Overnight, supplies of synthetic fertilizers and pesticides and mechanized equipment all disappeared. Urban spaces were turned into gardens, plot sizes decreased, and organic practices were followed, as there was no alternative. The results have been dramatic, both in creating a new career for many and dramatically changing both the diet of the population and the appearance of Cuba. Now many people have access to fresh organic foods and unused land is turned to food production. Over one-half million tons of food were grown in Havana alone in 1998.

Before the 1990 Organic Foods Production Act, Title XXI of the Food, Agriculture, Conservation, and Trade Act of 1990, many state and other organizations certified organic production. The 1990 rules, published in December of 2000 after a decade in development, review, and revisions, set national standards for certification of agricultural products as organic. Certification for all but the smallest growers and compliance for all agricultural products sold under these standards must be completed by late 2002. Certain practices and types of substances, like synthetic fertilizers and pesticides, are prohibited. The use of the word "organic" is now nationally regulated. In the United States, a raw or processed product labeled "100 percent organic" must contain only organic ingredients, although it can contain water and salt; if labeled "organic" it must be at least 95 percent organic and if labeled "made with organic ingredients" it must have at least 70 percent organic ingredients. Both the "100 percent organic" and "organic" designations can use an approved "USDA Organic" seal and penalties can be levied if there is any deliberate misrepresentation.

Land under Organic Cultivation

In 1997, 1.3 million acres in forty-nine states were certified organic, and although this number had more than doubled in the 1990s, certified organic land still represents just 0.2 percent of all cultivated land (828 million acres). These totals include crop, range, and pasture lands. All indicators are that the amount of certified organic land is increasing rapidly, however. For example, in California, certified organic acreage increased by 38 percent between 1995 and 1997 and in Washington it increased by 150 percent between 1997 and 1999. The highest production crops that are certified organic are corn and wheat, although thirty-five states are producing a variety of certified organic grains. Tomatoes, lettuce, and carrots are the primary organic vegetables, with about 48,227 acres in organic vegetable production (in 1997); grapes produced on 39 percent of the acreage and apples on 18 percent of the certified organic farm land account for about 2 percent of the certified land that is devoted to producing these crops. Organic herbs are grown in thirty-two states; three states have certified specific land for harvesting wild herbs.

Prior to this national legislation for organic certification, organic land certification was given by over 40 organizations, which included twelve state programs. For example, California grew almost half of all certified organic vegetables in 1997; vegetable farming in Vermont, which has been promoting organics for 30 years, was 24 percent organic. Many states have started to develop incentives for organic conversion.

Sales

Most organic farms are about one-third the size of the conventional farm and average about 140 acres. Organic vegetables are generally grown on even smaller holdings, with the majority less than 10 acres in size. They are frequently marketed directly to the consumer primarily through farmers' markets and restaurant chefs, accounting for 3 percent of total organic sales. A very popular form of direct marketing is subscription farming, sometimes known as CSA, an innovative way of connecting the consumer directly with the farm and crop. In 1998, there were 2,746 farmers' markets operating in the United States. Natural food stores, long a source for all organic products, recorded sales of $4 billion in 1999, and an annual sales growth rate of at least 20 percent. Total retail sales of all organic products are estimated at $7.8 billion in 2000, and $833 million of fresh organic fruits and vegetables were sold in natural food stores in 1999.

Organic Agriculture Worldwide

On a global level, in Europe, Japan, the United States, and the United Kindom, retail organic food and beverage sales accounted for about 2 percent of the total, about $13 billion in 1998, with an anticipated annual growth rate of 20 percent.

In 2001, Canada reported of 246,923 farms, 2,230 produced certified organic products, and 614 of these, or 27.5 percent, produced fruits, vegetables, or greenhouse products. Nearly fifteen hundred farms, or 64.7 percent, reported organic field crops. In Canada, the formation of the Land Fellowship in Ontario in the 1950s provided the foundation of the organic farming movement. As in the United States, these early visionaries were joined in the 1970s by a host of individuals and organizations whose concerns for the environmental health of the planet made an immediate linkage to the principles of organic agriculture. Numerous organizations, like the Canadian Organic Advisory Board, which is composed of volunteers, promote and support organic agriculture in a variety of ways throughout the provinces. Canada's National Standard for Organic Agriculture is a voluntary standard for organic production, whose principles and practices focus on protection of environmental biodiversity, a comprehensive and systematic use of organic practices for the production of foods, and a verification process to ensure the standards are met.

Sir Albert Howard is not the only founder of the early organic movement in the United Kingdom to have a global impact. Lord Walter Northbourne is credited with creating the phrase "organic farming" in his 1940 book *Look to the Land*, and Lady Evelyn Balfour, whose book *The Living Soil* was based on years of comparative farming data, inspired many to support the principles of organic agriculture put forward by Howard. Lady Balfour was also involved in the founding of the Soil Association in the United Kingdom in 1946. The Soil Association remains an active advocacy group for organic standards. Throughout the United Kingdom, there is a wide range of organizations, government ministries, colleges, and research centers focused on research, education, advocacy, and sustaining organic agricultural practices. The first organic standards were published by the Soil Association. The group performs the majority of the inspections, although several other approved inspection groups also perform certification inspections.

In the United Kingdom there were 2,865 licensed organic farmers in production, or in conversion, in 2000, a dramatic increase from the 828 listed in 1997. In late 1999, 2 percent of all agricultural land (a little over 1 million acres) was farmed organically (fully organic or in conversion). Organic vegetable production value for 1999 was $28.8 million in the United Kingdom. Nearly half of the consumers interviewed said they bought organic produce for the taste.

The Food and Agricultural Organization of the United Nations (FAO) has published the *Codex Alimentarius* to establish global food standards and guidelines for organically produced foods. The FAO states:

> Foods should only refer to organic production methods if they come from an organic farm system employing management practices which seek to nurture ecosystems which achieve sustainable productivity and provide weed, pest and disease control though a diverse mix of mutually dependent life forms, recycling plant and animal residues, crop selection and rotation, water management, tillage, and cultivation. Soil fertility is maintained and enhanced by a system which optimizes soil biological activity and the physical and mineral nature of the soil as the means to provide a balanced nutrient supply for plant and animal life as well as to conserve soil resources. Production should be sustainable with the recycling of plant nutrients as an essential part of the fertilizing strategy. Pest and disease management is attained by means of the encouragement of a balanced host/predator relationship, augmentation of beneficial insect populations, biological and cultural control and mechanical removal of pests and affected plant parts.

In Europe, the European Union countries have a total of 10 million acres held in 145,113 organic farms, which represent about 2 percent of farms and about 3 percent of the farming acreage. This figure represents a rapid rate of growth, about 25 percent over the last ten years in European Union member countries. For example, as of 2001, France had over 10,000 organic farms, an increase of 12 percent from the previous year. Ongoing research in organic agriculture is being conducted in most countries, and some have adopted educational programs that support the organic farmers as well as the consumers. Uniformity of standards and dissemination of research are critical to the future of organic agriculture. The International Federation of Organic Agriculture Movements (IFOAM) was founded in 1972 to coordinate research and represent organic agriculture worldwide in forums for policy and law. Currently, IFOAM is working in 100 countries with more than 690 member organizations. Perhaps most important, it sets, maintains, and revises the IFOAM Basic Standards of Organic Agriculture and Food Processing, which are translated into eighteen languages and ensure the quality of and equal application of the organic certification through the IFOAM Accreditation Programme.

See also **Agriculture, Origins of; Agronomy; Canada; Codex Alimentarius; Crop Improvement; Ecology and Food; Environment; Farmers' Markets; Food Politics: United States; Food Production, History of; Green Revolution; Organic Farming and Gardening; Organic Food; Pesticides; Tillage; Toxins, Unnatural, and Food Safety.**

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Daphne L. Derven

ORGANIC FARMING AND GARDENING.

Organic farming is the practice of growing crops and livestock without applying any synthetic products such as inorganic fertilizers, growth hormones, genetically modified organisms, or pesticides. In contrast, the modern practice of growing crops that relies largely on the use of synthetic (human-made) products is termed "conventional" agriculture. Organic farming not only consists of using a different set of production tools to grow crops, but its philosophical approach to farming also differs from that used by "conventional" farmers. In general, organic farmers intend to establish a production system that works with nature instead of one that dominates nature. For instance, organic farmers strive to maximize natural nutrient cycles that mimic those found in natural ecosystems. Similarly, organic farmers strive to exploit natural pest control mechanisms, such as biological controls, which are also typical of natural ecosystems. In contrast, conventional growers rely on capital- and energy-intensive production methods, such as those that use inorganic fertilizers and pesticides, to overcome problems of poor soil fertility or to manage the outbreak of damaging pests and diseases.

DEFINITIONS

Eutrophication. Oxygen depletion in aquatic habitats due to excessive nutrient leaching (especially phosphorus) from agricultural runoff, resulting in the death of aquatic biota.

Community supported agriculture (or CSA; also termed subscription farming). Members of the community purchase "shares" from local growers, "investing" in the current production season, and thereby sharing in both the risk and bounty of agriculture. Produce from the farm is distributed to members on a weekly basis during the harvest season.

Soil quality. In general terms soil quality refers to a combined number of physical and biological soil attributes that result in optimal crop growth. The particular attributes that affect soil quality may vary across locations and by the crop being grown. Some traits that promote soil quality include high organic matter content, good texture, no compaction, good drainage, optimal temperature, and a deep soil profile.

Natural enemies, or beneficials. The typical farm is a host to a wide number and diversity of macro- and microorganisms living both above and below ground. Only a very small percentage of these organisms is considered harmful to crop growth—and thus categorized as a pest. Organisms in the soil or in the plant canopy that feed on, or that in some way antagonize, crop pests are called natural enemies or "beneficial" organisms.

Organic certification guidelines. Written guidelines have been established for growing crops organically in many parts of the world. Farms that follow these guidelines can become certified, which allows farmers to label their products as organic in the marketplace. Federal organic standards in the United States will facilitate the global expansion and consumer awareness of this growing eco-industry.

History

The organic farming movement was born in the twentieth century as a response to the concerns of some agricultural ecologists that so-called conventional farming practices were causing environmental harm, and that in the long term were basically unsustainable. Concerns that organic farming practitioners have with conventional farming include contamination of ground waters with fertilizers and pesticides, loss of genetic crop diversity, eutrophication of aquatic habitats, and depletion of soil fertility. Organic farming proponents used production techniques that built upon those long used by traditional farmers prior to the discovery of agricultural chemicals. In fact, even today, millions of small farmers in the developing world continue to follow chemical-free production techniques. Most of these subsistence farmers, located in tropical areas, follow chemical-free practices by default, because they lack the capital or access to relatively expensive synthetic products. In the developed world, organic farming increased rapidly in popularity in Europe, Japan, Oceania, and the United States, beginning in the second half of the twentieth century. Even though organic farms still represent less than 5 percent of all the agricultural acreage, their popularity continues to increase in both developed and developing countries. Despite the fact that the acreage under organic farming is rapidly increasing, to date the demand for organic produce has actually outpaced the available supply. Because of the real

Cultural Practices Typical of Organic Farming

- Increased soil organic matter through organic amendment applications
- Rotations
- Use of cover crops and green manures to break pest and disease cycles and to improve soil fertility
- Increased vegetational diversity
- Enhanced biological control
- Alternative marketing techniques such as Community Supported Agriculture or direct marketing to health-food stores.
- Use of organic fertilizers and organic pesticides approved by the Federal Organic Standards list of approved products.

or perceived safety of organic produce, the appeal and demand for organic products are expected to continue to increase exponentially in the foreseeable future.

Organic farmers normally undergo a rigorous on-farm certification process before they can label their products as organic. This process, created to protect the consumer, simply certifies the production process, but the organic label itself makes no claims as to the safety or chemical composition of the labeled product. The recently established federal organic standards in the United States, and similar standards already established worldwide, will further facilitate the expansion and trade of organic products on a global basis.

Production Practices

One of the fundamental principles of organic farming is the goal to maintain and improve soil quality. Proponents believe that having a healthy soil is the basis for having a sound crop production system. According to this perspective, crops grown on healthy soils will grow faster, will better tolerate or resist pests and diseases, will have better quality, and will result in adequate yields, year after year. Important tactics to improve soil quality include increasing the organic matter content of the soil, crop rotations, and growing a diversity of crops on the farm. Organic matter is added to the soil by applying composts, using organic mulches, or by growing cover crops as part of the crop rotation program. If the soil suffers from a nutrient imbalance or lacks a particular nutrient, this can be rectified by applying accepted natural materials such as lime, rock phosphate, or sulfur. A healthy soil is also believed to result in crops that better resist or outgrow pest invasions. Other important cultural practices used to minimize pest attack include crop rotations, field sanitation, planting resistant varieties or cultivars, crop diversification, and the conservation of natural enemies. When pest outbreaks occur, as a last resort, organic farmers may apply naturally occurring pesticides (such as sulfur), use botanicals, release beneficials purchased from a commercial supplier, or use other tactics approved by the organic certification guidelines.

Historically, organic farmers have received little support from established research universities, as the overall research focus to date has been to increase yields of conventionally grown crops. However, as the demand for organic products continues to increase worldwide, more and more research resources are gradually being devoted toward improving organic systems. Thus, in the foreseeable future, research will improve our knowledge of how organic systems function, revealing new alternative methods to maintain long-term fertility of the soil, and ways to manage important pests and diseases.

Risks and Benefits of Organic Farming

Farmers throughout the world have adopted organic farming mainly because of a concern about the environment, to protect the health of the family farm and its hired labor, and with the goal of marketing crops that are free of pesticide residues or genetically modified products. However, the label of an organically certified crop only makes claims about the production process, and not about the quality or nutritional composition of the crop being sold. While organic produce sold in the marketplace is, for the most part, considered safe for human consumption, critics point out that organic produce may pose a health risk due to the possible presence of biological contaminants (such as *E. coli*), or toxic botanical pesticides. Other real or perceived problems with organic farming include a higher cost of production, lower relative yields, lower quality due to a greater incidence of blemishes in the produce caused by insects and diseases, and the general lack of technical information currently available to manage large-scale organic production systems to supply a large consumer base with high-quality produce on a year-round basis.

Future Trends and Opportunities

The organic farming industry is currently undergoing a fast transformation from a relatively small niche market, into a part of the mainstream global produce production and distribution system. As the demand for organic produce continues to increase at about 20 percent annually, the supply cannot currently keep up with the growing demand. As the size of the organic industry grows and as the international markets develop, the industry will grow in sophistication from a production and marketing standpoint to meet the quality and service standards expected by consumers. Thus, the organic industry will need the support of universities and government agencies to continue to develop the technological know-how and marketing infrastructure needed to establish a dynamic and competitive world-class organic produce industry.

See also **Adulteration of Food; Biodiversity; Biotechnology; Crop Improvement; Farmers' Markets; Genetic Engineering; Green Revolution; High-Technology Farming; Organic Agriculture; Organic Food; Sustainable Agriculture.**

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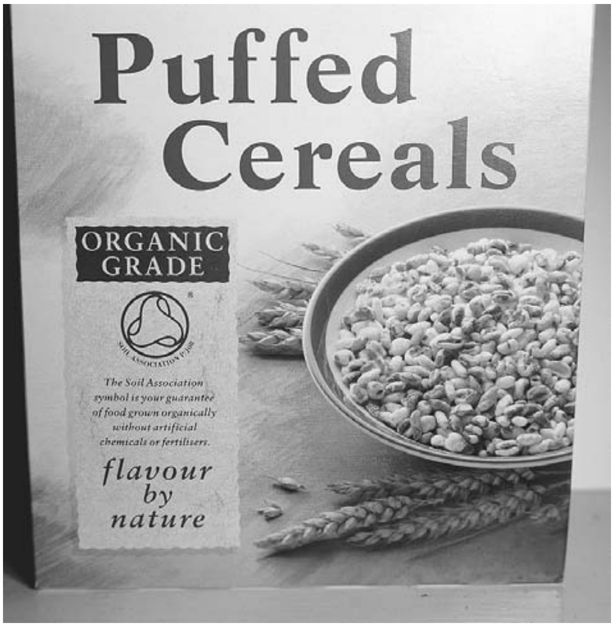
ORGANIC FOOD. Organic food refers to crops or livestock that are grown on the farm without the application of synthetic fertilizers or pesticides, and without using genetically modified organisms. In contrast, the type of agriculture followed by most farmers, which does include the use of synthetic pesticides and fertilizers, is termed "conventional" agriculture. In 2002, with a value in the United States of over $4 billion, organic foods still represent only a small segment of the entire food industry. However, since the early 1980s the organic food industry has increased considerably both in the acreage devoted to grow organic products and in its popularity with the general public.

Consumer surveys indicate that the public is concerned about the safety of the produce that they purchase in stores due to possible pesticide contamination. The media has also highlighted some environmental concerns that exist with "conventional" farming. These environmental concerns include pollution of aquatic habitats and aquifers by synthetic fertilizers and pesticides; agricultural labor and consumer exposure to pesticides; the short-term approach to "conventional" farming, which often results in unproductive unfertile soils a few years after intensive use of the land; the loss of biological diversity by replacing natural landscapes with extensive monocultures (the practice of growing the same crop, on the same location, year after year); the potential threats to native habitats and wild species from contamination by genetically modified organisms; and the displacement of the family farm by large plantations or corporate-style farming operations. The list of real or perceived health and environmental problems that exist with conventional farming, has in part, contributed to the increased popularity among the general public of organically produced food.

During the 1990s the U.S. organic food industry grew at a fast pace of over 20 percent annually. Because the supply has not been able to keep up with the high demand, organic food normally commands a premium price, compared to conventional food. Thus, organic farming is an attractive proposition for both established and new farmers concerned about human health and about the environment, and also because of the premium price obtained from selling organic produce in several countries.

History of the Organic Movement

The organic farming movement was born in the early twentieth century as a response to the concern that some agricultural ecologists had with conventional agriculture. Early critics of conventional agriculture and organic farming proponents included agricultural ecologists such as Sir Albert Howard in both England and India, and Scott Nearing and J. I. Rodale in the United States. For conventional agriculture, they claimed, short-term profits took a precedence over the environment, resulting in rapid degradation of fertile agricultural lands. From their perspective, the excessive reliance on external inputs such as fertilizers and pesticides, and continuous monocultures, antagonized the natural nutrient cycles and pest suppression mechanisms that exist in natural ecosystems. They proposed and developed production systems that precluded the use of synthetic external inputs, and substituted them with alternative production methods, only allowing the use of naturally available amendments such as composted animal manures, botanical pesticides, and the use of green manures (a cover crop, such as clover, that protects the soil from erosion and is subsequently turned under to amend the soil). Early organic production techniques were actually built upon production practices that were originally used by subsistence farmers throughout the world before the discovery of synthetic fertilizers and pesticides. These early farmers, over millennia, developed farming systems that worked closely with nature, resulting in a finely tuned system that periodically "regenerated" itself from an ecological standpoint, and thus ensured that the land would remain healthy and productive indefinitely. From the early twentieth century, organic farmers have continued to promote those well-tested techniques used originally by subsistence farmers,


Puffed
Cereals
ORGANIC
GRADE
The Soil Association symbol is your guarantee of food grown organically without artificial chemicals or fertilisers.
flavour
by
nature

This cereal was produced organically in England and has been certified as organic on the side of the box shown here. © IAN HARWOOD; ECOSCENE/CORBIS.

and have continued to modify and perfect them, and to introduce new innovative techniques as they learn more through research and experience.

From a production standpoint, the heart of organic farming is considered to be a healthy soil. Organic farmers consider the soil to be a living entity that needs to be cared for and nurtured. Furthermore, they claim, many of the ailments that today's farmers encounter in the field, in terms of nutritional problems or pest damage on their crops, is nothing but a symptom of an unhealthy soil. Modern research has actually substantiated that all aspects of the production system of the farm are interrelated. Some studies have found links between soil quality and pest, weed, or disease outbreaks. Key tactics used by organic farmers to improve soil quality include incorporation of organic amendments such as composts; the use of organic mulches, which also serve to smother weed growth and retain moisture; and the use of cover crops or green manures, which are incorporated into the soil after reaching a particular stage of growth. If the soil suffers from a nutrient imbalance or lacks a particular nutrient, this can be rectified by applying accepted natural materials such as lime, rock phosphate, or sulfur. Today, organic farmers can monitor the quality of their soils, not only by observing how well their crops are growing, but also by having their soils analyzed by certified diagnostic chemical laboratories.

Crop losses from pest attack can be one of the primary production problems for a farmer. Organic farmers believe that a healthy soil rich in organic matter will result in a balanced system that allows crops to better resist or outgrow pest invasions. The farmer's goal, concerning management of pests in the organic farm, is to establish a balanced system, in which pests and diseases are kept in check through natural pest suppression mechanisms, including the activity of natural enemies. Natural enemies are macro- or microorganisms that act as predators or parasites to reduce pest populations. Populations of natural enemies can be promoted in the farm through crop diversification, including intercropping, and by growing a diversity of crops concurrently on the farm. Other important cultural practices used to minimize pest attack include crop rotations, field sanitation, and planting resistant varieties. When pest outbreaks occur, as a last resort, organic farmers may apply naturally occurring pesticides (such as sulfur) and botanicals, release beneficials purchased from a commercial supplier, or use other tactics approved by organic certification guidelines.

The Organic Certification Process

Because the organic food industry is relatively small and new, it is important that consumers become aware of its claims, limitations, and potential benefits. In order to better protect the consumer, organic certification programs were created in many parts of the world to develop a label for organic food. An organic certification label makes a claim as to the production process used to grow a crop, but the label makes no claims concerning either the quality or the chemical composition of the product itself. Thus, an organic label does not claim that a particular product is more nutritious, pesticide-free, or tastier—it only indicates that the product was grown following a defined set of organic practices as certified by an accredited state, federal, or international certifying agency.

As the organic food industry grows in size, popularity, and value, its products are increasingly traded across national borders and continents, as it joins the global food trade market. To further the national and international expansion of this industry, and the ability of local growers to export organic products, the United States published a set of federal organic production standards in early 2001. The new federal organic standards will cover the entire country, and replace the guidelines previously used by independent or state agencies in various parts of the country. Because a similar area-wide certification program also exists in Europe and in other regions, it will become easier in the future to trade organic products across borders. In the end, the certification process results in an organic label in every item sold as organic, and this label assures the consumer that this product was produced following a strict set of standards that are uniform across the United States, and similar to those followed in other parts of the world.

The process to certify a farm as organic is a rather rigorous task that involves a lot of planning, good management, and record-keeping. Farmers rely on published organic certification guidelines to find out what practices are acceptable and what products are allowed for use on the farm. For land to be certified as organic, no synthetic fertilizers or pesticides can be applied to it for three years prior to certification. Part of the application process involves a detailed plan provided by the farmer that describes the entire operation, with a focus on what organic techniques will be used to produce and market crops in the farm. If the original fertility of the soil is deficient, the plans detail what will be done to rectify this problem. The certification process also includes taking soil samples to evaluate soil fertility and to detect the possible presence of any unacceptable pesticides in the soil. To ensure that the farm remains in compliance, organic inspectors will visit the farm annually. The record-keeping maintained by the farm helps the inspector to double-check that the farm operations are being conducted as indicated in the original farm plans.

Risks and Benefits of Organic Foods

Currently, organic products are sold at premium prices in an ever-increasing number of stores, and increasingly compete for shelf space with conventionally grown produce in supermarkets. Reasons for the premium prices obtained for organic products include that they are grown without pesticides and thus may be more expensive to produce because of the added labor; because they are grown in a way that does minimal harm to the environment; because no genetically modified organisms are used in the production process; because of a perception that they are better tasting; and also because the produce may have been grown locally and the consumer wishes to support small family farms. Because conventionally grown products are often bred to withstand shipping and to withstand a long shelf life after harvest, often at the expense of flavor, consumers often prefer to purchase tastier varieties, grown locally under organic conditions. However, consumers should be aware that exceptions may occur, and that in some instances conventionally grown products may actually be more nutritious, tastier, and grown in ways that minimized damage to the environment. Also, in some instances some organic farms may not be managed correctly, resulting in environmental problems such as excess erosion. Botanical pesticides, even though they are “natural,” should also be evaluated for their risk to humans, wildlife, and the environment. Similarly, improper handling of organic produce after harvest may result in product contamination and in food-borne illnesses. Thus, it is important that the consumer becomes educated about both the benefits and possible risks of purchasing either conventional or organic products, so that better decisions can be made about what products to buy, and whether it pays to invest in products with a premium price.

Current Trends for Organic Foods

Because of its popularity, the organic industry grew at a fast pace since the mid-1980s. Throughout the 1990s in the United States, the organic industry grew by 20 percent annually. Similar trends were observed in regions where affluent and educated consumers support environmentally sound production programs, small family farms, locally grown produce, and products free of pesticide residues or bioengineered materials. Thus the organic industry has also grown in Europe, Japan, New Zealand, and Australia, sometimes at a faster pace than in the United States. However, questions exist as to the future expansion of the industry. Even though many conventional farmers are interested in converting to organic production, this process becomes more difficult as the area under production increases. As the area of production increases significantly, from farming only a few acres, into farming hundreds of acres, problems of soil fertility or pest outbreaks become more difficult to manage with organic techniques. This lack of appropriate technology is explained in part because in the past little formal research was conducted by universities to support organic farmers. During the twentieth century, most agricultural researchers were busy supporting an agricultural system that relied on the use of expensive synthetic chemicals. Thus, considerable research support will be necessary in the future to develop production techniques that will allow for the successful production of organic crops on a wider scale than is possible today. Considerable consumer support will also be necessary to facilitate the expansion of the organic industry. Better informed consumers may learn to accept products with minor blemishes, realizing that the minor defects do not affect taste or nutrition and that these products were grown without the use of toxic chemicals. Educated consumers may also be willing to pay a premium price for organic products, knowing that a large organic industry translates in the long term into a healthier environment with cleaner lakes and rivers and potable aquifers.

If the organic farming movement is to expand the area under cultivation and into other countries, the industry will have to grow in sophistication, to establish a seamless delivery system from the farm to the dinner table. The organic industry also will need to better educate the public about what organic farming is, and what it is not. The newly released national organic standards in the United States, and equivalent certification programs in Europe and elsewhere, will facilitate this process. Because the certification standards clearly delineate the entire production system, the public will be better assured of what they are purchasing when they see an organic label. Misconceptions about organic products will have to be overcome to build public trust in the industry. For example, proponents often claim that organic products are tastier and more nutritious than conventional products. While some isolated studies have indicated that in some cases organic food was more nutritious (more vitamins, etc.), this cannot be generalized to all crops and locations. On the other hand, contrary to some public perceptions, organic produce is not often infected with microbial contaminants, and the risk of food-borne illnesses from organic produce is minimal.

Thus, from the consumer's standpoint, there are several important reasons to purchase organic products. These include supporting the production of farm products that are grown in a manner that minimizes negative impacts on the environment; advocating a system that protects the health of the agricultural workers by minimizing their exposure to toxic chemicals; supporting a system that helps to maintain a rich wildlife in rural areas; and standing for an agricultural system that provides a fair price for the food that is purchased, thus allowing small organic farmers to lead independent, productive lives. A number of innovative marketing techniques bring urban consumers into closer contact with the land. One example of this trend is called Community Supported Agriculture (CSA), or subscription farming. With CSA, community members purchase "shares" of an organic farm—and thus help the farmer to purchase needed inputs prior to the production season. By doing this, the community shares the risk of crop losses that farmers face every season. As part of the program, the CSA farm distributes to its members products from the farm on a weekly basis, providing a bounty of fruits, vegetables, and often dairy products. The urban family members also visit the farm, sometimes to help with the harvest, once or more during the growing season. This type of marketing program helps bridge the wide gap that exists between urban and rural areas, and both parties benefit from this innovative arrangement. The urban families, especially children, learn about where their food comes from, allowing them to become better consumers, and to understand the impacts of agriculture on the environment. In turn, this symbiotic association allows the CSA farmer to become more savvy about the likes and dislikes of the urban consumer, allowing the farmer to modify and improve the farm's menu of products year after year.

See also **Adulteration of Food; Artificial Foods; Biodiversity; Biotechnology; Crop Improvement; Farmers' Markets; Genetic Engineering; Green Revolution; High-Technology Farming; Natural Foods; Organic Agriculture; Organic Farming and Gardening; Sustainable Agriculture.**

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ORGANIZATIONS. *See* **Government Agencies; International Agencies.**

P

PACIFIC OCEAN SOCIETIES. Oceania, the collective name for islands in the Pacific Ocean, consists of high volcanic islands, atolls, and two larger continental islands. On the volcanic and continental islands, the topography, climatic range, and rich soil allow a range of foods to be grown. On atolls, in contrast, the poor soil, shortage of fresh water, and exposure to salt spray restrict the plants that will grow. Fiji thus has a wider inventory of foods than the atolls of the Marshall Islands and Tuamotus. Increasing population size also places stresses on local plant foods.

The islands of the Pacific Ocean are surrounded by seas that cover half the surface of the globe. They have been settled over the last three thousand years by people who sailed east from Southeast Asia, carrying the planting material for taro, yam, and breadfruit, and possibly coconut. Later westward voyages from South America carried other plant stock, such as sweet potato, cassava, and Xanthosoma taro, that added to the biodiversity. The settlers on the various islands gradually developed autonomous groupings and discrete identities and languages, along with different food preferences. These Pacific island societies became subject to colonial control from the early nineteenth century until the 1960s, when each society sought independence on its own terms. Coconut and sugar cane became plantation crops, while coffee, cocoa, and other plants were introduced. With the development of a cash economy, imported foods such as rice, flour, and canned meat have played an increasing role in people's diets.

Staple Foods

Root and tree crops are the starch staples of Pacific Ocean societies. These roots and edible fruits are usually eaten with fish, or, if none is available, then a piece of coconut. Several varieties of the root crops and tree starches have been developed in situ, so that Hawaiians had seventy-two different types of Colocasia taro that they used for food. Sago is another starchy tree crop that is widely used throughout New Guinea. The coconut tree provides nuts, the meat of which is a major accompaniment to any of these starches. Coconut juice is a pure beverage, and other parts of the tree are used in food preparation and other products. Rice imported from countries is a recent and ubiquitous addition to the diet (Malolo et al., 1999; Pollock, 1992).

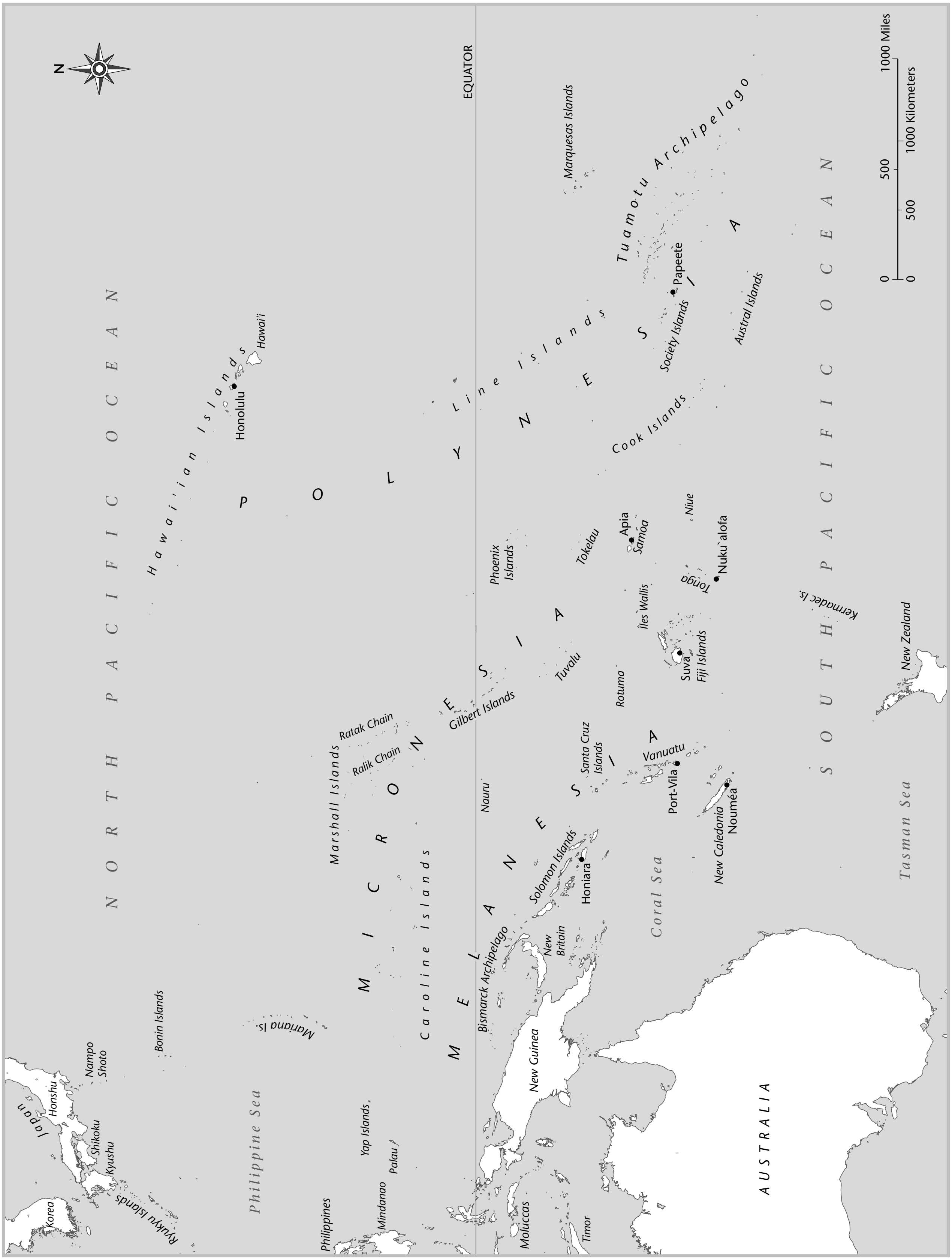
All these plants only reproduce vegetatively, so they had to be transported by people who knew their value. Over time many varieties have been selected for size of the root or fruits, extended seasonal availability, and reduced acridity. Taste has become more varied as fermented roots and fruits are either processed directly, or added to the fresh pulp, and then cooked. Cassava, sweet potato, and Xanthosoma taro (Xanthosoma chamissonis) have been added to the inventory, brought from the Americas. While widely accepted for household use, they have lesser status for ritual and ceremonial occasions. Taro and yam remain the major status foods for both household and ritual occasions (Pollock, 2002).

Diet and Nutrition

These starchy foods make up the bulk of the diet, because "they make us feel full" (Leota, in Pollock and Dixon, 1997:72–75); in local languages they are termed "real food" (Fijian *kakana dina*). About 80 percent of daily intake comes from one or a combination of these starches (including rice) (Malolo et al., 1999). But the starchy food must be eaten with an accompaniment for people to say they have "eaten." That accompaniment may be a piece of coconut or fish, or shellfish, and is vital to the feeling of satisfaction from eating. Outsiders may term these two components a "meal," though that is a concept introduced from the West (Pollock, 2000).

Local starchy foods are high in energy, and they provide some protein, minerals, vitamins, and dietary fiber (Malolo et al., 1999, p. 11). The nutrient content of the foods generally consumed by peoples of the Pacific islands is considered good (Dignan et al., 1994). Some Colocasia taro varieties can have 7 grams of protein per 100 grams, while Xanthosoma taro has a high Vitamin C content. Cassava is high in energy/calories but low in protein so is best consumed along with other root crops. The major source of fat in the diet comes from coconut and fish, though fried doughnuts and chicken are recent delicacies that are eagerly consumed when available, mainly in towns.

The traditional diet was high in fiber but low in salt, fat and sugars. However, the introduced foods, such as


N
EQUATOR
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
POLYNESIA
MICRONESIA
MELANESIA
Hawai'ian Islands
Honolulu
Hawai'i
Line Islands
Marquesas Islands
Tuamotu Archipelago
Papeete
Society Islands
Austral Islands
Cook Islands
Phoenix Islands
Tokelau
Apia
Samoa
Niue
Nuku`alofa
Tonga
Kermadec Is.
Îles Wallis
Tuvalu
Rotuma
Suva
Fiji Islands
New Zealand
Gilbert Islands
Ratak Chain
Ralik Chain
Marshall Islands
Nauru
Santa Cruz Islands
Vanuatu
Port-Vila
New Caledonia
Nouméa
Solomon Islands
Honiara
Coral Sea
Tasman Sea
Bismarck Archipelago
New Britain
New Guinea
Caroline Islands
Mariana Is.
Bonin Islands
Nampo Shoto
Japan
Honshu
Shikoku
Kyushu
Ryukyu Islands
Korea
Philippine Sea
Yap Islands
Palau
Philippines
Mindanao
Moluccas
Timor
AUSTRALIA
0
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fried chicken, turkey tails, and soft drinks, have increased the amount of fat, salt, and sugar in the diet and are thus considered to be major contributors to health problems, notably diabetes, hypertension, and obesity (Coyne, 1984). The Pacific Islands Nutrition newsletter, which is distributed in all the island communities, stresses the links between diet, health, and lifestyle and suggests how diet can be improved (i.e., no. 43, March 2000).

Production of local starchy foods is diminishing as land is diverted to cash crops. Farmers can get a high price for their taros or yams when sold in the local market and in urban centers, but the returns from export crops such as sugar and ginger are better. Competition with low-priced imported foods, such as rice and flour, is a concern to nutritionists, since these imported starches have less nutritional value than the local starches. Local campaigns, such as that run by the Fiji Food and Nutrition Committee, have highlighted the attributes of local foods with an "Eat More Local Foods" slogan.

Food Preparation and Eating Habits

The traditional manner of eating once a day, or perhaps only three or four times a week, has changed with Western ideology and practices. Early visitors to the Pacific islands decried the large amounts of food they saw being consumed at feasts, terming it "gourmandizing"or "gluttony." They taught the people to regulate their food intake, that is, to eat at least once a day (Pollock, 2000). Today people eat two or three times a day.

That earlier pattern of irregular eating was well suited to the seasonal nature of the root and tree crops as well as to the organization of daily life. People ate what was available, and then waited until the next occasion when the roots and fruits had been harvested and cooked in the earth oven. But that pattern of gluttony and abstinence was deemed uncivilized by the early missionaries. The regularity of meals is one contributing factor to the obesity that is being recorded today (Pollock, 1995).

Cooking of the root and tree starches is essential to render them edible. The earth oven was the most ubiquitous form of cooking, but it has been largely replaced by quicker forms of cooking, such as frying and boiling. In the earth oven, the peeled starches together with fish, or pig for a feast, were placed on hot coals and covered for a couple of hours, so the food was steamed. Much of the cooking in Polynesia was young men's work, with the women peeling the roots and fruits for the men to cook in the earth oven. Today women cook in the kitchen, using quicker processes, while the earth oven is used mainly for communitywide ceremonial feasts. The earth oven is more economical in the use of wood fuel, but the newer forms of cooking are a problem for those Pacific communities without access to electricity.

Fermented foods were in part a means of storing any excess but also a means of adding a distinct taste to the rather bland root and tree foods. At the end of the main breadfruit season, the Marshallese (and other Pacific peoples) devised a system of placing the ripe breadfruit in a pit in the sand lined with leaves, where it fermented for a few months. The resulting paste, which is said to resemble cheese, could then be prepared either on its own, or mixed with some fresh breadfruit and baked as a loaf. These pits were a valuable means of storage for times when the breadfruit trees were decimated by hurricanes, or the taro pits were inundated by a tidal wave. In Hawaii, poi was an important product of fermented taro that was highly valued when eaten with fish. Food researchers have commercialized poi, as it has properties that make it suitable for sick babies, the elderly, and those suffering from grain crop allergies.

Men and boys in American Samoa prepare earth ovens for a large feast. © JACK FIELDS/CORBIS.

Feasts

Feasts, an integral part of Pacific island life, are marked by a proliferation of foods, many prepared in more elaborate ways than the daily meal. These foods are generally referred to as "puddings" though they are unlikely to contain sugar. Whole fish, turtle, pork, and suckling pig (particularly in Tonga) form the centerpiece. Foods not eaten by those present at the feast are carried home to be shared with other household members. Traditionally, such feasts were the means of honoring a chief or important visitors. They still highlight important events, such as the coming of age of a Tongan princess. The feast is often part of a wider social display that is likely to include dancing, sports such as *krikiti* (cricket) in Samoa, and music.

Problems of Food Security

Sharing food is a hallmark of Pacific Ocean societies and continues to be a major way of fostering a feeling of food security. Food has been and still is exchanged on a daily basis between households and communities. Brothers and sisters send food to their mother and father. Well-being is assessed in terms of types of food available, abundance, and generosity toward extended family members and others. Such exchanges have contributed to the diversification of foodstuffs. They have evened out disparities so that no family should be shamed by failing to have enough to provide for others.

Imported food from outside the Pacific islands has increased markedly in the twentieth and twenty-first centuries. It adds further variety but only for those with the cash to buy those foods. Reliance on rice as a cheap everyday food is blamed for many of the nutritional and health problems now appearing for the first time in Pacific Ocean societies. Food poverty is a major concern noted in the Fiji Poverty Study (1996). Worst off are urban family households with only one income, which may have to feed some twelve or fifteen people. At the state level, governments have been trying to reduce the high proportion of food imports, which ranges between 12 and 35 percent of total imports. Support for local food producers is essential if the islands are to resolve the food crisis.

Food security is the key concern for the future. The gap between the food-poor and those with adequate food is increasing. Rice and tea or bread and tea may be all a family can provide on a daily basis if they have no land and little money. Weaning infants on sweet tea mixed in rice gives them a poor start in life. The problems of food security thus range from overeating to undereating: some island peoples consume too much fatty food and pop drinks, while many struggle to feed the growing numbers in their households.

Household food security has thus become a major concern for island peoples who until the 1960s had established a regime, both social and material, that met their needs. Today's needs are more complex and require complex solutions.

See also **Cassava**; **Fruit: Tropical and Subtropical**; **Southeast Asia: Indonesia, Malaysia, and the Philippines**; **Tubers**.

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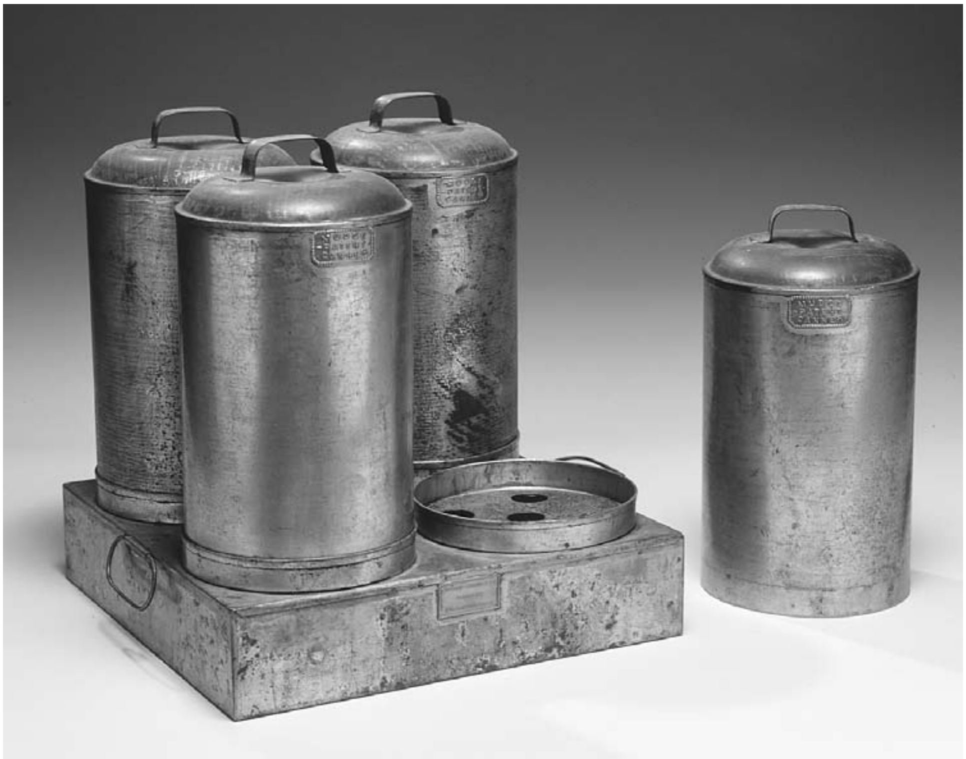
PACKAGING AND CANNING, HISTORY OF.

In preindustrial society, packaging of food was far from being unknown. It was used for food storage at home and for transport from the production place, the farm, or workshop to the local or regional market. Examples are the transport of cereals or flour in bags, tea in wooden boxes or tinplate canisters, and oils in jars. At the household level, people salted meat and pickled vegetables and preserved them in jars. In groceries at the end of the nineteenth century, most commodities were still unpacked and sold in bulk. Products such as tea, coffee, sugar, flour, or dried fruits were weighed out in front of the customer and wrapped in paper or put into a bag. In major cities in the 1880s, the milkman came around with a dipper and can to deliver milk, which was often dirty.

Origin of Modern Packaging and Canning

Early methods of sealing jars included waxed paper, leather, or skin, followed by cork stoppers and wax sealers. The beginning of modern food technology started with the experiments of the French confectioner Nicolas Appert (1750–1841). In 1795, the French government offered a prize of 12,000 francs to anyone who could find a way to preserve food because Napoléon Bonaparte needed to provide the military with a safe food supply. (The requirements of providing adequate food supplies for armies and navies have been of great significance in the history of modern packaging and food preservation.) After fourteen years of experimentation, Appert developed a method for preserving foods by heating. The food, meat, or vegetables, was first cooked in open kettles and placed in glass jars. After removing as much air as possible, the jars were carefully sealed with corks wired in place and then submersed in boiling water.

Appert chose glass for the container because he believed that it was air that caused the spoilage—glass is a material least penetrated by air. It is of importance to note that, in Appert's time, it was not known that microorganisms caused food to spoil. The processes in-



The introduction of the kitchen range brought about a revolution in home canning and preserving. The Mudge Stovetop Canner (shown here) was introduced in the early 1900s as a tool for sealing jars. Glass jars were placed inside the tight-fitting metal containers. Boiling water in the base caused steam, which built up pressure and thus sealed the jars. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

volved in food spoilage were not understood until the second half of the nineteenth century as a result of the work of scientists such as Louis Pasteur (1822–1895) on microorganisms (Thorne, 1986).

In 1810 Appert published his prize-winning essay on food preservation and the French emperor Napoléon awarded the 12,000-franc prize to him. Within a year, an English version appeared in London, and the new method of preserving food in glass spread quickly to other countries.

Canning

Two individuals in England are given credit for applying and improving Appert's invention, Bryan Donkin and Peter Durand. Bryan Donkin, an associate of John Hall's at his Dartford Iron Works, realized in 1811 that iron containers could be used instead of the fragile glass, and in 1812 the factory began to produce canned food such as meat. In 1810, Peter Durand patented the use of metal containers, which were easier to make and harder to break than glass jars. (The glass jars used by Appert frequently broke.) He covered iron cans, which were prone to rust, with a thin plating of tin (which is not adversely affected by water), and invented the "tin can." By 1813, Durand was selling canned meat to the Royal Navy. The British admiralty bought these foods as part of the medical stores for distribution to sick men as well as to supply expeditions.

By 1819 canning had arrived in the United States, but no one wanted canned food until the Civil War started. In 1821, the William Underwood Company in Boston introduced commercial canning in the United States. For a long time, people regarded canned foods with suspicion, and for good reasons. In the middle of the nineteenth century, the foods produced by the canning industry were as likely to spoil as not because of inadequate heating techniques (Morris, 1958). Then, beginning in 1868, first in the United States and later in Europe, handmade cans were replaced by machine-cut types. The new technology made it possible for giant meat-canning firms like P. D. Armour to emerge in Chicago and Cincinnati. The product, however, was packed in big, thick, clumsy red cans and was not very appetizing.

The American Gail Borden was a pioneer in food canning. In 1856 he successfully produced sweetened condensed milk in cans and was granted a patent on the process. With financial support, the New York Condensed Milk Company was established in 1857. The demand for condensed milk was at first limited, but during the American Civil War (1861–1865) it was introduced on a large scale. The Civil War contributed significantly to the popularization of canned foods in general (Clark, 1977). The army had to be fed and the government contracted with firms to supply food. Under difficult circumstances, people learned that canned foods such as condensed milk can be tasty and nourishing. The invention of practical can openers at the end of the nineteenth century made cans easier to open, making them even more convenient for consumers.

For many years, however, the flavor of most canned food left much to be desired. On the other hand, it should be realized that products such as canned peas and salmon were usually sold to people living on the American prairies or in the urban slums in Great Britain, most of whom had never eaten the fresh product. In addition, losses due to spoilage caused by microorganisms remained high. It was not until the end of the nineteenth century that research carried out at Massachusetts Institute of Technology made a substantial contribution to improving the keeping quality, nutritional value, and taste of food products preserved in cans and glass.

In the early twentieth century, the heavy cans were replaced by those made of lighter materials, and manufacturers could stress that their products were hygienically processed and, therefore, safer to eat than the traditionally unpackaged products that had been sold in bulk. As food technology advanced, numerous chemical additives were developed to control or speed up food processing and to increase the keeping quality of canned foods.

Originally, the nutritional value of food preserved by canning was not high, mainly due to the length of time required by the heating techniques. From the 1920s onward, however, the nutritional value of canned foods gradually approached that of the fresh product, thanks to modern food technology. Finally, in the 1960s, Reynolds and Alcoa companies succeeded in making all-aluminium cans out of one piece of metal, thereby solving the problem of the weight of the cans; only the lid needed to be attached (Clark, 1977). At the same time, the invention of the rip-off closure and the pop-top lid on aluminium cans made them even more convenient, and made can openers unnecessary. For consumers, the choice between fresh or canned food became largely a question of taste, convenience, and preference.

Glass

Despite its fragility and high production costs, glass had an advantage over cans: glass is chemically inert. In a metal can, iron, tin, and even lead may interact with the water of the preserved food due to chemical or galvanic reactions (although that problem had been solved when iron was replaced by lighter material). The problem of lead contamination had been removed in 1904 when the production system of the Sanitary Can Company in New York made soldering of the can unnecessary. Glass became a relatively cheap and convenient form of packaging in1903 when Michael J. Owen in Britain invented a semiautomatic machine for producing both jars and bottles. In the nineteenth century a major problem with glass containers had been finding a way to close a relatively expensive container without making the bottle or jar useless after it had been opened (Lief, 1965). Glass bottles could be closed with a cork, but closing bottles and jars that had wide mouths remained a problem.

Numerous ingenious inventions and innovations sought convenient ways to open and close glass containers (and cans as well). The breakthrough came with the invention of the zinc cap for the shoulder-seal jar. The most significant inventions were the Mason Jar in 1858 (named for its inventor, John Landis Mason), a glass jar with a thread at the neck that could be closed by screwing on a metal cap, and the Crown Cap for bottles, invented by William Painter in 1898.

In rural households in Europe from the 1890s until about the 1950s, food preservation in jars of glass and bottles by means of Appert techniques was common (Shephard, 2000), and small portable canning machines made it possible to use the new food preservation techniques in the 1930s and 1940s. As the technology of food preservation improved, however, homemade food preservation by means of salting and pickling in pots and jars of glass gradually decreased. With the invention of the home freezer, it largely disappeared.

Food Wrapping, Paper, Cartons, and Plastic

Paper and cardboard cartons emerged at the end of the nineteenth century as material for wrapping and packaging food. For a long time the price of materials for food packaging—tinplate, glass, and, to a lesser extent, paper—remained high and was often more costly than the food itself. Technological innovations made it possible to produce packaging material cheaply. Paper became important for wrapping food when it could be produced from wood pulp, but paper and cardboard cartons were not yet suitable for packaging fluids. In the 1880s in the United States, paper and cartons could be made impermeable to fat and fluid by coating them with a thin film of paraffin.

In the 1930s, cellophane became an important material for food packaging, but it was gradually replaced by the expanding possibilities of polyethylene and other forms of plastic (Borgstrom, 1967). Another breakthrough was the invention of the Tetra Pak in Sweden in 1952, which increased the capabilities of carton containers for packaging milk, fruit drinks, and other liquids. The carton container coated with polyethylene became a serious threat to the market for glass and cans.

In the 1940s, food packaging entered the era of fully disposable packaging. The convenience of the microwave was further enhanced in the 1980s with the development of special packaging materials. The demand for ready-to-eat fresh vegetables and fruits stimulated the development of Modified Atmosphere Packaging (MAP).

Labels and Brand Names

Closely associated with the history of food packaging is the development of food labels and brands (Opie, 1987). In the first half of the nineteenth century, food manufacturers realized that their products would sell better if a brand name was attached to them, a name with prestige that potential customers could easily recognize. Initially, labels with information about the contents were put on glass containers or cans. Gradually, the label and the packaging as a whole became a means for promoting the food product. In most industrialized countries, legislation regulates the information that must be provided on packaging for consumers' protection.

Since the beginning of the nineteenth century, food packaging has been closely associated with industrialization and urbanization. Originally, food packaging in glass and cans was primarily meant to preserve food, but convenience became the most significant aspect of food packaging in the twentieth century. The retail revolution, when supermarket chains supplanted family-owned grocery stores, made food packaging an indispensable part of urban food culture. On the other hand, it created problems of waste disposal, a much-discussed concern of critical consumers.

See also **Food Safety; Marketing of Food; Microorganisms; Military Rations; Preserving; Storage of Food**.

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Adel P. den Hartog

PACKAGING AND CANNING, MODERN.

Food packaging is an important part of food processing operations and food preservation. "Packaging" ensures safe product delivery to the ultimate consumer in a sound condition and at a minimum cost (Paine and Paine, 1983). In the last quarter of the twentieth century, many important developments in both materials and packaging systems led to the reduction of packaging costs and the development of novel and minimally processed foods.

Packaging serves a number of different functions including preservation, containment, and convenience. Preservation is one of its major roles: packaging protects the contents against environmental, physical, and mechanical hazards (oxygen, water/moisture, light, contamination from microorganisms, rodents, and insects, physical damage, chemical attack, etc.) during storage and distribution. Containment is another important function: packaging contains the food and keeps it secure until it is used. Packaging is also a means of providing useful information to the consumer; communication is its third important function. It provides a way of identifying the contents; attractive or eye-catching packaging helps to sell the product; and it provides a means of fulfilling any regulatory requirements concerning labeling of foods. In addition, food packages provide convenience: they unitize or group products together in useful amounts, have features like easy opening, dispensing, resealing after use, and so on. Finally, a successful, effective food package should fulfill many other requirements. It should have good machinability (that is, it should be easily filled, closed, and processed at high speeds); it should be aesthetically pleasing, recyclable or reusable, nontoxic, tamper-resistant (or tamper-evident); it should have a functional size and shape, be disposed of easily, have low cost, and be compatible with the food it contains.

There are three levels of packaging: primary, secondary, and tertiary. A primary package is in direct contact with the product. Usually, primary packages provide the major protective barrier. A secondary package usually contains several primary packages, and provides the strength for stacking in the warehouse. Like the secondary, a tertiary package contains a number of secondary packages. Its function is to hold together the secondary packages during distribution.

Due to the large variety of food products, a great deal of packaging materials, container types, packaging systems, and techniques exist. The selection and development of a package depend on the nature of the food, the desired shelf life of the product, the storage conditions, and the cost. It is a difficult task and requires in-depth knowledge of the food product and its deterioration mechanisms, transportation hazards, market and distribution requirements, and, finally, the properties and characteristics of all available packaging materials, machines, and systems.

Paperboard

Paper, and some combinations of paper-based packaging material, represents the most economical form of packaging. About 50 percent of all paperboard packaging is used to form corrugated boxes, and another 25 percent goes into fiberboard cartons. Paperboard packaging provides absolutely no oxygen or moisture protection for the product, but it does provide rigidity, mechanical support, and light barrier properties. Fiberboard cartons are popular forms of packaging materials: they are economical, collapsible, and printable; they provide versatility and excellent mechanical handling; they can have dispensing and/or resealing features, windows for product observation, and they can be used in multipacks. Another type of paperboard packaging, the corrugated box, is the most common type of shipping container. Paperboard is also used for the manufacture of composite cans and aseptic cartons, which consist of combinations of thin layers of aluminum foil, paperboard, plastic, adhesive, and coatings. The layers are either wound around a mandrel (composite can) or layered in a sheet (aseptic carton).

Glass

Glass containers are generally classified into two groups: bottles with narrow necks and jars with wide necks. Glass is chemically inert, it provides nearly absolute protection from oxygen, moisture, microorganisms, rodents, and insects, and, if colored properly, can filter out harmful UV light. However, glass has two negative properties: its heavy weight and fragility. Consumers prefer plastic packages to glass containers because plastic is lightweight, convenient, and not fragile. As a result, plastic packaging has replaced glass containers for many products and continues to do so. For example, glass containers for packaging milk, fruit juices, cooking oils, mayonnaise, soda drinks, and salad dressings have been replaced by plastic ones. Recently, the development of high-temperature resistant plastics led to the partial replacement of glass containers for jelly, ketchup, and spaghetti sauces. As plastic technology advances, other products usually packaged in glass containers will also be packed in plastic.

Metal

Metal containers, specifically those called "tin cans," have been widely used in the past and are still used for the production of commercially sterilized food products. The development of the metal can and the sterilization process are closely related. The series of operations that are part of the sterilization process is commonly called "canning." In canning sterilization processes, the product is sealed in a metal container and then treated thermally in order to destroy all pathogenic and spoilage microorganisms. This sequence of operations does not allow recontamination of the product after thermal treatment, and, as a result, it remains shelf-stable for a long period of time.

The use of metal containers has many advantages: they can be sealed hermetically; they provide excellent protection from gases, moisture, microorganisms, rodents, and insects; they are stackable, tamper-proof, and relatively inexpensive; and, in general, they can be thermally processed. On the other hand, the quality of the final product in cans is generally low; there are some safety issues (cut fingers); the containers are heavy, easily damaged, and not microwavable; and they usually do not open easily.

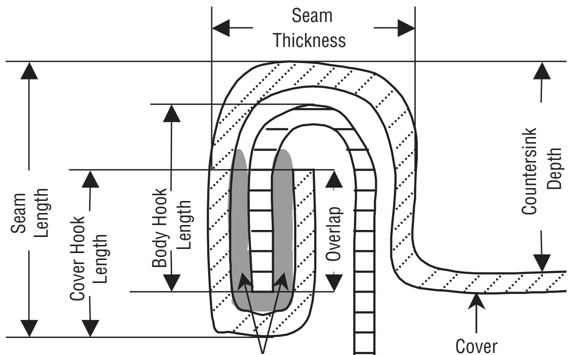
The most common type of metal container is the three-piece can, which consists of two ends and one body. One of the ends is applied by the can manufacturer and the other by the food packer. Most steel-based, three-piece can bodies are welded together, but they can also be secured mechanically. Aluminum cans cannot be welded economically. As a result, most aluminum cans are two-piece containers. Most metal containers are thermally processed. A series of ridges, known as "cluster beads," are embossed in the sidewall of the can to improve its strength and prevent collapse or paneling when pressure differential is encountered during the thermal process.

Two-piece metal containers consist of a can body and one end applied by the food packer. Two-piece cans are rapidly replacing three-piece cans due to their aesthetic appeal and their lower cost.

The portion of the can formed by rolling the curled edge of the end and the can body together, forming a hermetic seal, is called a "double seam." The double seam is a critical part of any can because it is the weakest point of the can. Each component of the double seam (Figure 1), particularly the overlap, must have the correct dimension and conform to strict guidelines to ensure a tight seal. A thermoplastic sealing compound attached to the cover melts during the formation of the double seam, fills the spaces in the seam, and results in a hermetic seal.

Most metal containers use the "tinplate" as their basic construction material. The tinplate is composed of a thick layer of steel with tin added on either side. The tin layers protect the steel from being corroded by the prod-

FIGURE 1



Cross-section of the double seam of a metal can and its components.

TABLE 1

Plastic materials used for food packaging and some of their properties

	Materials					
Properties – characteristics	**PE**	**PP**	**PET**	**PS**	**PVC**	**Composite materials**
Barrier:						
Moisture	Excellent	Excellent	Good	Poor	Medium	Excellent
Oxygen	Poor	Poor	Good	Poor	Poor	Excellent
Thermal stability and sealing	Excellent sealant; non-retortable	Retortable; good sealant	Hot Fill up to 185°F; crystallized form retortable (CPET)	Heat barrier (styrofoam)	Good sealing strength; microwaveable	Easy to seal or double seam
Mechanical	Good puncture resistance; can be made stiff	Good for films, stiff, brittle at low temperatures	Excellent resistance to mechanical abuse	Brittle form (HIPS)	Stiff and rigid when unplasticized	Not convection ovenable; retortable; need to protect from moisture
Chemical	Flavor scalping	Blooms; oil and grease resistant		Oil and grease resistant		
Optical	Cloudy appearance w/o colorant	Cloudy	High clarity	Good clarity	Good clarity	
Cost	Very low	Low	Moderate	Low	Low	High
Recyclability	Recyclable	Recyclable	Easy to recycle	Recyclable	Recyclable	Not recyclable

uct and by atmospheric moisture. Beyond the tin layers, there are coatings that also help to protect the metal from corrosion.

Decreasing tin resources and the resulting increase in the price of tin led to the development of tin-free steel (TFS). Tin-free steel plates use phosphates, chromium, aluminum, or nickel as protective coatings.

Aluminum cans are also coated for protection against corrosion. They are mostly used for carbonated beverages (beer and soda) because the high internal pressure helps the thin, soft metal container hold its shape and withstand mechanical damage.

Plastics

Plastics are long-chain polymers that can be melted, formed into a desired shape, and solidified during cooling. The general advantages of using plastic materials in food packaging include consumer acceptance and preference, excellent safety characteristics (nonfragility), less weight than other materials, good moisture and gas barrier properties, good puncture resistance, low heat conductivity, good sealant properties, recyclability, and microwavability. On the other hand, potential disadvantages include flavor scalping and migration issues. ("Flavor scalping" refers to absorption of the product's flavor compounds by the packaging material, and, conversely, "migration" is the transfer of compounds from the package to the product.)

There are many different plastics available for food packaging. The most important plastics in terms of volume are: (1) low density polyethylene (LDPE); (2) high density polyethylene (HDPE); (3) polypropylene (PP); (4) polyethylene teraphthalate (PET); (5) polystyrene (PS); (6) polyvinyl chloride (PVC); and (7) composite multilayer structures. The properties of the different plastics are presented in Table 1.

In addition to these plastics, other types are also used as food packaging materials, but they are not as popular due to their high cost. As a result, they are used only when their properties are required for the package. These plastics include: polyvinylidene chloride (PVDC), an excellent gas and water vapor barrier material; ethylene vinyl alcohol (EVOH), with excellent gas barrier properties; and some acrylics and nylons.

Laminates

When two or more plastic films are combined together, either with an adhesive or by co-extrusion, they form a laminate. The purpose of laminating materials is to combine the best properties of each film into a single packaging structure. The combination of different films into a laminate can provide a stronger seal, better mechanical properties, machinability, barrier properties for moisture, gas, odor, and light, graphics quality, and, in general, improved characteristics and appearance at a relatively low cost. Some disadvantages of the laminates include their low line speeds and environmental issues, since they are not recyclable.

When very low gas and moisture transmission through the package is desired, the use of an aluminum foil-laminated film is required. However, sometimes, when the foil in the laminate is very thin, it becomes susceptible to flex-cracking and pin-holing, which reduce significantly its barrier properties. A solution to this problem is the use of the metallization process. Vacuum metallization is the deposition of a thin metal layer on a polymeric material under vacuum. Metallized films are not as susceptible to flex-cracking or pin-holing, which gives them a distinct advantage over foil-laminated films. The most common metallized film is oriented polypropylene, which is used widely by the snacks industry, particularly for pretzels and potato chips.

Plastics and their laminations are used to make a variety of packages: bottles, cups, trays, tubs, pouches, bags, films/flexible packages, and composite structures. The large variety of plastics with a wide range of properties, and technological innovations in plastic manufacture, are the main reasons that plastics and their laminations are used increasingly for food packaging. At the same time, these technological innovations have led to the development of many novel and minimally processed products.

Microwavable Packaging

A major area of packaging development is in the microwavable products category. Consumer demands for convenient foods that need minimum time for preparation are satisfied by the use of plastics and their combination with other packaging materials that allow the product to be rapidly heated in a microwave oven. As a result, many shelf-stable, refrigerated, and frozen microwavable products are available in markets.

Another popular application in this category is the metallization of plastics and the development of susceptor technology for microwavable products (susceptors are metallized portions in packages that reflect microwaves). In the microwave, the metallized area creates localized hot spots to enhance heating, and, in some cases, to assist with browning. Examples of susceptor packaging include microwave popcorn, frozen dinners, and frozen pizza.

Modified Atmosphere Packaging

Another recent packaging development involving plastic films is modified atmosphere packaging (MAP). This method involves the alteration of the composition of the air in the package. This can be done by mechanically removing the air and obtaining vacuum, by flushing the package with another gas or mixture of gases, or naturally by the respiring product in the package (Floros, 1990). The modification of the atmosphere has a desired effect on the quality and shelf life of the product. Thus, modified atmosphere packaging can be considered an integral part of the processing operation. The composition of the modified atmosphere depends on the nature of the product and the desired outcome. The barrier properties of plastics play an important role in obtaining the desired result. The gases used for atmosphere modification include oxygen, carbon dioxide, nitrogen, carbon monoxide, sulfur dioxide, ethanol, and argon. The purpose for using each gas varies. Research regarding the use of ozone, chlorine dioxide, and other gases with antimicrobial properties indicates that the use of such gases in modified-atmosphere packaging increases the safety of the products.

The market for fresh-cut and minimally processed produce has grown tremendously over the past ten to fifteen years, and this is the result of the development and availability of plastic materials, packaging systems, and technologies, such as modified atmosphere packaging, that extend the shelf life of these products. Active packaging is a special type of modified atmosphere packaging. It involves the addition of an active substance inside the package that will cause a certain modification during storage. The substances used may be oxygen absorbents, moisture absorbents/regulators, antimicrobial agents, or other compounds with specific properties. An evolving technology is the incorporation of active substances into the packaging material itself (Floros, Dock, and Han, 1997).

Aseptic Packaging

One of the major applications of laminates is in aseptic packaging. The major difference between aseptic packaging and traditional methods of food packaging is that the product and the packaging material are continuously sterilized separately. Then, under aseptic conditions that prevent recontamination of the product, the sterile package is filled with the sterile and cooled product and hermetically sealed to produce a shelf-stable final product with extended shelf life and no need for refrigerated storage. This technique has allowed for substantial improvements in the quality of the final product, mainly due to the much milder heat treatment that the product undergoes compared to the traditional thermal process (Floros, 1993).

A popular aseptic package is the “brick pak,” a type of aseptic carton. Its composite structure usually contains both paper and aluminum foil. Paper is a mechanically stable, stiff, and groovable material with good heat resistance. It also provides good light protection and a printable surface. On the other hand, aluminum foil is an excellent gas, water, and light barrier (particularly when laminated between two plastic layers) and it is thermally stable. The combination of these properties has made paper/foil/plastic laminations popular in aseptic packaging. Aseptic cartons are used extensively for products such as fruit juices, milk, and other drinks.

Many changes in the packaging of food took place in the last quarter of the twentieth century, producing a wide variety of materials and technologies. The steady accumulation of research developments indicates that food packaging will continue to evolve and respond to the increased needs and demands of consumers.

See also **Fast Food**; **Food Safety**; **Frozen Food**; **Microorganisms**; **Microwave Oven**; **Military Rations**; **Storage of Food**.

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PAINTING. *See* **Art, Food in.**

PAKISTAN. *See* **Asia, Central; India.**

PALEONUTRITION, METHODS OF.

There are several kinds of data that inform us about what our ancestors ate. Reviewed in this entry are the data from studies of living primates, archaeology, paleontology, and living hunter-gatherer societies.

Primate Studies

The living primates include prosimians, New World monkeys, Old World monkeys, Asian and African apes, and people. Fossil evidence indicates that all primates evolved from insectivore-like mammals that lived some seventy-five million years ago. Primate ancestors may have been those insectivores that moved into the flowering trees of these tropical forests to exploit insects, and then the flowers, fruits, gums, and nectars of those trees. The large number of essential nutrients required in the human diet (forty to fifty essential nutrients) is likely a consequence of the tropical primate diet. Tropical forests are characterized by having a high diversity of species, but a low density of any given species. With a wide variety of food resources, especially fruit, foliage, and insects, ancestral primates were able to obtain many vitamins, minerals, protein, carbohydrates, and fats from their diet. It is metabolically expensive, in terms of energy consumption, for an organism to manufacture its own nutrients (a process called autotrophism). Through mutation and selection, those early primates that reduced autotrophism, and shifted to a dependency on dietary intake to meet their nutrient needs would have gained an energetic advantage, one that could be put to use, for instance, to increase reproduction.

The human primate is unusual in that seeds, grasses, roots, and vertebrate meat are major components of both its modern and ancient diet. Grasses and roots are the category of plant food most often missing from the diet of other primates. Seeds, grasses, and roots have their nutrients protected by cellulose membranes that must be mechanically broken. This can be done by mastication (chewing), or by using technology. Humans, and our hominid ancestors dating back to Australopithecus, possess the anatomy (e.g., small canines, flattened molars, and enlarged pterygoid muscles—those that move the lower jaw from side to side) that allows for a type of chewing called rotary grinding, which can break cellulose. Humans, and our ancestors of the genus *Homo*, are also dependent on technology (e.g., tools or fire) for food processing. Technology is also required for hunting at a level that makes vertebrate meat a regular part of the diet. For this reason, meat from vertebrates, either hunted or scavenged is not reported as a major component for any nonhuman primate species, although some baboons and chimpanzees regularly hunt mammalian prey.

Archaeology and Paleontology

Archaeological methods focus on the recovery and identification of food remains, of tools and other artifacts used for the acquisition and processing of food, on the analysis of food contained within coprolites (fossilized feces), on the reconstruction of ancient habitats, and on the analysis of hominid fossils. Paleontological data are derived from the kinds and percentages of fossil remains found at a site. Each type of evidence contributes some knowledge, but each has serious limitations. The association of hominid fossil remains with the skeletal remains of other fossil vertebrates may result from geologic forces, such as rivers carrying dead carcasses to a central location or a volcanic eruption burying simultaneously a community of animals, rather than hominid food gathering behavior.

In *The Descent of Man* (1871), Charles Darwin proposed that hunting large game provided much of the selection pressure for human evolution. That view persisted through the 1960s, but more recent data, based on fossil and archaeological remains and the study of living hunting and gathering people, such as the !Kung and Australian Aborigines, show that gathering and processing of plant foods is the main activity of tropical foragers.

Moreover, women in living foraging societies provide most of the calories consumed by these people. These observations turned "man the hunter" into "woman the gatherer."

Additional evidence is based on analyses of bone and stone tool material associated with early hominids. Scanning electron microscope images of mammalian long bones dating to 1.7 million years ago show that cut marks produced by stone tools were incised above those made by carnivore teeth and the teeth of known scavengers, such as porcupines. If one assumes that the order of markings reflects the order of use by hunters and scavengers, the hominids were the last to have at the bones, even after porcupines. Early hominids may have been collecting bones for their marrow and brain tissue rather than for any meat still remaining on the surface of the bone. Marrow and brain are high in fat and protein, but few carnivores have the morphology necessary to break open large long bones. The invention of stone tools, first manufactured by hominids about 2.2 million years ago, may have been a dietary adaptation for extracting marrow. Hominids may also have scavenged for larger pieces of meat, perhaps stealing meat from leopards. Leopards carry their kills up into trees and consume their prey over several days. J. A. Cavallo believes that human ancestors may have scavenged these arboreal caches of meat.

Despite the evidence for scavenging animal carcasses and, perhaps, preying on leopards, the bulk of the hominid diet has almost always been from plants. The stone tools of the early hominids may also have been used to process hard to chew plant foods, such as seeds. Studies of the finer details of early hominid dental structure and tooth wear using the scanning electron microscope and tooth wear experiments found that the diet of the early hominids, including Australopithecus and *Homo habilis*, was largely herbivorous, including softer plant foods (leaves, fruits) as well as the tougher seeds and tubers. Given all the evidence now available, perhaps it is safest to say that the gathering of plants, insects, bird's eggs, and other relatively immobile foods and the scavenging of marrow from carnivore kills typified early hominid food behavior.

Homo erectus added fire to its repertoire of technology. Fire, which may have been used as early as 1.4 million years ago and was certainly controlled by 750,000 years B.P., provided warmth, light, protection, and a new way to process foods. Where and how cooking was invented is a matter for speculation. Cooking, by roasting or boiling, increases the nutritional benefit of many vegetable foods by helping to break down the cellulose of those foods that is indigestible to people. Fire may be used to open large seeds that resist even stone tools. Cooking, especially drying or smoking, helps to preserve foods for storage. Fire may also be used to get foods, especially by driving game towards a convenient killing site. All of these uses of fire did not appear simultaneously, and many appear to be the invention of *Homo sapiens* rather than *Homo erectus*. What is certain is that the controlled use of fire was a significant addition to hominid technology with profound consequences for nutritional status.

Coprolites are fossilized feces. Such "hard evidence" might seem to provide unequivocal verification of dietary habits, but coprolites are subject to misinterpretation. First, the coprolite must be identified unambiguously as being from a hominid. Second, coprolites can only verify that a particular substance was eaten. That substance may or may not have been a food item itself, it may have been ingested coincidentally along with a food, such as a seed or insect clinging to an animal or plant. Third, only indigestible substances will be found in feces and those substances must be suitable candidates for fossilization to be preserved in a coprolite. Thus, coprolite analysis may provide a very biased picture of the true dietary intake. Even so, considerable information has been obtained about the diet of prehistoric humans and limited information about the diet of hominid species ancestral to modern people. The animal affinity of desiccated coprolites can be determined by placing the specimen in a trisodium phosphate solution for seventy-two hours. Human coprolites turn the solution an opaque dark brown or black color and no other species produces this effect. Other characteristics of human feces are inclusions of charcoal and the presence of undigested animal parts from a wide variety of species. Charcoal comes from cooking food over a wood fire. Since people cook their food and other animals do not, the presence of charcoal in feces is indirect evidence for a unique human behavior. People also have an eclectic diet compared with most other mammals, so undigested parts from a wide variety of species is another indicator of the human affinities of a coprolite.

More than a thousand paleoindian coprolites from the American Southwest have been identified and analyzed. One group of specimens was collected from Texas sites that date from 800 B.C.E. to 500 C.E., representing the temporary camps of hunting and gathering peoples. By comparing the pollen content of the coprolites with that found in the adjacent soils it was determined that the people had consumed high quantities of flowers. Because the physical characteristics of flower pollens are unique to each species it was possible to determine that flowers of agave, sotol, yucca, prickly pear cactus, gilia, and leadtree were popular foods. Also found were remains of wild onion bulbs, bark, grasshoppers, fish, small reptiles, and snails. Although not the current cuisine of Texas, this diet is typically human in its diversity of species. The flower pollen even provides a time frame for the occupation of the sites, spring and early summer.

The oldest verified coprolites of a hominid species are from the *Homo erectus* site of Terra Amata located on the French Mediterranean. These coprolites may be as old as 300,000 B.P. and they are heavily mineralized. They have only a slight reaction to trisodium phosphate rehydration. The specimens contain sand grains, charcoal, and mollusk shell fragments. The sand and shell are expected since Terra Amata is a beach front site, and the charcoal helps establish that foods were cooked before consumption (perhaps evidence for a prehistoric clam bake).

Trace element and stable isotope analysis. A general picture of the relative amounts of plant and animal food in the diet may be available from chemical analyses of stable isotopes and trace elements in skeletal remains. For example, the more δ 13C (a form of the element carbon) in a skeleton the more C4 plants in the diet. C4 plants include the domesticated grains maize, millet, and sugarcane, while C3 plants include virtually all those growing wild in temperate regions. The amount of the stable nitrogen isotope δ 15N in skeletons indicates an animal's place within the food web. The amount of δ 15N is higher as more animal protein is included in the diet. Figure 1 illustrates the relationship of these stable isotopes to diet in several mammalian species. This method is most useful when analyzing human skeletons during the transition to agriculture, that is, during the past ten thousand years. A greater dependence on agricultural crops shows up in human skeletons as more C4 plants (δ 13C) and, generally, less animal protein (δ 15N). Agricultural societies are often stratified socially into higher and lower social classes. Higher classes often have greater access to animal protein. Thus, within agricultural societies the upper classes may have more δ 15N in their skeletons. This allows archeologists to use stable isotopes as markers of social status.

There are exceptions to the usual δ 15N indicator of social status. In 1995 Douglas Ubelaker and coworkers analyzed the skeletons from high and low status graves at the archeological site called La Florida in Ecuador. The site dates from 100 to 450 C.E. There were no differences in the levels of protein (δ 15N) in these skeletons, but there is a statistically significant difference in the C4 levels between the two groups. The high status group had higher levels of C4. The only C4 plant—the only domesticated plant—that ancient people of highland Ecuador consumed in quantity, was maize. The researchers explain that the extra maize consumed by the elites was in the form of an expensive and politically restricted food called beer. Elites controlled the production and consumption of beer. Maize beer was produced by the chief's household and was doled out to the commoners at feasts in return for their labor. Chiefs also paid tribute to each other in the form of beer and offered copious amounts of beer at royal funerals. Chiefs were buried with many ceramic vessels, and at La Florida 70.5 percent of these were devoted to the brewing and serving of maize beer.

Studies of Living Hunters and Gatherers

All but one-tenth of 1 percent of humans derive their food from some form of agriculture. However, from the time of the Australopithecus until about ten thousand years ago, a period that covers 99 percent of human evolution, all hominids lived in bands and produced food by foraging—the gathering, scavenging, and hunting of wild foods. Most human physical traits, and many behavioral propensities, evolved during the time that hominids lived as hunters and gatherers. This includes current human dietary requirements, adaptations for food acquisition and processing, and biocultural responses to food. Studies of the few remaining cultures of hunting and gathering peoples offer an indirect view of that ancient style of life, now nearly extinct.

Foragers are a diverse group geographically and culturally, ranging from the arctic Inuit and Eskimo, to the tropical forest Ache (Paraguay), to the dry scrub San (Africa), and the desert Australian Aborigines. Yet, the research shows some consistencies in behavior and diet. The diversity of food resources utilized is high among gathering and hunting peoples compared with agriculturists. The !Kung San of southern Africa, for instance, eat 105 species of plants and 144 species of animals (Lee, 1984). The Australian North Queensland Aborigines exploit 240 species of plants and 120 species of animals. The Ache forage on fewer species, about 90 types of plants and animals. Even the Dogrib, residing in the subarctic of Canada, gather 10 species of plants and 33 species of animals (Hayden, 1981). That is a small food base for hunters and gatherers, but still a large number relative to agriculturalists who, on a world-wide basis, subsist largely on four species of plants (wheat, rice, potatoes, and maize) and two species of animals (cattle and hogs).

A second common feature is that gathered foods (plants, insects, bird's eggs, turtles, etc.) are the primary subsistence base in most foraging societies. Lee compared fifty-eight forager groups and found that the primary subsistence source was gathering for twenty-nine, fishing for eighteen, and hunting for eleven. Often, the use of many species for subsistence is correlated with the high diversity, low density, or seasonality of food items in the environment. In habitats where low density is combined with the wide dispersal of foods, foragers must be mobile and live in small groups. A small mobile social group is a third typical feature of forager societies. Average group size ranges from nine to fifty-five and average densities range from one to two hundred people per hundred square miles. Mobility ranges from daily movement from camp to camp to seasonal sedentariness at one camp, such as a winter lodge or a summer camp.

A fourth common feature is that all foragers depend on technology to procure, process, and store food. Technology ranges from simple to complex, both in amount and sophistication. Savanna and desert foragers, such as !Kung and Australian Aborigines, use a digging stick to get at roots and tubers that are hidden from view or not possible to extract using hands alone. The digging stick seems simple, but that tool more than doubles the calories available to the people who use it as compared with nonhuman primates living in similar habitats. Bow and arrow are used by some groups to hunt large game. At the other extreme of material culture are the Inuit and Eskimo, who possess dozens of pieces of equipment for hunting or fishing, including hooks, spears, sleds, knives, and specialized clothing. The relative complexity of Inuit and Eskimo material culture is required to extract food from a harsh environment.

Food preparation techniques include cooking (such as boiling, steaming, roasting, and frying), soaking, grinding and grating, pounding, drying, fermenting, and putrefying (as in "aged" meat). Many human foods are poisonous prior to preparation by one or more of these techniques. Such toxic raw foods include acorns and horse chestnuts, eaten by many North American Indian foragers and manioc, a root crop, which is a dietary staple of many African societies. The toxins in all these foods are removed by leaching, that is, by boiling them in water and then allowing the food to dry prior to consumption. Rhubarb and cashews, eaten by some people in modern industrial societies, are also toxic until cooked by boiling or roasting. Finally, food storage by drying, caching, and, where possible, freezing or salting is common to many forager groups. It is essential to point out here that dependence on technology for food procurement, the processing of food, and food storage are all behaviors unique to the human species and found universally in all known human cultures.

Sharing and the division of labor comprise a fifth characteristic of foragers. All known living hunters and gatherers share some food, even small game and vegetables in many cultures, and have some division of labor indicating that this is a universal human nutritional adaptation. Sharing and division of labor may best be viewed as behaviors that, first, reduce the effects of unpredictability and variance in food supply, and, second, increase reproductive fitness—that is to say, they increase the healthy development of the individual and his or her likelihood to reproduce. By dividing the social band into working groups based on sex and age, more of the necessary subsistence tasks may be accomplished in a shorter period of time. In tropical and temperate regions, adults may gather plant foods, honey, insects and other small animal foods, and hunt larger animal prey. Children may remain at the camp in an age-graded play group, with older children caring for younger children, or may accompany their parents so as to learn foraging techniques. In extreme environments children may provide significant amounts of foraged food, as they do in Hadza society.

Summary

The human diet is unusual because of our high intakes of grasses, seeds, and grains and, for some people, high intakes of meat. No other primate has this mixture of foods in its diet. The interaction between the biological history and the sociocultural behavior of people accounts for our diet. The human place in nature as primates explains our broad requirements of essential nutrients. Fossil and archaeological evidence help to account for the development of the types of foods eaten and the technology needed for food acquisition, preparation, and storage. The study of living hunting and gathering peoples compliments and supports these other sources of evidence. Five features of food, behavior, and demography are typically found in hunting and gathering societies: a high diversity of food types; greater dependence on gathering rather than hunting; small mobile social groups; dependence on technology for acquiring and processing foods; and division of labor and sharing (a sixth feature, stable population size with high infant and childhood mortality balancing fertility, is not discussed here, but see Bogin, 2001). Taken together, the sources of knowledge reviewed here provide the basis for understanding human paleonutrition and the biocultural nature of contemporary human nutrition.

See also **Agriculture, Origins of**; **American Indians**; **Animals: Primate Diets**; **Anthropology and Food**; **Australian Aborigines**; **Food Archaeology**; **Inuit**; **Maize**; **Prehistoric Societies.**

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Barry Bogin

PANTRY AND LARDER. In modern parlance, pantry and larder are used interchangeably to designate a place where food is stored. Historically, the two were once separate areas with very narrowly defined functions. During the Middle Ages, food was purchased in bulk; therefore, storage rooms were required for different types of food.

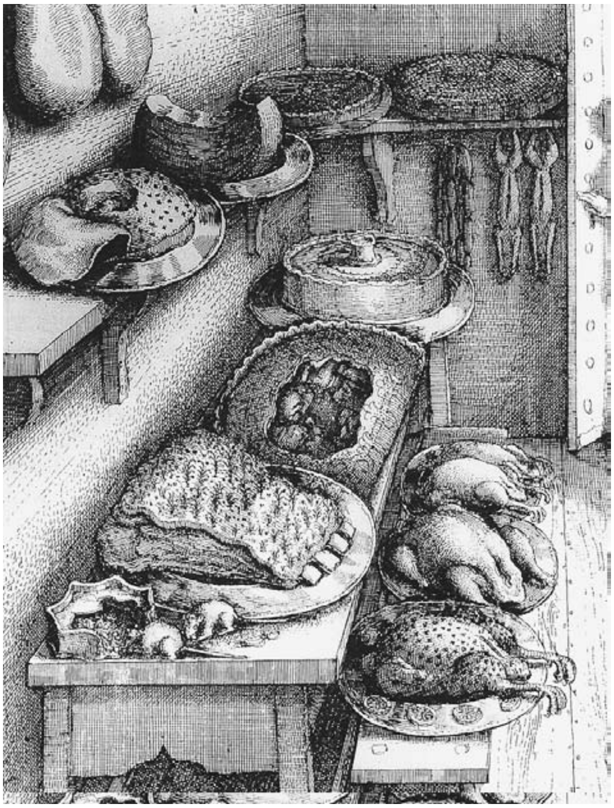
The larder was originally a cool room or cellar for storing meats, especially meats put down in large barrels or crocks of lard—hence the name. It was once common practice to partially cook meats and sausages, and then cover them with rendered lard until needed. Dried or smoked meats were generally stored in a loft or garret away from dampness. This division of function led to the evolution of the terms wet larder (cool room or cellar) and dry larder. The wet larder was used not only for meats stored in lard, but also as a holding room for uncooked meat, game, and vegetables. The dry larder would contain such things as dried fruit, grain chests, and even some types of hard-rind cheeses. Large loaves of rye bread were often buried in the grain chests for long-term keeping.

The term "pantry," and related words like "pantryman" and *pannier*, derive ultimately from Latin *panis* (bread). The core idea was a closet or cupboard where bread was stored, as in Old French *paneterie*, the term that passed into medieval English as *panetrie*. In aristocratic medieval households, the pantry was a standing cupboard where the bread was kept for the table. The finer sorts of cupboards were often elaborately carved since they stood in the room where dining took place.

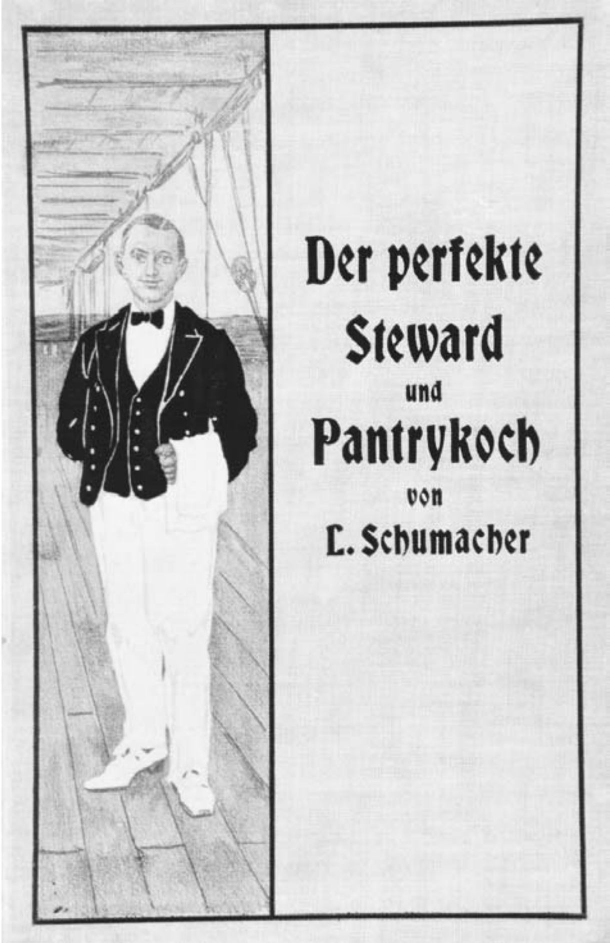
The pantler was the servant in charge of the bread and was the individual who actually sliced it for the table. This position attracted a degree of prestige since bread was such a critical part of the medieval meal. For this reason, in households belonging to the high nobility, the pantler was often a member of the lesser nobility. By the eighteenth century this function was more or less subsumed in hotels and large commercial establishments by the pantryman, a paid position whose main function was to oversee the supplying and resupplying of bread and provisions.

During the Middle Ages, two sorts of bread came from the pantry. The best bread was the *manchet* or dinner roll (normally round) made of the finest wheat flour. This bread was held in the hand and used like a utensil for dipping or scooping, since medieval diners ate with their fingers. The other sort of bread was the trencher bread, a coarse bread usually made from a combination of wheat and rye flours. Trencher bread was sliced and trimmed of crust to make a disposable plate on which the diner placed food, since dishes were only used as serving pieces during this period. Trenchers were changed frequently during a meal because they became soggy; thus it was the pantler's duty to remain vigilant and keep the table well supplied with trenchers.

By the seventeenth century, the function of the pantry had been expanded to include not only a bread storage cupboard, but also a closet or small room in which all sorts of food could be stored together. It was a cold room in that it was unheated and often ventilated with air from outside. Normally this closet stood near the kitchen, and it was common practice to put there roasts of meat, pies, and other items of uneaten food so that they could be reserved the next day. It became the butler's duty in large households to keep tabs on what was in the pantry, and this gave rise to the idea of a more specialized butler's pantry in the nineteenth century. This was a small room normally situated between the kitchen and dining room where fine silver, glassware, and china were stored. Aside from extensive cupboards and shelves, it also featured a sink. It was here that the butler, or his assistant, could undertake the final preparations for many dishes, such as decanting wine, heating a chafing dish, garnishing a roast on its way to table, or preparing fruit for dessert. A subsidiary pantry called the housemaid's pantry also evolved out of this. It was here that the head maid stored her tools. Butler's pantries were a common feature in upper-class American households on the East Coast well into the 1940s. Today, the term "pantry" has devolved into a much less specialized concept. The refrigerator and deep freezer have replaced the old larders



The interior of a larder as depicted in a 1668 illustration by Wenceslaus Hollar for an edition of *Aesop's Fables*. Note the storage of pies and roasts for reserving at a later time. Rats in the foreground are enjoying a meal of their own. COURTESY OF TOM JAINE. ROUGHWOOD COLLECTION.



L. Schumacher's handbook for the "perfect" steward and pantry cook was published in Hamburg, Germany, in 1914. It includes many recipes for salads and mixed drinks and was intended for use on passenger ships between Germany and the United States. ROUGHWOOD COLLECTION.

of the past, and the breadbox has replaced the pantry. In general, pantry and larder are now applied to any unheated storage room where food is kept, especially packaged foods, canned goods, and pickles.

See also **Food Pantries**; **Gardening and Kitchen Gardens**; **Preserving**; **Storage of Food**.

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William Woys Weaver

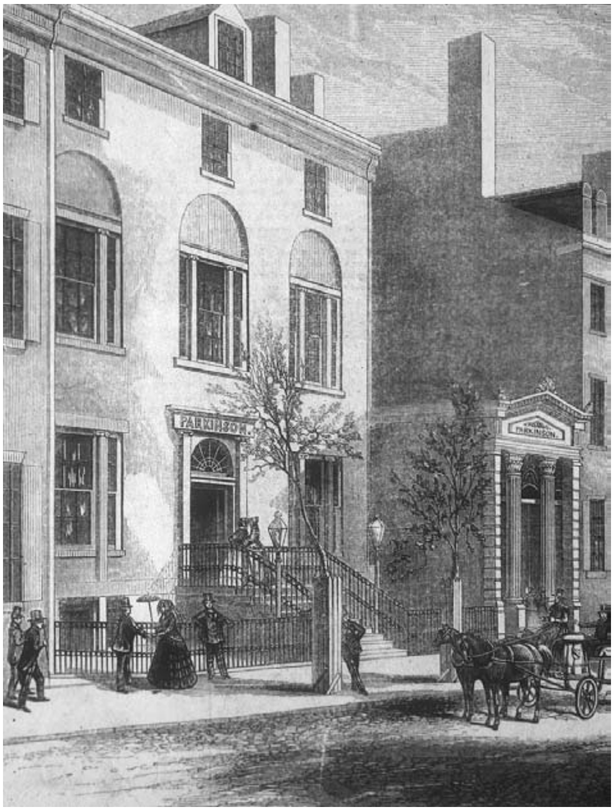
PARKINSON, JAMES WOOD. James Wood Parkinson (1818–1895) was one of the most influential American cooks of the nineteenth century. Trained by professional chefs from England, Italy, France, and Germany, his role was one of mentor to the profession rather than that of a popular cookbook author like Eliza Leslie or Sarah Josepha Hale. The core of his culinary education, however, came from his Scottish-born mother, Eleanor Wood, and his English-born father, George Parkinson, both confectioners by trade.

In 1818, Parkinson's parents purchased the Pennsylvania Arms, a Philadelphia tavern, with the intention of going into inn keeping. However, his parents' flair for confectionery soon established the family's reputation for ice cream, and it was the Parkinson family which made Philadelphia ice cream famous throughout the nineteenth century. During a banquet for the Marquis de Lafayette in 1824, the Parkinsons introduced vanilla ice cream featuring tiny flecks of the beans, thereby establishing a perfume essence as a signature flavor for a luxury desert.

By the mid-1840s, with financial backing from General George Cadwallader, the young Parkinson had established himself as a restaurateur in a lavishly furnished Philadelphia mansion located at 180 Chestnut Street. Complete with a rose garden for outdoor dining as well a delicatessen featuring imported foods from all over the world (including five types of French liver patés), Parkinson's Salon was generally considered not only one of the finest restaurants in America, but equal to those of Paris and Vienna.

James Parkinson was a master at marketing and something of an inventive genius when it came to recipes. In 1841, his delicatessen was the first in the country to feature Santa Claus at Christmas in order to draw children into a wonderland of French confections and imported toys. In 1850, he introduced his Champagne *frappé à la glace* which is now considered to be the original recipe on which the non-alcoholic ice cream soda was based. Parkinson's fame was firmly established in 1851 when he accepted a challenge from the Delmonico brothers to prepare a dinner that would would be more outstanding than one given earlier by Delmonico's. Parkinson's "Thousand Dollar Dinner" became a legend that helped launch the era of grand banquets in nineteenth century America. The menu survives and features such novelties as early eighteenth century wines, truffled poultry braised in Champagne, and a rare Tokay from the imperial wine cellars in Vienna frozen as sorbet.

Parkinson's influence continued even after he retired from the restaurant business during the 1860s. When the



Parkinson's restaurant at 180 Chestnut Street in Philadelphia was once a private mansion. There was a separate entrance for the confectionery store (on the right). Wood engraving from *Gleason's Pictorial* (May 1853). ROUGHWOOD COLLECTION.

Grand Duke Alexis of Russia visited the United States during the winter of 1871–1872 and declared that there was no true American cuisine, James Parkinson responded with his culinary manifesto *American Dishes at the Centennial.* In a call to arms for the nation's cooks, Parkinson extolled the rich variety of American ingredients and said that it was this body of regional foods that should serve as a basis for our national cuisine. It was his hope that these ingredients would be showcased at the U.S. Centennial in 1876. Unfortunately, due to Centennial politics, Parkinson was never invited to put his vision into practice, yet even today this theme is one of the underlying forces in modern American cookery.

Parkinson's manifesto also launched his career as trade editor for the *Confectioners' Journal*, a position he held from 1874 until his death in 1895. During this period he published hundreds of articles on specific topics such as "The Raspberry: Its Peculiarities and Uses," "Gelatin," or "Colored Sugars for Decoration." His material not only contains information not readily available in cookbooks of the period, but also a wide selection of rare recipes from leading cooks and confectioners.

See also **Candy and Confections**; **Delmonico Family**; **Ice Cream**; **Leslie, Eliza**.

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PASSOVER. Passover celebrates the Exodus of the Israelites from Egypt in the second millennium B.C.E. as narrated in the Bible (Exod. 1–15). According to the Jewish calendar, the holiday begins on the evening of the fourteenth of Nisan, which falls in late March or early April. Passover is observed for seven days in Israel and eight days elsewhere. On the first one or two evenings of the holiday, Jews are required to recite the Exodus story (Exod. 13:8) at a family feast called the seder and to eat matzo, an unleavened flat bread. They are prohibited from eating foods containing leaven (*hametz*) during the entire holiday.

History of Passover

The eating of a sacrificial animal, together with unleavened bread and bitter herbs, was central to Passover observance until the destruction of the Second Temple in 70 C.E. However, the paschal sacrifice and eating unleavened bread actually predate the Exodus, even in the Exodus account itself (Exod. 12:8), and are associated with two distinct holidays: Pesach, a pastoral holiday during which animals were sacrificed and eaten, probably as a propitiatory measure to protect the flocks; and Hag Ha'Matzoth, an agricultural festival associated with the beginning of the barley harvest, during which unleavened bread was eaten. The Bible distinguishes these two holidays (Lev. 23:5–6; Num. 28:16–17) and, in Exodus 12, juxtaposes them. The Samaritans still observe them as two separate events. Unleavened bread was also an ordinary bread made in haste. Sarah served it to guests (Gen. 18:6), and Lot offered it to the angels (Gen. 19:3). It is thought that eventually these two spring festivals were observed together and were later identified with the commemoration of a historical event, the Exodus, which also occurred in the spring.

According to the biblical account of the Exodus, God visited ten plagues on the Egyptians to persuade them to release the Israelites from bondage. Before the last plague, during which the firstborn in each household would be slaughtered, God told Moses to tell the Israelites to slaughter an unblemished yearling lamb or kid and smear the blood on their two door posts and lintel so their homes would be passed over and their firstborn spared. The Israelites, as instructed, roasted and ate the animals just before leaving Egypt but were in such a hurry that their bread had no time to rise (Exod. 12:1–28). Also symbolizing the food eaten by slaves and the poor, matzo is known as the bread of affliction or poverty (Deut. 16:3).

Passover became one of three pilgrimage festivals during which Israelites traveled to Jerusalem to make offerings, including the sacrifice of animals, at the Temple. They consumed parts of the roasted animal at a family feast. After the destruction of the Second Temple, animals could no longer be sacrificed, but the practice was remembered through symbols, such as the roasted shank bone placed on the seder table.

After the destruction of the second Temple in 70 C.E. and the wide dispersal of the Jews, Passover was gradually codified, and many local variations developed. The laws concerning Passover are in the Bible (Exod. 12–15), Tractate Pesahim of the Mishnah and Toseftah (compilations of the Oral Law completed in about 200 C.E.), Talmud, and later works. The *Shulhan Arukh*, written by Joseph Caro (1488–1575), with glosses by Rabbi Moses ben Israel Isserles (1530–1572), is the basis for modern religious practice.

Haggadah

The story of the Exodus is recounted from the Haggadah, which means 'narrative' in Hebrew, at the seder, during which participants eat foods symbolizing the Exodus from Egypt. The traditional Haggadah, which contains passages from the Bible and the rabbinic literature, blessings, prayers, and songs, is based on a compilation that began to be assembled in the Second Temple period. With several core elements in place by 200 C.E., the Haggadah continued to evolve, as did the seder, whose form is set out in the Haggadah.

The diverse Jewish communities of the Diaspora have created thousands of distinctive Haggadahs and modified them to reflect such concerns as egalitarianism (removing masculinist language), feminism (emphasizing the role of women in the Exodus story and in Jewish history), environmentalism (adding pollution and other dangers to the list of plagues), oppression (expressing solidarity with African Americans, Soviet Jews, Tibetans, Palestinians), social justice (adding poverty, homelessness, and AIDS to the list of plagues), humanism (stressing the theme of freedom rather than divine intervention), personal liberation (freedom from addictions), and remembering the Holocaust. These texts have encouraged the creation of new kinds of seders, whether adaptations of the seders held on the first two nights of Passover or a special third seder, as well as new and newly interpreted symbolic foods and cuisines. For example, Tibetan food is served at interfaith and international seders for a free Tibet, whether on American university campuses or in Dharamshala, India, home of the Dali Lama in exile.

Seder

The seder is organized around seven symbolic foods. They include three matzoth (two in some communities); four glasses of wine; a roasted bone *(zeroa)* symbolizing the Paschal animal sacrificed at the Temple; a green vegetable for spring; bitter herbs *(maror)* for the bitterness of slavery and for the ancient practice of eating hyssop with the Paschal offering; a roasted egg symbolizing a festival sacrifice once made at the Temple; and a mixture of fruit, nuts, spices, and wine or vinegar *(haroset)* for the mortar used by the enslaved Israelites.

Ashkenazim (Jews who derive from Germany and central and eastern Europe) present these foods on a special seder plate. Some Sephardim (Jews who derive from the Iberian Peninsula and the places they settled after the Expulsion in 1492) place these foods in a basket. Yemenite Jews set little bowls on a table covered with leafy green vegetables. In the late twentieth century, vegetarians replaced the bone with a roasted beet, or "Paschal yam," to symbolize the blood of the Paschal lamb. Among the many new Passover traditions is an orange on the seder plate, a practice introduced in the early 1980s by Susannah Heschel as a gesture of solidarity with those who have been marginalized within the Jewish community, including lesbians, gay men, and widows.

The seder, which means 'order' in Hebrew, proceeds through a set sequence of fifteen elements. These include blessings on the wine, the matzoth, and other symbolic foods; blessings and ceremonial washing of the hands; recitation of the Haggadah; eating the festive meal; the *afikoman* (half of the second of two or three matzoth); grace before and after the meal; and concluding songs and poems.

Many customs vary. Toward the end of the seder, Ashkenazim set aside a special goblet of wine for the Prophet Elijah and open the door to allow him to enter. The arrival of the Prophet Elijah is believed to herald the coming of the Messiah. A feminist innovation is the addition of Miriam's goblet, which is filled with water because Miriam, the older sister of Moses, is called a prophetess in the Exodus account and is associated with a miraculous well (Exod. 15:20). According to Erich Brauer (*The Jews of Kurdistan*, 1993, first published in 1947), with the mention of each of the ten plagues, Jews from Ushnu dip a finger in wine and shake a drop into an empty eggshell, to which they add some arrack, tobacco, and bitter herbs. Then "one of the men takes the egg and in silence throws it on the doorstep of one known to hate the Jews, returns in silence, and washes his face and hands before taking any further part in the Seder" (Brauer, 1993, p. 288). During the song "Dayenu," in which the refrain "that would have been enough" follows a verse describing how God executed justice, some Sephardi, Afghani, and Persian Jews beat each other gently with scallions to symbolize the lashes of Egyptian taskmasters.

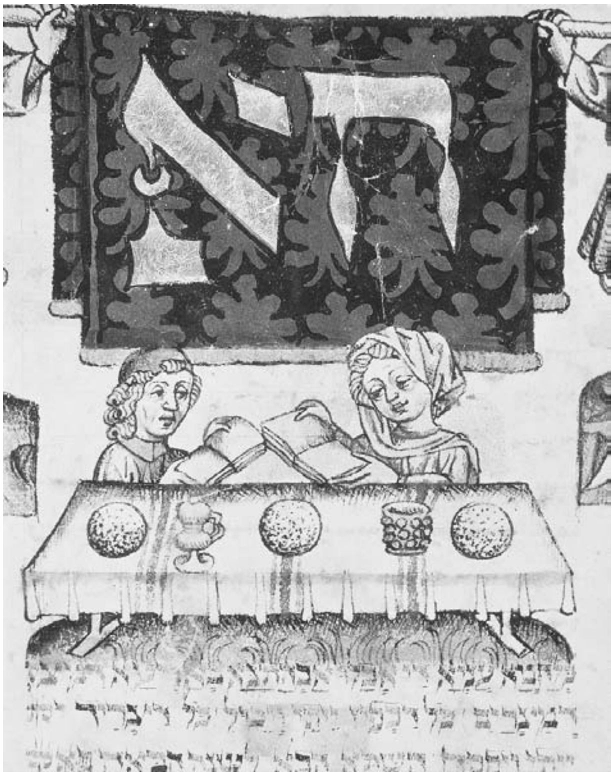
Haroset

Haroset is eaten at points nine *(maror)* and ten *(koreh)* in the seder sequence, after which the meal proper commences. Many of the ingredients in *haroset*, which vary from one community to another, have symbolic significance. The spices stand for the straw that was mixed into the mortar, red wine refers to the plague of blood, sweetness signifies hope, apples are mentioned in the Song of Songs (8:5), and various fruits (figs, dates, raisins) are associated with Bible lands. Ashkenazim favor apples, nuts, cinnamon, and red wine. Yemenite Jews, who refer to *haroset* as *dukeh*, a Talmudic term that only they use, combine dates, raisins, dried figs, roasted sesame seeds, pomegranate, almonds, walnuts, black pepper, cumin, cinnamon, ginger, cardamom, and a little wine vinegar. The Lopes family in Jamaica makes a paste of dates and sultanas soaked in orange juice and adds grated citron rind, port wine, and shredded coconut. The paste is shaped into little bricks and dusted with cinnamon (Michel, 1999).

Afikoman

The *afikoman*, a reminder of the Paschal sacrifice, is the last morsel consumed at the seder. The word *afikoman* derives from the Greek *epikomion* ('dessert') and *epikomioi* ('revelry'), which are associated with the final phases of the Greek symposium. While the seder resembles the Greek symposium in other ways, most importantly Socratic dialogue and learned discussion in the context of a festive meal (the symposium generally followed the meal), the rabbis stressed the differences between them because the symposium was associated with excessive drinking and licentious behavior. Many similarities between the seder and symposium (drinking wine, reclining, song) were characteristic of ancient banquets rather than unique to either of them, but these and other common practices (for example, dipping appetizers in a condiment) acquired special meaning in the Passover seder.

Ashkenazim hide the *afikoman* and reward a child for finding it at the end of the meal. While neither Sephardic nor Yemenite Jews hide the *afikoman*, they do reenact the Exodus, consistent with the obligation stated in the Haggadah that one is obliged to see oneself as if one had personally left Egypt. Syrian Jews do this by wrapping the *afikoman* in a special embroidered napkin cover, throwing it over their shoulders, reciting Exodus 12:34, and then asking and answering the following questions in Arabic: Where are you coming from? (Egypt) Where are you going to? (Jerusalem) (Dobrinsky, 1986, p. 256). In some Mediterranean and Central Asian Jewish communities, a piece of the *afikoman* is saved as a protection against misfortune. It is also a Sephardic custom, when breaking the *afikoman* during the seder, to do so in a way that forms a letter of symbolic significance.



Manuscript illumination from the fifteenth century showing a couple celebrating the Passover seder. © ARCHIVO ICONOGRAFICO, S. A./CORBIS.

Matzo

Although matzo is required only during the seder, it is customary to eat matzo throughout the holiday. To mark the distinction, many Jews use guarded *(shmurah)* matzo for the seder and regular matzo on the remaining days, while others eat *shmurah* matzo throughout the holiday. To ensure that the grain never comes into contact with any water or trace of leaven, *shmurah* matzo is guarded from the moment the wheat is harvested until the matzo leaves the oven, whereas regular matzo (matzo *peshutah)* is made from wheat that has been supervised only from the point of milling. Of concern is the practice of tempering grain by moistening it with water before milling. The flour for *shmurah* matzo is mixed with *mayim shelanu*, water that has been drawn from a natural source after sunset and left to stand overnight in a cool place.

All matzo, to be kosher for Passover, must be made from dough mixed, kneaded, rolled, perforated, and baked at a high temperature within eighteen minutes. A rabbi supervises the process and checks that the matzoth are properly backed, with no bubbles, folds, or soft spots. Between each batch of matzoth, tables and tools are scrupulously cleaned to ensure that no traces of dough adhere to them. In Yemen, Jews used to bake matzoth during Passover in order to have fresh soft matzoth throughout the holiday. Baked directly on the walls of a clay oven, these matzoth were somewhat like pita. Yemenites served thick matzoth at the seder, as did medieval Jewish communities, and thin ones during the rest of the holiday.

A traditional rich matzo *(matzo ashirah)* is made with white grape juice or eggs rather than with water. Only those who have difficulty digesting regular matzo, including the sick, elderly, or young children, may eat this kind of matzo during Passover. The Talmud and later sources debate the permissibility of decorating matzoth, whether by pressing them into molds or perforating them to make patterns, because the extra time devoted to this process might cause the dough to ferment. Illustrated Haggadahs show, however, that matzoth were indeed ornamented. In 1942, matzoth in the shape of V, for victory, were baked in the United States.

Rolled by hand, *shmurah* matzoth are round, in contrast with the square matzoth made by machines introduced during the 1850s in Austria. Machine-made matzoth were controversial for several reasons. First, round matzoth were stamped out of sheets of dough. Because the scraps were reused, there was a delay between mixing and baking the dough, prompting concern that the dough would start to rise. Second, to fulfill the religious obligation of eating matzo during the seder, matzo must be made intentionally for that purpose. Whether or not the intentional starting of the machine is sufficient to meet this requirement has been debated, and steps have been taken to increase human involvement in the machine process.

In time, square matzoth made by machine came to be widely accepted, so much so that matzo companies, such as Manischewitz, established in Cincinnati in 1888, made every effort to diversify their matzo products and to create a market for them all year round. Since the 1930s, their cookbooks have provided recipes for how to use their matzo products in everything from tamales to strawberry shortcake. In the late twentieth century, Manischewitz added an apple cinnamon matzo to its product line. Chocolate-covered matzo has become popular.

The claim that Jews added a victim's blood to the matzo or drank the blood at the seder is a late addition to the long history of blood libels accusing Jews of kidnapping and killing a Christian, usually a child. Blood libels have led to the execution of accused Jews and the massacre of Jewish communities. In 2002 in Saudi Arabia, a blood libel accused Jews of using the blood of non-Jewish teenagers in their Purim pastries.

Hametz

Whereas one is only obligated to eat matzo at the seder, *hametz* is prohibited during all eight days of Passover. *Hametz* refers to any of the five species of grain mentioned in the Bible (wheat, rye, oats, spelt, barley) that have come into contact with water after being harvested and allowed to ferment. These grains and anything that has come into contact with them or has been made from them cannot be eaten or be in one's possession during the holiday. Preparation for Passover entails a scrupulous cleaning of the home to remove every last trace of *hametz*, the "sale" to a non-Jew of any remaining *hametz* in one's possession (and repurchase following the holiday), the use of dishes and utensils dedicated exclusively to Passover or specially prepared for that purpose, and consumption of food that is kosher for Passover.

To prevent any possibility of violating the prohibition, "fences" have been created around these rules. Many Ashkenazim do not eat *kitniyot* (legumes, grains, and beans, including lentils, rice, corn, peas, millet, buckwheat, and anything made from them or their derivatives, such as oil, sweeteners, or grain alcohol). Sephardim generally eat fresh beans, and some groups eat rice. Most Hasidim do not eat *gebrokts* (matzo, whether whole, broken, or ground into meal, that has been mixed with water). Italian Jews do not consume milk during Passover, while Ethiopian Jews abstain from consuming fermented milk products. Many Jews do not conform to these restrictions, while some observe *kashruth* (Jewish dietary laws) during Passover but not during the rest of the year.

Cuisine

Passover dietary restrictions and requirements have prompted distinctive culinary responses. Signature dishes of the seder meal itself vary according to Jewish communities. While many are also served on the Sabbath and other holidays, some are specific to Passover.

Ashkenazim serve clear chicken broth with dumplings *(kneydlakh)* made from matzo meal and noodles made of egg and potato starch or matzo meal, gefilte fish (poached balls of ground fish), roasted fowl, stewed carrots, and nut tortes made without flour. Because of the limited availability of fresh fruits and vegetables in eastern Europe during late March and early April, carrots, beets, radishes, potatoes, and other root vegetables are important. *Rosl*, prepared weeks in advance by allowing raw beets covered with water to ferment, is the basis for a hot or cold borscht consumed during the week. Delicacies include beet or black radish preserves, *khremslakh* (pancakes made from matzo meal), sponge cakes, macaroons, and *ingberlakh* (candies made with grated carrot or small pieces of matzo and honey, nuts, and ginger).

Sephardim prepare *haminados*, eggs in their shells braised in water with red onion skins, vinegar, and saffron. Favorite Passover dishes among Moroccan Jews include dried fava bean soup with fresh coriander and stewed lamb with white truffles, which are harvested in February. Greek Jews feature artichokes with lemon, fish in rhubarb sauce, stuffed spinach leaves, leek croquettes, various dishes calling for lamb and lamb offal, and a baklava made with matzo. East European Jews traditionally made their own raisin wine for Passover, while Greek and Turkish Jews made *raki*, a liqueur derived from raisins through a process of distillation. Purchased wine must not only be kosher, which involves many strict religious regulations, but also kosher for Passover.

As if to demonstrate that Passover dietary restrictions are no impediment to innovation and variety, the kosher food industry has developed an astonishing array of Passover products. The historian Jenna Weissman Joselit, in "The Call of the Matzoh," notes that by 1900 Bloomingdales and Macy's featured Passover groceries, wine, and other holiday necessities (Joselit, 1994, p. 221). The most widely observed of the Jewish holidays, Passover occupies only 3 percent of the calendar, but generally accounts for 40 (and in some areas up to 60) percent of kosher food sales in the United States annually. This makes kosher for Passover products an estimated $2 billion industry. According to *Kosher Today*, a trade publication of the kosher food industry, more than six hundred new Passover products were introduced in 2001 alone, which gave consumers up to four thousand items from which to choose. However, in a world where almost everything is becoming kosher for Passover, from pizza to noodles, Passover may lose some of its culinary distinctiveness.

Public Seder

Whereas the seder is traditionally a family event, public and organizational seders arose even before the twentieth century in Europe, the United States, and elsewhere to meet the needs of Jewish soldiers away from home (for example, during the American Civil War and today in Israel); Jews confined in hospitals, nursing homes, and prisons; and the destitute. During the twentieth-century, the kibbutz, a collective agricultural settlement in Palestine and then in Israel, created its own Haggadahs and seders, consistent with the socialist and even atheistic tendencies of its founders and the practice of eating together in large public dining halls. During the Holocaust, Jews in Bergen-Belsen, separated from their families, organized to observe the holiday as best they could. Unable to obtain matzo, they determined that *hametz* was permitted and created a special prayer to say over it.

Even before World War I, seaside resorts in the United States attracted Jewish visitors who preferred to avoid the elaborate preparations for Passover and observe the holiday away from home. According to *Kosher Today*, over seventy-five thousand people participated in Passover programs in hotels during 2000 in the United States, and the Passover getaway business, which has grown in size and variety, hoped to fill thirty thousand rooms in 2002. In Israel, many orthodox families spend all eight days of the holiday at a hotel or kibbutz pension to avoid the considerable effort of preparing for Passover. Communal seders are also held in Europe. The first communal seder in Beijing took place in 1998. Caterers organize seders in banquet halls, and restaurants offer seders, in part as a response to the dispersal of families. Wolfgang Puck, at the prompting of his Jewish wife, began to host Passover seders at Spago, his Los Angeles restaurant, in 1985. The menu features such delicacies as roasted white Alaskan salmon (Panitz, 1999). Peter Hoffman, who has been hosting seders at his Mediterranean-style restaurant Savoy since 1994, created a seder inspired by Marrano traditions. Other restaurants may simply include matzo on the menu.

Third Seder

Whereas only one seder is required in Israel (and among some Reform Jews) and two seders in the Diaspora, a Lubavitcher tradition holds that the Baal Shem Tov, the eighteenth-century founder of Hasidism, a pietist movement, instituted a Messiah's Feast, mirroring the seder with matzo and wine, on the afternoon of the eighth day of Passover. During the 1920s, Zionist groups and members of the Jewish Labor movement organized third seders, although radical secular Haggadahs, which stressed human agency over divine intervention, were printed as early as the 1880s. In 2002 the Workmen's Circle, which is associated with the Jewish Labor movement, celebrated fifty years of its annual Third Seder, recently renamed A Cultural Seder. Their special Yiddish Haggadah, which makes no mention of God, focuses on liberation struggles and Yiddish cultural achievements. In the late twentieth century, they incorporated elements of the traditional seder for those who only observe this one seder. Other groups, prompted by such crises as Israeli soldiers missing in action and AIDS, also have created a third seder.

The Christian Seder

There is disagreement as to whether the Last Supper took place during the evening of the fourteenth of Nissan, after the Paschal sacrifice, in the form of a Passover meal (synoptic Gospels), or on the afternoon of the preceding day as an ordinary meal (Gospel of John). Consistent with the former, some Christians reenact the Last Supper as a seder, usually on Holy Thursday, based on practices thought to have been followed at the time of Christ. The Christian seder typically includes lamb, unleavened bread, bitter herbs, *haroset*, *karpas* (raw vegetables), and wine; washing of hands and feet; reclining at the table; recitation of appropriate blessings and passages from Exodus, and singing of Psalms. As Gillian Feeley-Harnik explains in *The Lord's Table: Eucharist and Passover in Early Christianity* (1981), the Last Supper, as a sacrificial meal, "most closely resembles the passover, but every critical element in the passover is reversed: the time, the place, the community, the sacrifice, and ultimately the significance of the meal" (Feeley-Harnik, 1981, p. 19).

Mimouna

In some communities, a special meal ushers out the holiday or otherwise marks the return to everyday life. Moroccan Jews celebrate the Mimouna after sundown on the last day of Passover and on the following day with a great variety of post-Passover foods, music, and dance. The earliest record of the holiday dates from the eighteenth century. While the etymology of Mimouna remains unclear, some find a connection with *maimouna* (Arabic, meaning 'wealth', 'good fortune'), *emunah* (Hebrew, meaning 'faith'), and *mammon* (Hebrew-Aramaic, meaning 'riches', 'prosperity'). Some link the timing of the Mimouna with the anniversary of the death of the revered Rabbi Maimon, father of Moses Maimonides, who moved from Cordoba to Fez in 1159/1160. Moroccan Jews believe the holiday originated in Fez.

The evening holiday is traditionally celebrated at home, with doors open to relatives and friends. Ears of wheat and flowers are placed on the table and around the room. A lavish table is set with a white cloth, and depending on the community, symbolic foods may include flour, yeast, wine, five coins, five beans, five dates, five eggs, sweets, nuts, fruits, milk, buttermilk, butter, a live fish, and *mofleta*, the first leavened food eaten after Passover. Mofleta is a yeast-risen pancake fried in a skillet, spread with butter and honey, and rolled. In Morocco, where Jews "sold" their *hametz* to their Muslim neighbors before Passover, the Muslims brought the wheat, flowers, dairy products, and other foods to the Jews during the afternoon of the last day of Passover. After Passover, Muslims returned the *hametz* and were rewarded, in addition to receiving a piece a matzo, believed to bring good fortune. The day following Passover is a time for family excursions and picnics. During the Mimouna, a time of courtship, young people dressed in their finery, and betrothed couples exchanged gifts. With the immigration of North African Jews to Israel, other Maghrebi and Levantine Jews also celebrate the Mimouna, which has become a large public event.

See also **Bible, Food in the**; **Christianity**; **Fasting and Abstinence**; **Feasts, Festivals, and Fasts**; **Islam**; **Judaism**; **Last Supper**; **Middle East**; **Religion and Food**; **United States: Ethnic Cuisines**.

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PASTA. Ground grain of the wheat plant (genus *Triticum;* family *Gramineae* or grass), native to Eurasia, forms the fundamental component of commercial "pasta," the generic term for what the U.S. Federal Standards of Identity call "macaroni products." Italian commercial dried pasta combines durum wheat (*Triticum durum*, hard wheat, or semolina, its coarsely ground endosperm) and water into a large number of shapes and sizes. Soft or common wheat (*Triticum vulgare*) is used for homemade or "fresh" pasta (which often contains egg, and sometimes oil and salt), as well as for bread and pastries. These are the two most important wheat grains in the Mediterranean diet.

Pasta is a versatile, nutritious, economical, thus democratic, and increasingly international food. In past times, it was fried and sweetened with honey, or tossed with *garum* (fish paste) by the ancient Romans. Or it might have been boiled, or baked in rich pies, called *timballi*, that defied Renaissance sumptuary laws. Today, pasta is usually boiled to a slightly chewy, resistant consistency (*al dente*), and dressed with a variety of sauces, eaten in soup, or baked. The oldest, most traditional Italian condiment from the thirteenth to the nineteenth centuries consisted of butter and cheese (and sugar, cinnamon, and other spices); pasta was also boiled in meat broths. Only since the 1830s was it combined with the now familiar tomato sauce. In the course of its history, pasta has been both a luxury, and only recently (in the nineteenth century), a popular food.

As late as the 1960s, the people of northern Italy normally ate risotto, polenta, and egg pasta—just as, in terms of fats, butter versus oil divided the cooler North from the warm South. The leveling of traditional foodways has made pasta a truly national food. However, this Italian first course (*primo*) has been adapted to main dish, side dish, salad, and even dessert in its diverse cultural naturalizations.

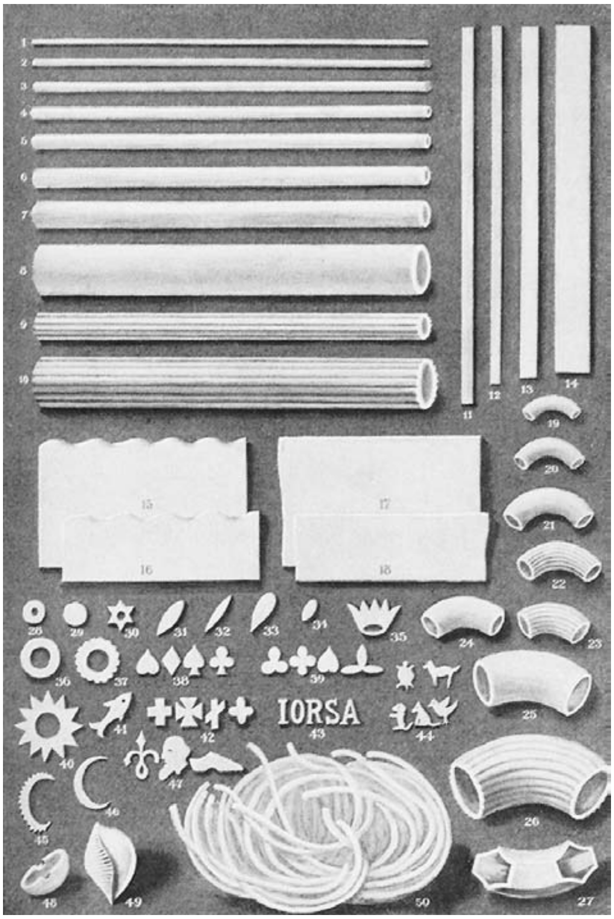
History: Dough Versus Pasta

It is vital to distinguish between two classes of pasta in order to make sense of its history. The most ancient form of pasta is flattened dough (Italian *sfoglia*) from which many fresh pasta forms (with and without egg) have evolved. Cereal-derived foods, based on whole, crushed, or finely ground grains, have been common to the Mediterranean for several millennia, taking the primitive form of mush (for example, Roman *puls*). Dough might be kneaded and shaped, and then fried, roasted, baked, or boiled. When it was flattened into a thin sheet and cut into strips, then boiled, a proto-pasta was created. This final step in the process appears to have created the archetypical category known today as "pasta."

Because a flour dough base is common to both pasta and bread, the histories of these foods have been merged and blurred. Although pasta may seem a simpler food, bread has held a more central place in the Mediterranean and Italian diet and worldview. Were historians to agree upon a common categorization of pasta, based on ingredients and cooking method (boiling in liquid), it might facilitate a clearer distinction between pasta and other forms of dough-based foods.

Terminology

Dough for boiling evolved into a variety of shapes. The original form appears to have been string-shaped, thread-shaped, worm-shaped, or ribbon-shaped—that is, long and thin, flat or round, as the earliest terms attest. For example, Latin *lásanum* (earthenware pot, from Greek *lásanon*, three-footed pot) blended with *láganum* (a long strip of thin, rolled dough), whence *lasagne*, a plural form in standard Italian. Still today, in Neapolitan or Calabrian dialect, a rolling pin is known as a *laganatura*. Other terms include Latin *tracta* (a long piece of dough, literally, 'drawn out'), Arabic *itrija* (string-shaped dough, whence southern Italian *trii* or *tria*, and Spanish *aletria*), Italian *vermicelli*, and later, *spaghetti*, *tagliatelle*, and *fettuccine.* Other early forms of pasta were created from small bits of rolled dough (Latin *lixulae*, Italian *gnocco* 'knuckle') or stuffed dough (*ravioli*). Standard Italian *maccherone* and dialectal Italian *maccarone* (source of English "macaroni"), an early synonym of *gnocco*, is said to derive from the Indo-European verbal root *mak-* ('to knead with force', whence Italian *ammaccare* 'to crush', e.g., *macco* fava bean purée); if so, it testifies to the force required to knead and shape durum wheat dough.



An American pasta advertisement from the early 1920s showing all the shapes of pasta and macaroni available at that time. ROUGHWOOD COLLECTION.

But even the earliest Italian terms for pasta present wide regional variation. Indeed, Italian pasta history has been vexed, enlivened, and bedeviled by profound lexical specificity. One outwardly identical term may designate different things, historically and geographically. For instance, *maccarone*, from its first citation in the twelfth century, has referred to short dry pasta (twelfth century and twentieth century), long dry pasta (southern Italy, eighteenth through the twentieth centuries), long fresh pasta (regional Italian), *gnocchi* (fourteenth through the seventeenth centuries), and even ravioli. And it is not clear whether *lasagne* (*lágana*), widely used by the thirteenth century, were not more like fritters (compare today's Carnival sweets, *cenci*, *bugie*, *chiacchiere*) than boiled dough.

Pasta means 'paste, dough, batter' in Italian. An earlier, now obsolete, term was "alimentary paste," a loan translation from Italian *pasta alimentare*. Today, a lexical shift makes "pasta" the generic term for which all others stand as subsets, and "macaroni" (Italian *maccarone/*

maccheroni) now refers to hollow, short dry pasta, with a few exceptions surviving as regional homemade specialties in southern Italy.

Origins: East or West

Spontaneously invented forms of pasta existed simultaneously in various parts of the world—East and West—a clear case of polygenesis. Even a cursory look at this basic starch in the food systems of China and Italy, for instance, makes this parallel development obvious. While certain similarities may be surprising (noodles = *tagliatelle*; wonton = ravioli), the differences are no less so. Pasta is eaten by a variety of peoples but in significantly different ways.

The innovative leap—and the part of pasta's history that is more closely associated with Italy—is the revolution that *dry* pasta entailed, in conservation, economy, and diffusion. This process was established by the twelfth century in the Sicilian-Arab world. Thus, only in Italy (and a few parts of Asia) did pasta become so central to diet and cuisine, and such a diversified food. Further, Italy must be credited with pasta's global diffusion.

Historical landmark versus legend. A few landmarks mark fixed points in an otherwise fluctuating ocean of pasta history. Alongside such documentation, however, exists a substantial body of pasta mythology, the most notable involving the vexed question of Marco Polo's supposed introduction of Chinese noodles to Italy, likely attributable not to the *Milione* itself (which, however, mentions noodles made from the sago palm tree, enjoyed by Polo in Fanfur, likely Sumatra), but to the October 1929 issue of *The Macaroni Journal* (of the American Association of Pasta Makers), featuring "The Saga of Catay." This legend tells of the encounter of a sailor named "Spaghetti" with a Chinese maiden preparing a strange dish of boiled strands of dough, and of how he divulges this secret to the West. The story evidently sought to create a plausible link between the presence of noodles in China's more ancient civilization (documented during the Shang dynasty, 1700–1100 B.C.E.), and the predominantly Italian identity of pasta in the modern world.

Polygenesis is not a concept that is easily grasped or generally appealing. Italians had been making, consuming, even exporting pasta before Polo's return in 1292, as the earliest document, a Genovese testament predating Polo's return by at least twelve years, clearly attests. Internal evidence further suggests that Polo considered the sago variety a type of pasta, which presupposes the existence of, and familiarity with, pasta as a food. Other data confirms the parallel development of this food in the West.

Etruscan and Roman. The Etruscan tomb "La Tomba dei Rilievi," in Cerveteri, fourth century B.C.E., provides iconographic evidence: a woman in the act of rolling out dough, accompanied by familiar implements (for example, rolling pin, sack of flour, water container, knife), although it is not clear how the flattened dough might have been prepared. Horace (*Satires* VI, book l) mentions the comfort of his simple dish of chickpeas, leeks, and *lágana*, whence Salentine *ciceri e tria*, still eaten today; Cicero also speaks of these long strips of thin, rolled dough made with water and flour. Apicius, in *De re coquinaria* (book IV, chapter 2), describes *lágana* fried in oil and tossed with pepper and (that all-purpose Roman condiment) *garum*—a dish of which Petronius's character, parvenu host Trimalchio (in the *Satyricon*), was particularly fond—and *tractae* (evidently dried durum pasta) for thickening broth. He also elaborates on a rich, layered *lágana* dish involving meats, fish, sauce, and spices.

Sicilian-Arab geographer. The first clear Italian reference to dried—hence preservable—pasta, and to a pasta industry, comes from Arab Sicily. In 1138, a Moroccan geographer, Abu Abdullah Muhemmed ibn Idris (known as Idrisi in Sicilian), was commissioned by Roger II, the Norman king of Sicily, to survey his kingdom. In his 1154 codex, he describes the vast fields, many mills, and farms at Tràbia (30 kilometers from Palermo), where a string-like pasta (referred to by its Arabic name, *itrija*) was produced and exported in "shiploads" to Calabria, and to other parts of the Muslim and Christian worlds. The pasta was evidently dry, and a large-scale operation is being described. Although no generic term, hence no notion of pasta, existed in Arab gastronomy at this time, Arabs knew of this dried convenience food—particularly useful for long caravan rides, and later to seafaring Genovese and Sicilian sailors. Beginning in the twelfth century, in fact, Genovese merchants became agents of Sicilian pasta's northward diffusion. By the fourteenth century, they began producing and selling *vermicelli* and other pasta "di Genova"—so that Genoa became, after Sicily, one of the earliest production centers in Italy.

***Genovese barrel of* maccheroni.** In the bequest of a soldier, Ponzio Bastone, written by notary Ugolino Scarpa (2 February 1279), a *bariscella plena de macaronis*, a small barrel of dried pasta, is listed. This earliest attestation of the term *macaroni* is important for three reasons: it suggests the value of the food product (for example, worthy of being listed in a will); that it was indeed dry pasta (for example, conserved in a barrel); and that it was, by this date, known as a generic term (as pasta is today).

***Gastronomic utopias:* Cuccagna.** In the mythic land of plenty, known to the Italians as *il paese di Cuccagna*, and in medieval Europe as Cockaigne, there was a very peculiar mountain.The Italian version of the myth was first described by Boccaccio (*Decameron*, VIII, 3, Calandrino, a fool's tale). In this gastronomic utopia, which he calls Bengodi, a cauldron sits on top of a Parmigiano-cheese mountain and continuously spews forth *maccheroni* and ravioli that roll down the mountain's side, land in a rich capon broth, and are free for the taking by the poltroons. Such macaroni, however, were evidently synonymous with *gnocchi*, chestnut-sized or larger balls of flour dough (not potato), often pictured as served on a skewer. This shape accounts for the ease with which they could roll down the *Cuccagna* mountain.

The Maccheronic Muse

Since pasta has inspired myth, legend, literature, art, film, and graphic design, its history ought take into account historical data as much as its presence in cultural history, for it has a long oral as well as written tradition. Its creation myths have involved the noblest of gods in the Roman pantheon, emperors, and magicians; pasta miracles have promoted worthy candidates to sainthood (for example, St. William the Hermit turned dirt-filled ravioli into a delicious dish); folk narratives often feature magic (pasta) pots; traveler's tales tell of marvelous and strange pasta dishes (for example, Marco Polo); and street theater masks—and actual Neapolitans—have made a public spectacle of pasta. The maccheronic muse has also inspired carnivalesque literature, theater, song, odes, proverbs, and more.

Pasta gave its name to a linguistic/literary phenomenon known as Maccheronic poetry, peaking in the fifteenth century. It was a pastiche of Latin and vernacular Italian, frequently producing a comic effect by borrowing a vernacular term that reflected the rustics, who, in turn, were referred to by the gross and simple food they ate, *maccherone* or *gnocco* (noodle-head), and who spoke no Latin, the language of culture. The most notable example of this tradition is the Maccheronic poet, Teofilo Folengo (alias Merlin Cocai), author of the mock-heroic epic *Baldus*, in which pasta-maker muses reside on Mount Cockaigne, and whose genius is attributed to the consumption of *maccheroni* and *lasagne*.

Eighteenth-Century Naples as Pasta Capital

Naples began to import pasta from Sicily at the end of the fifteenth century, but it was not until the eighteenth century that Neapolitans earned the title of *mangiamaccheroni* (macaroni-eaters)—a title earlier borne by Sicilians. Naples became the emblematic capital of pasta, and the city's representative was the *commedia dell'arte* character, half-starved Pulcinella, who on stage was always eating or talking about macaroni. By 1785 there were 280 pasta shops in Naples. Pasta became a street food and its most devoted consumers were street people—*lazzaroni*—as seen in myriad popular prints of the time, where they are characteristically portrayed holding the long strands, dressed with Romano cheese, with their fingers, and at arms length sliding them, often unchewed, down the gullet. Indeed, so unique was this spectacle that it became a must-see tourist attraction, and gentlemen on the grand tour often ordered up a plate of pasta for a *lazzarone*, just to see it performed.

Immigrants and Pasta

Neapolitans and other southern Italians were critical to pasta's diffusion throughout the world. For it was as much immigration—and the majority of immigrants were, in fact, Neapolitan and southern—as technological advances and transatlantic trade, that brought pasta to the world's attention. Along with the wave of late-nineteenth-century immigrants came shiploads of spaghetti in blue wrap (for example, Napoli Bella and Vesuvio brands), olive oil, and condensed tomato paste. Americans first considered these inedible foreign foods and tried to reform the newcomers' diet, but spaghetti won out and eventually became American, not merely ethnic, fare. Italian immigrants were to introduce many other cultures to pasta wherever they settled.

Although Thomas Jefferson, much interested in macaroni and pasta technology, brought cases of the foodstuff to America in 1786 (and later had a pasta machine shipped to him from Campania), it was not until 1848 that it began to be produced commercially in America. The World War I years and the interruption of pasta imports from overseas gave rise to an expanded pasta industry in the United States, as many Italian-American pasta importers became manufacturers, through small family operations, many of which still exist. Prohibition may have given pasta a boost as well, since it seemed a logical accompaniment to speakeasy wine. In the expanding pasta industry of the 1930s, pasta ceased to be merely Italian and became an American food.

Pasta as Emblem

Ethnic stereotyping frequently makes reference to food. Italians have long been associated with pasta, and Italians from different regions represent themselves by the type of pasta they eat. In England, from approximately 1750 to 1850, a "macaroni" referred to a foppish Englishman, a dandy, who affected foreign (Italian) style by overdressing, wearing a preposterous wig, and perhaps eating foreign foods (for example, *Yankee Doodle Dandy* who "stuck a feather in his hat and called it macaroni" and the London gentlemen's club, The Macaroni Club). On the negative side, a cultured Italian might have referred to a simpleton or country bumpkin as a *gnocco*, *maccarone*, or *spaghetto*. Sicilians—later Neapolitans—were derogatorily labeled *mangiamaccheroni* (macaroni-eaters) by Italians farther north. Americans have referred to Italians as "Spaghetti Benders." And Marinetti's Futurist Manifesto did not help matters when it declared war on traditional foods, especially pasta, a food which, the avant-garde insisted, promoted moral and physical laxity. The ideal, evidently, was the Germanic meat-eater, a virile warrior race. Italians ignored the Futurists' cultural violence. Instead, Mussolini waged a battle on wheat (*battaglia del grano*) in an attempt to make Italy wheat-sufficient. The vastly increased wheat acreage had the effect of shifting the epicenter of production northward (pasta producers included Agnesi in Oneglia, Buitoni in San Sepolcro, Barilla in Parma), thereby ending the dominance of Naples by the 1940s.

Many legendary Italian pasta-eaters have helped raise the image of this food: Rossini, Caruso, Sophia Loren. Pasta iconography, old and new, traces its presence in cultural history, from early popular prints of *Cuccagna* or of Neapolitan pasta-eaters, to pasta advertisements, packaging, and film (for example, Charlie Chaplin in *City Lights*, Disney's *The Lady and the Tramp*, and in Italy, Totò, Sophia Loren)—all of which molded pasta's image for millions.

Commercial Pasta: From Artisan Guilds to Multinationals

From the fourteenth to the sixteenth centuries, pasta became well established all over Italy. Pasta makers became so numerous that they formed corporations and guilds, largely to protect their interests against competing guilds (for example, bakers). These guilds were in Florence (*lasagnari*), 1337; Genoa, 1574; Savona (*fidelari*), 1577; Naples (*vermicellari*, *pastai*), 1579; Palermo, 1665; Rome, 1642.

It is in the passage to dried pasta that the quantum historic leap is achieved and pasta commerce begins, the earliest record of which goes back to medieval Arabs and Sicilians. In more recent times, increasingly efficient technology relating to the basic phases in pasta production—kneading, pressing, extruding, cutting, and drying—together with improved distribution networks and power sources (electricity), have led to an enormous increase in production and consumption. Indeed, by the mid-twentieth century, commercial pasta had truly become a universal food for all classes.

Large-scale pasta production first flourished in coastal areas (Palermo, Genoa, later Naples) where plenty of sun, and alternating warm and cool sea breezes allowed for outdoor drying—the most critical part of the process—and also made shipping easy. Like laundry, spaghetti was hung to dry on outdoor lines and became part of the Neapolitan folkloric milieu. Pasta brands from Gragnano and Torre Annunziata, where warm Vesuvian air and cool sea breezes created perfect drying conditions, became renowned. Once artificial drying technology was devised, however, manufacturing was freed from such climatic considerations.

Other technological milestones included mechanical kneaders, continuous feed presses, even refinements of the fork. Cesare Spadaccini of Naples invented the first mechanical kneader to replace feet (although this was not developed), as well as a four-prong shortened fork to make spaghetti twirling easier and its consumption possible at the Neapolitan court of Ferdinand II (circa 1840). But it was a spate of mostly nineteenth-century inventions that revolutionized the industry: for example, Féreol Sandragné's prototype of the "continuous" feed machine, and the "Marsigliese," a mechanical sieve that could sort crushed grain.

Early artisans' guilds and small family-run businesses have largely given way to multinational giants who count pasta manufacturing among their diversified holdings and enjoy large market shares of a lucrative, expanding global market. Some of these companies are the following: Borden (largest pasta producer in the United States, sole U.S. distributor for De Cecco since 1988, and head of an empire of small, regional companies); Philip Morris (parent company of General Foods, acquired Kraft in 1988); Nestlé (acquired Buitoni in 1988); Hershey's; Campbell's; and Lipton.

Wheat

Sicily and southern Italy—ancient Rome's, then Italy's, breadbasket—was an early source of durum wheat for Italian pasta, which, since 1967, has been the only legally mandated grain allowed for this food. While Italians came to produce and consume the world's largest quantities of pasta outside Asia (over fifty pounds per capita in 1988), Italy's capacity to produce wheat was easily overwhelmed. In the nineteenth century, other sources were added. Genovese merchants imported the best Kubanka wheat (up to 19 percent protein), grown in the fertile black earth of Taganrog, Crimea, on the Black Sea. But famines, revolution, and genocide had destroyed this mythic Russian wheat by the 1920s and 1930s, apparently forever. North American wheat from Manitoba and North Dakota filled the vacuum. American durum wheat production—which, in turn, boosted the American pasta industry—was largely due to the efforts of one man. Mark Carleton, an agronomist for the U.S. Department of Agriculture and an expert in plant pathology, went to Russia in 1898 looking for rust-resistant wheat and, upon returning, converted farmers, milling companies, chemists, and hotel and restaurant cooks to accept durum wheat.

Pasta Typology: Cutting the Linguistic Dough

Estimates of the number of pasta shapes range from 600 to 1000. Pasta atlases are only recently beginning to appear. The sheer volume of regional, traditional, and also industrial and historical types—although only a fraction of them remain in common use—makes this task a daunting one. Some of the earliest terms refer to length and thinness, for example: Arabic *itrija* and *sev* or *seviyan* (from Hindi *sevika* 'thread'), Italian *vermicelli* ('small worms', originally, finger-length), and later, Italian *spaghetti* (from *spago* 'string'). Other terms refer to the dough and to shaping techniques that involve cutting (Italian *tagliatelle*, from *tagliare* 'to cut'), rolling, or stamping. Greatest variation occurs in commercial, not homemade pasta, for the obvious reason that industrial dies have made such innovations possible.

A raviolo by other names. The language of pasta (as of music) is Italian. Much of its rich lexicon is attributable to the richness of the Italian language itself. There are suffixes, given in their plural forms here, that can reduce its dimensions (*-elli*, *-etti*, *-ini*, *-otti*, as in *ravioli/ravioletti* and *tortelli/tortellini*), or increase its dimensions (*-oni*, as in *ravioloni*, *tortelloni*), or subtly grade it by increasing width (*tagliolini* > *fettuccine* > *tagliatelle* > *pappardelle* > *lasagne*). There is also rich regional variation. For example, the case for filled pasta (of which Emilia-Romagna is the heartland) is known as *casoncelli* (*cansonsei*) in Bergamo, *tortelli* in Emilia-Romagna, *agnolotti* in Piedmont, *pansoti* in Liguria, *cappelletti* or *ravioli* in central Italy. As for the most common homemade ribbon-shaped egg pasta, *tagliatelle* are also known (with slight variation in size) as *fettuccine*, *lasagnette*, *trenette*.

Still today, a marked distinction exists between egg-based fresh pasta, a special, often festive food, and dried commercial pasta, daily fare. But Italians also divide pasta as follows: pasta in clear broth (*pastina in brodo*); pasta in heartier vegetable soup (*minestra*, whence *minestrone*); dried pasta drained and served with a sauce (*pasta asciutta*); and baked pasta (*pasta al forno*: for example, *lasagne*, *timballo*, *pasticcio*).

Pasta typologies might further be ordered according to varying criteria: method or place of preparation (home, restaurant, factory); grain type (soft, durum, whole, alternative); calendrical occurrences (festive versus penitent pasta, for example, with and without meat sauce or eggs); Italian versus non-Italian or emigrant pasta (for example, Italian-American spaghetti and meatballs); and finally, pasta morphology. Pasta can even be classified according to consumer profile, age, cultural background, and health concerns. For instance, adult pasta differs from children's varieties: there is Italian nursery food, *pastina in brodo* (tiny pasta in clear broth); American macaroni and cheese and canned dinosaur or alphabet pasta; and pasta on toast for the British. Special pastas have been developed for the wheat intolerant; and gourmet pastas are aimed at the high-end market. Homemade pasta can be further classified according to the instrument used: rolling pin versus pasta maker or small press (for example, a *torchietto* for extruding *bigoli* in the Veneto); a "comb" or *pettine* (for example, for *garganelli* in Romagna); a zither-like instrument, known as a *chitarra* (guitar), over which thin dough is stretched and rolled to produce thin strands (for example, for *tonnarelli*, resembling square spaghetti, in the Abruzzo); a long metal rod or *ferro* (for long *maccheroni* in Calabria, Puglia, Sicily).

Then there is morphology—long versus short, smooth versus ribbed, hollow versus filled, straight versus fluted. The myriad shapes draw on many semantic areas—human, natural, and even divine. There are helixes, tubes, shells, pearls, nests, worms, butterflies, snails, birds, stars, moons, waves, threads, ribbons, bowties, even "priest-stranglers" (*strozza-* or *strangolapreti*). Paternosters and avemarias (resembling rosary beads), and other shapes inspired by politics (*garibaldini*, *mafalde*, *tripoline*, *assabesi*, *abissini*), are no longer made. But innovation continues, even though some shapes prove to be mere fads (for example, radiators, UFOs).

Matching pasta to sauce, determining pasta to sauce ratio, and knowing the correct cooking time are subtle areas of pasta connoisseurship, traditional for Italians but learned by others (although traditional canons are shifting even in Italy). In a fifteenth-century cookbook, *De honesta voluptate ac valetudine* (Of honest pleasure and well-being), Bartolomeo Sacchi (pseudonym Plàtina) cautioned that pasta should be cooked "for as long as it takes to say three paternosters"—a short amount of time, even for fresh pasta.

Trends

Pasta trends take place within wider social and nutritional contexts. There has been a move toward whole foods and alternative grains such as corn, buckwheat, and spelt. Innovative ingredients—some restaurant-driven—include colored pasta (tomato, herb, beet, mushroom, shrimp, even chocolate) and novelty-stuffed pasta (seafood, artichoke, dried tomato). There has also been a trend toward fusion cuisines, for example, blending East and West. New health guidelines advise lower fat, higher fiber, increased vegetarianism, less processing. The American trend toward greater convenience favors ready-cooked, frozen, microwaveable, and cold-serve pastas, although the Slow Food movement is beginning to counter this trend in the new millennium. Americans are becoming more sophisticated in regard to better quality products, taste, nutritional value, authenticity, seasonality, and the artisan tradition.

Nutritional Value: Fat or Skinny?

Pasta's fortunes have fluctuated over its long history: it has been considered both a luxury food (in the sixteenth century, Neapolitan authorities prohibited its consumption in times of famine or scarcity of wheat) and a vernacular staple. Commonly perceived as a poor man's food at the beginning of the twentieth century, pasta began, with the support of nutritionists extolling the virtues of the Mediterranean diet in the 1970s, to experience a rehabilitation. New nutrition guidelines (and the food chart reformulated in the 1990s) recommend less protein, less saturated animal fat, more fiber, and more complex carbohydrates. Pasta, therefore, is now recognized to be a healthy food. It is also a highly versatile, immediately satisfying food, recommended for athletes ("carbo-loading" sustains energy before strenuous sports) and even for refined palates.

Vegetables, lean meats, or fish, combined with good quality (even enriched or whole wheat) pasta, makes an excellent, balanced meal. Components of pasta include moisture (water), energy, protein, fat, carbohydrates, and ash. According to the U.S. Department of Agriculture bulletin (1981), nutrient values for one cup of spaghetti (two ounces uncooked) are approximately seven to fourteen grams of protein, thirty-nine grams of carbohydrates, and when enriched, it provides calcium, phosphorus, iron, potassium, thiamin, riboflavin, and niacin.

The caloric value of one cup of cooked pasta is approximately 190 calories (if *al dente*) and 155 (if tender).

See also **China**; **Italy**; **Noodle in Asia; Noodle in Northern Europe; Wheat**.

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Luisa Del Giudice

PASTEUR, LOUIS. Coupling true scientific genius with a talent for dramatic self-promotion, Louis Pasteur (1822–1895) rose from humble beginnings as the son of a tanner in a small French village to international fame before his death.

Pasteur was trained as a chemist, and his earliest work on the crystals of tartaric acid, a naturally occurring by-product of wine production, caught the attention of several established chemists, who promoted his career and helped him secure an appointment as professor of chemistry at the University of Strasbourg.

Arriving in Strasbourg in January of 1849, he met Marie Laurent, daughter of the university's rector. With characteristic decisiveness, Pasteur proposed marriage within a few weeks, and in May of that year he and Marie were married. He chose well: For the rest of his life, Marie Pasteur supported and assisted him in his work; often they spent their evenings together, with Pasteur dictating notes or letters to his wife.

The Pasteurs moved in 1854 to the university at Lille, a thriving industrial area of France. Pasteur encouraged the practical application of science to the industries around him. His efforts on behalf of a local manufacturer who made alcohol from sugar beets were his first serious study of fermentation.

Moving on to Paris, he assumed positions at his old college, the Ecole Normale Supérieure, and later at the Sorbonne as well. He was not provided with a research laboratory, so he set one up at his own expense in a cramped unused space. This included a compartment under the stairs so small that he had to crawl in on his hands and knees to check his cultures.

In 1863, Emperor Napoleon III asked Pasteur to assist France in combating various "diseases" of wine that often caused exported French wine to go bad before it reached its destination. Pasteur believed that the yeasts observed in wine were the cause of fermentation, a fact that was not understood by much of the scientific community. These living yeasts appeared so mysteriously that many chemists believed they were generated spontaneously. Pasteur devised ingenious experiments to demonstrate that the yeasts came from the atmosphere. His belief in germs as causative agents that could infect a new medium on contact was sustained in his later work with animal and human diseases.

Pasteur also observed that other microbes besides the wine yeasts were present whenever the wines soured. In fact, he and his assistants soon learned to predict the taste of a wine according to which microbes they spotted in it with their microscopes. Pasteur urged the winemakers to provide conditions conducive to the growth of wine yeast and not to that of other microbes. He suggested a prolonged gentle heating, which discouraged undesirable microbes without altering the taste of the wine. A jury of wine experts conducted a taste test at Pasteur's request to establish that the taste was unaffected by the heating. This technique, which is today regularly applied to all kinds of foodstuffs, especially milk, quickly came to be called "pasteurization." Pasteur took out a patent on this process, but he soon allowed it to pass into the public domain. Though less dramatic than his later work with diseases, pasteurization is perhaps Pasteur's greatest contribution to the safety of food throughout the world. Pasteur was not the first to preserve foods by heating and protecting them from contamination, but he extended the practice to a variety of foodstuffs and offered a theoretical basis for its success.

Pasteur also advised vinegar makers, as well as the French beer industry. He hoped to make French beer superior to German as a gesture of revenge for the Franco-Prussian War of 1870. He taught hygienic practices to France's silk industry and, less easily, to the medical profession. The germ theory was then successfully applied to the development of vaccines for anthrax and other animal diseases, and finally to prevent the development of the dread rabies in human beings.

Pasteur achieved all this by dint of persistent hard work. His was not a balanced life. His labors, his ambition, and his aggressiveness in promoting his theories and reputation may all have been culprits in his severe stroke at age forty-five, which paralyzed his left side and left him with a limp. However, he continued to work for another two decades before his increasingly frail health gradually slowed him down.

Despite stirring up a good deal of controversy, Pasteur was given many honors in his lifetime. He received scientific prizes and awards and was elected to the French Academy of Sciences, the Academy of Medicine, and finally the august Académie Française. In 1888, the private Pasteur Institute was established in Paris, funded by contributions large and small from all over the world. Pasteur's seventieth birthday was the occasion for a national jubilee, and at his death he was given a state funeral in Paris before his body was interred in a grand tomb at the Pasteur Institute.

Even before his death, Pasteur was regarded, especially in France, almost as a secular saint. His earliest biographies were hagiographic, in keeping with the preference of the late nineteenth and early twentieth centuries for heroes of mythic proportions. The current age, on the other hand, needs to debunk, demythologize, and deconstruct the legends of the past. Accordingly, a modern reassessment of Pasteur has been in progress since the late twentieth century, aided by material from Pasteur's private laboratory notebooks, which have been available to scholars only since 1971. In the end, when all the evidence is gathered and reconsidered, the popular view of him may be altered, but Pasteur will remain a human being whose unceasing effort, scientific imagination, and inspired intuition unquestionably improved the food we eat and the world we live in.

See also **Fermentation; France: Tradition and Change in French Cuisine; Microorganisms; Food Safety; Wine from Classical Times to the Nineteenth Century.**

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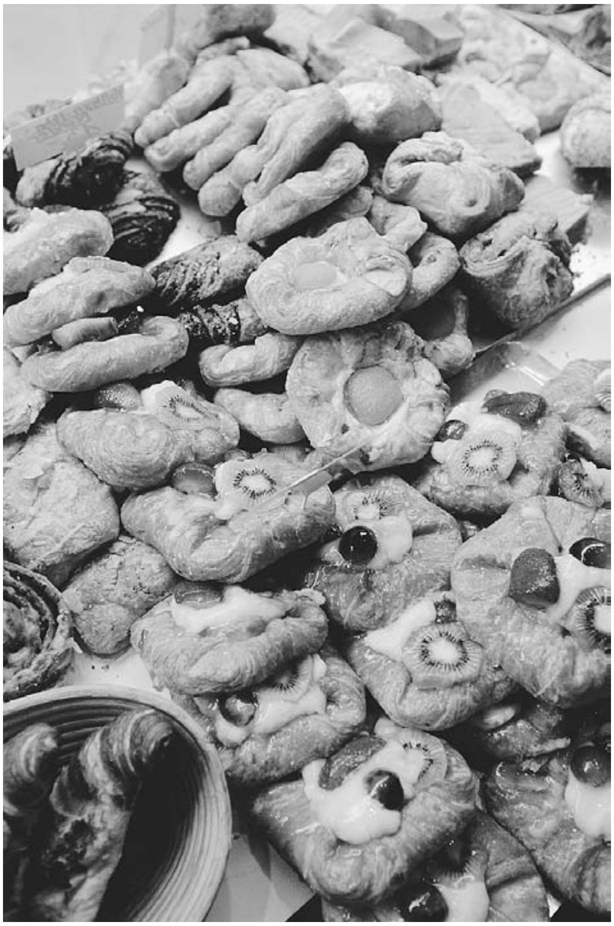
Alice Arndt

PASTRY.

Pastry is flour mixed with shortening and flavoring ingredients to produce a coherent mass, used for pies and other dishes in North American, European, and Middle Eastern cuisines. Basic additions are fat, a little salt, and water. Pastry-making, *pâtisserie* in French, has developed as a special branch of cookery. Specialized products of the pastry cook or pâtissier include delicate flour and sugar confections (cakes, cookies, waffles, meringues, frostings, glazes, and fillings) combined in small pastries for snacks, taken with tea or coffee or after meals. By extension, the word pastry is sometimes used collectively to indicate sweet, flour-based items for dessert.

Defining pastry types is difficult, as there are numerous variations. Three basic ones are short-crust or pie pastry, puff pastry, and flaky or rough puff. Short-crust pastry is one part fat (butter, lard, or commercial pastry fat) to two of flour by weight. The fat is cut or rubbed into the flour until the mixture resembles breadcrumbs, a little ice water is added, and the mass is pressed together with minimal working to make a dough. French *pâte brisée* is similar, but uses a little more fat and is mixed with egg. Variations include sweetened *pâte sucrée* and *pâte sablée* (very rich, similar to cookie dough). Short pastries are crumbly when cooked and used for many pies and tarts.

Puff pastry or *pâte feuilletée fine*, is an elaborate, layered pastry with a tender melting texture and excellent flavor. Equal proportions of butter to flour by weight are used. About a fifth of the butter is cut into the flour, and water is added to make a dough. This is allowed to rest in a cool place, and then rolled out; the remaining butter is then placed as a block in the center of the sheet of dough, which is folded over it. It is rerolled and folded in three, a process known as a "turn." Four turns are made with rests between, giving a dough with thin, even layers of fat between leaves of dough; air pockets also get trapped in the layers. Well-made puff pastry has up to 240 layers, and expands up to eight times its original thickness during baking. It is used for napoleons, cornets (cone-shaped pastries often filled with whipped cream or ice cream), and other fine pastries, sweet or savory, in the French tradition. Yeast-leavened doughs are turned with butter in the same way to make croissants and Danish pastries.



Vienna still reigns as the capital of fine pastries. These pastries, ornamented with strawberries and kiwi fruit, were displayed in the window of Janele's Bakery in Vienna, one of the well-known pastry shops in the city. © WOLFGANG KAEHLER/CORBIS.

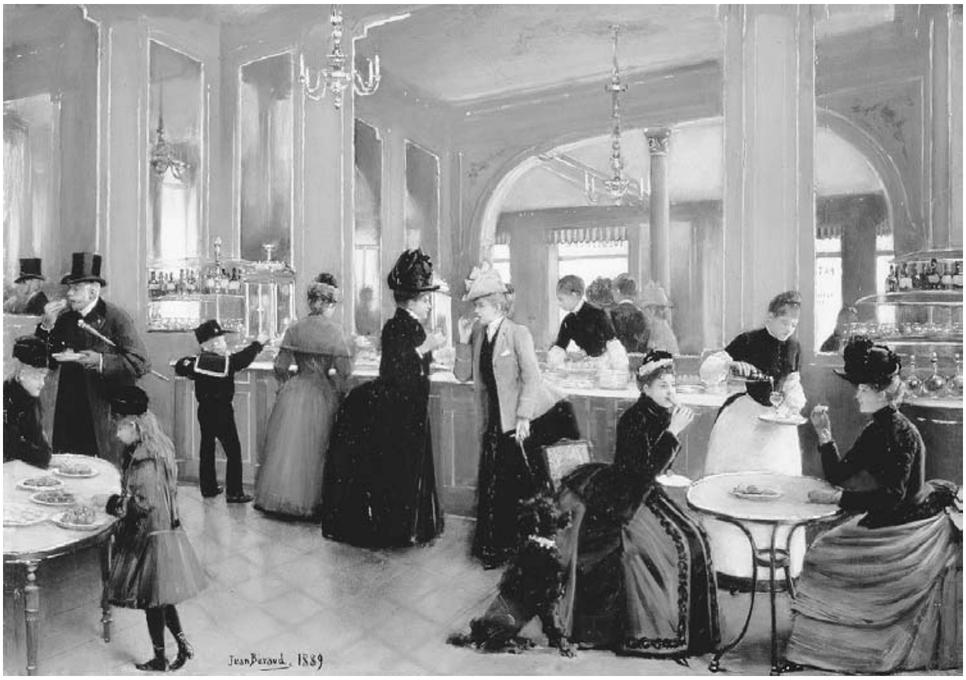
Flaky or rough puff pastries, French *demi-feuilletées*, are less well-defined. They usually have fat-to-flour ratios that are higher than that of short-crust but lower than that of puff pastry. They are made with the general method used for making puff pastry, but the butter may be spread over the dough in one batch or incorporated in three fractions, one each time the dough is turned. Quick versions are made by cutting the fat into pea-sized lumps, adding water to make a dough, and then giving it three or four turns. The dough has a light and layered effect but does not rise as high as puff pastry. It is also used in similar ways, especially with meat dishes such as beef Wellington.

Many other pastry recipes exist. *Choux* pastry uses a very different method. Water and butter are heated together; the result is mixed with flour, and eggs are beaten into the mass. The paste produced is soft and supple, and is piped to make cream puffs, chocolate éclairs, and other shapes, or flavored with cheese for the French *gougère*. English cookery includes hot-water crust: water and lard heated to the boiling point and mixed with flour, giving a malleable, strong paste that is raised while hot to make tall pies of pork or game; and suet crust, made of flour, beef suet, and water, and used for suet puddings and dumplings.

In Central Europe, the Middle East, and North Africa, strudel and phyllo pastries are made from a dough of flour, a little butter or oil, and water, which is worked to form an elastic mass that is stretched into a paper-thin sheet. When the pastry is ready for use in baking, its surface is brushed with melted butter. Strudel pastry is rolled around fillings such as apples or poppy seeds, while phyllo is often cut into sheets and stacked in layers with nuts to make sweet dishes, or with spinach and cheese for savory ones.

Indian cookery involves pastry made from flour with a little ghee (clarified butter) or oil. This is used to enclose savory fillings for *samosas* (turnovers), and is deep-fried, providing the crispness that baking gives to pastries from the European traditions. Some types are cooked alone and drenched in sugar syrup to give sweet pastries. Chinese cookery also includes a few plain short-crust–type pastry recipes, notably that used for moon cakes, filled pastries traditionally eaten to celebrate the Moon (or Mid-Autumn) Festival.

Protein content of the flour is important: too much, and the pastry is tough and shrinks; too little, and it is very mealy. A medium protein content is best. Development of gluten (the protein complex that gives texture to bread) is inhibited by cutting in the fat, a process which



The pastry shop became a social institution by the end of the nineteenth century. This painting of the Gloppe Pastry Shop by Jean Beraud in the Musée Carnavalet, Paris, provides a vignette of the dainty snacking once associated with these elegantly appointed establishments. © ARCHIVO ICONOGRAFICO, S. A./CORBIS.

coats the flour particles, preventing the water from reaching the proteins. In flaky and puff pastries, turning encourages limited gluten development in horizontal sheets for the characteristic texture.

Fat choice is also important. Butter gives a good flavor but produces a less short texture than lard, which gives a flaky texture. Lard has a coarse crystal structure that coats the flour particles more effectively and is one hundred percent fat, unlike butter, which contains a little water. Some cooks consider a mixture of lard and butter to give the best balance of flavor and texture. Margarine and specially tailored vegetable fats are often substituted on grounds of cost, nutrition, or ethics. Oils give very crumbly pastry. Keeping pastry cool during working is also important, otherwise the fat becomes oily and the texture suffers.

During baking, the water in pastry vaporizes and allows crisp flakes of dough to form. In puff pastry, water vapor and air trapped between the layers expand and force them apart, making the pastry rise; a similar effect produces the characteristically hollow texture of *choux* pastry.

The history of pastry has been little explored. Pastry of a sort was known to both Greek and Roman civilizations, but it was oil-based, and limited in its applications. Late medieval references to pastry do not make it clear what type is being referred to. In the seventeenth century, the work of La Varenne (originally published in 1651) and others shows that several types of pastry were recognized. Methods for puff pastry had developed, as had pastes rich with butter, cream, or eggs, used for little tarts and pies. These were intended to be eaten, unlike the coarse puff paste made for great pies, which was plain, made from brown rye flour with only a little fat. It protected game and meat fillings from intense heat during cooking, and acted as a container that excluded air and preserved the contents afterwards. By the nineteenth century, pastry making was a complex art, recorded by chefs such as Jules Gouffé who moved between the great houses of Europe, learning and codifying techniques from different places. Pastry had also developed as a traditional product in certain areas, such as Cornwall in England, where Cornish pasties, semicircular turnovers filled with meat and vegetables, had become a traditional food for miners.

The ingredients of pastry make it an energy-dense food, and the use of fats such as butter and lard gives it a high cholesterol content, but it is so important and convenient as an edible container that it seems likely to remain popular. Many types of sweet pastry that were developed were intended to be treats, not everyday food; it is only the abundant wheat and fat production of modern agriculture that has made them so accessible.

See also **Baking**; **Butter**; **Candy and Confections**; **Pasta; Pie**; **Wheat: Wheat as a Food**.

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Laura Mason

PEANUT BUTTER. Peanuts (*Arachis hypogaea*), also widely called "groundnuts," originated between southern Bolivia and northern Argentina. In pre-Columbian times, they were found throughout Brazil, Peru, Mexico, and the Caribbean. Early in the sixteenth century, European explorers transported them to Africa and Asia. From the beginning, peanuts were ground into paste and used as a flavoring in soups, stews, and other dishes.

Through the slave trade, peanuts were introduced into the British North American colonies. Slaves grew peanuts in their gardens and introduced them into mainstream cookery. Hand-ground peanuts appeared as an ingredient in American recipes by the 1830s.

John Harvey Kellogg

Ground peanuts were a minor product until popularized by John Harvey Kellogg, the vegetarian director of the Seventh-Day Adventist Sanitarium in Battle Creek, Michigan. In 1894 he created a process to make "nut butters," which were intended as a substitute for cow's butter and cream. Peanuts were the least expensive "nuts" available, and the product made from grinding them was promptly called peanut butter. It was served to members of America's elite who visited the sanitarium, and vegetarians began selling it in small batches. Kellogg's new culinary treat spread throughout the United States and, subsequently, the world. Kellogg decided not to patent the process for making peanut butter, but he did create the Sanitas Nut Food Company to sell his nut butters.

Peanut butter quickly became a fad among health food manufacturers in America. Vegetarians adopted it almost immediately, and recipes for making it appeared in vegetarian cookbooks beginning in 1899. Vegetarians employed peanut butter for many purposes, but particularly for making mock meats or meat substitutes that purportedly imitated the appearance and taste of such diverse products as chicken, veal cutlets, tenderloin steak, oysters, and meat loaf.

Mainstream Peanut Butter

Peanut butter quickly spread into the culinary mainstream and was employed as an ingredient in salad, fudge, biscuits, muffins, cookies, and breads. A major early use of peanut butter was for making sandwiches, which were initially flavored with a variety of ingredients, such as mayonnaise, cayenne, paprika, nasturtiums, cheese, watercress, meat, Worcestershire sauce, and cream cheese. Recipes for peanut butter sandwiches proliferated throughout the early twentieth century. The first known reference to combining jelly with peanut butter was published in 1901. During the early 1900s, peanut butter was considered a delicacy and, as such, it was served at New York's finest tearooms.

Commerce and Industry

Initially, peanut butter was made by grinding a few nuts at a time in a mortar and pestle. As this was a slow and difficult process, it was unlikely that peanut butter would ever have become a major culinary product. It was at this point that technological innovation intervened, and converted a food fad into an industry. Commercial peanut butter made its debut in 1896. Before the development of special grinders, the peanuts were ground in adapted meat grinders. The peanut butter was manufactured in small quantities by individuals and sold from house to house; then small factories sprang up, and peanut butter became a familiar article on grocers' shelves. The first recorded peanut butter trademark was granted to the Atlantic Peanut Refinery in Philadelphia in December 1898. The recipe consisted only of ground peanuts with salt added. By 1899, an estimated two million pounds of peanut butter were manufactured in the United States. The largest producers were located in the South and the West. By 1929, there was hardly a city that did not have one or more peanut butter factories, and its consumption during the next five or six years equaled that of all preceding years combined.

Peanut butter sandwiches moved down the class structure as the price of peanut butter declined. After the invention of sliced bread in the 1920s, children could make their own sandwiches without using a sharp knife. The combination of these two factors helped make peanut butter sandwiches one of the top children's meals in America. Beginning in the 1920s, manufacturers lobbied school cafeterias to buy inexpensive peanut butter. Its flavor was liked by children, and minimum time and equipment were required to prepare it. However, peanut allergies among children have recently been on the rise, and peanuts and peanut products have been banned from some schools.

Today, three major peanut butter manufacturers dominate the market: Skippy, created by Joseph L. Rosefield of Alameda, California (first produced in 1932); Peter Pan peanut butter, manufactured by the E. K. Pond Company (Pond, a subsidiary of Swift & Co., began making peanut butter in 1926); and Procter & Gamble's Jif (first produced in 1958), whose plant in Lexington, Kentucky, is the largest peanut-butter-producing facility in the world.

Peanut Butter as an American Icon

Peanut butter was initially considered a health and vegetarian food, but it quickly became a major mainstream staple, a mass-produced commodity sold in almost every grocery store in America. It was employed on virtually every type of food from soups, salads, sauces, and main courses to desserts and snacks of every description. Few other products in American culinary history have achieved such influence in so many ways in such a short period of time, and peanut butter has remained a staple food in America ever since.

Peanut butter has been employed in a number of other commercial products—cakes, confections, cereals, and many snack foods—the most successful being in the manufacture of chocolate bars. In 1928 H. B. Reese Candy Company produced a chocolate-covered peanut butter cup, which subsequently became known as "Reese's Peanut Butter Cup." Two years later, Frank and Ethel Mars introduced the "Snickers Bar," a combination of peanut butter nougat, peanuts, and caramel encased in milk chocolate. Snickers quickly became America's most popular candy bar, a position it has held ever since. Chocolate and peanut butter are combined in some of America's best-selling chocolate bars, including Snickers and Reese's Peanut Butter Cup.

Peanut butter cookbooks have been regularly published since William Kaufman's *"I Love Peanut Butter" Cookbook* was published in 1975. The Adult Peanut Butter Lovers' Fan Club currently counts over sixty thousand members. Today, Americans consume annually about 857 million pounds of peanut butter, or 3.36 pounds per person. It can be found in 83 percent of American households. Peanut butter is also consumed in Saudi Arabia, Canada, Japan, Korea, and Western Europe.

See also **Kellogg, John Harvey**; **Legumes**; **Nuts**; **Oil**; **Snacks**.

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Andrew F. Smith

PEANUTS. *See* **Legumes; Nuts; Oil; Peanut Butter.**

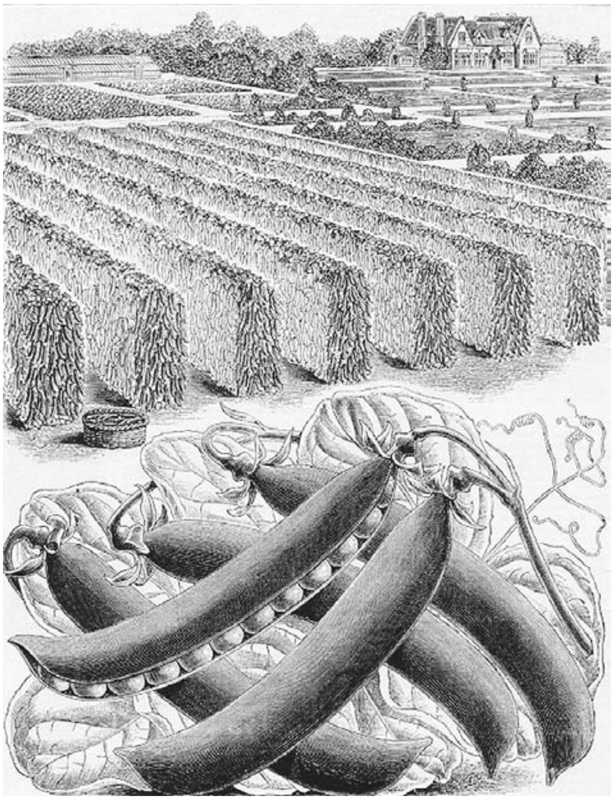
PEAS. Peas are among the oldest cultivated vegetables and once served as a dietary cornerstone for the early agrarian societies of Europe and the Middle East. The English word for pea derives from Latin pisum, a term that now serves as the name of the genus to which peas belong. Pea is thus used in English in two senses: as a descriptor for other pea-like vegetables, such as cowpeas, chickpeas, pigeon peas, and winged peas; and as the specific name for Pisum sativum, the peas employed by humans as food or for such agricultural uses as fodder and green manures.

Genetic Origins

All true peas belong to the same species, but are divided out into three distinct groups or subspecies. This means that even though peas are self-fertile, they readily hybridize in nature and as a result, there a numerous crosses that often blur the differences between the subspecies. This discussion will focus exclusively on the three subspecies and their historical uses as a source of food.

The genetic origin of peas is thought to be southwest Asia, somewhere in the vicinity of Afghanistan. The ancestral pea is now extinct, although its immediate descendants, the wild pea (*Pisum sativum*, spp. *elatius* and spp. *humile*) survive in the Middle East. This is a vining plant with tiny flowers (often crimson or rose) that rambles over rocks or climbs on low bushes for support. Like modern peas, it has tendrils that allow it to use the limbs of nearby plants so that the pods are raised up and out of reach of rodents and other small animals. Stone Age sites in Greece and coastal Turkey dating from about 5700 B.C. have yielded carbonized remains of the *elatius* subspecies, whereas sites from the same period more inland in present Israel and especially the Tigris Valley, have produced remains of the subspecies *humile*. The general conclusion is that wild peas were recognized for their food value at an early date and were gathered both as a fresh vegetable in June (when the seeds are green and sweet) and as a dry seed for use during the rest of the year.

Wild peas later appear in the remains of Swiss lake dwellings (about 3000 B.C.E.), so it is evident that they were carried out of their native habitat into Europe and maintained either as a cultivated plant or as a managed plant in the wild. Since the pea formed a dietary triumvirate with lentils and such ancient grains as emmer,



Advertisement for the Wordsley Wonder, a marrowfat pea introduced in 1888 by Webb & Sons of Stourbridge, England. Where Americans have developed a passion for tomatoes, the English have taken their passion for peas even farther. Between 1700 and 1900, the English developed over a thousand varieties of peas, and perfected methods of growing them in large fields, as seen in the background of this woodcut. ROUGHWOOD COLLECTION.

einkorn, and barley, it is likely that peas traveled as a useful weed along with the migration of early grains. Archaeological evidence suggests that wild peas were commonly found in areas planted with grain and that the entire plants were harvested, hung up and dried, then threshed as needed. Wild peas were mashed and cooked alone or with grains to make porridges, or they were ground into flour and mixed with other flours to make flat breads. Pea flour was also used as a medicine, especially in the treatment of wounds.

Cultivated Peas

The next step in the evolution of the pea was the appearance of the field pea, which is written botanically as *Pisum sativum*, spp. *arvense*. This is a form of pea that evolved artificially through human intervention and supplied early agricultural societies from China to Ireland with one of the most important staple foods down to the eighteenth century. Pease pottage was a common dish in the Middle Ages, and in India, *vatana* (dal made from peas) is still an important element of everyday diet. In the southern portion of the United States, people commonly refer to cowpeas as field peas, but the practical point is clear: this is not a plant grown in kitchen gardens; it is an American substitute form for the true field peas of Europe. Field peas, like wild peas, were harvested on the vine and dried in the barn. The peas were threshed as needed and the straw given as fodder to the livestock.

There are many heirloom varieties of field peas surviving today, although they are grown mostly as fodder or as a green manure (plowed under to enrich the soil). In the Middle Ages they were food for man and beast, and it is this type of pea that was introduced into China from India during the T'ang Dynasty. Pea soup even appears in early Buddhist texts as a healthful, albeit simple dish consistent with a monastic lifestyle.

Regardless of where they are cultivated, all field peas share certain common features that separate them from the so-called garden peas which later became more important. The vines are generally shorter and stronger than those of wild peas, the plants are more compact, and through natural mutation and careful selection over time, they normally yield a higher number of pods often with large seeds. However, to the casual viewer, the most distinctive feature is the flower, which is multicolored. Some of the most beautiful flowers in this species appear on field peas. Furthermore, the dry seeds are normally speckled. The tiny, speckled Jämtlands Grä Förder Ärt of Sweden, and the tan-seeded Groch Pomorski (Pomeranian Pea) of medieval Poland are two surviving examples of this type.

Field peas are often referred to in horticultural literature as gray peas, a term that seems to have evolved in the low countries owing to the color of the seed and the flour they yield. During the late Middle Ages, Capuchin monks in Holland and northern Germany devoted considerable energy to the improvement of field peas for agricultural purposes. This has resulted in a group of large-seeded gray peas referred to as Capuchin, especially those from the Netherlands where the breeding of new pea varieties became a national pastime by the early 1600s. One of the classic peas from this group and one which dates from the 1500s is the handsome blue pod Capucijner, a soup pea growing on six-foot (two m) vines.

Garden Peas

Dwarfism is a recessive gene in peas, and every so often short plants will appear in the field. This dwarfism was noted by Dutch growers in the seventeenth century and manipulated through careful selection to produce a variety of so-called bush types. Holland Capucijners with two-foot vines, and the delicious raisin Capucijners (which actually do look like dried raisins) represent a further evolution of this old category of pea. While they are technically field peas, these bush varieties were also adapted to kitchen gardens and therefore moved up a notch in culinary status. This brings us to the true garden pea, which is genetically different from its cousins in the field.

The garden pea is written botanically as *Pisum sativum*, spp. *sativum* and is readily recognized by its white flowers. The white flower suggests albinoism, especially since the flowers of wild peas are not naturally white. Genetic mutation is further supported by the fact that the seeds are generally very light in color, from near-white to yellow, and when dry are either smooth or wrinkled. Horticulturists now group garden peas by these seed textures since the two types yield peas with different culinary characteristics. Both types, however, contain more sugar than field peas when green, and it was this unusual sweetness that probably first caught the attention of observant gardeners in the Mediterranean some two thousand years ago.

The common white flowering garden pea was known to the ancient Greeks and Romans, but its precise place of origin and date of appearance is unknown. It appears to have been treated as an aristocratic vegetable, hence its mention by Apicius and other classical authors. It was raised in the gardens of the great Roman estates for the luxury of the nobility, but it was not food for the masses: field peas were their sustenance. Garden peas continued to be grown during the Middle Ages, again as food for the aristocracy and church princes. It is not until the horticultural revolution of the 1600s that we find this pea moving into middle-class gardens. The Dutch took the lead in developing new varieties like the tender mangetouts (snap or sugar peas) and the dwarf *petit pois*, but it was the French court of Louis XIV that made green peas fashionable. During the reign of William and Mary, Dutch horticultural enthusiasm caught on in England, and England has remained the center of pea development ever since.

The English have developed elaborate horticultural categories for classifying peas, but doubtless their marrowfats stand out as a singular contribution to this class of vegetable. Marrowfats are peas that are sweet and buttery when cooked green, although they are rarely sold that way in England. Their dry seeds are somewhat chalky in appearance and reduce to a creamy texture when used in soups. Most commonly they are canned, and as a canned product, they became a standard feature of English cookery by the late Victorian period. The very best varieties were developed by Thomas Andrew Knight (1759–1838), a genteel horticulturist who was responsible for a wide range of improved fruits and vegetables. Many of Knight's peas were used by later breeders like Thomas Laxton and Alan MacLean to create some of the Victorian varieties that are still popular today, among them Laxton's Fillbasket (1872) and MacLean's Paradise Marrow (also known as Champion of Paris) introduced in the 1850s.

On the other side of the English Channel, the Paris seed house of Vilmorin introduced some of the most popular pea varieties in nineteenth-century Europe, especially several French varieties that are now much sought after by Paris chefs. These would include Gloire de Quimper, a dwarf bush pea of the *petit pois* type similar to American Wonder, the scimitar-podded Serpette d'Auvergne from the 1830s, and the Pois Géant sans Parchemin (Giant Sugar Pea), which has bicolor flowers, a tell-tale sign of its field pea ancestry.

PEAS THE FRENCH WAY

Shell your Peas, and pass a quarter of a Pound of Butter, gold Colour, with a Spoonful of Flour; then put in a Quart of Peas, four Onions cut small, and two Cabbages cut as small as the Onions; then put in half a Pint of Gravy, season with Pepper, Salt, and Cloves. Stove this well an Hour, then put in half a Spoonful of fine Sugar, and fry some Artichokes to lay round the Side of the Dish; serve it with a forced Lettuce in the Middle.

SOURCE: *Adam's Luxury, and Eve's Cookery* (London, 1744).

Through trade contacts with the Dutch and Portuguese, the Chinese and Japanese were introduced to mangetouts (sugar peas) in the seventeenth century. Since then, they have developed numerous new varieties of tender-podded peas popularly referred to in present-day seed catalogs as snow peas or Chinese peas. The sprouts and young pods are commonly employed in stir-fries and should not be confused with commercial American snap peas. Snap peas are large sweet peas with a crisp, edible pod. This name is somewhat misleading since many peas, like the Sickle Pea of the eighteenth century, can be eaten whole like a snap pea when picked very young. Snap peas are really nothing more than an improvement of the old melting marrows or melting sugar peas, as they were called in the 1800s.

Many of the more recently developed varieties, like the Slim Pea, or the odd Parsley Pea with its bushy tendrils, have evolved to reflect very specific shifts in contemporary diet. In the case of the Slim Pea, it makes an ideal freezing pea for small gardens owning to its diminutive vines, not to mention that the name implies weight loss and low calories (peas are very high in calories). Peas were among the first vegetables marketed as frozen food in the 1920s, and today there is increasing commercial interest in varieties that can be frozen and then cooked in the microwave oven. The Parsley Pea represents a much different mentality, since it is a pea that appeals to organic gardeners and followers of macrobiotic or vegetarian diets. Its peas and pods are edible and its tendrils may be cooked and transformed into faux seaweed salad for a meal with the ascetic appointments of Taoist simplicity.

See also **British Isles: England**; **Frozen Food**; **India**; **Legumes**; **Low Countries**; **Mediterranean Diet**; **Porridge**; **Tillage**.

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William Woys Weaver

PEPPER. *For pepper (spice), see* **Herbs and Spices;** *for peppers, see* **Chili Peppers.**

PESTICIDES.

A pesticide is any agent used to kill or control a pest. Pests include insects, weeds, and diseases, such as fungi. In addition, mice, rats, birds, and algae may become pests at some time. When pests damage plants or property, people often use pesticides to control them. The term "pesticide" can apply to insecticides, herbicides, fungicides, antimicrobials, growth regulators, defoliants, and desiccants, most of which are applied to food or food plants before or after harvest. Common pesticides are encountered every day—in pet flea collars, kitchen disinfectants, cockroach baits, swimming pool chemicals, and mosquito repellents. Pesticide products contain both active and inert ingredients, and both must be specified on the label.

Pesticide Controversy

Modern farmers use pesticides to help them to grow almost all of the world's food. In general, pesticides have been a quick, effective, and inexpensive method of control for pests that attack most of the world's food crops. Pesticides are credited with helping to save millions of lives by controlling diseases, such as malaria and yellow fever, which are spread by insects. However, most pesticides present some risk of harm to humans, animals, or the environment because they are designed to kill living organisms.

Sulfur, herbal extracts, tobacco, soaps, oil, arsenic, pyrethrum, and lime have been used as pesticides for many centuries, but the widespread use of synthetic pesticides is a relatively recent phenomenon. Dichlorodiphenyltrichloroethane, or DDT, is probably the best known early pesticide. DDT was created in 1873, but it was not until the late 1930s that Swiss researcher Paul Müller discovered that the compound was effective in killing insects. Müller won the Nobel Prize in Physiology and Medicine in 1948 for his work. DDT was an inexpensive and effective solution to many insect problems, and it virtually eliminated malaria from parts of the world. After World War II, DDT became a common agricultural pesticide. In the 1950s, the United States was producing 220 million pounds of DDT per year.

Insect resistance to the substance developed quickly. DDT residues were found in human milk and fatty tissues, and in wildlife food chains. In 1962 writer and ecologist Rachel Carson wrote *Silent Spring* to warn the public about the long-term effects of misusing pesticides. Carson challenged the practices of agricultural scientists and the government, and called for a change in the way humankind viewed the natural world. Carson testified before Congress in 1963, calling for new policies to protect human health and the environment. While no longer used in the United States, DDT use continues in other parts of the world. Many tropical countries still use DDT to control malaria.

All pesticides (natural and synthetic) have the potential to cause harm during their manufacture or refinement, at the time of application to crops, as residues that persist on food, and in the disruption of the natural balance that exists between pests and their natural enemies. For example, traces of the natural insecticide "rotenone" may be found on vegetables after cooking. Atrazine, a weed-killer commonly used on corn and soybeans, suburban lawns, and utility rights-of-way, has contaminated groundwater where those crops are grown. Insecticides like DDE and dieldrin, which are related to DDT, were banned in the United States in the 1970s, but still show up in the U.S. food supply. Persistent residues of these chemicals travel long distances in global air and water currents. These insecticides are still produced and used in many countries. Recent studies have linked pesticides with acute poisonings, cancer, brain damage, reproductive harm, and many childhood illnesses and learning problems, leading concerned citizens to feel that pesticides should be banned.

Organic Agriculture

Some agricultural experts predict that the quality and quantity of our food supply would be lessened if pesticides were eliminated. However, practitioners of organic agriculture (organic farmers use no synthetic agricultural chemicals and instead rely on management practices such as crop rotation, disease-resistant varieties, and natural enemies to control crop pests) claim that food quality and yield are equally productive under organic management. Fortunately for conventional and organic farmers, the number of safer, reduced-risk options for pest control is increasing. For example, there were approximately seven hundred new, biological pesticide products registered by 1999. Biological pesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and minerals.

Garlic, mint, and baking soda all have pesticide-like properties and are considered biological pesticides. Biological pesticides include the common cabbage worm killer *Bacillus thuringiensis*, which produces a protein that helps to kill specific worm pests. Some of the new reduced-risk pesticides, while synthesized in a laboratory, are considered safer because they do not kill beneficial insects (such as lady beetles and lacewings), or they break down quickly to inactive products. In 1977 U.S. president Jimmy Carter issued a Presidential Decree that mandated the use of integrated pest management (IPM)—a comprehensive approach to pest control that uses a combination of less toxic means to reduce the status of pests to tolerant levels, while maintaining a quality environment. Together, the new reduced-risk pesticides and IPM practices have helped to lessen the amount of pesticides that are used on food and other crops. Levels of pesticide residues on IPM produce have been reported as higher than those of organically grown food, but lower than those in conventionally grown produce.

Pesticides and Their Regulation

In the United States, pesticides are regulated by the Environmental Protection Agency (EPA). EPA regulates the sale, distribution, and use of pesticides and has the authority to suspend or cancel the registration of a pesticide if information shows that continued use would pose unreasonable risks. In 1996 the Food Quality Protection Act (FQPA) was signed into law, giving EPA more effective power. Among its many benefits, the FQPA established a new health-based safety standard for pesticide residues in food; included special provisions for infants and children; required periodic tolerance reevaluations; incorporated provisions for endocrine testing; and allowed for enhanced enforcement of pesticide residue standards.

Scientists predict that, in the future, pesticides will continue to play a role in pest management of food crops, partly because reduced-risk pesticides have become less harmful to the environment, and less toxic to people and wildlife. Societal concerns, scientific advances, and regulatory pressures continue to drive some of the more hazardous pesticides from the marketplace. In addition, consumer interest in safe and healthy food will create more demand for organically grown products.

See also **Herbicides**; **Organic Agriculture**; **Organic Farming and Gardening**; **Food Safety**; **Toxins, Unnatural, and Food Safety**.

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PETRONIUS. In the surviving manuscript, the authorship of the Latin picaresque novel *Satyrica* is credited to "Petronius Arbiter." Most scholars believe (although conclusive evidence is lacking) that this is Gaius (or Titus) Petronius, who served the Roman emperor Nero as *Arbiter Elegantiae* (judge of elegance, or director of entertainment). He fell from the emperor's favor and was ordered to commit suicide in A.D. 66. The historian Tacitus describes the courtier's death in his *Annals* (book 18, sections 18–19).

The *Satyrica* is a novel of low life in Roman Italy, centering on the narrator Encolpius and his boyfriend Giton. The author may seem to celebrate—he certainly does not condemn—his characters' amoral lifestyle: they are usually penniless and often involved in disreputable sexual adventures.

In medieval Europe the *Satyrica* was a secret classic. No complete copy survived to modern times; we have only fragments. The longest surviving episode (sections

26–78), important for food history, is known as *Cena Trimalchionis*, or ‘Trimalchio’s dinner’. This immensely rich former slave regales his guests (including Encolpius) with food and conversation intended to display urbanity but more truly betraying empty pretentiousness. The main course is a roast pig, served as if still whole. In fact it had been gutted normally, and afterward stuffed with cooked sausages, which look like (and are made from) intestines: a clever, but tasteless, presentational trick. The wine is labeled “opimian, one hundred years old,” but at the date of the fictional dinner any surviving Italian wines of the famous opimian vintage were 180 years old and almost undrinkable: such contradictions are meant to reveal the host’s ignorance of gastronomy. Almost every item in the menu has some satirical undertone. Cleverly balancing between naive astonishment and cynical disdain, the narrator tells us a lot about gastronomy and dining customs under the early empire. Featured among the hors d’oeuvres at Trimalchio’s dinner, dormice (roasted, dipped in honey and rolled in poppy seeds) will forever remain typical of Roman cuisine.

See also **Rome and the Roman Empire**.

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PHILIPPINES. *See* **Southeast Asia.**

PHOSPHORUS AND CALCIUM. Phosphorus and calcium are essential macronutrients in the human diet. Most of the phosphorus in the human body is found in association with calcium (as the mineral complex hydroxyapatite) in bones and teeth, where it is essential to structure. This form of phosphorus, along with phosphorylated sugars and proteins, is termed *inorganic phosphorus*. Organic phosphorus occurs primarily in the form of phospholipids.

Phosphorus absorption in the human body is proportional to the dietary intake, unlike calcium, where absorption is inversely related to the logarithm of intake. Absorption of phosphorus is facilitated by vitamin D. Phosphorus levels in urine are also directly related to dietary intake.

Important regulatory functions of phosphorus in the human body include maintaining the pH of body fluids,

TABLE 1

Amounts of calcium and phosphorus in 100 grams (3.5 oz.) of selected foods, and the ratio of these two elements

Food	Calcium (mg/100 g)	Phosphorus (mg/100 g)	Ca:P Ratio
Dairy Products			
Buttermilk	116	89	1.30
Cheese, camembert	387	347	1.12
Cheese, cottage, low fat	69	151	0.46
Cheese, processed	720	511	1.41
Cheese, ricotta, whole milk	207	158	1.31
Cheese, Swiss	959	607	1.58
Milk, canned sweetened condensed	284	253	1.12
Milk, nonfat	123	101	1.22
Milk, nonfat canned evaporated	290	195	1.49
Milk, whole	119	93	1.28
Yogurt, low fat	199	157	1.27
Yogurt, whole milk	121	95	1.27
Vegetables			
Broccoli	47	66	0.71
Carrots	27	44	0.61
Corn	5	63	0.08
Cornmeal	350	623	0.56
Kale	138	28	4.93
Lettuce, iceberg	19	20	0.95
Okra	96	46	2.09
Parsley	140	60	2.33
Peas, green	24	90	0.27
Rhubarb	145	8	18.13
Spinach	100	50	2.00
Turnips	152	34	4.47
Meat			
Chicken	20	229	0.09
Crab	101	260	0.39
Duck	12	203	0.06
Oyster	62	159	0.39
Sardine	382	490	0.78
Turkey	25	213	0.12
Cereals			
Barley	19	221	0.09
Couscous	24	170	0.14
Oat bran	59	734	0.08
Rice, brown	10	83	0.12
Rice, white	28	115	0.24
Wheat flour, white	338	619	0.55
Legumes and nuts			
Lentils	19	180	0.11
Lima beans	21	74	0.28
Macadamia nuts	71	198	0.36
Peanuts	88	519	0.17
Pecans	71	279	0.25
Soybeans	145	245	0.59
Miscellaneous			
Chocolate, semisweet	32	132	0.24
Egg, whole	48	178	0.27
Kiwifruit	26	39	0.67

SOURCE: Adapted from the Nutrient Data Laboratory, United States Department of Agriculture, Beltsville, MD (http://www.nal.usda.gov/fnic/foodcomp/)

the cellular osmotic pressure, and the energy transfer system in cells. Phosphorus is also an important component of DNA and RNA. Phosphorus deficiencies are rare and have been linked to anorexia, rickets, and skeletal and muscular abnormalities.

The amount of calcium consumed is not always related to the amount retained by the body. Availability of calcium for absorption is referred to as bioavailability, and is improved by factors such as the presence of phosphorus, vitamin D, and the extent to which the calcium mineral salt is ionized to form the divalent Ca^{2+} ion. Cellulose and hemicellulose fibers decrease absorption of calcium in the intestine. Sodium and caffeine both increase urinary calcium. Caffeine also causes an increase of calcium secretion into the human gut. Unabsorbed fats interfere with calcium absorption by forming a fatty acid–calcium soap complex, which is subsequently excreted. The bioavailability of calcium ranges from 5 to 70 percent for most foods, depending upon the type of mineral from which it is derived, the food product, and the presence of inhibitory substances. Oxalate and phytate both inhibit calcium absorption. A diet deficient in calcium may increase the risk of rickets, hypertension, osteoporosis, and scurvy. Vitamin D stimulates the absorption of calcium and phosphorus into bones. Osteoporosis is one consequence of low calcium intake during the younger years of bone mineralization. There are conflicting opinions on the efficacy of increasing the intake of calcium for older people who are already suffering from osteoporosis.

About 1.5 percent of the weight of an average person is made up of bones, which contain 99 percent of the body's calcium. Approximately 0.05 percent of the calcium in bones is exchanged daily by a process of solubilization and precipitation. In addition to its structural function, calcium in its ionized form allows blood clotting to take place. Calcium also regulates muscle contraction and relaxation.

Calcium is often found in association with phosphorus, forming the mineral calcium phosphate. This mineral is less soluble at higher temperatures (unlike most other minerals), resulting in "boiler-scale," a white precipitate on surfaces that come into contact with hot mineralized water. Table 1 presents a selection of foods containing phosphorus and calcium and gives the ratio of calcium to phosphorus in each; this is one important indicator of bioavailability. A low calcium to phosphorus ratio is associated with bone loss over time.

Milk is a very good source of dietary calcium. Calcium in milk is found primarily in the mineral calcium phosphate, which is approximately 30 percent bioavailable. It is possible that the high level of insoluble calcium phosphate in milk could cause calcification of the mammary gland, but casein milk proteins solubilize the mineral calcium phosphate. Calcium phosphate and proteins are responsible for much of the high buffering capacity of milk, which is a resistance to change in pH after the addition of acid or base. This allows milk to absorb a large amount of acid, such as that found in the human gut, providing some relief from acid reflux. Milk also contains a large amount of lactose. This precludes the use of milk as a source of dietary calcium and phosphorus for people suffering from lactose intolerance, an inability to metabolize lactose. For these people, other dairy products such as matured cheese and yogurt can be used to provide dietary calcium. Both of these dairy products are low in lactose. More information on calcium phosphate and lactose in milk can be found in Table 1 under Dairy Products.

Calcium in used in food to increase the gel formation of polysaccharides such as alginate and pectin, which can be used to increase the firmness of canned vegetables. Calcium also increases the firmness of milk gels and the rate of milk clotting, such as what occurs in cheese manufacture, by promoting aggregation of casein milk proteins. Phosphorus is present in emulsifiers used to produce the smooth texture required for processed cheese. It is also used to increase moisture retention in comminuted meats, as a leavening agent, as a pH buffering agent, and to acidify beverages. Phosphorus-containing agents such as phytate, oxalate, and phosphate act as chelating agents by binding calcium strongly.

The recommended dietary allowance for calcium is 210 mg/day (from birth to six months), 270 mg/day (aged seven to twelve months), 500 mg/day (aged one to three years), 800 mg/day (aged four to eight years), 1,300 mg/day (aged nine to eighteen years) and 1000 mg/day above eighteen years of age. The recommended dietary allowance for phosphorus is 100 mg/day (from birth to six months), 275 mg/day (aged seven to twelve months), 460 mg/day (aged one to three years), 500 mg/day (aged four to eight years), 1,250 mg/day (aged nine to eighteen years) and 700 mg/day above eighteen years of age.

See also **Body Composition**; **Composition of Food**; **Dairy Products**; **Dietary Assessment**; **Dietary Guidelines**; **Digestion**; **Enteral and Parenteral Nutrition**; **Lactation**; **Milk, Human**; **Nutrient Bioavailability**; **Nutrients**.

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PHYSICAL ACTIVITY AND NUTRITION.

Regular physical activity and proper nutrition are critical for optimal health. Both have been linked to reducing the risk of a large number of common chronic diseases. In most cases, it is difficult to separate the roles

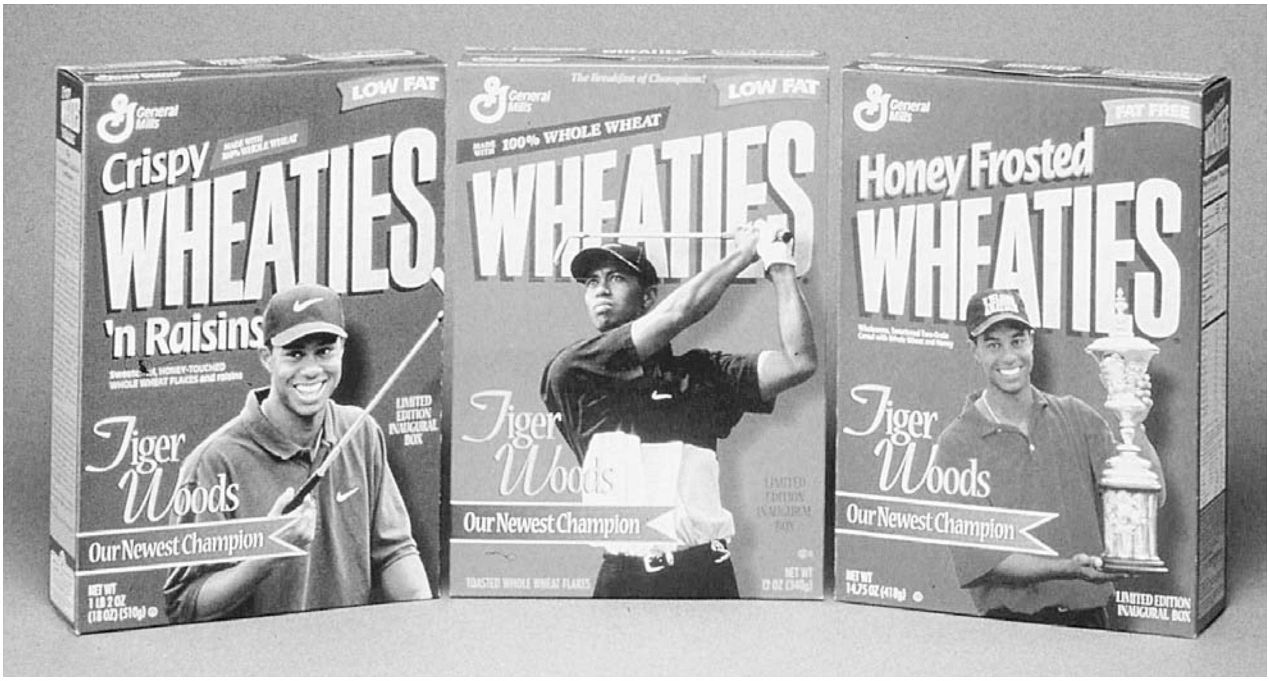
BENEFITS OF REGULAR PHYSICAL ACTIVITY

- Decreases the risk of premature death
- Decreases the risk of dying prematurely from coronary heart disease
- Decreases the risk of Type II diabetes mellitus
- Decreases the risk of hypertension
- Helps reduce blood pressure in people with hypertension
- Decreases the risk of colon cancer
- Decreases feelings of depression and anxiety
- Helps control body weight
- Helps build and maintain healthy bones, muscles, and joints
- Improves strength in older adults and decreases their risk of falling
- Promotes psychological well-being

these two factors play in decreasing disease risk. The importance of both of these factors is highlighted by the United States government in the *2000 Dietary Guidelines for Americans* published by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture. The guidelines' recommendations include aiming for a healthy weight; being physically active each day; following the food guide pyramid; eating a variety of grains, fruits, and vegetables each day; choosing a diet low in saturated fat and cholesterol and moderate in total fat; consuming less sugar and salt; drinking alcohol only in moderation, if at all; and keeping food safe to eat. These suggestions can greatly reduce disease risk. The role of physical activity in particular is a primary focus in the article that follows.

Benefits of Physical Activity
The 1996 Surgeon General's report, *Physical Activity and Health*, summarized many of the advantages obtained through participation in regular physical activity. It should be noted that these benefits can be acquired through a broad variety of activities; thus, the terms "exercise" and "physical activity" should not be limited solely to describing activities that are specifically designed to enhance fitness. Activities considered beneficial to health include structured exercise (e.g., walking, running, cycling, weight lifting, etc.), participation in sports, leisure-time and recreational pursuits, occupational duties, and other forms of movement.

Jeremy Morris and colleagues (1953) were among the earliest researchers to suggest that physical activity confers benefits to health. In their study, the rate of coro-



Physical activity and a balanced diet are underlying themes in modern food advertising. This breakfast cereal uses golfing hero Tiger Woods to draw a connection between the food product and winning a sport. It could be argued that the easy pace of golf should not be equated with a full physical workout. © AP/WIDE WORLD PHOTOS.

AMERICAN COLLEGE OF SPORTS MEDICINE GUIDELINES FOR FITNESS

Cardiorespiratory Fitness and Body Composition

1. Frequency of training: 3–5 days per week.
2. Intensity of training: 55/65 percent–90 percent of maximum heart rate. The lower intensity values (55–65 percent) are most applicable to individuals who are quite unfit.
3. Duration of training: 20–60 minutes of continuous or intermittent (minimum of 10-minute bouts accumulated throughout the day) aerobic activity. Duration is dependent on the intensity of the activity; thus, lower-intensity activity should be conducted over a longer period of time (30 minutes or more), and, conversely, individuals training at higher levels of intensity should train at least 20 minutes or longer.
4. Mode of activity: Any activity that uses large muscle groups, that can be maintained continuously, and that is rhythmical and aerobic in nature, e.g., walking-hiking, running-jogging, cycling-bicycling, cross-country skiing, aerobic dance or group exercise, rope skipping, rowing, stair climbing, swimming, skating, and various endurance game activities or some combination thereof.

Muscular Strength and Endurance, Body Composition, and Flexibility

1. Resistance training: Resistance training should be an integral part of an adult fitness program and should be of a sufficient intensity to enhance strength and muscular endurance, and to maintain fat-free mass. Resistance training should be progressive in nature and individualized, and should provide a stimulus to all the major muscle groups. One set of 8–10 exercises that conditions the major muscle groups 2–3 days per week is recommended. Multiple-set regimens may provide greater benefits if time allows. Most persons should complete 8–12 repetitions of each exercise; however, for older and more frail persons (approximately 50 to 60 years of age and above), 10–15 repetitions may be more appropriate.
2. Flexibility training: Flexibility exercises should be incorporated into the overall fitness program sufficient to develop and maintain range of motion. These exercises should stretch the major muscle groups and be performed a minimum of 2–3 days per week.

nary events (i.e., angina pectoris, thrombosis, death) for double-decker bus and tram conductors in London was compared to that of their more sedentary driving counterparts. Conductors had an overall lower incidence of coronary events and mortality than drivers, and the authors suggested that the greater level of physical activity that results from conducting versus driving might be the explanation. Many other investigators have since confirmed the notion that being more active reduces risk of heart disease and premature death, as well as many other common health problems.

Many of the health benefits of exercise are probably indirect, through control of body weight; however, physical activity alone also appears to be helpful. A recent review of the literature by Stephen Blair and Suzanne Brodney (1999) concluded that the current understanding of the importance of exercise to health suggests that physical activity reduces health risks that are usually associated with overweight and obesity, even in those who remain obese. Furthermore, they concluded that inactivity and low cardiorespiratory fitness increase the risk of premature death so that the risk is equal to being overweight or obese. Thus, physical activity is essential for optimal health regardless of body weight.

The reasons for the apparent health benefits of physical activity with regard to multiple disease conditions have been addressed by many studies. Although all of the mechanisms are not yet completely understood, several physiological effects of exercise have been observed and may be responsible. It is likely that improved cardiac and musculoskeletal function account for many of the benefits. Additionally, physical activity alters metabolic and hormonal processes that may modify disease risk, and activity also appears to be involved in improving immune function.

Physical Activity Guidelines

Quantifying the optimal level of physical activity required to reduce the risk of disease has proven difficult. However, leading organizations have provided recommendations for minimal levels of activity. Exercise guidelines from the American College of Sports Medicine (1998) for cardiorespiratory fitness, muscular strength and endurance, flexibility, and body composition are provided in the sidebar "American College Sports Medicine Guidelines for Fitness." Additionally, the Surgeon General's report (1996) recommends that people of all ages include a minimum of thirty minutes of physical activity of moderate intensity (such as brisk walking) on most, if not all, days of the week. Furthermore, two objectives of Healthy People 2010 (2000), a set of health objectives developed by the United States Department of Health and

Human Services, are, first, to increase the proportion of adolescents who engage in vigorous physical activity that promotes cardiorespiratory fitness three or more days per week for twenty or more minutes per occasion, and, second, to increase the proportion of adults who engage regularly, preferably daily, in moderate physical activity for at least thirty minutes per day.

Although numerous positive effects of physical activity exist, participation in strenuous exercise and work is not completely without risk in all circumstances. Primary risks include musculoskeletal injuries and cardiovascular events such as heart attacks. To avoid musculoskeletal injuries, it is most commonly recommended when beginning a physical activity program that the participant gradually increase the duration and intensity of the routine. Although physical exertion can result in a cardiovascular event, this is a rare occurrence in the healthy population. However, the Surgeon General's report (1996) suggests that adults with chronic diseases, such as heart disease, diabetes, or obesity, consult a physician before starting a program of physical activity, as should men over forty years of age and women over fifty years of age who plan to start a "vigorous" exercise program.

Conclusions

Many beneficial effects of diet and exercise are known; however, the interactive effects of the two are less understood. The relative importance of these lifestyle choices on various risk factors for chronic diseases is not clear. In some cases, physical activity and proper nutrition effects may be additive. In other cases, a synergistic effect of the two may exist. Additionally, it is also possible that for some risk factors, high levels of physical activity may even negate the adverse effects that a poor diet typically has on more sedentary individuals. For example, regular strenuous exercise appears to abolish the cholesterol-raising effects of a diet high in saturated fat. Clearly, the interaction between physical activity and nutrition relative to health benefits deserves considerable investigation now and in the future, so that we may optimally manage risk for chronic diseases.

See also **Assessment of Nutritional Status; Dietary Assessment; Dietary Guidelines; Dietary Systems; Dietetics; Fats; Food Politics: U.S.; Health and Disease; Malnutrition; Nutrients; Nutrition; Nutritionists; Obesity.**

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Mark Kern

PICA. *See* **Geophagy.**

PICNIC. There is no reliable etymology for the word *picnic*, with the original use of the word lagging about three hundred years behind the first descriptions of *alfresco* (open air) dining. From about 1340 until the very early 1800s, there are three contextual descriptions of picnics, whether or not the word is actually used: a pleasure party at which a meal was eaten outdoors; a hunt assembly; and an indoor social gathering or dinner party. An outdoor meal in a garden is described in Italian literature by Giovanni Boccaccio in a poem that dates from about 1340. Sixty years later a similar event occurs in one of Geoffrey Chaucer's *Canterbury Tales.* It seems certain that the *assemblée*, or meal served during the hunt that is described and illustrated in the hunt manual of Jacques du Fouilloux's *La Vénerie* (Hunting) (1560) and George Turberville's *The Noble Arte of Venerie* (1575), are picnics in all but name. By 1692, the concept of the *alfresco* meal shifted, and when cited in Gilles Ménage's *Dictionnaire du Etymologique de la Langue Françoise* (Etymological dictionary of the French language) *piquenique* is assumed to be of unknown origin, but means *un repas où chacun paye son écot* (a meal where each pays his share). By 1750, Ménage's editors suggest that *piquenique* may be of Spanish origin and that it appeared in 1664 in a French translation of works by Francisco Quevedo. Oliver Cromwell, Lord Protector of Great Britain, had a dinner served on the grounds of Hyde Park in 1654. Samuel Pepys, the English diarist, ate many meals while boating on the Thames or sitting on its banks. These are picnics in all but name, but they are only recorded as a dinner alfresco.

The *Oxford English Dictionary* says that the word "picnic" originally referred to fashionable social entertainment in which each person contributed a share of the provisions, and says that the first recorded use of "picnic" in English appears in 1748 in a letter from Lord Chesterfield to his son, in the sense of an assembly or social gathering. It seems that the word was used in this sense widely in Germany, as Chesterfield's son was in Berlin at the time. A subsequent mention occurs in a letter from Lady M. Coke to Lady Stafford in 1763 from Hanover. Gustaf Palmfelt, a Swede, in a 1738 translation into Swedish used "picnick" (in the sense of an assembly); Swedish continues to use "picnick" and suggests that it is of French or English origin. *Larousse Gastronomique* (2002) states that 'picnic' is a contraction of *pique* (to pick), *piquante* (sharp or pungent), and *nique* (of small value). This suggestion seems commonsensical, but it is guesswork based on the technique of word formation by clipping words together to form a new word.

In the arts and literature, picnics tend to be more concerned with place, action, and figurative meanings and less concerned with food, if it is mentioned at all. Oliver Goldsmith, whom Georgina Battiscombe (*English Picnics*, 1949) credits with describing the first picnic in English literature in *The Vicar of Wakefield* (1766) provides these bare bones: "Our family dined in the field, and we sat, or rather, reclined round a temperate repast, our cloth spread upon the hay." Battiscombe insists that a picnic must be a meal eaten outdoors to which diners bring something to eat, even if there is no sharing. She suggests that before the Romantics made nature fashionable "no one connected the idea of pleasure with the notion of a meal eaten anywhere but under a roof" (p. 4).

In London, the so-called Picnic Society (1802) was a short-lived elite social club organized for entertainment. But a decade later "picnic" is used only in the sense of a meal eaten outdoors. Occasionally, it was used in the sense of an anthology, as in Charles Dickens's *The Pic-Nic Papers, by Various Hands* (1841), or as a term of disapprobation as in a person accused of picnickery and nicknackery, or being frivolous.

Germans use *picnick* in the sense of holding a meeting, as in the phrase *ein Picknick halten*. The verb is *picknicken*, which literally means holding a picnic as you would hold a meeting or a party. Italians use *scampagnata* (holiday in the country), or *lolazione sull'erba* (luncheon on the grass). Spaniards use *comida al aire libre* (luncheon on the grass), or *comida campestre* (eat in the country). Spanish dictionaries seem unaware that Ménage thinks the word may be of Spanish origin. Koreans use both the Chinese *so pong* (a little meal in the country) and "picnic." Their favorite picnic time occurs when the cherry trees are in bloom. The Japanese have a long history of depicting meals taken outdoors, often celebrating *hanami*, the cherry blossom season, or another seasonal event. In 1862, "picnic" was translated as *shokuji* (meal), and in the twentieth century, the Japanese adopted the loanword *pikunikku*.

Food Writers on Picnics

Cookbooks are excellent resources for picnic menus and recollections. Jean Anthelme Brillat-Savarin delights in the hunt assembly ("Halts of a Shooting-Party"), which he does not call a picnic: "At the appointed hour we see arrive light carriages and prancing horses, loaded with the fair, all feathers and flowers. . . . Seated on the green turf they eat, the corks fly; they gossip, laugh, and are merry in perfect freedom, for the universe is their drawing-room, and the sun their lamp" (*Physiologie du goût*, pp. 152–153). Mrs. Isabella Beeton's recommendations for a picnic for forty persons are for formal entertaining carried outdoors in some location where an elaborate feast could be organized and served by servants.

An Egyptian Picnic

Claudia Roden's "A Middle Eastern Affair" in *Everything Tastes Better Outdoors* (1985) tells that her favorite picnic spot was in the dunes of Agami in Alexandria, where she was raised as a child. She explains that in the Middle East eating out is a way of life: "There are even official occasions for picnic. Among these are the *mulids,* when people flock to the principal scenes of religious festivals, public gardens, shrines, tombs of saints, and burial grounds. Thousands gather sometimes for days and nights, sleeping under tents . . . . The most important of the national picnics in Egypt is not a religious occasion. It is *Shem en Nessem,* which celebrates the arrival of spring. Town dwellers go out in the country or in boats, generally northward, eating out in fields or on the riverbank, smelling the air, which is thought to be particularly beneficial on the day" (pp. 167–168). Picnic foods include *blehat samak* (Fish rissoles), *qras samak* (Arab fish cake with burghul,) brains Moroccan style, sanbusak (pies filled with meat and pine nuts), meat ajja (an omelet) kukye gusht (an Iranian omelet) *kibbeh naye* (raw lamb and cracked wheat paste), *bazargan* (burghul salad), *tabbouleh* (cracked wheat salad), stuffed vegetables, stuffed onion, leeks, zucchini, lemon chicken, *lahma bil karaz* (meatballs with cherries), *salq bi loubia* (spinach with black-eyed beans), lentil tomato salad, and *loubia bi zeit* (green beans in olive oil).

Elizabeth David, a known lover of picnics, says that

> Picnic addicts seem to be roughly divided between those who frankly make elaborate preparations and leave nothing to chance, and those others whose organization is no less complicated but who are more deceitful and pretend that everything will be obtained on the spot and cooked over a woodcutter's fire conveniently at hand (*Summer Cooking*, p. 208).

James Beard suggests that a picnic requires that you travel somewhere to eat. He is certain that

> Wherever it is done, picnicking can be one of the supreme pleasures of outdoor life. At its most elegant, it calls for the accompaniment of the best linens and crystal and china; at its simplest it needs only a bottle of wine and items purchased from the local delicatessen as one passes through town. I recall a recent

Grapes are one of the oldest and most universally popular picnic fruits, and no tasteful American picnic is complete without wine and cheese—or the ever-popular cold fried chicken. © Arthur Rothstein/CORBIS.

> picnic in France where we bought *rilletes de Tours* (in Tours), and elsewhere some excellent *salade museau*, good bread, ripe tomatoes and cheese. A bottle of local wine and glasses and plates from the Monoprix helped to make this picnic in a heather field near Le Mans a particularly memorable one (*Menus for Entertaining*, p. 272).

Claudia Roden, aficionado of picnics and outdoor eating, describes English picnics, Revival Week picnics, a Middle Eastern Affair, a Japanese Picnic, and a Picnic in the Himalayas. Roden confesses,

> The pleasures of outdoor food are those that nature has to offer, as ephemeral as they are intense. A bird will sing his song and fly away, leaves will flutter and jostle the sunlight for a brief second—sky, flowers, and scents have each their small parts to play in the perfect happiness of those enchanted moments. They serve, as Jean Jacques Rousseau said, to "liberate the soul" (*Everything Tastes Better Outdoors*, p. 4).

See also **Beard, James; Beeton, Isabella Mary; Brillat-Savarin, Anthelme**.

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Walter Levy

PIE. The word *pie* derives from a related word *piece*, as expressed in medieval Latin *petia* or *pecia*. Both terms can be traced to Gaulish *peth* (Lambert 1997), which appears as *pighe* in Irish and Scottish. The core meaning of the word both in Celtic and in later medieval Latin was twofold: a morsel which could be eaten with the fingers and which also contained some type of filling—in short, a pastry envelope.

Pocket Pies

The Gaulish origin of our English word does not imply that the Celts invented the pie concept; it merely underscores the fact that this culinary idea is one of great age and wide distribution, with many counterparts in the Near East and Asia. It also reaffirms the growing realization among food historians that many modern concepts, such as *bouillon-blanc* (early medieval *bugillo albo*) derive from non-Roman European cultures, although they are transmitted to us through Medieval Latin.

In keeping with this, the original "pie" at least as it was known to continental Celts, consisted of a square, triangular, or more commonly a circular piece of dough folded over a filling and pressed together to form a half-moon or pocket. This concept was carried over into medieval cookery, and linguistic evidence suggests that these pies were large, since diminutive adjectives or endings were needed to describe small ones. In medieval everyday cookery such pies probably served as a substitute for roast meat since they could employ meat leftovers or such foraged poverty fillings as elderberries or sorrel. Furthermore, they could be baked down hearth in a kettle set on a tripod over hot coals, with some of the coals scattered over the kettle lid. The ease with which such fare could be prepared in very simple medieval kitchens may explain why the pie became so firmly integrated into the traditional cookery of the British Isles. However, in medieval court cookery, handheld pies formed an adjunct to other dishes brought to the table, and very often contained exotic ingredients or flavors intended to contrast with carefully orchestrated sauces, dips, and roasted meats.

The identifying pocket shape, which is highly convenient in societies where food is eaten with the fingers, may be found in many traditional grain-based cookeries where flour is compounded with oils or fats in a variety of ways. This age-old concept survives in the form of Spanish *empanadas*, in English turnovers, in Greek *kolokotes*, and in a vast number of other similarly shaped foods now prepared in both the Old and New worlds—even in the modern pop tart invented for toasters.

One thread common to all forms of traditional pocket pies is that the crust was usually short (with a high fat content). Because of this, the pie was normally associated with festive or special occasion cookery, and thus forbidden by the Christian church for consumption on lean days or on days of fasting. This restriction varied regionally since ecclesiastical enforcement was at best uneven.

Restrictions were profoundly altered during the Protestant Reformation, which did away with fast days. Thus the pie became a status symbol, which in time assumed far more importance in English cookery than it did on the Continent. This cultural emphasis was transferred to North America through English colonization. Furthermore, by the time the pie reached American shores in the seventeenth century, it had already undergone several transformations in England, so that there was not one, but five types of pastry called pie: pocket pies, two-crusted pies, one-crusted pies, standing pies, and potpies. All these forms evolved distinctive English identities during the late Middle Ages and were slow to change, since they became tied up with concepts of English national identity.

Even into the nineteenth century, the pocket pie in its most ancient meaning lingered on alongside the newer forms in both demotic speech and literature, especially in cookery books of a highly colloquial nature. The unifying principle was that they were considered finger food during a period of English cookery predating the introduction of forks—quite literally something broken or cut into pieces. Indeed, this idea of eating with the hands has persisted for a very long time and is still preserved in such American creations as the Pennsylvania Dutch shoofly pie, a breakfast cake baked in a pie shell and meant to be sliced, held in the hand, and dipped into strong coffee.

This marriage of very different types of pies under the umbrella of one term is further linguistic evidence that the turnover shape was indeed the oldest type and that the English language did not have a wide range of indigenous terminologies to accommodate the newer forms. It is also evidence that the transition from one form to the next was sometimes gradual, especially in the countryside. Food historians generally concur that there is a definite genealogical link between the ancient pie and its modern two-crust descendant, although there is no firm agreement as to how this transition took place. There are several possible avenues of evolution. The shallow dish or saucer pie and the deep dish or potpie offer two theoretical possibilities.

Dried Pumpkin Pie

In the age before canned pumpkin puree, home cooks had only two choices: fresh pumpkin from the winter pantry, or dried pumpkin. The internal reference to a brick bakeoven suggests that the setting for the following recipe is a well-off farm somewhere in the Middle States, where bread baking was still done in an outdoor bake house.—Ed.

Dry the pumpkin after the following manner: — Boil it a good while, then spread it upon plates, or drop a spoonful at a time upon buttered paper, which is laid on tins, forming cakes, as it were, and set the tins into a brick oven after you have removed your baking; it dries in this way, without getting dusty.

In making the pies, take for one pie three cakes of pumpkin, and three eggs; sugar to your taste; soften the pumpkin in warm milk; strain through a colander; spice with cinnamon, and bake in a deep dish. This is an excellent pie, and preferred by some persons to the fresh pumpkin.

When well dried, the pumpkin will keep more than a year.

SOURCE: *Breakfast, Dinner, and Tea* (New York, 1883), p. 176.

The Saucer Pie

A turnover or large pocket pie that is baked in a saucer-like dish were known colloquially as saucer pies (Coolidge, 1875; Weaver, 1990) and consisted of one, sometimes two, turnovers baked in a small redware saucer and served in it. Milk could be poured over the pie, which was mashed and thus eaten like porridge. The next stage in the evolutionary line is achieved when the pastry dough is spread over the saucer and the dish rim is used for sealing the upper crust. The pie then moves from half-moon or pocket shape to circular. It can still be lifted from the dish and eaten out of hand, but the new shape now requires the use of a knife to cut it.

Muggety Pie

The following is a traditional British pie of a highly regional type made with an unusual sort of mincemeat: sheep's pluck, otherwise known as sheep's heart.—Ed.

> Prepare a sheep's pluck by soaking in water and thoroughly cleaning. Boil for several hours, and when cooked, put through mincing machine; then add a few currants, season well, and flavour with parsley or spice. Mix well together, put into a pie dish, cover with good short crust, and bake three-quarters hour.

SOURCE: Edith Martin, *Cornish Recipes* (Truro, England, 1937), 38.

An alternative form, which persisted into the nineteenth century (Leslie, 1857), was the saucer pie with only a thick upper crust. The baked pie was then turned out into a bowl with the top crust down so that it could be broken up and eaten with the fingers or so that milk could be poured over it for eating communally with a spoon. In either case, the underlying concept is one of expansion: the small handheld pie evolves into something of larger size for communal consumption.

The Potpie

The deep-dish or potpie form evolved parallel to this and appears to have very old antecedents in military and seafaring diets. It was a pragmatic adaptation imposed by limited equipment, in this case the employment of an iron kettle or cauldron over charcoal or over an open fire. The interior of the pot was lined with dough and the pot filled with ingredients including small pieces of dough often referred to as dumplings, then sealed on the top with a pastry lid. The pie was more or less stewed until thick inside its pastry cocoon, rather than baked, but like the one-crusted saucer pies, it too was turned out with its pastry parts and eaten communally with a spoon or piece of bread. The fish chowders of the North Sea Celts were prepared in this manner. Early American peach potpie conforms to this premedieval type, although the ingredients give it a thoroughly New World twist. If the potpie is taken one step further and prepared in a shallow dish, it is transformed into the sort of common two-crusted pie we know today. This is yet another possible line of evolution.

The potpie was especially popular on the American frontier, and the lore surrounding that historical role is rich. It continues to be a popular one-pot meal with many Americans even to this day, but it has evolved into a type of baked stew served with or without a largely ornamental top crust and has little resemblance to the rustic ancestral form once prepared in a large iron pot.

Two-Crusted Pies

In the context of English cookery, both types of two-crusted pies appear to have gained in popularity during the Reformation. They gradually moved from Sunday fare in the eighteenth century, to almost daily fare for farmers during the nineteenth. In both England and America, lard was the universal shortening ingredient for the crust. Butter was only used by the well-to-do. One of the most common types of round, two-crusted pies was also the cheapest: pies made with apple fillings, either from fresh apples or from dried apples soaked in hot water or cider. The apple pie was such standard fare in British and American farmhouse cookery that it became a symbol for the cookery as a whole.

Pies Derived from Tarts

The two other types of pie in Anglo-American cookery derive from quite divergent origins. The first is the shallow pie without top crust (or ornamented with a latticework crust). These are often referred to as tarts in old English cookery books, and in fact derive from flat cakes covered with a filling. This category of pie includes fruit tarts and baked puddings, the most famous of the latter being American pumpkin pie (technically a custardlike pudding). It also appears in the blurring of distinctions inherent in such Americanisms as "pizza pie," a linguistic attempt to make a traditional Mediterranean flatbread conform to older Anglo-American notions of pielike things. The pizza is, after all, cut up into pieces and eaten out of hand.

The Raised Pie

The fifth type of pie is the raised or standing pie. This type of pie reached its zenith during the Middle Ages, when it served as an *entremet* or showpiece for banquet entertainments. In this case, emphasis was not so much on the taste as on the spectacle it created when brought to table, for there are many well-documented instances where pies were constructed to resemble castles, or built to encase whole roasted animals, or which popped open to reveal musicians, or served as a temporary prison for the four-and-twenty blackbirds mentioned in an old children's rhyme. The crust of such pies was incidental as food, and normally consisted of coarse flour mixed with hot water until it could be molded like clay. It baked hard and was given to the hounds or to the poor.

The game and fish pies of the Victorian era baked in copper or tin molds are lineal descendants of this old culinary tradition. In fact, several English china manufacturers created serving pieces imitating the color and shapes of elaborate game pies. These ceramic substitutes dispensed with the trouble and unpredictability of crusts assembled by poorly trained cooks, and of course they could be used over and over as needed. Like elaborately crusted pies made of real pastry, the expensive china ones also served as the focal point for festive occasions, such as Christmas, a hunt luncheon, or a wedding.

However, the standing pie of greatest importance in English cookery appears to have been mincemeat, and the elaborate construction of the crust was no less important than the spiciness of the filling inside. The Reformation did away with sumptuary restrictions; thus mincemeat could be consumed all through the winter. In fact, it became a fixture in winter cookery both in Britain and America. Diaries from the eighteenth and nineteenth centuries often mention baking large numbers of mincemeat pies for storage in a cold pantry and then consuming them as breakfast, dinner and supper fare. Ground beef, suet, chopped apples, and dried fruit (commonly raisins) formed the core ingredients and doubtless provided high-energy food for hardworking farmers. This common man's mincemeat pie devolved from the elaborate standing crust of a manorial Christmas feast to the sort of old two-crusted affair tracing its origin back to the pocket pie. Indeed, pocket pies filled with mincemeat also served farmers as snacks in the field, their convenience and practicality ensuring the survival of the form into this century under the dialect name of pasty (also called fried pie), especially in eastern mining towns and in the American upper Midwest. Pasty is also a term used for the leek-and-potato pies of Cornwall in England.

The Pie as a Styled Centerpiece

There has been a noticeable evolution down through the centuries in the presentation of pies as culinary centerpieces to the formal dessert course. Part of this is due to the ever-changing role the pie has played as a symbol of wellbeing and status. In fact, the treatment of the pie probably mirrors larger shifts in social values about food, indeed even the philosophical aspirations of the beholders.

The medieval standing pie, with its elaborate detail, gilding, and highly artificial appearance doubtless reflected a sense of suppressing nature through art. The choice of ornamental themes definitely appealed to medieval idealism and a fascination with romantic anachronisms—such as the popular tale of the fish-woman Mélusine. This boisterous artificiality is certainly carried down into Renaissance and Baroque cookery, but by the same token, it is obvious from period paintings and prints that pie bakers were also masters of crust design. Even small pies were meant to be studied up close, and therefore they were covered with neat, tight patterns as crisply executed as sculpture. The farmhouse pie was never quite that elaborate, but it was a centerpiece and a measure of the housewife's cooking abilities. So her crusts were no less neat, even if only ornamented with a careful rim and the so-called "bird-track" patterns commonly seen in nineteenth-century prints. This preoccupation with fine detail was important to a world in which everything was made by hand: the more artificial, the more sculpted, the more it stood out as a thing of beauty.

Industrialization changed this attitude dramatically. The craftsmanship of pie baking was replaced by the industrial pie sold frozen in tin pans, the crusts pressed out by machine. Therefore, in the early twenty-first century, the rustic look is in. Large, crudely executed patterns, clumsy rims, crusts indeed much too thick for the pies

METHODIST MINCEMEAT

Why eat mincemeat? It is a symbol of Christmas luxury, and therefore deeply embedded in religious sensibilities, at least in the English-speaking world. Rather than reject it on grounds of high church decadence, the object of some Protestant groups became to reform it, that is, to bring it in line with their shifting religious values. This reform was undertaken on two fronts, although they overlapped considerably. One was to eliminate alcohol, the other was to abjure the "carnal kitchen"—the consumption of meat. Temperance and vegetarianism come together in the following working-class version of Christmas luxury purified of sin.—Ed.

Yield: one 9-inch pie or 12 tartlets
Short crust
1 large lemon
8 tablespoons unsalted butter
½ cup brown sugar
1½ cups dried currants
3 large apples
⅓ cup lemon juice
2 teaspoons ground cinnamon
¼ teaspoon ground clove
1 teaspoon freshly grated nutmeg
½ cup chopped candied citron

Line the pie pan or tartlet pans with short crust. Remove the pithy membranes from the lemon and cut the rind into quarters. Place the rind on a saucepan and cover with boiling water. Simmer 20 to 30 minutes, or until the rind is tender. Strain, reserve the lemon rind, and discard the bitter water. Chop the rind very fine in a food processor.

Preheat the oven to 350°F (210°C). Melt the butter in a deep stewing pan, add the sugar and currants and cover. Stew the currants until they are plumped. Pare, core, and chop the apples, and add them to the currants together with the chopped lemon rind, the lemon juice, and the spices. Cook for 15 minutes, then add the citron and remove from the stove.

When the filling is cool enough to work with, fill the pie shells and cover each with a top crust. Bake in the preheated oven for approximately 25 to 30 minutes; the tartlets will bake in about 20 minutes.

SOURCE: William Woys Weaver, *The Christmas Cook* (New York, 1990), p. 42. Adapted from a recipe in the *Methodist Christian Advocate and Journal* (New York), 16 November 1827.

Classic Lemon Meringue Pie

Recipe of Cecilia Rubio, Perris, California, and 1987 national winner of the Crisco American Pie Celebration contest.

Yield: one 9-inch pie
one 9-inch pie crust pre-baked and cooled.
Filling:
1½ cups sugar
¼ cup cornstarch
3 tablespoons all-purpose flour
¼ teaspoon salt
1½ cups hot water
3 egg yolks, beaten
2 tablespoons butter or margarine
1½ teaspoons grated lemon peel
⅓ cup plus 1 tablespoon fresh lemon juice

Meringue:
½ cup sugar, divided
1 tablespoon cornstarch
½ cup cold water
4 egg whites
¾ teaspoon vanilla

Preheat the oven to 350°F (210°C). Assemble the filling by combining the sugar, cornstarch, flour, and salt in a medium saucepan. Add the hot water, stirring constantly. Cook and stir over a medium heat until the mixture comes to a boil and thickens. Reduce the heat to low. Cook and stir constantly for 8 minutes, then remove from the heat. Slowly add about 1/3 of the hot mixture to the egg yolks and mix well. Return this to the saucepan and bring to a boil over a medium heat. Reduce the heat to low and cook 4 minutes, stirring constantly. Remove from the heat and add the butter and lemon peel. Add the lemon juice slowly so that it does not curdle the mixture, then spoon the mixture into the pre-baked pie crust.

To prepare the meringue, combine 2 tablespoons of sugar with the cornstarch and cold water in a small saucepan. Stir until the cornstarch is fully dissolved, then cook and stir over a medium heat until the mixture is clear. Set aside to cool.

Combine the egg whites and vanilla in a large bowl. Beat until soft peaks form, then beat in the remaining sugar, adding it 1 tablespoon at a time. Combine the meringue with the cornstarch mixture and beat until it forms stiff peaks. Spread this over the filling so that it completely covers the pie and seals it at the edges.

Bake in the preheated oven for 12 to 15 minutes or until the meringue becomes golden. Cool to room temperature before serving.

they cover, nonetheless convey the immediate impression that they are handmade and therefore of greater intrinsic value than the commercial article. To the master pie baker of the past, these modern-day creations would appear as though flopped on the table by a child, but it is this very naïveté, this "country look" that modern food journals find so appealing as cover art subjects. That the pie is a perennial showpiece for the covers of magazines and cookbooks speaks volumes about its power as a food symbol.

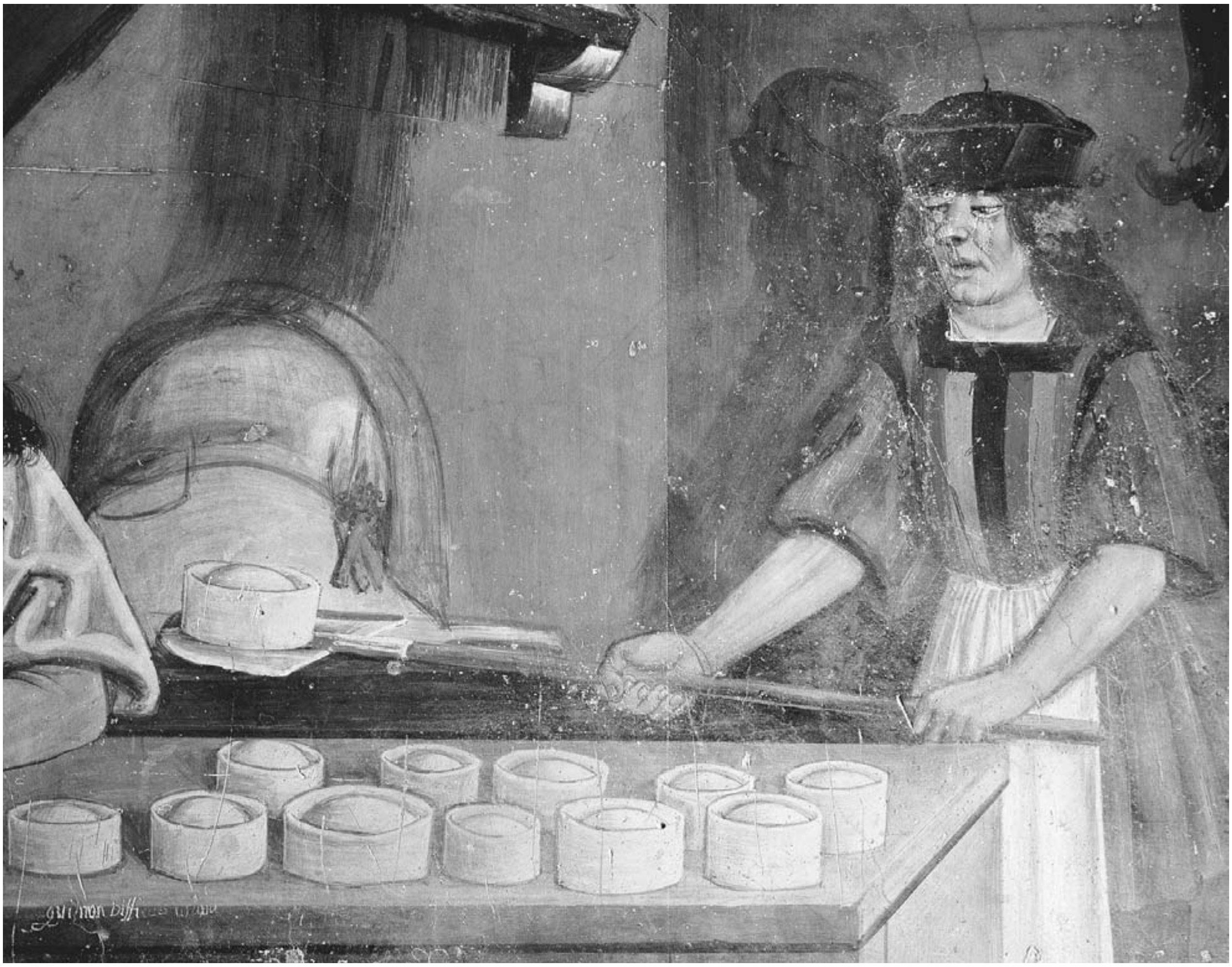
The Pie as Symbol: Motherhood and Apple Pie

It is no exaggeration to suggest that the pie is perhaps one of the ultimate icons of American cookery. This idea is not new. In an 1874 issue of the *Household* the editor made this comment:

> If we have a national dish . . . we suppose its name is Pie. The line between winter and spring is accurately defined in the minds of half the housewives in the country as the time when there is nothing to make pies of. Dried apples are used up, prunes are too expensive, and rhubarb has not yet made its appearance.

The pie became a symbol of American cookery because of its huge diversity and easy adaptability to seasonal dietary changes. There are pies for festive occasions: cranberry, mincemeat, and oyster pies for Christmas; pumpkin pies for Thanksgiving. There are pies for life cycle events, such as the funeral pie (otherwise known as raisin pie) among the Pennsylvania Dutch. And there are a great number of pies closely identified with regional cookeries, such as Boston cream pie in New England; pecan, sweet potato, and Key lime pies in the South; tuna pie (made with cactus pears) in the Southwest; and vinegar and molasses pies in the Midwest. Both of the latter pies were also known as harvest pies since they were served to field hands during haying and other harvest periods.

The harvest was one of the most evocative subjects for American art and literature in the preindustrial era, and images of pies are woven into that rich tapestry of food iconography. Industrialization did not destroy the pie's symbolic value, but rather transformed it into new images like pie à la mode (literally "pie in the latest style"), which married a scoop of vanilla ice cream to a slice of pie. This symbol of working class indulgence soon became an icon for diner and soda fountain fare. Likewise, the numerous meringue covered pies, originally referred to by the baking trade as pies in the "hotel style" (a



A late medieval baker prepares raised pies for the oven. The pies are filled with meats or fruit, or both. Fifteenth-century Italian fresco in the Castile di Issogne (Aosta Valley) in Northern Italy. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

metaphor for luxury food), achieved their greatest popularity as standard fare at diners and truck stops during the Great Depression. Homemade meringue pies were also featured desserts for church suppers, not to mention worthy material for pie baking contests.

The voluptuousness of a well-made meringue pie was not lost on Hollywood, since the culinary perfection it stood for could be converted into high comedy by means of the outbursts of pie throwing which occur in many old black and white films. We do not see apple pie (a symbol of patriotism) or mincemeat pie (a symbol of Christmas) thrown into peoples' faces. But meringue clinging to the cheeks of a wide-eyed blonde-haired woman elicited laughter, real and perhaps also somewhat nervous, because in the context of those times the image was unquestionably lewd.

See also **Baking; Cake and Pancake; Candy and Confections; Pastry; Pizza**.

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William Woys Weaver

PIG. Human beings eat more meat of the pig than any other domesticated livestock on earth, even with pig being a food forbidden to more than one billion followers of Islam or Judaism. This lowly beast, whose intelligence and cleanliness has been underestimated for centuries, is a prolific animal that quickly converts a variety of feeds to a mild-flavored meat. One of the first domesticated animals, the pig appears in oriental and Greco-Roman mythology as well as in the Torah, the Bible, and the Qur'an. Despite its utility as a source of food, leather, and pharmaceuticals, the word, pig, is an insult or gentle rebuke in many cultures. While the pig itself may not have grown more controversial, its modern, industrialized husbandry draws criticism from an array of opponents.

The Omnivorous Pig

The pig, *Sus scrofa domestica*, is a subspecies of *Sus scrofa*, the Eurasian wild boar. It is in the order of mammals, Artiodactyla, which means even-toed and hoofed. That order includes ruminant livestock such as cattle. Bacteria in the rumen help these animals digest cellulose in grasses. *Sus scrofa* is a member of the Family Suidae, or swine. These animals do not ruminate and cannot digest grasses. They are omnivores. In the wild, their diet is fungi, leaves, roots, bulbs, tubers, fruit, snails, earthworms, small vertebrates, eggs, and carrion. The Suidae family includes African bush pigs and African warthogs.

There are some three hundred breeds of domestic pigs. Most are endangered. In the United States, only eight breeds are widely used for commercial production: the Berkshire, Chester White, Hampshire, Duroc, Yorkshire, Landrace, Poland China, and Spots. The Meishan breed, developed in China two thousand years ago, was imported to the United States in 1989 for research and to add genetic diversity.

In common usage, most people make no distinction between a pig and swine, but the precise meaning of pig is "a young swine." The experienced swine breeder Kelly Klober notes that "what really separates the pros from the tenderfeet is how the word 'pig' is used. To be country correct, it is the term for a very young pig. A hog is a swine that weighs over 120 pounds" (Klober, p. 24). A mature female swine is a sow. A mature male is a boar. Barrows are castrated male pigs raised for slaughter. Gilts are immature females. Both are sold as "market hogs" at five to seven months of age and at weights of between 220 to 260 pounds. Mature hogs can grow much larger. Boars have topped one ton.

Use of the meat of the pig, known as pork, is also not without controversy. Until the early twentieth century, the hog was bred for fat, or lard, just as much as for meat. Later in that century, the saturated fats found in many types of meat were targeted as contributors to coronary heart disease. Breeding and changes in the way hogs are fed has made modern swine 30 to 50 percent leaner than in 1950. At the beginning of the twentieth century, the lard-type hog, nicknamed "cob rollers," was so fat that its stubby legs were barely visible.

Pushing the Chicken Fat Barrier

The leanest cuts of pork can approach the fat content of skinless chicken breast. According to U.S. Department of Agriculture (USDA) nutrition data cited by the National Pork Board, an industry group, a three-ounce roasted pork tenderloin has 4.1 grams of total fat, more than the 3.1 grams in a comparable portion of roasted, skinless chicken breast, but much less than the 9.3 grams in a chicken thigh.

Lean cuts of pork are also richer in some essential vitamins and minerals than other meats. Another USDA database lists broiled fresh pork as having .923 milligrams of thiamin, or vitamin B1, in a 100 gram serving (about 3.5 ounces). That amount is more than half of the recommended daily consumption of thiamin and ten times the amount of thiamin found in a comparable cut of beef and even more than the amount in chicken breast (0.070 mg). The body uses thiamin to metabolize carbohydrates, protein, and fat.

The Pig's Fatty Underbelly

For all of modern pork's improved qualities, the pig is still a source of less desirable calories. As much as two-thirds of each slaughtered hog is used for processed meats—hams, sausages, and bacon. These meat products can be much higher in fat and salt than the amounts considered healthy by the medical profession.

The Center for Science in the Public Interest in the United States characterizes bacon, hot dogs, and sausage, all of which can contain pork, as among the most unhealthy foods available, recommending that consumers buy bacon and sausage that has no more than 45 percent of its calories from fat and no more than 480 milligrams of sodium per serving. In a recent survey of products sold in grocery stores, typical pork bacon (which comes from a pig's belly) had a whopping 9 percent of its calories in the form of fat. Only certain brands of turkey bacon were truly "low fat." The pork bacon was lower than turkey bacon in sodium, however, with only 170 milligrams.

Lean or fat, the swine family is an old one, geologically and in the archeological records of early human agriculture and civilization. The swine family has inhabited the earth since about forty-five million years ago, when the horrific seven-foot-high entelodont roamed central Asia and North America. Like modern pigs, entelodonts had cloven hooves and were omnivores. Their scarred fossils show evidence of fierce battles. They had much smaller brains and may not have had the social herding characteristics of modern swine. They died out twenty-five million years ago and were succeeded by smaller direct ancestors of the wild boar and modern pig.

The Javan warty pig (*Sus verrucosus*) will win no prizes for good looks or sweet temper, but it is important for preserving the biodiversity of the species. It is found only on the island of Java in Indonesia. PHOTO COURTESY OF BIOS.

Older Than the Cow

The pig is one of the first domesticated animals: its remains in some archeological excavations have been found to date earlier than the bones of cattle. Agricultural settlements raised pigs in the Middle East at least nine to ten thousand years ago. In Jericho, one of the world's most ancient cities, archeologists unearthed domesticated pig bones in soil layers predating 7000 B.C.E. Archeological excavations in the East Indies and Southeastern Asia show evidence of domesticated swine at about the same time. The East Asian pig arrived in China around 5000 B.C.E. Some of the first written recipes for pork are from China, where the pig has been an integral part of agriculture for thousands of years, feeding on garden waste and table scraps in pens next to farm huts. Recent archeological evidence suggests that Neolithic farmers rapidly spread agriculture, and pigs, along the Mediterranean shore of Europe before 5500 B.C.E.

The pig appears again in the writing and art of first recorded history. Pork was a popular food in early dynasties of Egypt. The ancient Greeks ate pigs. The Romans were masters of smoking and salting pork. From the time of medieval Europe through colonial North America, pigs were allowed to forage for acorns, nuts, and other foods in the forest in a semi-wild state. In the fall, they would be rounded up, slaughtered, butchered, and preserved by smoking, salting, and curing. In the United States, the pig was the most popular source of meat through the nineteenth century. The westward migration of American settlers into what would become the Corn Belt in America's Midwestern states was the perfect marriage of an Old World livestock with the grain of native Americans. The diet of swine shifted ever more from woodland forage and scraps to corn. Not until the 1950s did beef surpass pork as the most popular meat in America. Increased beef consumption coincided with the rise of industrialized cattle feedlots and post-World War II affluence. With suburbanization came the popularity of backyard grilling of steaks and hamburgers.

Many of the breeds of swine raised in North America came from England, as their names, Hampshire, Yorkshire and Berkshire, suggest. Some of these English breeds are at least four hundred years old, according to both historical records and DNA studies.

Prolific and Efficient Meat Producers

The Spanish, too, brought hogs with them to the New World. The explorer, Hernando de Soto landed in what is now Tampa Bay, Florida, in 1539 with thirteen hogs. Three years later, the swine herd had grown to seven hundred.

This ability to multiply rapidly is a quality that endears the pig to some of the poorest farmers on earth as well as the most modern swine production complexes. A sow produces almost three litters of pigs a year, although 2.25 litters per year is more realistic on smaller, traditional farms. From each litter eight or more pigs usually survive. Sows on large commercial farms can produce nearly twenty-six pigs per year.

Not only are pigs prolific, they grow fast on modest amounts of feed. A pig easily gains a pound for every three to five pounds of feed it eats, reaching more than two hundred pounds in six months. In some intensive industrial swine farms, where pigs are confined in a small space with little to do but eat, feed efficiency has approached one pound of meat for every two pounds of feed—about the same as poultry. Pigs are much more efficient at converting grain to meat than cattle or sheep.

PET PIGS OF NEW GUINEA

Perhaps nowhere on earth is the pig so honored and well treated as in the highlands of Papua New Guinea—at least until it is eaten.

The great anthropologist Margaret Mead visited the Stone Age tribes of New Guinea and noticed that pigs there acted like dogs. "They assume all of the characteristics of dogs—hang their heads under rebuke, snuggle up to regain favor, and so on," she wrote in *Letters from the Field: 1925–1972*.

In this still primitive island nation south of the equator and north of Australia, the women of highland tribes rear pigs and treat them as well as their own children. They will even nurse a pig if it is orphaned. Women, children—and pigs—eat and sleep in huts that are separate from those of the men. The pigs are named, hand-fed, groomed, and fussed over if they become sick. Not until they are large are the pigs kept in a separate pen in the hut.

Eventually, though, the men slaughter some of these pigs in a ritualized sacrifice. Then the pigs become a feast for the tribal village. Pork and sweet potatoes cooked on hot stones add flavor to weddings, funerals, festivals, and other special events.

To Westerners, this may seem like bizarre, almost schizophrenic behavior. But within the context of New Guinea's tribal cultures, it is a bit more logical.

Pigs have great economic, political, and even mystical importance in New Guinea. They are symbols of wealth. They are used to buy a bride, for example. Pigs are sacrificed to appease ancestral spirits. Some tribes consider them humanlike—and humans, piglike.

Eating one's best friend does not seem so strange in New Guinea, where only a few decades ago cannibalism was practiced. And breast-feeding pigs is just a low-tech version of U.S. sheep ranchers bottle-feeding orphaned lambs. Valuable animals often receive loving care in many livestock-rearing cultures.

Even today, decades after Margaret Mead lived in New Guinea in the 1930s, the tribes there prize their pigs. At the turn of the twenty-first century, Jeff Tyler traveled to New Guinea for *The Savvy Traveler,* a public radio travel program and Web site in the United States.

Tyler joined a group of American and Australian tourists who visited a mountain village where a sow was ritually slaughtered. Village men, covered with black and ceremonial paint, clubbed the sow and cooked her for their guests.

Tribal warfare still continues in New Guinea. A local guide tells Tyler, "There is a reason for tribal warfares. The main reason is we fight for land. We fight for woman. And we fight for pigs."

Until the late twentieth century, pigs were weaned from their sow from about thirty-five to fifty-six days after they were born. From a birth weight of about three pounds, they would reach a weaning weight of about forty to fifty pounds by fifty-six days. After a short period of receiving a rich "starter feed" of grains, milk products, and perhaps medication, the pigs were ready to sell to another farmer who specialized in "finishing," or feeding hogs to market weights. Sometimes the farmer whose sows produced the pigs would keep the pigs and move them to another barn or pen to feed them to market weight in a method of production called "farrow to finish." (Farrowing refers to the action of a sow giving birth.) Farrow-to-finish production was typical of small- and medium-size "family farms" in North America. On some farms, farrowing took place in small huts big enough for one sow, placed in a pasture of alfalfa or other digestible forage. After 1950, farrowing more commonly took place in specialized buildings or modified barns.

The farmers who specialized in farrowing would cross several breeds of swine in order to produce stronger, healthier pigs that grow faster. This benefit from crossbreeding was called hybrid vigor. Farmers who specialized in feeding pigs for slaughter began to separate them by sex, so that the males and females could be given different feeding rations tailored to the nutritional needs of each sex.

Commercial Complexity

In large commercial farms, swine production is even more complex, having moved beyond the traditional one-site or two-site production system. On these farms, pigs are weaned at much earlier ages, sometimes when only ten to fourteen days old. This technique, called medicated early weaning, was developed in Britain in the 1980s by veterinary medicine professor Tom Alexander at the University of Cambridge. Alexander discovered that very early weaning could prevent a sow from passing certain swine diseases to the next generation of piglets. Weaned pigs are moved to separate nursery buildings, at enough distance to lessen the chance of infection by wind-born disease agents. The pigs are usually held in the nursery for seven weeks. before they are moved to another set of buildings for the "finisher-production" stage, where they reach slaughter weights.

In large pig farms, pigs are kept in small groups that remain isolated from older pigs. By avoiding the mixing of pigs after they are weaned, the risk of spreading diseases is lowered. Each week, while one group of pigs is moved from the site where they were born to a nursery building, another group is moved from a nursery to a finishing building, and yet another is moved out of a finishing building to the slaughter plant. After each group is moved, the building is washed and disinfected. To make this system work like a well-oiled machine, the farm or hog producing company must have 12,000 to 24,000 sows. This system can produce more than 600,000 market hogs a year.

Industrialized Production Spreads across the Globe

This multisite system of production has existed along with the more traditional ones, in which farmers raised only a few hundred or a few thousand pigs for slaughter. But at the start of the new millennium, multisite production was rapidly taking over the industry. In Corn Belt hog-producing states, individual families that ran grain farms still fed hogs, but only in the second and third stages of multisite production. The families no longer owned the pigs. Instead, they raised them for large companies, much as local entrepreneurs run franchise outlets for fast-food chains. The pigs were owned, from birth through slaughter, by large companies, including packers. The parent animals in this system are complex proprietary mixtures of breeds owned by a handful of multinational companies. By the late 1990s, more than half of U.S. production was in some stage of this "vertical integration," meaning that each step in hog raising is owned or controlled by one company. The multisite pig production system was becoming global, existing not only in the United States and Britain, but also in Canada, Mexico, Brazil, Chile, Spain, Germany, Poland, Italy, China, and France.

Many of these countries are also the top producers and consumers of pigs. China is the leader, producing 43.2 million metric tons of pork in 2002, more than half of the global production of 85.2 million tons. The European Union was a distant second, with 17.8 million tons. The United States ranked third, producing 8.7 million metric tons of pork. China's livestock practices supply the main reason the world eats much more pork than other meats. Of the world annual beef production of about fifty million tons, China raises only 5.8 million tons of beef.

Pigs Led to Slaughter

Just as pig farming has changed, so has the slaughter of hogs and the curing of pork. Hogs are trucked to packing plants where they are unloaded, held in pens to fast, and then slaughtered, most commonly by stunning with a high-voltage electrical shock. Then the carcass is hung by the hind legs from an elevated conveyor line, bled, and cut apart. The treatment of hogs before slaughter is both an economic issue as well as one of humane treatment. If the animals are frightened and stressed for a long period of time, lactic acid builds up in the muscles, affecting meat quality. Some breeds of pigs are more susceptible to stress than others and can produce pale, watery fresh meat. The swine industry has dealt with the problem two ways. First, it has bred hogs to exclude lines that produce poor quality meat when stressed. Second, the packing industry is changing slaughter methods to treat hogs more humanely, which also reduces stress.

Colorado State University animal scientist Temple Grandin has devoted her life to making the last few minutes of cattle and hogs as pleasant as possible. As a result of her studies of how animals react to new environments, both farmers and slaughter plants are starting to move pigs through curved chutes onto trucks, and out of trucks into the packing plant to prevent pigs from witnessing what lies at the end of the line. Pigs are instinctively frightened when forced into a confined space. In Denmark, slaughter plants are experimenting with stunning hogs with carbon dioxide gas, which may be less stressful than electrical shock.

Refrigeration is the modern method of preserving pork, even for most ham and bacon, which is injected with brine, smoke flavoring, and, usually, sodium nitrite to give the meat a pink color and to protect against the growth of toxins responsible for botulism.

The Art of Curing and Cooking Pork

Traditional methods of air curing, which may date to pre-Roman times, are still used in China, Europe, and the American South. Hams are made by covering the meat, usually from the upper rear leg or hip but sometimes from the shoulder, with salt, sometimes sugar, and flavorings for several days in a cooler. The meat is then smoked at room temperatures in a smokehouse for about ten days and allowed to cure for at least six months. Before cooking, traditional air-cured hams should be soaked in cold water to remove excess salt.

Exactly why so much of the pig is cured and made into bacon and ham, while less beef and lamb is consumed as dried or smoked products may be a question for archeologists, not historians. One theory about the popularity of cured pork, offered by the National Pork Board, is that pork is a mild meat that, having less flavor than some meats, readily takes on added flavors.

Fresh pork faces another obstacle when compared to flavorful cured meats. As it became leaner in the late twentieth century, the potential to make fresh pork less palatable by overcooking increased. With less fat in the meat, overcooking can make pork taste very dry. The habit of overcooking stems from consumer fears that rare pork risks exposure to the parasite that causes trichinosis.

The parasite has been virtually eliminated from pork in most developed countries. To be safe, food experts recommend cooking pork until internal meat temperatures reach 170 degrees Fahrenheit, or piercing to the center of a cut of cooked pork. If the juices run clear, the meat is done, and no further cooking is needed.

Fighting the Flavor Drought

Dry pork is just one factor causing a growing reaction against raising pigs in the industrial system. As North Americans and Europeans consume more natural and organic vegetables, grains, and dairy products, a market is developing for natural and organic meats raised on smaller farms, sometimes with methods that animal welfare organizations consider more humane.

In the United States, one company, Niman Ranch of San Francisco, California, hires farmers to raise pigs without antibiotics or growth hormones for sale to natural foods stores and upscale restaurants. These farmers raise pigs in pastures or on straw bedding in barns and sheds and periodically submit samples of meat to a taste panel to make sure that it is not too lean to be palatable. They use swine breeds that are not quite as lean as the crossbred hogs in large multisite hog businesses. After tasting this type of pork, *New York Times* food writer Marian Burros reviewed it as "so delicious it needed no seasoning beyond salt and pepper. . . . [The] meat was superior heirloom pork, suffused with a bright clean flavor, with none of the unpleasant aftertaste that pork often has" (September 1999).

Dry pork is less of a problem in China, where much of the pig meat consumed in that country still comes from small farms and traditional breeds that are not as lean as those from Europe. The western provinces of China, known for spicy Szechwan dishes, also produce a type of ham, Yunnan or Xuanwei ham, that is exported to Southeast Asia and Europe. Mu Shu pork, consumed in the northern provinces near Beijing, is a dish that is popular in the United States as well. This rural Chinese dish is a mixture of sautéed pork and diced vegetables that is wrapped in small, steamed pancakes and dipped in a sauce. Unlike in the West, where pork is eaten by itself, in China most recipes use it sparingly, cut into small pieces and mixed with other ingredients. Blending flavors of many foods, an important principle of Chinese cuisine, has stretched supplies of pork and other meats in times of scarcity. The preciousness of pork may also be why no part of a pig is wasted in China. Even the head of the pig continues to be served by some pushcart vendors and urban restaurants.

Fear and Loathing of Pigs

As beloved as pork is in many cultures, the pig is despised in the traditions of others. Many theories exist to explain why Islam and Judaism consider the meat of pigs unclean. To some followers of these faiths, the abhorrent nature of pigs is obvious. The animals often wallow in mud and look dirty. But pigs, unable to sweat, wallow in mud as an efficient way to stay cool. Nevertheless, their breeding conditions may have created a social stigma. Animal scientists M. Eugene Ensminger and R. O. Parker point out that because "close confinement was invariably accompanied by the foul odors of the pig sty . . . early keepers of swine were often regarded with contempt" (Ensminger and Parker, p. 1).

Anthropologist Marvin argues that the pig's downfall in the Middle East was economic. Pigs are costly to raise in the climate of the Middle East. They are more difficult to herd than the sheep and goats favored by the desert nomads who quickly adopted Islam. And there is evidence that over the past ten thousand years, the environment in the Middle East grew less hospitable for animals originally adapted to foraging in forests.

Harris contends that for Jews, "the food laws of Leviticus were mostly codifications of traditional food prejudices and avoidances" (Harris, 1985, p. 79). A book of the Torah, Leviticus was written in 450 B.C.E., long after swine herding and consumption had lost prestige in many other ancient near eastern cultures as well as in ancient Israel. He finds even more support for his theory in China, where pork-disdaining Islam failed to penetrate far. There, the pig complemented an agrarian ecology, eating stems, leaves and scraps from many vegetable crops, and in turn, being eaten.

Archeological digs in the Middle East give evidence that the pig was once worshipped as well as eaten. In early stages of Phoenician, Egyptian, and Babylonian civilizations, people freely ate pork. But as those civilizations matured, pork fell from favor. When the Greek historian Herodotus visited Egypt before 430 B.C.E., he saw that "the pig is regarded among them as an unclean animal so much so that if a man in passing accidentally touches a pig, he instantly hurries into the river and plunges in with all his clothes on" (quoted in Harris, 1985, p. 83).

The anthropologist Carlton Coon attributes the demise of pigs in this region of the world to deforestation and population increases. At the beginning of the Neolithic period, pigs could root in oak and beech forests. As human population density increased, Coon argues, the forests were cleared to make room for more farms, especially olive groves, and in times of famine and scarcity, pigs competed with humans for life-giving grain.

Pigs Provide More Than Meat

In the future, the economic relationship to cultural and religious taboos may be tested if pigs become more than a source of meat and go on to save more lives. Besides providing pigskin leather and byproducts with industrial uses, pigs are already a source of pharmaceuticals, such as insulin. Since 1971, pig heart valves have been used to replace damaged human heart valves. Pig valves are treated and contain no living cells, preventing rejection by the human immune system. Soon, genetic manipula-

SPAM

Spam might be described as the Woody Allen of the meat world. Like the American film actor, this small 12-ounce can of pork is a commercial success thriving on self-deprecation. In enticement, the rectangular block of pink processed meat sliding from the can onto a platter cannot contend with a juicy steak or a real ham. Consumer advocates cite it as an example of a high-fat food. The Oxford English Dictionary defines the adjective, spammy, as "consisting or tasting chiefly of 'bland' luncheon meat. . . mediocre, unexciting."

Spam drew widespread ridicule in the 1970s in a comedy skit on British television's *Monty Python's Flying Circus* when a Spam-pushing waitress was drowned out by a group of Vikings singing "Spam, spam, spam, spam. Lovely Spam! Wonderful Spam!" More recently, this trademarked brand of canned meat received a dubious tribute in the adoption of the term "spam" to denote unwanted e-mail, or unsolicited electronic mail messages. The association of the term with a food product may, in fact, have been overwhelmed by its new slang definition.

Even so, Hormel Foods Corporation, the maker and inventor of the original Spam, has profited on the sale of some five billion cans of the stuff, marketed in roughly one hundred countries, since its introduction in 1937 as "Hormel Spiced Ham." The Austin, Minnesota–based food company, founded in 1891 as Geo. A. Hormel & Company, pioneered the production and sale of canned hams in the 1920s. A New York actor, Kenneth Daigneau, won a naming contest by calling it Spam.

Spam is made from ham, pork shoulder meat, and a secret mix of spices. World War II turned this depression-era canned luncheon meat into a global product. Spam helped keep Russian troops from starving. It cheered the British palate. And it drew ribbing from U.S. forces in the South Pacific, where they named one encampment "Spamville." After the war, U.S. president Dwight Eisenhower admitted that he, too, ate his "share of Spam along with millions of other soldiers" (Hormel website).

In recent years, Hormel reports selling one hundred million cans of Spam annually in the United States, and another forty-two million overseas. Hawaiians are the top per capita consumers of Spam in the United States, at more than four cans per consumer a year. South Korea and the United Kingdom are the top overseas buyers of Spam.

In 2001 Hormel opened a 16,500 square-foot SPAM Museum in Austin, Minn. The following summer, it planned a media event with television stars; Barbara Billingsley, who played June Cleaver on the series *Leave It to Beaver,* was invited to present her favorite Spam recipe, "Overnight SPAM & Broccoli Cheese Strata."

Spam's notoriety has achieved recognition. An original Spam can is in the Smithsonian Institution's National Museum of American History in Washington, D.C. Spam inspired a book of haiku poetry, *Spam-Ku: Tranquil Reflections on Luncheon Loaf.* Meanwhile, the company valiantly fights misuse of the word "spam" for what it calls "unsolicited commercial email (UCE)." Hormel's "official SPAM Home page. The one in good taste," gives company policy: "We do not object to use of this slang term to describe UCE, although we do object to the use of our product image in association with that term." Hormel also prefers that the name of its trademarked food be capitalized as SPAM, while "spam" as junk e-mail should be lowercase.

The company seems to recognize that its original Spam is high in fat. With 140 of a serving's 170 calories coming from fat, those eating half of a can would have nearly exceeded the recommended daily intake for saturated fat and sodium. In response to these concerns, Hormel began offering SPAM Oven Roasted Turkey, SPAM Smoke Flavored, SPAM Lite, and SPAM Less Sodium with "the same great taste."

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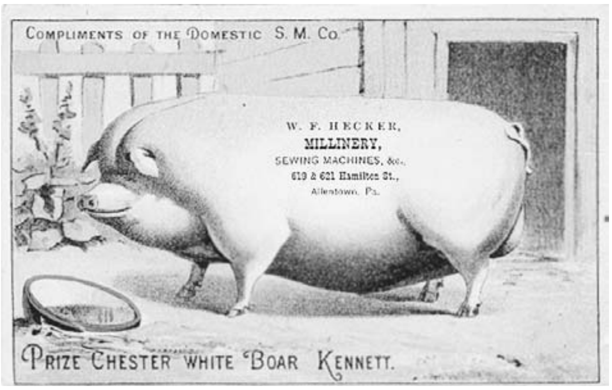
tion may allow transplants of whole, living organs from pigs to humans. Pigs offer an advantage over other animalsby closely matching those of humans.

Many scientific barriers remain, but in early 2002 two rival biotechnology companies announced a major step toward xenotransplantation (the transplanting of animal organs into humans). Both had cloned pigs that are missing a gene that causes an immune reaction in humans. The offending gene sets off production of an enzyme that makes a sugar that human bodies recognize as foreign. Pig organ transplants without the gene may be less likely to be rejected.



Trade card (circa 1883) showing a prizewinning Chester White boar named "Kennett." This breed of hog was raised primarily for lard, which explains why there is so much fat on the animal. Roughwood Collection.

Even in cultures that do not view pigs as unclean, xenotransplantation has vocal opponents, including animal rights activists and others who worry that this technology may introduce new viruses from pigs to humans.

The Pig in Myth

It remains to be seen whether pigs will physically become parts of humans. Symbolically, they have been transplanted into human culture for centuries, in medieval Europe, modern China, and ancient Mesopotamia. Pigs first symbolized deities, and later, human weaknesses and strengths.

In China, the pig is one of twelve animals symbolizing a year in a twelve-year lunar calendar. According to Chinese mythology, all animals were invited to race for this honor. A year was assigned to the first twelve winners, as each one finished. The pig came in twelfth. Just as westerners who believe in astrology tie personality traits to signs of the Zodiac, the Chinese attribute personality traits to the year in which they were born. Those born in the Year of the Pig (also called Year of the Boar) are said to be easygoing, sincere, tolerant, and honest. They are also considered naïve. Naïveté was linked to pigs in Homer's *Odyssey*, when Ulysses' men were turned to pigs by the sorceress Circe. While the men themselves were naïve, their behavior even before their conversion was almost piglike. They were attracted by Circe's sweet voice and lulled to complacency by her rich meal. Homer seems to use this tale to impart a sensuality to pigs, as well as a pig-likeness to the mariners. The pig was sacred to Aphrodite and an important image in Celtic mythology.

A vision of a sacred white sow was part of the legend of the founding of Rome. In Christian Europe, the sensuality of pigs came to take on a harder edge, an association with gluttony, perhaps because Jesus is depicted as casting demons into swine. The strong personality of the squealing, ever-present pig became a convenient device for the writers and fable makers of Europe in the eleventh through thirteenth centuries. Moralized fables called bestiaries made use of pigs to symbolize the Seven Deadly Sins, not just gluttony, but also pride, covetousness, lust, envy, anger, and sloth.

Pigs are recognized as intelligent, exhibiting a range of emotions and behaviors in real life just as in fables and mythology. For centuries, farmers have found herding and catching pigs difficult. This intelligence makes pigs a priority for animal rights organizations that challenge the methods of confining pigs in intensive industrial production, in which pigs are kept on concrete floors with slats that allow for the collection and flushing of manure into earthen lagoons or metal holding tanks.

Modern confinement appears clean compared to hogs wallowing in outdoor pens. The use of metal crates to restrict sow movement is humane, say the system's defenders, because it prevents newborn pigs from accidentally being crushed by a heavy sow. The U.S. National Pork Board's position on animal welfare is that "because the welfare of their animals directly affects their livelihood, pork producers work to ensure their animals are treated humanely. Anything else would be self-defeating." Some farmers are, in fact, beginning to revise their methods.

Attempts to Treat Pigs More Humanely

At the urging of farmers in Sweden, that nation in 1986 banned the routine use of antibiotics in raising animals for food. In 1988, it required that all animals used for food be allowed to behave naturally. Small metal stalls that restrict the movement of sows about to give birth were banned. Minimum space requirements for sows and boars were established for hog buildings. If pigs were housed inside, straw bedding was required, to absorb manure, to keep pigs clean and dry, and to give pigs a place to root, a natural behavior. In the United States, the Animal Welfare Institute, founded in 1951, has worked with farmers to set up voluntary use of Swedish pig-raising methods.

Straw bedding must periodically be moved onto farm fields to keep pig buildings clean. This requires labor that larger intensive farms may not have. Large farms flush manure with water into lagoons or tanks. That manure is also spread onto farmland as fertilizer. But critics charge that current environmental standards in the United States do not require the manure to be spread over a wide enough area and allow it to eventually build up excessive amounts of nutrients in soils that can wash into streams or contaminate groundwater. Spills of manure have already caused fish kills and stream pollution in Midwestern states. In 1999 a large hog-producing company in Missouri, Premium Standard Farms, agreed to pay $25 million to settle a lawsuit accusing it of violating the state's Clean Water Act.

Clearing the Air?

Untreated pig manure stored in open-air lagoons or tanks just plain stinks to neighbors and rural residents. In part because of complaints from rural voters, the Iowa legislature passed a law in 2002 that will require manure from confined hogs to be spread over more land. In a state with five times as many pigs as people (nearly fifteen million), the Department of Natural Resources is also developing a scoring system that considers community and environmental needs before the department approves construction of any more large hog buildings. Yet the law gives local governments no control of hog farm growth, critics say.

Adding low levels of antibiotics to pig feed may be the most serious environmental challenge from large-scale confined livestock. Feeding antibiotics has fostered antibiotic-resistant bacteria in livestock, including pigs. These antibiotic-resistant bacteria can be transferred from animals to people. Resistance genes may also transfer from one bacteria type to another more dangerous one such as salmonella.

In 1999, the Center for Science in the Public Interest, the Union of Concerned Scientists and several environmental groups petitioned the U.S. Food and Drug Administration to rescind the approval of agricultural use of antibiotics when their use endangers human health. Other groups supporting that view include the World Health Organization, the Centers for Disease Control and Prevention, and the American Public Health Association. Some of these antibiotics have been banned from feed in Europe.

Hygiene, humane farming, and health benefits and threats are among the many controversies surrounding the controversial pig, an animal that is likely to continue to feed the minds and stomachs of billions of humans as it has already for thousands of years.

See also **Cattle***;* **China**; **Folklore, Food in**; **Food Safety**; **Goat**; **Judaism**; **Livestock Production**; **Mammals**; **Meat**; **Middle East**; **Packaging and Canning**; **Sheep**.

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Dan Looker

PIZZA. Although it is one of the world's simplest and most popular foods, pizza is oddly difficult to define. Centuries of evolution have transformed it from the patties made of mashed grains that were its earliest antecedents into a dish that, though related to those early grain cakes, is almost unrecognizable as their descendant. Most significant is the change in the primary ingredient, from various coarse grains to a solely wheat-based dough, and eventually to a dish made almost exclusively with white flour.

However, though pizza has taken many forms, and its composition, toppings, seasonings, methods of preparation, and the equipment used to make it have altered radically over the years, it has usually been a flatbread baked at high temperatures.

Early History of Pizza

For millennia, pizza, a food of various origins and multiple styles, has played an important role in the diet of those who inhabited the land now called Italy. Neolithic nomads, the Etruscans from the North, and the Greeks from southern regions were the three earliest societies to develop pizza prototypes, for example, *focaccia*. Each group made small adaptations that changed the original product into a slightly more refined dish.

As early as the Stone Age, Neolithic hunter-gatherer tribal groups foraged throughout what would become Italy for wild grains, among them wheat varieties such as emmer and einkorn, as well as barley. Commonly first soaked or boiled, these grains were mashed into pastes and cooked on hot stones over open fires.

Later, around 1000 B.C.E., the Etruscans, a people of uncertain origin, introduced their flatbread to Northern Italy. Like the Neolithic tribes before them, the Etruscans pounded their grains. However, unlike their predecessors, the Etruscans baked their mash on stones and buried the stones in the ashes, creating smoky tasting bread. They further elaborated on the primitive Neolithic flatbread by seasoning the mash with oil and herbs after baking it. Though little more than rough slabs of cooked grain, these Etruscan flatbreads, among the earliest forms of this type of food documented, were often used as dough "plates" in lieu of dishes.

The Greeks, who had superior baking skills and technology, further advanced and elaborated on pizza during their 600-year (730–130 B.C.E.) occupation of the southern areas of the Italian peninsula. Like their predecessors, they produced a grain-based mash, but instead of placing the toppings on the cooked breads, they placed

Derivation of the Term “Pizza”

The word “pizza” simply means “pie” and is a Southern Italian derivative of the Roman term *picea,* both a bread itself and the ash-blackened underside of the Roman bread called *placenta.* Some say this term eventually evolved into “piza,” then “pizza.” Similarly, another flat bread, *pitta,* thought by some to have been introduced to southern Italy during the sixth-century Byzantine conquest, may also have influenced the modern day pronunciation of “pizza.”

them on the raw dough prior to baking, perhaps to ensure a more highly flavored dish. *Plakuntos*, for example, flat, round breads, were made with various simple toppings, among them oil, garlic, onion, and herbs. Additional Greek contributions included the use of ovens, instead of open fires, and the development of kneading, which produced a more digestible bread. Evelyne Sloman highlights early excerpts from Plato’s *Republic* that refer to meals created from barley flour kneaded and cooked into “cakes” with olives and cheese (Sloman, 1984, p. 5).

Although it is not firmly established, many also credit the Greeks with improving on the knowledge of leavening agents that came down to them from the Egyptians, and then introducing yeast into their own flatbreads. The Greeks also added a raised rim to the outside of their dough circles, to stabilize their dough “plates,” making them easier to hold, and, perhaps, even helping to keep the toppings in place.

Much later, the Romans combined the Etruscan and Greek techniques to create the pizza antecedent most like the pizza known today. They valued the intense heat the Etruscans achieved by baking their flatbreads below the fire, and they appreciated the Greek idea of preseasoning the dough. They also modified the Greek *plakuntos*. Known to them by the Latin term *placenta*, their adapted bread, though still round, was topped with cheese and baked on a wood-burning hearth. *Laganum*, a light, thin wafer bread, was also cooked on the hearth.

If the Greeks and Etruscans were primarily responsible for creating the prototypes of what was to become pizza, and the ancient Romans were responsible for improving it, it was largely the Neapolitans who brought it fame. Probably not coincidentally, the Neapolitans were responsible for the addition of the ingredient most commonly associated with pizza today—the tomato.

No one is sure of the precise reason, but it took well over two centuries from the time the New World tomato was introduced to the continent of Europe during the Columbian food exchange for Neapolitans, and various other inhabitants of the peninsula, to begin consuming tomatoes in quantity.

There are several theories about why adoption of a fruit that has almost come to symbolize Italian cuisine took so long. One argues that it was because tomatoes were believed to be poisonous, another that the earliest tomatoes were inferior and, therefore, eaten only in modest amounts until quality improved enough to make the fruit genuinely popular. In the area of Naples, for example, a key moment appears to have come in the middle of the eighteenth century with the development of a pleasing, large, and sweet tomato. The fruit quickly became the mainstay of Neapolitan pizza toppings.

It was also around this time, during the era of Bourbon King Ferdinando I and Queen Maria Carolina, whose empire included Naples, that one of the earliest pizza legends took root. In one version of the story, the queen (Marie Antoinette’s sister and the daughter of Empress Maria Teresa of Austria) is said to have been described by the king as having “common tastes,” apparently a quality thought to explain her love of pizza, a dish of the people. It is, however, a measure of the confounding nature of pizza lore that in a variant of the story, it is the king who relishes pizza and the refined queen who does not understand his passion.

Whichever of their majesties was the real enthusiast, the object of desire was probably flavored with lard (a less expensive alternative to oil), tomatoes, salt, and sometimes tiny eels, anchovies, or sardines. Over time, craving for this pie became so great that either the king, to gratify his wife’s yearning, or the queen, to gratify the king’s hunger, had a pizza oven built at the Capodimonte palace, so they could make the dish at home, an act that brought the pie even more attention. Pizza became the fashion, and other nobles followed suit, building pizza ovens where they lived.

However, it was not until 1889, a time when yet another ingredient is purported to have become part of the equation, that pizza began its march toward wide celebrity. It was then that inspiration is said to have struck Raffaele Esposito, a noted Neapolitan *pizzaiolo* (pizza chef), who decided to pay homage to Queen Margherita and King Umberto I of Savoia, the ruling house of Italy, by adding mozzarella to the traditional tomato and basil pie. The combination of red, white, and green suggested the colors of the Italian flag and saluted the United Kingdom of Italy, a gesture that for patriotic reasons is said to have made the pie a favorite of the queen.

Though most stories of origin give Esposito credit for adding cheese and thereby inventing the tri-color pizza, still known as Pizza Margherita, others deny it, believing that mozzarella had been used earlier. There is no doubt, however, that Esposito popularized the “made for each other” combination of cheese, dough, and tomato that produced a dish even more delicious than before, thereby setting the modest pie on a course to fame that he could never have imagined.

In Italy today, pizza exists in a number of regional styles, of which two of the most famous are the Neapolitan and the Roman. Both schools knead the dough, but *pizza alla Napoletana* is round, has a high border, takes diverse toppings, and is generally sold in pizzerias, while *pizza alla Romana*, also called *pizza bianca*, is more or less rectangular, often as much as a meter long, topped only with oil and salt, and sold by weight, primarily in bakeries and groceries, according to the size of the piece requested. Many other regions of Italy—Sicily, for example—also have distinctive versions of pizza. However, the popularity of the dish has meant that the styles are not always confined to the geographical areas in which they were created. Neapolitan-style pizza, for example, can be found in many places in Italy, as can *Pizza alla Romana*.

The Birth of the Pizzeria

From the beginning, pizza was rarely prepared at home because few people had the skill to stretch the dough properly or the money to build a wood-fired oven in which to bake it. Consequently, it was almost always bought from small stalls or from pizza sellers carrying their aromatic wares through the crowded Neapolitan streets. Some more elaborate open-air pizza stands offered slightly more upscale options, along with makeshift seating, but it was not until 1830 that the first documented pizzeria, that is, an inexpensive gathering place specializing in pizza and equipped with wood burning stoves, began doing business in Naples. It was called Port'Alba. Still in operation, its opening marked the birth of a style of eating establishment now known around the world.

The notion of a pizzeria as a fast-paced, economical restaurant has continued. In fact, the institution of the pizzeria is as critical to its vast global appeal as the food itself is.

The Development of Pizza as an American Icon

Although pizza is not exclusively Italian in origin, there is no question that from a cultural standpoint, it is an iconic food of Italy. Italians "own" this delicacy. Nevertheless, pizza in the United States may also be considered an icon food, perhaps even more so than in the land of its birth. The dish has become an American institution—embracing food-on-the-run, corporate enterprise, and American ingenuity, and it may fairly be said to be as representative of American foodways, food customs, and food choices as it is of Italian ones.

Pizza arrived in the United States in the latter half of the nineteenth century, along with a wave of largely southern Italian immigrants. Soon many of those immigrants were making their livelihood operating bakeries and groceries where they sold pizza alongside produce and staple ingredients.

The first real American pizzeria, opened in New York City in 1905 by Gennaro Lombardi, was located in Manhattan, at 53⅓ Spring Street. As with other early pizzerias, the clientele was composed predominantly of southern Italian immigrants, who wanted to eat their own dishes in a familiar and homey atmosphere. However, after World War II, when GIs returned from Italy well acquainted with pizza and other Italian foods, they forged a new and growing market for those foods.

Pizza has evolved from a relatively simple peasant dish into a vast array of preparations, including "gourmet" and vegetarian interpretations. © GERALD ZANETTI/CORBIS.

As is the case with so many other traditional Italian foods, pizza underwent significant changes in the United States. Thanks to the American postwar emphasis on excess and increased portion size, as well, possibly, as the desire of poor Italian immigrants to eat more copiously than they had been able to do at home, the delicate Neapolitan pizza was transformed. Formerly lightly embellished with tomatoes and other toppings, it was increasingly laden with an abundance of meats and cheese, sometimes creating slices weighing close to a pound.

Other differences developed in the United States, too. The pie acquired regional American styles, New York, Chicago, California, and New Haven the best known among them. New York pizza is cheesy and gooey, with a high, dense border and medium-thick crust; it can be bought by the slice or whole. California style has a very thin crust, adorned with an array of toppings unlikely to be found in Italy, ranging from goat cheese to tandoori chicken, to *moo shu pork* or bacon with pineapples. Chicago style is "deep dish," prepared in a pan, and based on a thick-crust pizza. New Haven style is somewhat similar to New York pizza, but is known especially for its white clams.

In addition to the regional pizzas available in the United States, ethnic variations exist. Because the costs of opening a pizzeria are relatively low compared with those of opening a more formal restaurant, the business of pizzerias has long attracted immigrants. In addition,

Preparation of the Pizza

Pizza preparation is simple, with few rules dictating a sublime product. The dough is made only with flour, natural yeast or brewer's yeast, salt and water. Dough is then kneaded either by hand or mixer, and the dough is punched down and shaped by hand.

Although most pizza is served as a round pie, a folded over variation, known as a calzone (or pants leg, so called because of the calzone's resemblance to the loose trousers once worn by Neapolitan men), is also popular. Originally from Naples, as is pizza itself, this style of turnover appears elsewhere as a *mezzaluna* (half moon) or *panzerotti* (stomachs). Additionally, there are double-crusted, or stuffed, pizzas filled with all sorts of meats, fish, vegetables, and cheeses. They are referred to by the same name as flat pizzas, but some argue that such famous examples as pizza *rustica* and pizza *pasqualina* come out of a different tradition entirely, one that dates back to the pies of Medieval times. In addition, there is a rolled variety of pizza called *bonata,* known to Americans as *stromboli.*

While standard toppings—among them, sausage, ricotta cheese, peppers, mushrooms, and meatballs—vary from region to region and city to city, the dough remains quite similar. Although any flour may be used, prized pizza is prepared using the high-gluten variety that produces strong dough that rises easily. Such flour, along with yeast, water, salt, and olive oil, creates the perfect dough.

Equipment

- Commercial pizza oven—may be wood, coal, gas, or electric, but ideally should achieve a temperature of at least 700°F. Pizza stone or quarry tiles (to supply intense heat) simulate a pizza oven's temperature for home use.
- Pans—pizzas are either first baked in round pans to secure the shape or baked directly on the stones or oven floor.
- Pizza peel or paddle—an elongated wooden or metal paddle used to place the pizzas in and remove them from deep ovens.

because pizza seems to be a blank slate inviting adaptation, Arabs, Chileans, Israelis, Greeks, Indians, and a diversity of other pizzeria owners often serve ethnicized versions next to traditional Italian pies. Depending on ownership, the menu may offer curried double-crust pizza, or pizza topped with feta cheese, or falafel. (It should also be noted that the same process occurs abroad. Pizza flourishes in Tokyo, Shanghai, Tel Aviv, Moscow, and other cities around the world.Though still associated with Italy or, perhaps, even the United States, the pizza itself often bears minimal resemblance to the original dish.)

Once a handcrafted art form, pizza in America (and often elsewhere) is now mass-produced by an overabundance of pizza chains that incorporate the technological advances featured in the monthly print-and-on-line trade journal *Pizza Today*. In 1951, just ten years after the Minneapolis-based members of the Totino family founded one of the first Midwestern pizzerias, that family initiated the frozen pizza business. In 1953, 100,000 stores were offering refrigerated or frozen pizza (Trager, 1966, p. 544), and at least 15,000 pizzerias similar to the Totino original were operating in the United States. Shakey's opened in 1954, Pizza Hut in 1958, Little Caesar's in 1959, and Domino's in 1960. In 1973, perhaps cashing in on the American attraction to anything French, Stouffer's introduced frozen French bread pizza.

In 1982, the California chef Wolfgang Puck joined the California food revolution and introduced his super thin–crusted, "designer" pizzas, featuring among other choices, a smoked salmon variety. This marked the beginning of the "anything goes" upscale and innovative pizza, completely characteristic of quintessentially American iconic foodways.

See also **Bread; Icon Foods; Italy; Take-out Food; United States: Ethnic Cuisines.**

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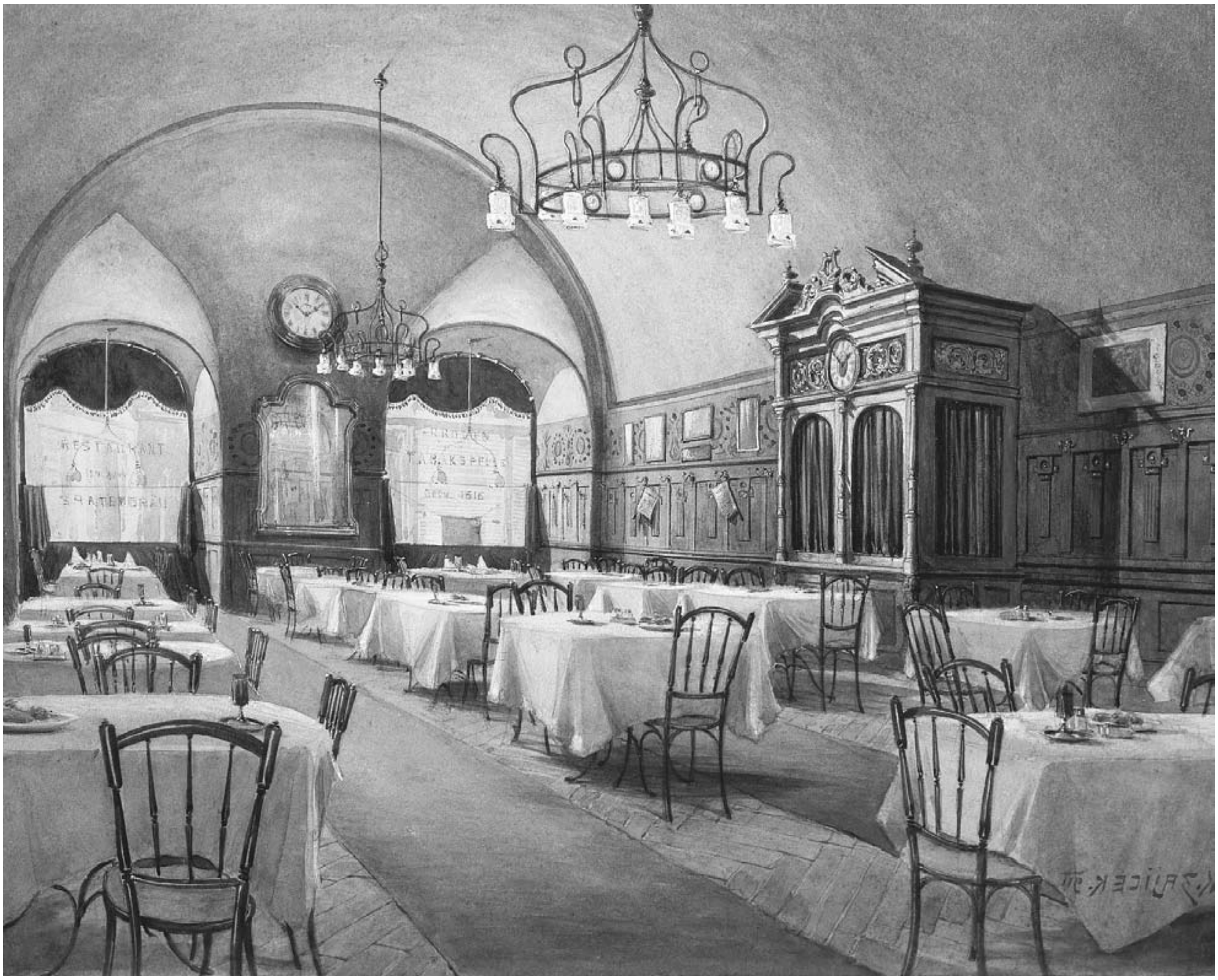
PLACES OF CONSUMPTION. A discussion of places of consumption should begin where food has been consumed since the beginning of humankind, in the home. In the twenty-first century in most countries the home remains the primary location for eating. That is not to say that the nature of the food eaten in the home has remained constant or that the preparation of the food has not changed. Even the formality and regularity of dining in the home was altered in the twentieth century.

During the nineteenth century and the early twentieth century in the United States, dining at home was usually regular (breakfast, lunch, and dinner) and occurred at the kitchen table or in the dining room. Food was often seasonal. The heaviest meal (dinner) was at noon or, if the breadwinner worked outside the home, in the evening. If the lighter meal occurred at night, it was called supper. The fare did not include a great deal of variety.

The improvement in the means of transporting food and people as well as the advancements in preservation markedly increased the places of consumption and the types of food consumed in much of the world. With modern transportation and refrigeration in mind, this overview examines places where people eat, starting with the contemporary home, moving to the world of work, touching upon the varying modes of travel and places where people play, and concluding with the increasingly vast array of dining-out possibilities.

The Home

The sit-down meal three times a day at set times is disappearing. Although such mealtimes happen, they are becoming a rarity in technologically advanced societies, where mothers and fathers work and children come and go more freely. The family eats when there is time and often not together. Dress is casual. People eat at the



The interior of a typical nineteenth-century Viennese restaurant by artist Karl Josef Richard Zajicek. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

kitchen counter, in a breakfast nook, in front of a television, in bed, on the porch, on a patio, on a lanai, or in the yard. The dining table has become a catchall that is only cleared for company. Food is seldom prepared from "scratch." More often than not the food is semiprepared in the cupboard, the refrigerator, or the freezer. Ready-to-eat meals are found in supermarkets and delicatessens.

The mainstay of the diet in the United States and most other countries of the world, is the sandwich, which competes with the rice ball in Asia. It can be prepared quickly and can be eaten in any room or while walking. Traditionally, bread forms the basis of the meal, but the tortilla wrap is making inroads. Fillings vary, and the most common in the United States are peanut butter and jelly, tuna, meat slices, and cheese. Each of these fillings alone may form the basis of the sandwich, or each may be combined with one another, other fillings, vegetables, and condiments.

Take-out meals may be purchased from most restaurants, and ethnic foods, such as Chinese, Thai, and Mexican, are especially popular in the United States. Pizza is a favorite either ordered and delivered or frozen ready to heat and eat. Barbecues are frequent in sunny climates and are not unusual in colder ones, where the cook must bundle up to prepare the main course.

Entertaining at home is usually informal. The dining table, kitchen counter, or cooking island may serve as a buffet table. While complete meals may be served, "heavy" hors d'oeuvres are not uncommon because guests can consume their meals standing. If dinner guests are seated for a traditional meal, the number invited is usually limited to one or two couples. This is not the case for family gatherings, when substantial meals are served and guests find seating either at a large table or throughout the house.

In sum, whether preparing food for the family or for guests, contemporary home cooking utilizes the many available shortcuts to delicious cuisine. It should be noted that worldwide the less advanced the society, the more traditional the meals at home.

The Workplace

For most of the workers of the world, lunch is the meal most frequently consumed at work. Traditionally it was brought to work in a paper sack or a lunch pail. Among blue-collar and white-collar workers the principle source of nourishment was the sandwich. In Asian countries the rice ball was most common. While this custom continues to some extent in the twenty-first century among blue-collar workers, white-collar workers generally purchase their lunches either in the workplace or nearby.

White-collar workers usually work in office buildings with many other personnel. Frequently the company that employs them provides a cafeteria or food machines for their convenience. A lunchroom is usually available with hot and cold running water, a refrigerator, and a microwave. Executives often have their own dining room, which comes with a dress code, a view, a higher cost, and presumably better food. Until the late twentieth century it was expected that food would be consumed away from the desk. This custom has been relaxed, and many office employees are allowed and encouraged to eat while working through their lunch hours.

Office workers have food choices outside their buildings. Many restaurants cater to the lunch crowd and offer quick service and specials. In areas where the work population is not so large and the location is more remote, lunch trucks service the workers. As in the office building, dress for the most part is working attire. Many blue-collar workers may bring their lunches because, particularly with construction workers, sites vary and the nature of the work produces a real appetite. Factories usually provide cafeterias, and lunch trucks are regular fixtures.

In the United States coffee is considered a necessity at any place of work. The coffee break is usually for fifteen minutes midmorning and midafternoon, even if the food consumed is tea, soda, or a snack. In a traditional office coffee was consumed in a break room. By the late twentieth century it was most likely enjoyed at a desk. Whether fresh-brewed or freeze-dried, coffee is provided when possible, often twenty-four hours a day. If that is impossible, most workers bring their own in appropriately insulated containers. While work sites around the world have similar customs, some substitute tea, and the younger generation prefers soft drinks.

Some work sites are so remote or removed from modern technology that food consumption requires high-tech preparation. The U.S. military frequently runs into this situation when its troops are in the field. The dried food of the past has been replaced by meals ready to eat (MRE). Whether eaten in a jungle or a desert, the MRE has generally received a positive response. Astronauts also dine in outer space on compacted and nonperishable food. Interestingly, advances made for consumption in these unusual sites have found their way into the modern home as convenience foods.

Some workers earn their living by driving, and they find restaurants along the highways as well as in the towns and cities they drive through. Although truck drivers can eat in their trucks, many of them want to get out of their drivers' seats and park their long, cumbersome vehicles. Consequently a place of consumption was created just for them, the truck stop. Known for its large portions, filling food, and affordable prices, the truck stop services truckers and other travelers interested in a casual yet substantial meal.

Many jobs are combined with travel, and the next section overlaps travel for work with travel for leisure. Like consumption at home, consumption at work reflects modern society. Even the more primitive cultures have access to some type of refrigeration and dehydration, making for a more varied working diet.

Traveling

The earliest form of travel was by foot. The fare was simple, was carried in a knapsack, and was eaten on the trail. Hiking is no longer a necessity, but it is a popular activity throughout the world. The variety of edibles contained in the backpack would astound early travelers. Trail mix, a popular edible designed for eating while walking, has appeared on grocery shelves for general consumption. Overnight camping can be high tech and effortless, but many hikers prefer cooking over an open fire for taste, smell, and aesthetics.

The modern automobile comes equipped with holders designed to facilitate consumption. Many workers carry a travel mug containing their hot or cold beverage of choice in the car for consumption on the way to work. Those who choose not to brew at home find convenient drive-ins featuring breakfasts and hot beverages. This continues through the day and evening as drive-ins and restaurants compete for automobile or roadside diners. Travelers by car have a food treat not afforded other modes, the roadside fruit and vegetable stand. Travelers may stop at the side of the road and enjoy the fruit or juice of the region. Eating in the car has become so common that Americans have developed a slogan, “Friends don’t let friends eat and drive.” The campaign is not likely to be effective because around the world the automobile is an exceedingly popular place of consumption.

Travel by air has prompted two places of consumption, the airport and the airplane. Airplane travelers expect food on long flights, although expectations are not high, even in first class. Perhaps because of the reputation of airplane fare, many passengers eat before boarding or buy food at the airport to eat in flight. Airports often feature regional cuisine that offers the traveler one last chance to enjoy a local dish, albeit an expensive one.

One of the lures to travel by train was the dining car. Trains around the world offered white tablecloths and the appearance of fine dining. While a few specialty routes offered fine fare and required passengers to dress accordingly, on most twenty-first century trains clothing is casual, and food is adequate. It is usually the view passing the window that makes dining on the train memorable. Like the airport, the train station offers food for immediate consumption or for the trip. Prices are more reasonable than at most airports. The food is varied, and in some locations, such as Union Station in Washington, D.C., and Grand Central Station in New York City, the station is a destination for dining, not just travel.

Travel by water also provides eating opportunities. Whether by ferry or luxury liner, food is available en route. Ferries usually offer drinks and snacks. Hot beverages are especially appreciated in colder climates. Luxury liners offer fine cuisine with appropriate attire and manners. Most cruise ships offer opportunities for more casual dining too. Passengers wishing an informal trip by water choose a freighter, often by its reputation for providing tasty food. In the Western world, yachts and small boats come with small kitchens. Eastern vessels may lack the kitchen but carry a small charcoal grill onboard. Traveling by sea seems to stimulate the appetite, even on the brief dinner cruise.

Whether traveling by foot, air, train, or boat, the modern traveler expects food and gets it. Of the four the traveler by boat is probably the best fed. Each mode may offer a splendid vista to gaze upon while consuming food. Of all the food consumers, travelers have the most exotic places of consumption.

Playing

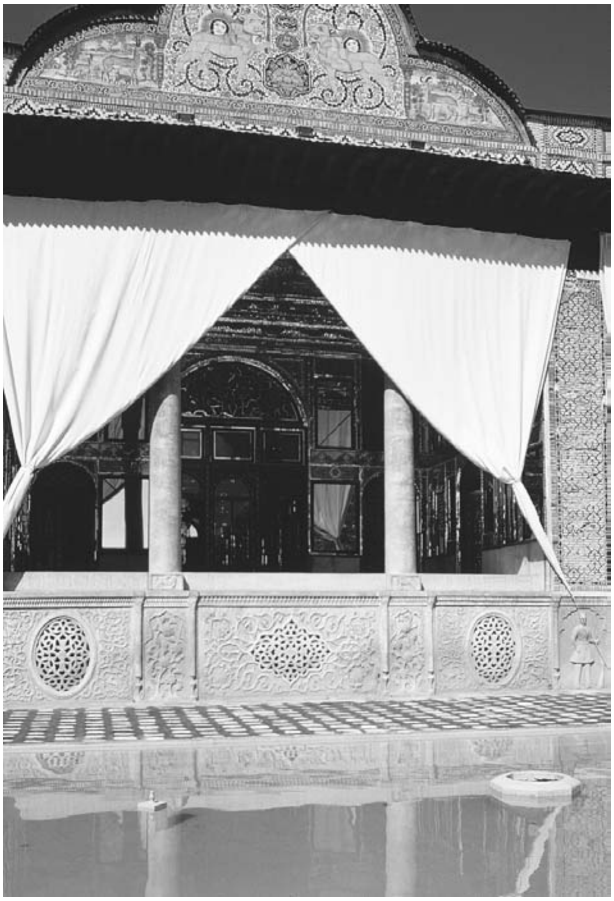
All work and no play is an old adage. Since the beginning of recorded history, the consumption of food has been an important component of play. This section features the variety of places where people eat and play, starting with some of the older pastimes still popular in the twenty-first century.

Fairs began as an annual event to celebrate the foods, crafts, entertainment, athletic prowess, and livestock of a given locale. Fairs have expanded to encompass states, countries, and the world. Food, such as candied apples and cotton candy, and the smells of barnyards and sawdust floors are unforgettable memories of many fairgoers. Fairs are not dress-up occasions in part because they are usually outdoor events held in temporary structures and tents.

The circus and later the carnival grew out of the fair. Both were situated out of doors and provided food for participants, notably popcorn, peanuts in the shell, and caramel corn. Today, there are fewer carnivals, and circuses have moved indoors. They have largely been replaced by television and theme parks. One outgrowth of the circus that seems here to stay and is found worldwide is the food circus, a grouping of food stalls featuring foods from around the world that can be enjoyed indoors and outdoors from Seattle to Singapore.

Athletic prowess has been celebrated by itself , as the long history of the Olympic Games testifies. Sports stadiums and arenas are traditional sites for food consumption. Baseball celebrates its memorable edibles—peanuts and cracker jack—in song. These staples have expanded to include hot dogs with mustard and sauerkraut and regional favorites such as tacos in the West and saimin in Hawaii. Other team competitions, such as football and soccer, include a variety of hearty snacks, regional treats, and lots of beer. The tailgate party precedes football games across the United States. With a distinctive regional flavor, food is often prepared adjacent to the car in the parking lot over hot coals and is shared with other sports enthusiasts. The lazy tailgater can find tailgate fare to go in the city.

The younger set also enjoys eating at the sites of their baseball, football, or soccer games. They do not provide the food, their parents do. More often than not the parents arrange a potluck. That way each family contributes,



Dining in shaded pavilions by cool pools of water has been a recurring theme in the history of Middle Eastern eating habits. This inviting enclosure is located at the Palace of Nerenjestan in Iran. © CORBIS.

and all share in the bounty. Athletic events seem to increase appetites and expand the places of consumption.

The street vendor has always existed around the world, in industrialized and developing countries. The food on each cart is limited, regional, and usually cooked at the site, and in underdeveloped countries it is often of questionable sanitation. For the brave the taste is delicious, but the suffering afterward may be keen. Tourist destinations, such as temples, museums, and historic sites, often offer an edible specialty of the area. It may have begun with priests and monks preparing food for the weary travelers. However, modern tourists expect to be able to purchase a drink or a snack upon reaching their destinations. If there is a specialty item to eat, some find it as exciting as the monument.

Natural beauty attracts visitors. Mountains, ocean beaches, deserts, lakes, and nature's curiosities draw crowds. With the crowds, opportunities to eat appear. When the sites are made into national or state parks, some aesthetic control is established. If not, places of consumption can be unattractive to the eye and to the palate as well as a distraction from the beautiful scenery.

The movie theater has carried on the popcorn tradition. Popcorn and soda are musts for most moviegoers. Twenty-first century theaters, like cars, provide holders for drinks. Theaters must be swept after performances to remove the litter caused by moviegoers eating in the dark.

Walt Disney created the theme park, and with its advent came new places of consumption. Within the theme park are restaurants, fast-food facilities, and vendors. As theme parks developed into adventure parks, the places of consumption continued to grow.

Many enjoy an opera, concert, or play. Unlike their neighbors at the movies or athletic events, they cannot eat during the production. They are offered an intermission, when wine, beer, or snacks may be purchased, but they must not be taken back into the theater or concert hall.

For many throughout the world, shopping is an enjoyable leisure-time activity, of which food is an important part. Shopping malls are replete with food to be eaten seated or while walking. Shopping centers offer family-style restaurants and fast food. Department stores often devote a floor to eating establishments. While grocery stores may offer free promotional samples, large wholesale food chains offer so many samples that customers can and do make a meal of the shopping expedition. Little doubt exists that eating and playing go hand in hand around the world.

Dining Out

The consumption of food in the home is more traditional in less-advanced societies, but highly technological societies have a vast array of dining-out opportunities and increasingly take advantage of them. This section introduces the myriad possibilities. The discussion is arranged from the most formal dining to the least and concludes with some special sites where food is consumed.

The finest dining, measured by expense and formality, usually occurs in large cities around the world. Such locations have dress codes that require men to wear suits or sport coats and ties. Women are monitored as well but, because of the nature of female attire, not as closely. In the most exclusive establishments, one must be appropriately attired to dine. Expensive but less-exclusive places offer men a "house" sport coat or tie. The emphasis on fine clothing is matched by the dress of and attention provided by the entire house staff, the quality of the china and tableware, the reputation of the chef, and most importantly the cuisine.

To afford the ultimate in exclusivity, private dining clubs are located around the world in major cities. Traditionally these were for men only. While this is no longer the case in the United States due to sexual discrimination laws, it remains a phenomenon elsewhere around the world. Private dining clubs are often affiliated with a leisure pastime, such as tennis, golf, or yachting. Patrons of these clubs usually have dining areas where they may eat in the attire of the sport. However, on special evenings the dress code can be formal. In private clubs the places of consumption are attractive to the eye, are furnished with style, and offer a view if possible. Interestingly, the restaurant with the finest view seldom serves the finest food. Nonetheless fine dining usually means the finest money can buy.

The moderately priced restaurant is found worldwide. In the United States it is often a franchise with set menus and standardized ingredients. Whether serving families or corporately owned businesses, medium-priced restaurants are found wherever people congregate or travel. They offer food of the region and food from locations far away. In the United States the foods of China, Mexico, Italy, Thailand, and Vietnam abound. In fact, Chinese food or something resembling it is available throughout the world.

Dress codes are not restricted to fine dining establishments. Medium-priced restaurants in beach locations often require a shirt and footwear other than rubber sandals. Shorts may be banned for both sexes. These restaurant owners obviously believe that the attire of the patrons is part of the ambiance of their places of business.

Outdoor dining is not as commonplace in the United States as it is in Europe and many countries in Asia. These establishments, called cafés, are generally located along city streets and offer dining inside and out. Coffee is always on the menu, and a cup of it alone can offer the patron an hour or two of street watching.

Specialty coffee shops serving latte, espresso, and cappuccino are popular places of consumption worldwide. Students study in them, senior citizens visit in them, and professionals dash in and out for a caffeine hit. The cost of both the coffee and the food sold therein is anything but cheap.

Around the world, bars and pubs (the word "tavern" is disappearing) are places to drink, to eat, and to congregate with friends. For many the neighborhood bar is a home away from home. While classic food items like pigs' feet and hard-boiled eggs may still be offered, hearty sandwiches and salty snacks are the norm. Visiting the sports bar with its wide-screen television is almost as good as going to the game itself. Some would argue that it is better.

In the technologically advanced twenty-first century people are in a hurry. Food is often eaten on the run. As a result, fast food eateries have flourished, especially in the United States, in every city, town, and village and along most highways. They are apt to be franchised with standard fare. Patrons may eat inside in clean, colorful, sparse, and plastic surroundings or, more the norm, may take their food home, to another site, or consume it in the car. The items most frequently offered include hamburgers, hot dogs, fried chicken, and a standardized version of Mexican food.

The drive-in restaurant appeared in the 1950s in the United States and afforded Americans a place to be waited on and to eat in the car. This novelty, just like the drive-in movie, has worn off and almost disappeared. It has been replaced by the drive-thru. The drive-thru offers fast food and is most often found in conjunction with a fast-food restaurant. However, depending on the part of the country, it may offer specialty items. In the Pacific Northwest, for example, the drive-thru latte abounds.

Caterers allow people to consume food in many locations where food is not prepared. Some examples are botanical gardens, meeting halls, aquariums, and outdoor sites. Many occasions, such as birthdays, anniversaries, showers, graduations, weddings, awards banquets, and even funerals, are celebrated with food. While they may be held in restaurants, many are catered in a variety of locales.

Whether dining in an automobile, a bar, or a bed, people around the world consume food several times a day. They appear to be limited in location only by their imaginations and the availability of food. Seldom does either limitation present a barrier to the consumer in the twenty-first century.

See also **Fast Food; Restaurants; Serving of Food.**

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Doric Little

PLATINA.

A noted humanist of the Italian Renaissance, Platina, born Bartolomeo Sacchi (1421–1481), is distinguished for culinary historians as the author of the first work on cookery ever printed: *De honesta voluptate et valetudine*, first in Rome c. 1470, without printer or date, then in Venice in 1475. Translation of the Latin title helps to define a central premise of the revolution in thought that broke with medieval traditions in fifteenth-century Italy. "On honest [meaning 'legitimate'] pleasure and good health" speaks of Platina's allegiance to new understanding and validation of the philosophy of Epicurus brought about from the 1430s by Lorenzo Valla, recognizing that rather than hedonism, it celebrated the creator's love for humans in sensory endowments if these were enhanced through self-control and moderation.

In addition to an Epicurean orientation, Platina underscored his devotion to another Greek philosopher, Pythagoras, by signing the *i* in his name as the Pythagorean *Y*, symbolizing the divided path at which one must choose virtue over its alternative; the conceit appears also in the funerary inscription he designed for himself and his brother (Rome, S. Maria Maggiore). From Sacchi's birthplace at Piadena near Cremona came his classicized name Platina, chosen in conformity with practice among fellow members of a premier Roman sodality of humanist scholars under the leadership of Pomponius Laetus, Platina's friend and neighbor on the Quirinal, near the ruins of the Baths of Constantine. Reformist ideas gained from early Church fathers and from pagan antiquity that invested the self-styled "academy" of the Pomponians added to Platina's problems in the curia of Pope Paul II. He was among those imprisoned and tried in 1468 for heresy, but shared in their return to favor under Sixtus IV from 1471. By 1475 Platina had been appointed chief administrator of the Vatican Library.

His treatise on cookery and good health seems to have been written and circulated in manuscript by 1465, following a summer spent with his patron, formerly his pupil in Mantua, the young Cardinal Francesco Gonzaga, as guests of the contemporary "Lucullus" of Rome Ludovico Scarampi Mezzarota, Cardinal Trevisan. The final six books of Platina's study are Latin translations of recipes acknowledged as those of his friend, Maestro Martino of Como, head chef to Trevisan. Added to Platina's advisories on principled well-being, essays on natural history, and Galenic medical lore inspired by humanist research in the writings of the ancient Roman agricultural writers, Pliny the elder, and Apicius (whom he calls "Caelius"), these final books or chapters enhanced the reputation of the work.

Platina/Martino remained in print until well into the seventeenth century, seeing Italian editions (often retranslating Martino's vernacular text) in 1487 and 1494, a French translation in Lyons by 1505, and one in German by 1542, plus at least fourteen Latin editions. Abetted by pirated editions of Martino (whose manuscripts were not edited until modern times) such as Epulario (Venice 1516, said to be by one Roselli and very influential in translation for Tudor England) and another by Clement VII's chef, Maestro Giovane, *Opera dignissima (et) utile per chi si diletta di cucinare* (A both elegant and practical guide to cooking; Milan, c. 1530), *De honesta voluptate* may be called the thinking man's guide to Renaissance foodways, as opposed to representatives of a courtly tradition.

See also **Apicius; Chef, The; Cookbooks; Epicurus; Italy; Pythagoras; Renaissance Banquet**.

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Phyllis Bober

PLEASURE AND FOOD.

The pleasure of food is the sensation of well-being that derives from the fulfillment of a natural instinct. Two essential elements are involved in food pleasure, the emotional and psychological tension created by the initial impulse or desire and the subsequent consummation of that inner need. Thus eating pleasure clearly corresponds with the two basic requirements of life, replication and sustenance.

Along the thresholds of pleasure, two distinct worlds intersect, the internal and the external. Pleasure from within is derived from a desire to satisfy the basic necessity of existence, while pleasure from without corresponds with the means of achieving that satisfaction. Both worlds are connected by the senses. Eating pleasure acquires enormous existential importance when confronted by the problem of the sensation or experience of living. This category of pleasure belongs to an area of the senses that is most basic and primal to the concept of happiness. In classical Greco-Roman culture it was consummated in the Greek *symposion*, where primal pleasure was linked to a Platonic communication of ideas—in other words, the intersection of physical pleasure with spiritual pleasure. The biblical Book of Ecclesiastes also arrives at this conclusion, where the pleasure of feasting and the pleasure of friendship are found to be the only human alternatives to the vanity of existence.

The superiority of eating pleasure over all other forms of pleasure is obvious, for it is related to needs that are more long-term and vital, embracing the entire life span, from feeding at the mother's breast to the final moment of existence. In human beings the pleasant necessity of eating is renewed daily, and because it is ineludible, it also transcends any moral code. On the other hand, since the human animal is omnivorous, the sensory stimulation must be infinitely varied to accede to this kind of pleasurable experience. This same rationale collaborates with hedonism so fantasy can develop its maximum potential. From this comes the popular expression of "creating a need from pleasure," which, when reworded in a more precise manner, ought to become "creating pleasure out of necessity." Is this necessity a requirement for pleasure? Pleasure is one of the rewards for eating.

In the initial approach to the pleasure of food, the first signal comes in the impulse or need to eat. Later the bodily senses direct the person to a means for satisfying this impulse. Finally, distension is created in the act of eating itself. Yet culturally this simple phenomenon becomes more complex than that, since the stimulation deriving from food directly intervenes in the need to eat to the point of provoking it. Consequently the pleasure of eating has evolved into an art, the art of food consumption, with the goal to contain, draw out, and direct in a more focused and concentrated manner the primal necessity of nourishment. Unquestionably the need for satiety and for satisfying the senses plays a role in the pleasure of eating. Human and cultural contexts also add to this. Out of these conflicting sensations evolved the perceived ties between the pleasure of eating and the source of the food (such as climate and geography) as well as diverse cultural ideas defining it.

Pleasure and Culture

Contrary to popular belief, the determining factor in the importance of food pleasure is not derived from the taste of foods produced in a given place but from their cultural contexts or definitions. For example, it is not the intense flavor of a homegrown orange that pleases, rather the idea that it is homegrown, which is a cultural value. Taste is chemical and biological; food pleasure is perceptional. Although pleasure derived from the act of eating is beyond question, its importance also competes with other forms of pleasure or other forms of interest current in a given social context. The availability of time, the relationship to other forms of pleasure, its ritualistic value, and its connection to health all help to define the hedonistic role.

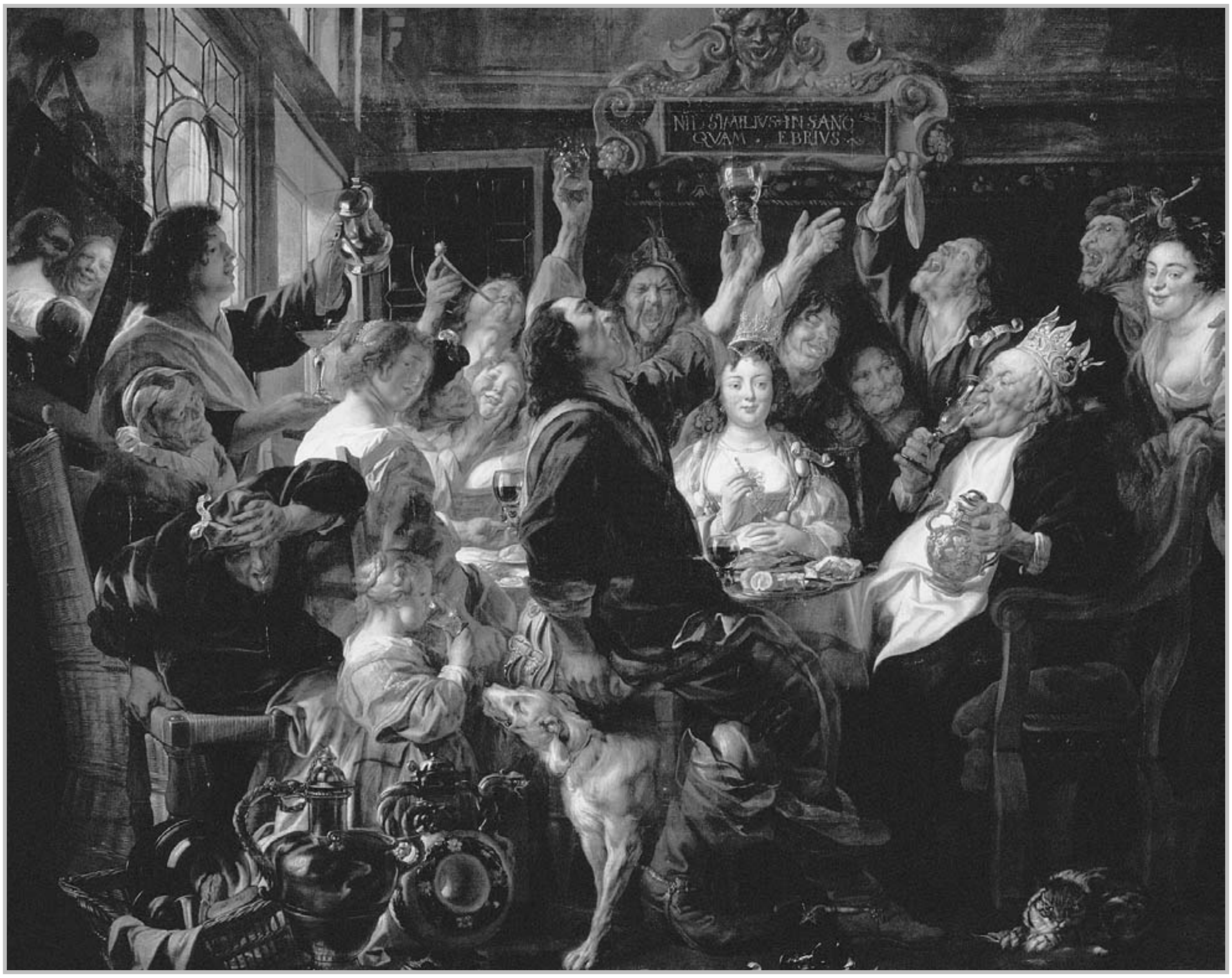
Using Western civilization as a point of reference, the excess amount of food available creates a problem in selecting and determining the line of preparation a person should follow with any given choice, which is one reason for the proliferation of cookbooks. All of this may increase the pleasure of creativity in the kitchen but not the actual act of eating. Cultures in which the sources of nutrition are more limited exhibit a realization that consumption must take place as soon as time and circumstance will permit. Indeed in primitive cultures hunting, gathering, and eating all day long was a necessity. Thus in those cultures all the potential for pleasure was concentrated in the act of daily nourishment, even if it was just one meal from a common pot.

In non-Western societies the act of eating is sometimes occasional because of the sporadic nature of food gathering as well as the difficulty of conserving food in areas of high temperature and humidity. When the sources of food become secure and predictable, the food itself propitiates the ritualization of meals at fixed times. Mediterranean culture is paradigmatic in this regard, since daily, family-oriented meals take place at set times. These times are referred to as "sacred" because changing the fixed pattern would cause an imbalance within family relationships and personal well-being. The intimate relationship between pleasure and necessity makes it difficult to know to what extent pleasure affects such eating habits, since it is normal for pleasure to accommodate itself to all nutritional possibilities.

Appreciating the determinate element in pleasure requires an analysis of all gratuitous and extraordinary factors that intervene in the refinement and culinary expression of food. Unusual or complex methods of preparation not justified by any other reason, the inclusion of spices and additives that are purely hedonistic, extraordinary ingredients, and the presence of stimulating beverages, such as wine and liquor, are all elements clearly associated with food pleasure.

Cultural Differences

The islands of Asia, especially Japan, have developed the visual elaboration of food to an art form. In continental cultures the importance of taste acquires greater emphasis. In the cultures of coastal regions with a mild climate, spices and herbs magnify the aroma of food. In the industrialized West closely managed food production and fixed times of consumption have altered pleasure with precooked or packaged meals. While this promotes growth for the food industry on a mass-market level, the elements of pleasure derived from the time devoted to preparation and consumption are diminished. Some examples of these elements are visual, as in Japanese dishes that resemble ikebana; intense flavor, as in the excessive heat in many tropical cookeries; the rich aromas of Mediterranean home cookery; and the infinite varieties of elaborate desserts available in all cultures. Yet food pleasure is mutable, and an inherent contradiction derives



The pleasures of tippling, heavy flirting, and good food are brought together in this memorable scene of a Twelfth Night feast painted about 1656 by Dutch artist Jacob Jordaens. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

from the fact that even microwave popcorn eaten in front of the television is pleasurable.

Each individual has his or her own pleasure values for food and alcohol, which for some is an actual addiction, such as chocolate, and for others a natural dimension of the extended food experience. The latter evolves into such things as wine as an aperitif before the meal, wine to embellish consommés, fish and meats, sparkling wines for celebrations, and sweet wines for dessert. Arguably wine is not necessary for food pleasure, for this is easily demonstrated in cultures that prohibit alcohol. The point, however, is that its pleasures are cultural, and where alcohol is perceived as part of the eating pleasure, it is employed to enhance it.

The evening meal has become by definition the most hedonistic, although the motives that give rise to this type of food pleasure may be quite diverse, such as business gatherings, a sentimental or romantic rendezvous, or celebrations and anniversaries. The classical symposium of the ancient Greeks has been preempted by restaurants and hotels, especially those meals of a ritualistic nature. An example is wedding banquets, which are common and are becoming more and more similar the world over. To this can be added specific religious life-cycle observances, such as baptisms, communions, circumcisions, funerals, and the like. In the more industrialized countries the pleasures of food and eating have been banished to the position of last, behind such factors as dieting for better health or weight loss, fear of contaminants, and minimal time in preparation and consumption. Much of this has been defined by the various artificial "styles" of consumption created by the food-packaging industry in such labels as "home style" and "Oriental style."

The Ritualized Pleasures of Food

Ritualized pleasure may be defined as the pleasure derived from the time designated for eating over the course of the day, and it varies greatly from one culture to the next. In Europe it is defined by breakfast, dinner, and supper, to which some cultures also add optional meals in between. Two of these would be the light aperitif and the late afternoon break or snack. Both follow purely hedonistic impulses, both are defined by economic status, and both are limited by such considerations as care of children, the sick, the elderly, or workers who may require more nourishment due to hard labor. The aperitif has a more social and hedonistic quality since alcoholic beverages play an important role.

The Pleasure of Beverages as Food

The problems alcoholic beverages pose derive from their double roles as mood-altering drugs and as hedonistic elements of food consumption. To begin with, the higher the alcoholic content, the more likely the beverage will be employed as a pleasurable drug rather than as an adjunct to food. Wine, with its infinite variations of aromas, tones, textures, and alcoholic content, is the beverage most used for pleasure at the table. Without a doubt it is also the beverage endowed with the most hedonistic associations, not to mention its intimate relationship with Judeo-Christian culture and Greco-Roman culture.

Liquors have a double origin in that they are often derivatives of other beverages of lesser alcoholic content, such as beer and wine. One of the major contributions of human ingenuity to the search for pleasure was the discovery that alcohol could be extracted from seemingly unlikely substances. Such is the case with liquors from cacti, milk, honey, seeds, or indeed any nutrient containing carbohydrates susceptible to alcoholic fermentation. These types of beverages with higher alcoholic content are the most distant from pleasures of the table because they are most like drugs, and many were in fact first employed as medicines. Wine alone is intimately associated with gastronomic culture.

Pleasure for Pleasure's Sake

It has been said that the human being is the only animal capable of detaching itself from the pleasures of the natural instincts that sustain life. In the case of food, since it is connected to a vital necessity, expectation induces excitement. Pleasure, separated from necessity, is aimed more at taste than smell, more to the scarcity and cost of the food item, and more to the capacity for satiety, including the dimension of danger.

The history of elegant and refined food is written with rare and costly materials, which become the criteria for cultural values. The Romans prepared dishes appreciated because of their rarity, such as peacock eyes, which later seemed absurd and repugnant. Some foods that were once scarce and thus greatly valued subsequently were later viewed as vulgar because they were everywhere accessible. This commonness lessened the pleasure of their consumption due to the loss of their exotic and sumptuous qualities.

Finally, the ultimate forms of food pleasure come to the element of extreme danger. Mushrooms have always posed a great risk due to the possibility of poisoning, especially in earlier periods. This fear has not detracted from their gastronomic interest, rather, the risk has made them all the more attractive. Risk has achieved an even higher level of refinement in the consumption of fugu, a Japanese fish that poses sudden death due to the presence of dangerous toxins its the entrails. A dish composed of this particular species of fish and prepared by a specially certified chef is a luxurious delicacy in Japan, a pleasurable mockery of fear that can be experienced in the intense tingling the fish causes to the lips and mouth. Here the delicate meal passes beyond the boundaries of mere satisfaction. It is no longer food; it is a victory over death.

See also **Acceptance and Rejection; Appetite; Eating: Anatomy and Physiology of Eating; Luxury; Sensation and the Senses; Sex and Food**.

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Alicia Ríos

Translated from the Spanish by
Enrique Balladares-Castellón

POACHING. The "moist heat" technique of poaching was very much a part of the recorded recipes of the ancient world. In one of the earliest cookbooks, the Roman Apicius's *De re Coquinaria*, recipes for delicacies like *Isicia Plena* (Dumplings of Pheasant) show that stiff forcemeat dumplings were poached in water seasoned with garum. And certain other savory and sweet recipes, like *Aliter Patina Versatilis* (A Nut Custard), instructed cooks to pour custard into molds to be placed into pans partially filled with hot water. After the invention of the printing press and the appearance of the first printed cookbook, *Le viandier* (1490), by the Frenchman Taillevent, the various aspects of poaching found a broader audience. However, it was not until the seventeenth century and the ever-increasing management of fire that poaching as a culinary technique gained in popularity. In 1651, with the printing of original cookbooks in addition to the collected works of the past, recipes began to integrate a repertory of techniques, basic mixtures, and raw materials. Lightly cooking certain ingredients in a small amount of liquid was not only part of a process of making a certain dish, but it also opened the possibility of refining the dish with savory sauces.

When Charles Ranhofer, chef of the famous New York establishment Delmonico's, published *The Epicurean* in 1893, various poached egg, seafood, and chicken dishes were featured as sophisticated menu offerings. Ten years later in his monumental cookbook *Ma Cuisine*, Georges-Auguste Escoffier listed 141 variations for *oeufs pochés* along with fifteen more recipes for cold preparations including *en gelée* and *chaud froid* dishes. And when Prosper Montagné published *Larousse Gastronomique* in 1938, he provided the formulas for several poached egg dishes beginning with *oeufs Aladin* (poached eggs on a mound of saffron risotto, garnished with sweet peppers, and napped with tomato sauce) and ending with *oeufs à la zingara* (poached eggs placed on oval fried croutons covered with thin slices of ham, and coated with Zingara sauce, a tomato-flavored demi-glace with a julienne of ham, tongue, and mushrooms). The same sophistication in the utilization of poached fish and poultry could be seen in recipes for *filets de soles à la normande* and *suprêmes de volaille*. And with the advent of nouvelle cuisine and especially *cuisine minceur* (calorie-defused dishes developed by the French chef Michel Guerard) in the 1960s, poaching various ingredients in flavorful liquids and substituting innovative vegetable and herb purées for sauces canonized the technique of poaching as a healthy trend.

In comparing the various examples of "moist heat" cooking, the amount of liquid, the timing, and the temperature are distinguishing factors. In poaching, the item to be cooked is generally submerged entirely in liquid, except in shallow poaching, when the item is only partially submerged in liquid and loosely covered with parchment paper. Timing is critical and depends on the size, density, and ripeness of the item to be cooked. The temperature for poaching registers between 160° and 180°F (71–82°C), and should always be maintained lower than a simmer (185°F [85°C]) to guarantee tenderness.

Although plain water or salt and vinegar-infused water is used in poaching, the liquids more frequently utilized in this cooking method are usually more flavorful. Stock, court bouillon, vegetable juice, vermouth, and various aromatics, such as herbs, spices, and citrus zest, contribute to the taste of the item cooked and also serve as the basis for a congenial sauce to nap the prepared poached fish, poultry, vegetable, fruit, or meat.

Unlike boiling, which requires only water, a pottery or metal pot, and heat to perform, poaching has acquired through the years a distinctive *batterie de cuisine*. An oblong covered pan called a poacher with handles at both ends and a convenient rack for lifting the prepared item from the pan greatly facilitates cooking a large fish. Egg poachers feature an insert with a specified number of round or oval, often perforated, cups to submerge eggs in a pan of water. Also used are metal rings that contain the entire egg when it is slipped into the water. A specific kind of shallow skillet with sloping sides called a *sauteuse* is used for poaching smaller items. And to insure even cooking and avoid curdling, various custards, timbales, and terrines are poached in their containers in a bain-marie, or water bath.

Poached Eggs

Instructions for poaching eggs are varied, many, and often contradictory. Some directions, for instance, recommend adding salt or vinegar to the poaching water; some call for breaking eggs into a saucer before lowering into the water; others for boiling eggs in the shell for ten seconds before breaking and poaching in water; still others for creating a whirlpool in the center of the pan and dropping each egg into it individually; and others for removing eggs and trimming them to the desired oval shape before serving.

The use of salt is debatable, although some chefs suggest that it speeds up the cooking process. Vinegar and acids, like lemon juice and wine, denature the proteins in egg whites and should be added to the poaching water. Breaking the egg into and as close to the poaching water as possible is the direct approach, but some cooks prefer the perforated cup method. Without exception, however, recipes for poached eggs advocate the use of the freshest eggs possible because the yolk membrane will still be strong, and the egg white will cling firmly to the yolk in a mass and not trail off in feathers. The older the egg, the looser the white becomes.Timing in poaching depends on the size and grade (Grade AA is preferable) of the egg, and the temperature of the poaching liquid. Some cooks suggest immersing in lightly boiling water and then, when the whites begin to set, reducing the water temperature to 175°F (79°C) or covering the pan and removing it from the heat. Cooking for too long a period of time, or with too hot a temperature, toughens the proteins. So attention to cooking time and water temperature is necessary, especially if the eggs are to be stored in fresh cold water for use later.

Recipes for poached eggs appear in almost every cookbook either as comforting food *pour un malade*, a display of the skill and inventiveness of the cook, or a staple of the breakfast/brunch buffet. Many distinctive dishes also are garnished with a poached egg, including the traditional veal cutlet dish Wiener schnitzel; the famous curly endive and lardon salad of Lyon, France; the American breakfast steak; and corned beef hash. In 1861, the Englishwoman Isabella Beeton suggested serving poached eggs on toasted bread or on slices of ham or bacon in her *Book of Household Management*. A hundred years later, avoiding what she called "that sodden toast," in *French Country Cooking* (1959), Elizabeth David recommended serving a poached egg on a purée of split peas, corn, or mushrooms, with fried bread on the side. And she included a traditional recipe for *oeufs Benedictine*, in which poached eggs are placed on a bed of creamed salt cod in individual flat dishes and napped with Hollandaise sauce. In *Simple French Food* (1975), an avid American practitioner of French cooking, Richard Olney, recommends preparing poached eggs and placing them in artichoke bottoms, topped with Mornay (cheese) sauce and surrounded by a julienne of lightly blanched vegetables (p. 101).

In the United States, serving poached eggs on a piece of toast covered with a slice of ham and napped with Hollandaise sauce translated into an American idiom when it was named after a Wall Street stockbroker (the term appeared in print for the first time in 1928). Lemuel Benedict reputedly used poached eggs, toast, and bacon sauced in Hollandaise as a cure for the extravagances of the "night before." In time Oscar Tschirky, maître d'hôtel of the Waldorf-Astoria hotel in New York, refined the dish by substituting toasted English muffins and ham for the toast and bacon, and by adding shaved truffles. Eggs Benedict was also served at Delmonico's restaurant in New York. The dish has not gone out of favor, but has been enhanced by many variations on the basic theme of a poached egg, toast, ham, and sauce blanche.

From the breakfast and brunch table to the buffet, chefs have devised multiple variations of *oeufs-en-gelée*, or cold poached eggs in jelly. Time-consuming but easy to make, jellied consommé or aspic is systematically added to a mold holding a poached egg and various garnishes until the mold is filled. After the final setting of the jelly, it is unmolded, and served.

Poached Seafood

Poaching is an ideal way to cook a large fish because no fat is used. The skin can be easily removed, and the delicate flavor and texture of the fish is preserved. The cooking process begins in cold liquid, usually a court bouillon (vegetable broth and wine) and is maintained at 176°F (80°C). If a fish poacher is too large, small whole fish, fillets, and steaks are usually wrapped in cheesecloth for easy removal and poached in any pan large enough to hold sufficient liquid to cover the fish. Some cookbooks also suggest poaching delicate fillets in melted butter in an enclosed casserole, but rather than poaching, the French call this technique *poêler*.

Because the poaching liquid is both flavorful and acidic, reduction and emulsified sauces can be made to nap the fish, however, the glories of French cuisine have been more traditionally displayed in the repertory of elaborate sauces—Blanche, Bordelaise, Diplomat, Dauphin, and Hollandaise—frequently prescribed for fish.

Delicate shellfish like scallops, oysters, and shrimp can also be poached in wine, aromatics, or in their own liquor. And seafood mousses in various-sized porcelain molds are always poached either on top of the stove or in the oven in a pan half-filled with water at 176°F (80°C).

Poached Meats and Poultry

Almost any tender cut of meat or poultry can be poached, and this technique offers an alternative to meats whose exteriors are browned and caramelized in the cooking process. Sweetbreads, eye of the round, small legs of lamb, duck and chicken breasts, and even beef tenderloins can be poached in stock, with or without vegetables, in a comparatively short time, and either served hot with a variety of sauces or served cold encased in a flavorful jelly or *chaud-froid* preparation. (*Chaud-froid*, literally "hot-cold," is a seasoned white or brown sauce to which gelatin is added; it is then spooned over fish or meat and glazed with aspic.) *Boeuf à la ficelle* is a classic variation on the traditional pot-au-feu, in which the beef tenderloin is tied with a string for easy removal from the poaching pan and served with vegetables and a reduction of the cooking stock. Formulas for finishing poached chicken breasts are as varied as the sauce repertoire for fish fillets, and again feature main course entrees as well as cold preparations.

A galantine is a dish made from the ground meat or forcemeat of poultry or meat that is stuffed into the skin of the chicken or duck of which it is made. Frequently the forcemeat is garnished with small cubes of ham, tongue, truffles, or pistachios. It is usually shaped into a cylindrical shape, wrapped in cheesecloth, tied with string, and poached in 176°F (80ºC) liquid until an internal temperature of 160°F (77ºC) is reached. When cool, the galantine is usually coated with aspic or a *chaud-froid* preparation.

Timbales, Terrines, and Quenelles

A large timbale (Arabic *thabal*, drum) is basically a preparation of forcemeat, meat, fish, or fruit baked with eggs and seasonings in a crust in a round mold with high sides. Small timbales are single servings of custards with forcemeat, shellfish, fish, puréed vegetables and fruits made in glass or porcelain round molds instead of a crust and poached in a water bath of 176°F (80ºC) in a warm oven. Nouvelle cuisine, especially, espoused a variety of flavorful puréed vegetable timbales which captured the essence of the flavor of the main ingredient.

Whether a terrine is made with well-seasoned goose, duck, rabbit, venison, pork, or liver combined with forcemeat or delicate shellfish, fish, and vegetable mousse, the rectangular mold in which it is baked in the oven should be standing in a water bath whose temperature does not rise above 176°F (80ºC). It is the gentle poaching that distinguishes the terrine from the pâté, which is baked in a crust in a hot oven.

Quenelles, on the other hand, are meat or fish forcemeat dumplings that are bound with eggs, either piped or shaped into their distinctive oval shape with two spoons, and poached in lightly salted water. Small shaped quenelles are often used as elements in various garnishes, such as *financière* and Toulouse. Larger quenelles, usually containing truffles, are used to embellish sizeable whole fish and other entrée presentations.

Poached Fruits

Although many nutritionists maintain that eating fruits raw provides the most vitamins, many out-of-season fruits or slightly under-ripe fruits can benefit from light cooking or poaching in a sugar syrup variously flavored with a cinnamon stick, cloves, orange, lemon zest, or vanilla. Cooking with the proper proportions of water and sugar firms the fruit, and when the fruit is lightly cooked and removed from the liquid, the fruit syrup can be reduced and thickened. At that point, fruit liquors, brandy, or rum can be added to the fruit sauce to reduce the sweetness and add more flavor. Fruits prepared this way make for simple but elegant desserts; however, poached fruits can also be glazed and served on meringues or cookies, or in custards or fruit tarts and compotes as in the classic Peach Melba and Pears Belle Hélène.

As a cooking technique that is almost ten thousand years old, poaching has always had a certain culinary cachet. Associated more often with feasting than with famine, the process of gently cooking delicate marrows, fish, shellfish, eggs, fruits, and certain kinds of poultry and meats in savory liquids has always lent finesse to various dishes, while, at the same time, exhibiting the skill of the cook.

See also **Beeton, Isabella Mary**; **Boiling**; **Chef, The**; **Delmonico Family**; **Eggs**; **Escoffier, Georges-Auguste**; **Fish**; **France**; **Gelatin**; **Health Foods**; **Sauces**; **Soup**; **Taillevent**; **Utensils, Cooking**.

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Joan Reardon

POISONING. Throughout history and across cultures food and drink have been used to deliver lethal poison. Since a person's demise from a slow-acting poison mimics so many natural diseases, and there is typically a time lapse between administration and expiration, this method made it almost impossible in early times to prove homicide. With the advent of chemical analyses for poisons (rudimentary arsenic tests were introduced in the 1840s) and autopsy, poisoning in the early twenty-first century, if suspected, is readily detected.

Poisoning in History

Since at least Greek and Roman times, there is historical documentation of poisonings. During the reign of Artaxerxes II of Persia (405–359 B.C.E.), it was said that his queen, Parsysatis, poisoned her daughter-in-law, Satira, by serving slices of fowl carved with a knife that had been coated on one side with venom. This allowed the queen to dine with Satira—Parsysatis reserving for herself the uncontaminated slices.

When selecting food or wine to serve as vehicles for poison, poisoners prefer a substance that will mask the bitter taste of the poison. Consequently, sweet foods were often selected. Wine had the advantage of preventing the victim from being on guard. Tea, coffee, hot chocolate, tarts (sweet and savory), jams, puddings, fruit pies, pastries, steak and kidney pie, chocolates, corned beef, porridge, and rice have all been used in poisonings.

According to medieval literature, many prelates, sovereigns, and pretenders or heirs to the throne were victims of poisoning plots. The murderers were most often from the victim's inner circle. In 1152, for example, Hugues d'Amboise was poisoned by a coterie of his knights at a banquet given by his brother. The historical heyday for poisonings was Renaissance Italy (1400–1700). So many deaths occurred that Romans hardly believed that any man of prominence or wealth had died a natural death. The legendary Borgia family, specifically Lucretia, gained a wide reputation for poisonings, especially of cardinals. Cantarella, a slow-acting poison, was said to have been dropped into food or drink, even sacramental wine. These murders were supposedly undertaken on behalf of Lucretia's father, Pope Alexander VI, who as head of the Roman Catholic Church was heir to the cardinals' estates. As these allegations were repeated, they became part of the historical record. More recently, they been revealed to be outright myth.

There are other instances in which an assumed poisoning has profound historical implications. When the exiled Napoleon Bonaparte died in 1821, his demise was at first attributed to stomach cancer, but examination of his hair has found the presence of arsenic. In the 1960s, the U.S. Central Intelligence Agency (CIA) devised a number of food- and drink-based poisons for assassination, including a lethal milkshake intended for Cuban leader Fidel Castro. Ultimately, the spy agency abandoned this, as the delivery system was too unreliable; it was thought to be much easier to get a target to inhale poisonous gas. In his 1962 autobiography, the late King Hussein I of Jordan relates his uncovering of a Syrian Intelligence plot to bribe his cook to poison his food. The tip-off: The untimely deaths of the palace cats, victims of the assassin's experiments.

Poisoning in Fiction

Poisonings have become the stuff of myth and legend, and a staple of mystery writers. The premeditation of the crime—acquisition of poison, calculation of lethal dosage, decision about which food or drink to use, preparation of the concoction, and making the victim consume it—adds to the insidiousness of the murder. In the fairy tale *Snow White*, a story that has survived for centuries in all European countries and languages, the wicked queen offers Snow White a poisoned apple that will induce a deathlike coma. The duel scene in Shakespeare's *Hamlet* features a poisoned cup of wine intended for the prince but mistakenly and fatally drunk by his mother, Queen Gertrude. In the 1941 American play "Arsenic and Old Lace," two seemingly innocent sisters in their sixties poison twelve men (a thirteenth as the curtain falls) with their homemade, arsenic-laced elderberry wine. In the 1996 literary mystery bestseller *The Debt to Pleasure* by John Lancaster, gourmet murderer Tarquin Winot suffers a brief setback when his intended victim turns down one of Winot's famous mushroom (Death Cap) omelets, saying he is allergic to eggs. After arguing that migraine is a small price to pay for gustatory pleasure, Winot recoups and whips up mushrooms on toast. In this poisoning, the food is not simply a disguise for poison, but the poison itself.

Gender and Poisoning

Although poisonings are committed by both men and women, they have been stereotyped as a female crime. In 1584, English writer Reginald Scot claimed women had invented poisoning and were "addicted" to the method. Nineteenth-century European writers, including criminologists, always profiled the poisoner as female. As recently as 1961, criminologist Otto Pollak claimed in *The Criminality of Women* that poison was the murder method of choice of most female offenders. Women's social roles as wives, meal-preparers, and caretakers, he argued, afford them unique opportunities to commit poisonings.

Royal Tasters

During the Middle Ages and Renaissance, fear of poisoning was so great that royalty required that their food and drink to be tasted in their presence before they would eat. The tasting—a complex ceremony—usually fell to the food-preparers and servers. For Charles the Bold, Duke of Burgundy from 1467 to 1477, for example, the kitchen steward first tasted all food under the watchful eyes of the house steward. Then, as each dish was uncovered before the duke, a sample was given to official plate-bearer for tasting. The butler was the last servant to taste the dishes.

Wine required its own ritual. The royal cupbearer poured the libation into not only the duke's glass but into a tumbler as well. The glass was immediately covered, and water was added to the tumbler, which was drunk by the cupbearer's assistant. Only then would the wineglass be placed in front of the duke.

Tasting practices were largely abandoned in the mid-sixteenth century, although the ceremony was retained until the seventeenth century. Tasting is still practiced in the early twenty-first century in some Middle Eastern countries and Thailand.

In some form, tasting rituals have been with us since hunter-gatherer days when it was by trial and error that our ancestors learned to distinguish toxic from nontoxic plants. In the 1990s, research on taste has identified a subset of people known as supertasters, most often female, who have the genetic ability to sense tastes more intensely. They are so supersensitive to bitter tastes (a characteristic of poison) that the flavor actually causes them pain.

Throughout the literature, there are numerous examples of poisonings associated not only with women but also with their adultery, magic, and witchcraft. The near hysteria that swept nineteenth-century Victorian England, generated by tabloid reports of trials of forty women for putting arsenic in their husbands' food, was misplaced paranoia. When death records were examined, it was found that spousal murder of all kinds had risen dramatically between 1830 and 1900, with about one thousand people being found guilty. More than 90 percent of these murders were committed by men, the result of beatings and stabbings; only twenty cases were poisonings of wives by husbands.

In the twentieth century, concerns about poisoning of both food and water came to focus on bioterrorism.

In a celebrated case in 1984 in The Dalles, Oregon, members of a religious cult inserted salmonella bacteria in salad-bar foods, provoking 751 cases of infection. The purpose (this was only a trial run) was to keep voters away from the polls in an election several weeks hence where a land-use issue involving the cult's property could have an unfavorable outcome. Intentional criminal poisoning was not suspected at first; it was proved a year later. A paper written on the case was not published until 1997 out of fear of stimulating "copy-cat" incidents. Two other cases in Asia in 1996 include a mass poisoning with cyanide inserted into a curry stew at a festival in Japan, killing four people and, in India, the contamination of rice at a canteen with datura, a poisonous weed of the nightshade family, causing fifty-two fatalities. In the wake of the terrorist attacks in New York and Washington in 2001, the possibility of intentional poisoning of the food and/or water supply is being taken very seriously, particularly where botulinum toxin, the most deadly chemical known, is concerned. Where heads of state and other dignitaries are concerned, this has translated into extensive background checks on food preparers, servers, and suppliers as well as x-raying of liquor and produce received by restaurants and close surveillance in the kitchen.

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POLAND. *See* **Central Europe.**

POLITICAL ECONOMY OF FOOD.

In the eighteenth and nineteenth centuries the term "political economy" referred to concerns classified under the discipline of economics. In the twentieth century Marxist and Social Democratic critics of the emergent discipline, who believed it was blind to systematic social inequalities, primarily used the term. In the twenty-first century inequality, both national and international, continued as the hallmark of any work identified with the tradition of political economy.

Three kinds of work typically are classified under the rubric of political economy of food. The most widely recognized is political economy of hunger, especially the work of the Nobel laureate Amartya Sen. A second group concentrates on food fights between great powers, such as the conflicts between Japan and the United States over rice imports into Japan. The third group focuses on the development of underdevelopment, that is, processes by which poor nations are kept poor.

Political Economy of Famines

Sen and his associates developed a richly empirical research agenda showing that famines occur not because of too many mouths to feed but because the poor cannot access food. Famines in the late twentieth century occurred in sparsely populated regions, such as sub-Saharan Africa, not in densely populated China, India, or Bangladesh. Although populations continued to grow dramatically in India and Bangladesh, those nations last experienced famines in 1947 and 1974 respectively, the dates they became independent. This implies that where political will exists famines can be averted by following "famine codes." Developed in British India in the 1880s, famine codes are both early warning systems and suggested countermeasures, such as wage employment in public works. Famine codes are only effective in the presence of a relatively coherent public administration and transportation and communication infrastructures. Ethiopia, Somalia, and Afghanistan lacked these elements. The last catastrophic famine in China, which probably killed about 20 million people between 1959 and 1961, occurred in the context of a disintegrating communication system within the Chinese Communist Party.

Why repeated famines in sub-Saharan Africa? The immediate problems of eastern sub-Saharan Africa are civil war and the dispersal of the rural population, which is 18 persons per square kilometer (8 for Somalia), compared to 228 for India, 681 for Bangladesh, and 104 for Nigeria. In a dispersed population the transportation system is underdeveloped and cannot support relief efforts. Dispersed settlements also provide little scope for building efficiencies in terms of the social division of labor and market development. Furthermore in much of this part of Africa the primary form of agriculture is slash-and-burn cultivation, which is a fragile system of sustenance in the first place. Yet such an extensive approach is essential to survival on land of some of the poorest quality anywhere in the world. On the African continent 60 percent of the area has a high expectation of drought, and only 30 percent of the land is suited to rain-fed production of millet, sorghum, and maize (Drèze et al., 1995).

Much of the potentially good land is exposed to endemic sleeping sickness that affects both livestock and humans.

Most people starve because they are either unemployed or the price of the agricultural commodity they sell is so low they cannot afford enough food in exchange. If the latter is the cause, as in most of sub-Saharan Africa, producing more cheap food in the first world for export to the poor nations drives down prices further and creates more misery.

Food Fights

Geopolitics have been central to the highly visible food fights between the affluent nations of the European Union, the United States, and Japan. In the 1940s the United States and the European nations assumed that agriculture would be relatively protected for reasons of reconstruction following World War II. But once Western European farmers revived, the U.S. government defended its share of the domestic agricultural market with the 1952 Defense Production Act, which banned the importation of anything from Danish cheese to Turkish sultana raisins (Friedmann, 1993). By 1975, when the European community had become a net exporter of wheat, the transatlantic trade conflict had become significantly hotter. In 1992 the Common Agricultural Policy of the European Union introduced support for domestic oilseed production and brought the transatlantic cousins to the brink of a trade war. Subsequently the most visible fights centered on hormone-injected beef and bananas.

Similarly during the military occupation of Japan, the United States sought to create a social base for the democratic system it was seeking to impose. The United States allowed Japanese protection of farm incomes both for the sake of recovery and in the interest of strengthening Japanese democracy. However, once the Japanese economy was independent it inevitably generated a conflict with the United States over markets and farm subsidies. This time instead of centering on wheat, maize, dairy products, and soybeans as with Europe, the conflict concerned rice, citrus, beef, and soybeans. Eventually the parties compromised on Japanese national sufficiency in rice and dependence on the United States for soybeans, nonrice grains, and beef. Protected rice remained an irritant in U.S.–Japanese relations in the twenty-first century.

Development of Underdevelopment

Political economists of underdevelopment concentrate on a segment of the international trade in food products that is distorted to benefit first world nations. Their basic argument is that free trade in food products never has existed. The U.S. government, among the most ideologically committed proponents of free trade, paid American farmers $71.5 billion in agricultural subsidies between 1996 and 2000. While pressuring third world nations to remove subsidies to their farmers, the first world nations heavily subsidize their capital-intensive agricultural systems. International trade in agricultural produce is shaped not by comparative advantage but by comparative access to subsidies (Watkins, 1996). Highly subsidized first world agricultural surpluses have created a serious disincentive for poor farmers in the developing world.

Furthermore it is argued that these unfair trade practices serve the interests of large corporations in the first world, such as General Foods, as illustrated by the case of instant coffee, the penultimate product of a commodity chain that begins with green coffee beans. Coffee is grown mostly in third world countries and is consumed in the first world. Most value-added parts of roasting, grinding, and packaging are done in first world countries. At the end of World War II the market was dominated by first world corporations, but major producers of green coffee, such as Brazil, sought "forward integration," from coffee to instant coffee, to appropriate more value-added parts of the chain. Brazilian prices were about 20 percent lower, and the quality of the powder was higher (Talbot, 1997, p. 124). General Foods opposed Brazilian imports that cut into the company's profits. The corporation lobbied hard for Article 44 of the Coffee Agreement, which compelled Brazil to impose an export tax on instant coffee and to sell 560,000 bags of green coffee beans per year to its competitors in the United States without the export tax. Receiving almost one-half of this coffee, which it converted to instant coffee, General Foods developed a further advantage over its Brazilian competitors by way of marketing and distribution networks.

In the larger pattern Mike Davis (2001) showed how colonial governments created the third world at the end of the nineteenth century through agricultural policies in the course of subsistence crises in 1876–1879, 1889–1891, and 1896–1902. These three crises were triggered by El Niño events, but capitalism had destroyed traditional networks of support, such as patron-client relations and their associated notions of customary charity, which resulted in the deaths of about 30 million people in the third world and generated conditions of chronic poverty. For example, Europe and India had relatively equal standards of living in 1800, but by 1900, Europe's standard of living was about twenty-one times higher than that of India, by economist Romesh Chunder Dutt's estimation based on the quality of housing, clothing, and diets (Davis, 2001, p. 292). By the end of the nineteenth century the processes of underdevelopment were firmly in place.

See also **Food as a Weapon of War**; **Food Security**; **Food Supply, Food Shortages**.

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POLYNESIA. *See* **Pacific Ocean Societies.**

POPCORN.

Popcorn was an early variety of maize, whose range in pre-Columbian times extended from the American Southwest to Chile. It was introduced into New England about 1800 and almost immediately became popular. Its main advantage was that, when heated, it exploded. While this trait is not unique, popcorn expands to a much greater extent than other varieties of maize and other seeds. This explosion fascinated children, and popcorn became increasingly associated with children and children's holidays, such as Halloween, Thanksgiving, Easter, and particularly Christmas, when it was given to children and employed as tree decorations. Popcorn was also used in children's confections such as popcorn balls, which were sold at circuses, baseball games, and fairs. Cracker Jack, a popcorn, peanut, and molasses combination, became the most famous confection in the world by the early twentieth century.

Movie Popcorn

Until the 1930s, popcorn was not sold in movie theaters. To some owners, vending all concessions was an unnecessary nuisance because profits were negligible compared with the trouble and expense of cleaning up spilled popcorn and scattered boxes and sacks. Theater owners shifted their perspectives dramatically during the Depression, when popcorn's profit margin of almost 80 percent generated more income than did the box office sales.

During World War II, sugar and chocolate were rationed, and popcorn was the obvious alternative. Popcorn sales soared. By 1945, almost half of the popcorn grown in America was consumed in theaters. By 1949, surveys showed that 86 percent of the movie theaters in the United States sold popcorn, which six out of every ten patrons bought.

When television took America by storm in the 1950s, movie popcorn sales declined. Despite initial misgivings, however, the advent of television gave popcorn producers a boost unparalleled in their history. Americans who bought popcorn in movie theaters also wanted popcorn when watching television. The first product for the home market, "TV Time" popcorn, was unsuccessful. However, it triggered a convenience revolution in popcorn. Frederick Mennen experimented with an aluminum package to which he attached a wire handle. (Electric poppers were manufactured shortly after the turn of the twentieth century. They did not become big sellers until major retail stores began offering them in their catalogs.) In October 1959 the newly created Mennen Food Products Company launched "Jiffy Pop." It was marketed as a fun food that youngsters could easily prepare and parents could conveniently tidy up, and a national advertising campaign made it an immediate sensation. In 1960 Jiffy Pop sales exploded. American Home Products acquired Jiffy Pop, which continued to sell well throughout the 1960s and into the 1970s.

popcorn
Nutritious!
POP CORN
Delicious!

Popcorn has become an icon food largely through its association with the cinema. It was one of the first foods to be served in movie theatres and remains one of the most popular of all foods eaten in theatres. © CORBIS.

Microwave Popcorn

Percy Spencer of Raytheon discovered the heating properties of microwaves when he leaned in front of the microwave tube with a candy bar in his pocket—it promptly melted. He then popped corn using the microwave tube. Spencer's discovery led to the birth of microwave ovens. Spencer's first patent application for heating food with microwaves was submitted in 1945. However, the cost of the early microwave ovens was simply too high to justify buying one to pop corn.

During the 1960s, two major events turned the microwave oven industry around. The first was the invention of a compact, low-cost magnetron. The second was the invention of the self–stable microwave popcorn, "Micro-Pop," which had a multilayered film package that kept moisture in and oxygen out. Today, the majority of popcorn consumed in America is popped in a microwave oven—its second major use in the United States.

Orville Redenbacher

Before the 1950s, popcorn was sold at the regional level, rather than on a nationwide basis. It was considered a generic item, and quality was not a key factor in selling the product. It was promoted as an economical snack. High poppability of all the kernels in a package was the main claim advertised to consumers. Orville Redenbacher and Charles Bowman singlehandedly introduced the concept of "gourmet" popping corn, proving that consumers would pay more for a product that popped up "bigger, fluffier, and more tender." At first, Redenbacher literally sold Red Bow out of the trunk of his car. He and Brown visited Gerson, Howe and Johnson, a public relations firm located in Chicago, who convinced them to change the name from Red Bow to "Orville Redenbacher's Gourmet Popping Corn." As the price was higher than that of other popcorn, the agency argued that consumers needed to be convinced that Redenbacher's popcorn was of a better quality than its competitors. With virtually no advertising, they had achieved their success through word-of-mouth promotion. But Redenbacher and Bowman could not market their product nationally without additional assistance. In 1973 they teamed up with Blue Plate Foods, a subsidiary of Hunt-Wesson Foods based in Fullerton, California, to market their gourmet popcorn nationally. This connection permitted national advertising and a widespread distribution system. Appearing on numerous television shows as part of a massive advertising campaign, Redenbacher became a television personality. He made hundreds of personal presentations a year and appeared in scores of television commercials. Redenbacher was one of America's most unlikely television stars. His bow tie, dark-framed spectacles, and Midwestern accent convinced many that he was just an old country hick. Consumers easily recognized the glass jar and simple label adorned with Redenbacher's folksy image. It lent the product owned by a corporate giant a homey, small-town aura.

Popcorn represents less than 0.02 percent of the entire maize crop. Of all the types of maize, however, none is more commonly recognized than popcorn. Americans eat popcorn in movie theaters, amusement parks, and sports arenas, and around campfires. As a snack food, we feast on ready-to-eat savory and candied popcorn confections. American intake of popcorn in all forms has more than doubled during the past two decades, and consumption abroad has expanded at an even faster pace. As trivial as popcorn may appear when compared to the total maize crop, Americans annually devour 11 billion popped quarts, an average of about forty-four quarts per person. By volume, popcorn is America's favorite snack food. And, partly aided by the spread of American popular culture overseas—including the export of American films—popcorn consumption has also increased in Europe and Asia.

See also **Art, Food in: Film and Television; Fast Food; Halloween; Maize; Snacks.**

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Andrew F. Smith

POPULATION AND DEMOGRAPHICS. Every place in the world has a population, human or otherwise. Big or small, old or young, growing or declining, every population changes over time and space. Human populations inhabit countries, cities, suburbs, and rural areas. In some places populations are dense, in others sparse. In some places there are more young people, in others more old people. Men dominate in some places, women in others. All of these factors constantly change over time. The study of all the statistics that describe how populations change over time and space is termed "demography." Demographic data includes, among other things, the size of a population, its density, spatial distribution, age, and gender.

Population Distribution

The distribution of the world's population is spatially uneven. Deserts contain very few people, for example, and cities contain many. Different countries, too, have very different populations. For example, consider the contrast between China and the United States. With a population of over one billion, China contains 21 percent of the world's population, whereas the United States, with a population of 283 million, has less than 5 percent. The number of people per unit area of land—the population density—also varies among countries. In a small country like the United Kingdom (population 59 million), the density is 628 people per square mile. In comparison, a large country like the United States has a population density of 76 people per square mile, despite its larger population. Within countries, population densities vary significantly. São Paulo, Brazil, for example, has a density of around 17,000 people per square mile, whereas

Amazonia has one of the lowest population densities in the world.

Since birth and death rates change over time, and since people migrate from one place to another, the world's population distribution is always changing. Countries where birth rates are greater than death rates will, in the future, gain a greater share of the world's population, as compared to countries where birth rates are similar to or less than death rates. Cross-country migration is another important factor contributing to changes in population distribution. In the early twenty-first century, some 150 million people, or 2.5 percent of the world's population, migrated either temporarily or permanently away from their countries of origin. For example, due to high rates of immigration (mainly from Latin America), the foreign-born population of the United States increased from 9.6 million in 1970 to 24.4 million in 1998. People also move within countries from rural to urban areas in a process known as urbanization. In less developed countries, for example, urbanization takes place at a rapid rate: just 18 percent of people lived in urban areas in 1950, compared to 40 percent in 2002. This number was expected to reach 56 percent by 2030.

Populations are likewise characterized by age and gender distributions. Some countries have an overwhelmingly young population, most notably those in Latin America and Africa, while others have aging populations, such as the more industrialized countries of North America and Europe. Different populations also have different sex structures. Urban societies, for example, have more males than females, a higher proportion of young adults, and a greater life expectancy.

World Population Growth

On a worldwide scale, population increases when births outnumber deaths. Although experts disagree on how exactly the world's population has grown over time, it is clear that for most of human history population growth proceeded at a very slow rate. Estimates suggest that in 40,000 B.C.E. the world's population was approximately 1.5 million, and it increased to 700 million by 1750. A falling death rate and a steady birth rate resulted in a marked increase of population to 1.6 billion in 1900. After this, in what is often termed the "population explosion," the world's population took an unprecedented move upward. In a mere sixty years the population almost doubled to 3 billion. Forty years later, in 2000, it had doubled again to over 6 billion. The reason for this growth was a rapidly falling death rate, a trend usually attributed to an increase in the world's food supply and a reduction in the rates of disease. Birth rates also fell, partially as a result of the spread of contraceptive practices, thus slowing the potential growth rate. The continuing decline of the birth rate means that the rate of population growth, though still rapid, has been slowing down. In 2002 the birth rate stood at around 1 percent, or 80 million more people per year.

Population and Food Supply

To some, the growth of the world's population has been the cause of much alarm. Even though greater food availability is part of the explanation for the ever-increasing population, at one time it seemed unthinkable that the world could support so many people. The relationship between population growth and the human food supply has, in fact, been the subject of a heated debate for hundreds of years. On one side are the so-called neo-Malthusians, named for the English clergyman Thomas Malthus. In 1798 Malthus wrote the "Essay on the Principle of Population," in which he argued that population has a tendency to increase geometrically (or more appropriately stated, exponentially), but food production increases arithmetically. Thus, population will eventually outstrip food supply, the result being many deaths from starvation. Neo-Malthusians tend not to share Malthus's analysis in its entirety; they simply share his belief that it is possible to have too many people in the world. The world, in other words, can become "overpopulated" if the number of people exceeds a carrying capacity determined by food availability and environmental resources.

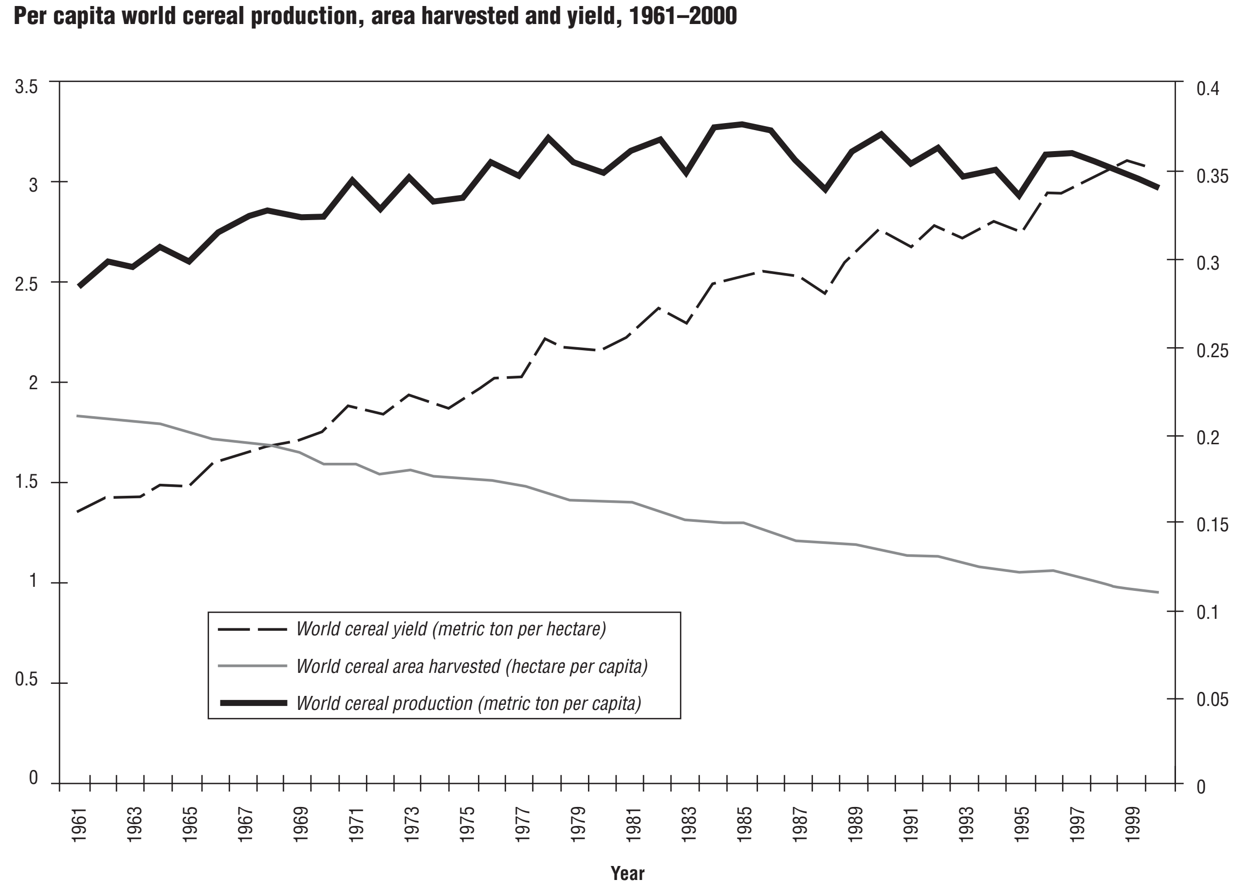
Modern-day neo-Malthusians—such as Lester R. Brown, Paul Ehrlich, Joel Cohen, Donella H. Meadows, Thomas F. Homer-Dixon, David Pimentel, and Norman Myers—believe that population growth is a cause of famine and environmental destruction. Growth, they argue, has limits. Generally speaking, they claim that the increased demand for food arising from population growth reduces agricultural resources per person, degrades the environmental conditions in which agriculture is practiced (via soil erosion and deforestation), and exacerbates macro-environmental change (such as global warming and the depletion of the ozone layer). These changes result in a decline of food production per person and, consequently, specific populations (especially those in poor countries) experience increased death rates from malnutrition. In his book *The Population Bomb*, Paul Ehrlich predicted that by the 1980s the world would see massive famines as a result of food shortages stemming from overpopulation. The much-discussed 1972 Club of Rome report "Limits to Growth" concluded that the world could not support economic and population growth indefinitely. Environmentalist Lester Brown argued in numerous texts, most notably 1994's *Full House*, that the demand for food leads to the adoption of more intensive agriculture, which degrades environmental resources and leads to a slowdown of food output. In *Environment, Scarcity, and Violence*, Thomas F. Homer-Dixon maintained that environmental resources are being degraded by rapid population growth, a situation he believed would lead to conflict and insurrection, particularly in the developing world.

On the other side of the population growth debate are those who are more optimistic about the growth of the world's population. Although they possess a wide variety of views, the so-called optimists look at the situation differently. Broadly speaking, they reject the concept of overpopulation and the notion that earth has a certain carrying capacity determined by food supply and environmental limits. Rather, the optimists believe that population and resources can be manipulated by humans through ingenuity and innovation and are therefore relative.

Some of Malthus's critics are termed "cornucopians" because they believe population pressure induces technological and institutional changes that can raise food output per person. Ester Boserup argued in *The Conditions for Agricultural Growth* that population growth stimulates improved methods of agricultural production—via crop rotation, fertilizers, and so on—thereby increasing food supply. The economist Julian L. Simon was another prominent cornucopian. In *The Ultimate Resource*, he reasoned that the demand for food influences the choice of agricultural technique and leads to adoptions of innovations in market agriculture. Simon also argued that a larger population also stimulates food availability, first by expanding the pool of inventive thinkers, thereby increasing the propensity for technological change, and second by making effective food distribution systems more cost-effective. An example of technological change often put forward to disprove Malthus's thesis is the development of high-yielding varieties of crops such as rice. Bred as part of the "Green Revolution" in the 1960s, these kinds of crops arguably enabled India and other countries to feed themselves, thereby counteracting fears of calamitous starvation.

Other thinkers do not concur with Malthus simply because they believe that political and economic conditions, not population growth, determine famine and environmental destruction. An early critic of Malthus was the political economist and philosopher Karl Marx. In works like *Capital* (volume one), written in the 1860s, Marx accused Malthus of excusing the social conditions of his time, conditions that Marx believed were the real cause of poverty and hunger. The need to accumulate profit, Marx said, inherently means that at certain times there is a "relative surplus population," a labor force that is largely superfluous to the needs of industry. Thus,

FIGURE 1



SOURCE: Available at http://apps.fao.org.

there is a class of people who periodically are unable to earn enough to afford a means of subsistence. In this way Marx asserts that it is the economic system, not population growth, that creates a population in which too many people do not have enough to eat. Economics professor and Nobel Laureate Amartya Sen has also argued that poverty and famine cannot be blamed on overpopulation. Though he accepts that population growth can place undue pressure on the environment and the lives of women, in *Poverty and Famines* he argues that famine results from a collapse in people's ability to purchase or otherwise acquire food, not from a shortage of food. Another critic is advocate Frances Moore Lappé and her colleagues. In *World Hunger: Twelve Myths*, she noted that there is no correlation between population density and hunger, and that population growth is not the root cause of hunger but is itself a consequence of social inequality. The solution, she said, is to distribute more equally the world's resources.

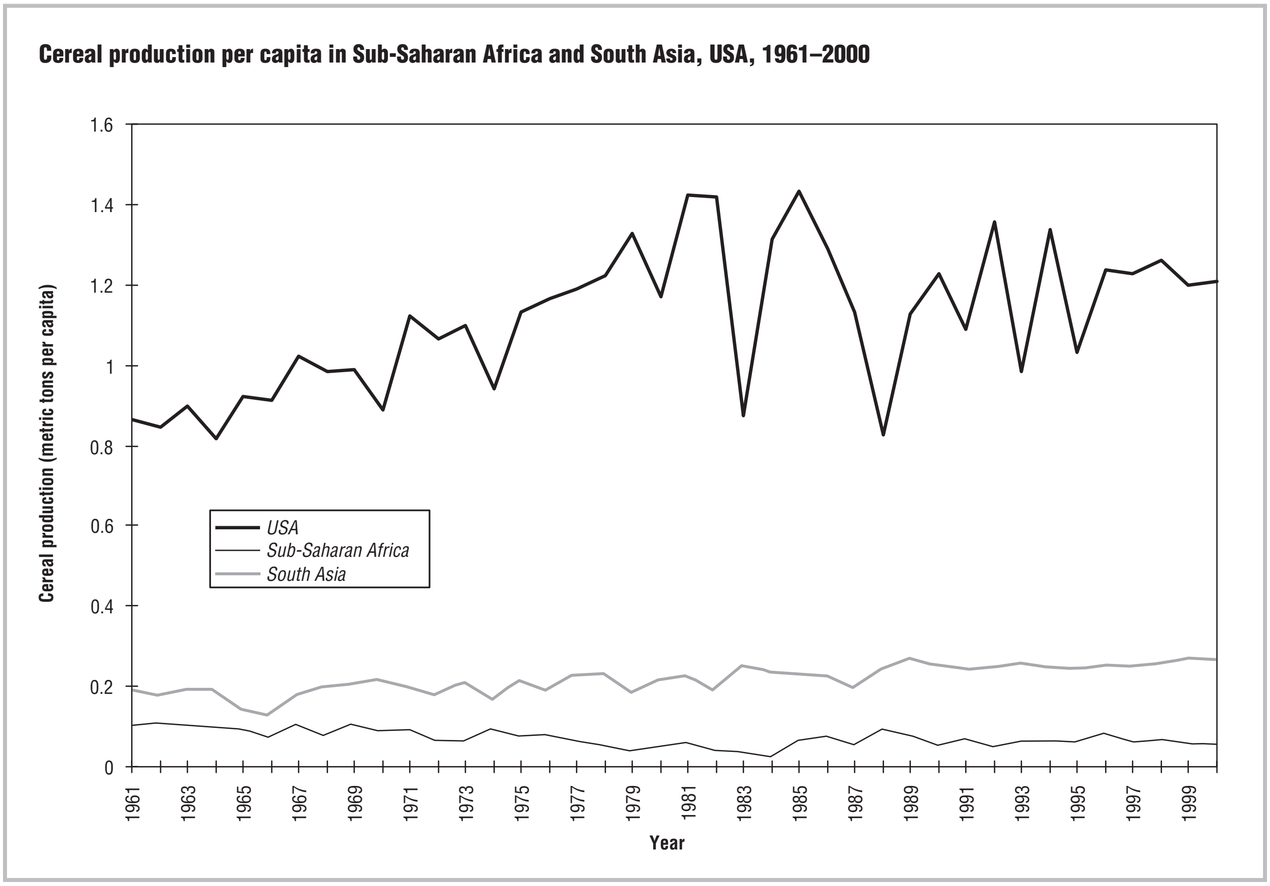
Trends in Population and Food Production

Throughout history, the world's food supply has grown faster than the world's population, as illustrated by the increase in the amount of cereals produced per capita. Figure 1 gives an example from recent history, indicating that cereal production has outstripped population growth since 1960 as a result of increasing yields. The area harvested per capita has actually declined.

Given this trend, it appears that neo-Malthusians have been overly pessimistic about the growing population. Most neo-Malthusians now accept that changing methods of food production have stimulated yield in a way not predicted by Malthus, but they claim the real problems have only just started. As evidence, they point to the declining rate of per-capita cereal production since 1985 (Figure 1) and the stark contrasts in food supply at the regional level (Figure 2). For example, cereal production is 0.125 metric tons per person in sub-Saharan Africa and has been declining over the past few decades. In South Asia, the per-capita rate of cereal production is higher, and the trend has been moving steadily upward. The developed world, as exemplified by the United States, produces far more cereals per capita (1.21 metric tons), but the amount has fallen since 1985.

Long-range future projections by the United Nations suggest the world's population will continue to grow, reaching 7.67 billion in 2020, and eventually 11 to 12 billion or higher by the end of the twenty-first century. Over 95 percent of growth will occur in the devel-

FIGURE 2



oping world, and the largest absolute and relative population increases will occur in Asia and Africa, respectively. Much of this growth will be in cities. The developing world's urban population is projected to double from the 1995 level of 1.7 billion to 3.4 billion in 2020.

This ever-growing population means an increased demand for food. Estimates of how much will be needed depend on the weight given to demographic factors, such as population growth, and nondemographic factors, like changing per-capita consumption. In an estimate by Tim Dyson in 1996, population growth alone will stimulate cereal demand by 728 million tons from 1990 to 2020; if nondemographic factors are accounted for, demand will be over 1 billion tons in total. Simulations by the International Food Policy Research Institute (IFPRI) predict that the world's population will demand 690 million tons more of cereal in 2020 compared with 1995. Eighty-five percent of the added demand will come from developing countries. The increasingly urbanized nature of the population means that the demand for meat will increase by 115 million tons.

The question of whether the food supply will keep up with the growing population is also the subject of a debate that has grown on local, regional, national scales. Concerns are greatest about developing countries. IFPRI predicts that food supply will not keep up with food demand in these countries. Yet IFPRI also points out that if cereal imports from the developed world doubled from 1995 levels to 2020, demands would be met. On the regional scale, sub-Saharan Africa has been the subject of significant attention. Issues such as drought and land degradation, warfare, and HIV/AIDS are all predicted to have an impact on the current trend toward declining per-capita food production. At the national scale there have been particularly marked debates about China. In *Who Will Feed China?* Lester R. Brown predicted that factors such as declining land availability and the degradation of water supplies will result in a shortfall of cereal production relative to population growth.

More recently, the debate has moved toward the community and household scale, the level at which people access and consume food. At this scale, however big or small the population, people are only able to eat enough food if they can access it. In order to do that, they need the means to grow food for themselves or, more likely, the money to buy it.

See also **Cereal Grains and Pseudo-Cereals; Food Politics: United States; FAO (Food and Agriculture Organization); Food Supply and the Global Food Market; Food Supply, Food Shortages; Geography; Government Agencies; Political Economy**.

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Corinna Hawkes

PORK. *See* **Mammals; Meat; Pig.**

PORRIDGE. Porridge is generally defined as a dish made by stirring oatmeal or rolled oats into boiling water and simmering the mixture gently until it is cooked. It is usually eaten hot; often, though not invariably, for breakfast. Meal or flour from other cereals may be used, in which case the dish is so designated; the cooking liquid may be water or milk or a mixture of both.

Porridge is considered an essentially Scottish foodstuff—it was hailed by Robert Burns, Scotland's national poet, as 'The halesome parritch, chief o' Scotia's food'—even though oats are grown in many regions of the world. The words "porridge," "parritch," and variants are allied to the word "pottage," indicating the practice of cooking ingredients together in a pot and thickening it with cereals, though "pottage" itself came to mean soup or broth. They may also be linked to *porray*, which is derived from *porrum*, the Latin word for leek—an age-old pottage vegetable. The Scottish *purry* was a mixture of oatmeal and kail.

Cooking and Serving

Traditions surround the making and eating of porridge. Stirring should always be done clockwise (for luck) with

Pewter porringer (*écuelle*) with lid. France, circa 1740. The rustic porringer, which throughout the Middle Ages provided hearty sustenance for kings and peasants alike, reached its zenith of elaborate detail in eighteenth-century France. Roughwood Collection. Photo Chew & Company.

DEVELOPMENTS

In 1877 the Quaker Oats Company of the United States developed rolled oats or oatflakes by steaming and rolling the coarsest grade of oatmeal—the so-called pinhead oatmeal, which is the whole grain halved. This innovation simplified the preparation of porridge and all oat-based dishes.

The muesli of today, regarded as a health food, is generally formulated with oats as its principal ingredient, with the addition of other cereal flakes, dried fruits, and nuts. It requires no cooking and has grown more sophisticated over time, but it is still recognizably a derivative of the Scottish porridge.

a *spirtle* or *theevil*, a wooden stick tapering to a rounded point, for stirring, and a carved head. In Scots, porridge was always referred to in the plural and was customarily eaten while standing, but the reasons for this latter custom are obscure. Some aver it was due to the proverb: "A staunin' sack fills the fu'est" (A standing sack fills the fullest), while others consider folk ate standing up lest an enemy catch them unawares.

Once cooked, the porridge was ladled into porringers (bowls) with a separate bowl of milk, buttermilk, or thin cream close by. Each spoonful of porridge was dipped into the cold liquid and then eaten. Some sprinkled sugar over the porridge, and others preferred honey, treacle or syrup, or a knob of butter—the men might replace the milk with ale or small beer. Porridge was sometimes poured into a drawer in the kitchen dresser to be sliced when cold, either for eating out in the fields or for reheating in the evening.

MAKING PORRIDGE BY THE TRADITIONAL SCOTTISH METHOD

For each person allow about a handful of oatmeal to half an (imperial) pint of water and a small teaspoonful of salt. Bring the water to the boil and add the oatmeal in a slow but steady stream, stirring briskly. Once it has returned to the boil simmer gently until cooked, about 20 to 25 minutes. Add the salt near the end of the cooking time.

Quantities are necessarily inexact as meals vary, as do the tastes of those eating the end product. Rolled oats require less cooking, so follow the manufacturer's instructions; the microwave, too, shortens the cooking time.

The basic mixture allowed for numerous permutations, all with their own nomenclature according to locality. Brose was made by pouring boiling water over oatmeal, butter, and salt: with meat stock it became fat brose, while the addition of a green vegetable gave kail brose. Hasty Pudding was a form of porridge enriched and sweetened. Gruel was made by boiling the liquid that oats had soaked in, flavoring it with assorted ingredients and allowing it to cool to a jellylike substance. To make *sowans*, oat husks were soaked until sour, at which point the mixture was sieved and the husks thrown out. The liquid was a pleasant drink and the starchy sediment underneath was boiled and eaten either hot or cold, with milk, cream, or beer again served separately.

Oatmeal augmented every type of dish and some drinks, too, while assorted oatcakes and bannocks baked on a girdle (a flat iron plate hanging over the fire) took the place of yeasted bread.

Porridge is highly nutritious because oatmeal contains protein, carbohydrate, fats, and soluble fiber, all the B vitamins, vitamin E, calcium, and iron. The lack of vitamins A, C, and D is redressed when it is combined with milk or vegetables. Research has revealed that porridge might aid in the prevention of coronary heart disease as well as in the treatment of hypertension and certain diabetic conditions.

A Scottish Staple

The consumption of porridge, together with other oat-based products, is considered an essential benchmark of Scottish nationality. In the geographical and climatic conditions of Scotland, both oats and barley provided a more reliable harvest than did wheat, but oats did not predominate until the eighteenth century. Thereafter, they played an increasing role in the diet, particularly in rural areas where oatmeal often formed the basis of every meal: "Oatmeal, with milk, which they cook in different ways, is their constant food, three times a day, throughout the year, Sunday and holidays included," observed J. Donaldson in 1794 regarding the farm laborers in the Carse of Gowie, a fertile area along the River Tay's north bank. Places in England and Wales with similar conditions saw a parallel dependence on oatmeal. Emigrants from the United Kingdom, but most especially the Scots, took their traditional habits with them, including their food preferences, and oatmeal was subsequently exported to many far-flung corners of the globe.

See also **British Isles**; **Cereal Grains and Pseudo-Cereals**; **Middle Ages, European**.

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Una A. Robertson

PORRIDGE, POTTAGE, GRUEL. In Great Britain, porridge is synonymous with hot oatmeal gruel, a common breakfast food that also has become an icon of Scottish cookery or at least an icon of presumed Scottish origin. Food packaging and mass-market advertising have helped create this mythology, but in fact porridge is a universal dish that cuts across many cultures and geographic boundaries. Furthermore, oats are not a defining feature. They do not even play a role in the origin of the word "porridge."

The old children's rhyme moves closer to the real meaning of porridge: "Peas porridge hot, peas porridge cold, peas porridge in the pot nine days old." The key ingredient here is not oatmeal but peas, and not fresh peas but rather dried peas cracked into grits. The dried pea probably was not the only ingredient in peas porridge, because porridge, the original porridge, was a vegetable preparation, not a dish based on cereal grains (as in the case of gruel). The etymology of porridge has not been neatly worked out because the chain of evolution has a number of missing links, but this much is clear: porridge shares a common ancestry with words like "pottage," "porringer," "puree," and "potage," the latter the French word for soup. This word family also includes *potager*, the hearth where vegetable soups were boiled, and by extension the kitchen garden, in which those ingredients were grown.

The presumed underlying link for all of these concepts is the Latin word *porrum* or *porrus*, a leek. It appears in the Middle English word *porree*, a term used for leek porridge. It would seem, from etymological evidence, that originally porridge was a preparation made from leeks (or green onions resembling leeks) and secondarily from other ingredients in the kitchen garden. In home cookery this type of porridge may have been relatively coarse, with the ingredients chopped or pounded, then stewed until tender. In court cookery, where more attention was paid to delicate textures, leek porridge was most probably served as a smooth purée thickened with bread—many medieval recipe collections contain directions for making just this sort of dish. It finds its counterpart in the modern-day Spanish preparations known as *porra*, which are made by pounding the ingredients in a mortar until they form a thick pulp. They are eaten like gazpacho, scooped up with a piece of bread rather than with a spoon.

A parallel theme in all of these dishes is the fact that they are thickened in some fashion. The most elegant medieval preparations were thickened with white bread, yet presumably lower down on the economic ladder poorer cooks used whatever coarse thickeners were on hand. Dark bread was one alternative. Animal blood, especially the blood of fowl or hogs, was certainly employed during the butchering season. Combining pounded vegetables with meal or grits was also one common solution. In southern Europe barley, emmer wheat (*farro* in Italian), or millet appear to have been the thickeners of choice among the peasants. In northern Europe oats, barley, and rye were commonly employed, depending on what was most abundant in a particular region. The great variation in the use of thickeners may have given rise to the idea of national "styles" of porridge, when in fact national identities as understood in the twenty-first century are of recent origin. While the British may be inclined to call prepackaged oatmeal gruel a porridge, historical evidence suggests that if indeed it was once a porridge, it has been stripped of all key vegetable ingredients, most importantly the leeks.

William Woys Weaver

PORTUGAL. *See* **Iberian Peninsula.**

POTASSIUM. *See* **Electrolytes; Minerals.**

POTATO. The potato is a tuber—a short, thick, underground stem with stored starches and sugars—of the potato plant. It was given its botanical name, *Solanum tuberosum*, in 1596 by the Swiss botanist Gaspard Bauhin, and belongs to the Solanaceae family, the nightshades, which includes eggplant, peppers, and the tomato. (The sweet potato is not a potato; it belongs to the morning glory family.) Growing wild as early as 13,000 years ago on the Chilean coast of South America, potatoes were first cultivated by farmers in the Andes Mountains nearly seven thousand years ago.

Nutritionally, the potato supplies complex carbohydrates—essential for energy—and a very low amount (about 10 percent) of protein. One serving (a 5.3-ounce medium potato) provides: 45 percent of Recommended Daily Intake (RDI) for vitamin C (most of it in the millimeters-thick layer immediately under the skin), 21 percent of potassium, 3 grams of fiber, essentially no fat, and only 100 calories. It is rich in the minerals iron and magnesium and supplies all the vital nutrients except calcium and vitamins A and D.

Potatoes are the vegetable eaten most frequently in the United States, and the one ordered most when Americans eat out. In 2001, the average American ate 41 pounds of potatoes. In 1996, the annual per capita consumption increased with age among those over eighteen: between eighteen and thirty-four, 74.3 pounds; thirty-five to forty-four, 80.6; forty-five to fifty-four, 87.4; fifty-five to sixty-four, 88.9; and, for those sixty-five and older, 109 pounds. Interestingly, consumption again peaked among those between thirteen and seventeen (83.2 pounds) and six to twelve (85.5 pounds), who presumably consume most of their potatoes as french fries, chips, and novelty forms.

The United States ranks fourth in world potato production, with an estimated 1.26 million acres planted in 2001. Russia is the largest producer. With a world harvest of 291 million tons grown in more than 100 countries, potatoes are second only to rice as a world food crop.

South American Origins

The potato was domesticated high in the Andes Mountains in South America by 3000 B.C.E., but it was not until the Incan civilization (ca. 100–1530 C.E.) that the tuber's true agricultural potential was realized. The climatic challenges of growing crops in the heights of the Andes are formidable. Radical swings in temperature, from highs of 62°F (17ºC) to lows below freezing (most nights of the year), occur even within a twenty-four-hour period, and constantly disrupt the potato plant's physiological processes. Yet, potatoes are ideally suited to these conditions; the plant grows in even the poorest soils, and the hardiest species can survive at an altitude of 15,000 feet.

The Inca devised agricultural innovations that maximized the potato crop. The introduction of terracing enabled steep slopes to be planted. A system of canals efficiently distributed water from higher in the mountains to each terrace level. In the absence of plows and oxen, a wooden foot plow called a *taclla* was invented that is still used in the Andes today. A representation of this tool is found in a Spanish woodcut from the late sixteenth or early seventeenth century (but the tool is presumed to predate that). The Inca wisely prized agricultural diversity, growing 3,000 varieties of potatoes in various sizes, textures, and colors. Their goal was to develop a different kind of potato for every type of soil, sun, and moisture condition. Thus, the rulers could secure a high yield of potatoes—enough to feed thousands of members of the expanding empire—from disproportionately small plots of land.

The Inca also serendipitously discovered how to freeze-dry potatoes. At night, the cold of the Andes froze the tubers. (Raw potatoes are 80 percent water.) During the day, however, they thawed in the warmth of the sun. As they defrosted, laborers stamped on them to press out all the moisture. After several days of alternating freezing and defrosting, the potatoes were dehydrated and transformed into a lightweight, transportable substance known as *chuno.* Stored in sealed, permanently frozen underground storehouses, the freeze-dried potatoes kept for five or six years. When needed for sustenance during the lean months, the *chuno* could be reconstituted by soaking in water, then being cooked or ground into meal, with no loss of nutritional value. *Chuno* was so precious to the Inca that it was used as currency and collected as tribute. It was also believed that potatoes have healing properties. Raw slices were placed on broken bones, aching heads, and rubbed on bodies to cure skin diseases, and slices were carried to prevent rheumatism

From South America to Europe

When the Spanish arrived in South America around 1537, they were not impressed by the potato. The strange tubers, misshapen and bitter, were about the size of peanuts, and bore little resemblance to potatoes we know today. The Spanish mistook them for a kind of truffle, calling them *tartuffo*. The Inca routinely consumed the choice, large tubers, and planted only the rejects, thereby propagating progressively inferior tubers.

Gradually, the Spanish realized that potatoes were perfect food for sailors on ships returning from Peru. The tubers traveled well, were cheap, nutritious, required little preparation, and prevented scurvy. Returning to Spain by way of sub-Saharan Africa, the Spanish introduced potatoes there in 1538. Leftovers from shipboard food found their way to Spain in the 1550s but, in most areas,

Heirloom Potatoes: The Pursuit of Old-Time Flavor

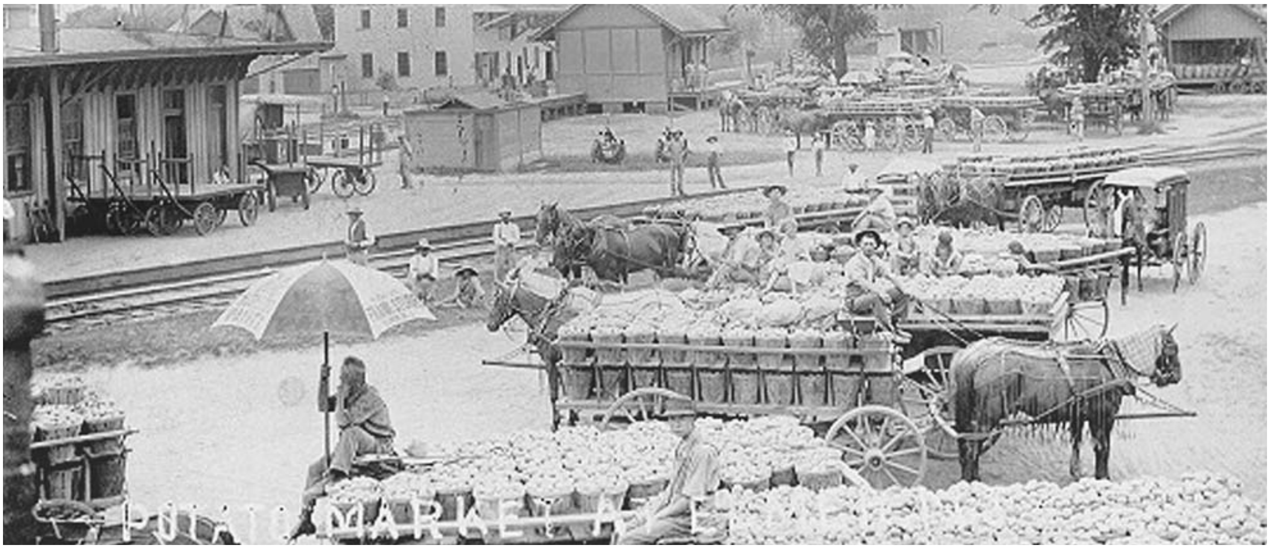
While the discussion over genetic diversity in crop potatoes has polarized the agricultural community today in much the same manner as the finger-pointing during the 1850s over the causes of the 1840s potato blight, market forces are quietly building new niches for time-tested heirloom varieties. Limited choices in the supermarket and hybrid potatoes without much character or flavor have sent frustrated chefs and small growers in search of the old standbys that once made home cooking so memorable. Interest began with the "fifty-somethings," the not-quite-antique varieties like the Pimpernel (1953) developed in Holland and the French yellow-fleshed fingerling called Roseval (1950). Both are good producers with very distinctive cooking qualities.

Those criteria have become important again, especially since heirloom potatoes are different from heirlooms passed down via seeds. Heirloom plants are generally defined as open-pollinated varieties that have been handed down over several generations, with particular emphasis on varieties dating from before the 1940s. Because potatoes are increased by planting pieces of tubers, they are genetic clones of their parents. That is why heirloom potatoes actually taste like the past. Potato classics like pink-skinned Early Rose (1867), developed by Albert Bresee of Vermont, and creamy 1840s Peach Blow from New Jersey sell out as quickly as growers can supply them. What better potato was ever invented for mashed potatoes, gnocchi, or dumplings than the aptly named Snowflake (1874)? Steam it, and it turns to fluffy snow.

The growing affection for heirloom potatoes is not just a grass-roots trend in the United States and Canada. Arche Noah, a private seed organization in Austria, has been building up an heirloom potato collection for many years, and the recently organized Association Kokopelli in France is establishing chapters in most of the leading countries in the European Union. Kokopelli is comparable to a horticultural Slow Food movement, and doubtless one food network will soon be influencing the other. Purple-skinned treasures like Violette du Lac Bret, a rich-flavored blue potato from Canton Vaud, Switzerland, and its cousin Vitelotte noir (1815) of France are finding their way onto the leading restaurant tables in those countries, just as La Ratte d'Ardéche (1872) has now become the salad potato most favored by Paris chefs.

In the British Isles, waxy yellow Duke of York, developed in Scotland in 1891, still reigns as the classic salad potato of choice. Lilac-skinned Arran Victory, developed in 1918 by Donald Mackelvie of Lamlash, Isle of Arran, Scotland; and Archibald Findlay's Catriona (1920), splashed with patches of blue on the skin, are considered by connoisseurs to be among the finest-tasting potatoes ever developed. Their flavors are complex, with hints of walnuts or hazelnuts, or, as some enthusiasts claim, Scotland's answer to truffles.

William Woys Weaver



The potato market in Elmer, New Jersey, 1907. Note the complete absence of motor vehicles. Roughwood Collection.

they did not grow well and were not popular. Still, as early as 1570, potatoes could be purchased in markets in Seville, and, by 1573, they were being fed to hospital patients in other parts of Spain.

Through the first half of the seventeenth century, potatoes were eaten primarily by the poor and soldiers in Spain. In 1653, however, the historian Bernabé Cobo made a laudatory reference to the culinary properties of *chuno*, describing how Spanish women were able to grind the substance into more white flour than could be obtained from wheat, and from which they made sponge cakes and pastries with almonds and sugar.

Not until 1760 did Spanish plant breeders start to improve the potato. Eventually, it was found that potatoes grew well in the mountainous Pyrenees and along the Atlantic coast, where they were popular among Basque fishermen during their voyages to the Grand Banks of Newfoundland.

The Potato Diaspora

From Spain, potatoes spread to all parts of Europe. Spanish ships carried the vegetable to Italy around 1560, making that country the first after Spain to eat potatoes on an appreciable scale. Potatoes also traveled along the "Spanish road" that connected Spain's imperial provinces in northern Italy with the Low Countries.

By 1600, the potato had entered Austria, Belgium, Holland, France, Switzerland, England, Germany, and, most likely, Portugal and Ireland. Some historians claim that it was Basque fishermen who first brought potatoes to Ireland, when they came ashore to dry their catches on their return voyages from Newfoundland. Others maintain it was Sir Walter Raleigh who planted the first potatoes on his estate in Ireland. The potato was introduced in India, possibly as early as 1615, and had reached the most remote parts of China by 1643. Beginning about 1730, the Scottish Highlands adopted potatoes as completely as Ireland had.

Fear of Potatoes

It is not unusual for new foods to be met with skepticism and fear, especially those arriving from a strange, faraway continent where they are consumed by "uncivilized" non-Christian peoples. The potato, however, had a tougher battle for acceptance than many other foodstuffs introduced from the Americas. Aside from its odd, unaesthetic appearance and initially bitter taste, the tuber was feared for a variety of reasons. Since it was not mentioned in the Bible, it was often associated with the devil. As a consequence, in the north of Ireland and in Scotland, Protestants flatly refused to plant them. In Catholic Ireland, to be on the safe side, peasants sprinkled their seed potatoes with holy water and planted them on Good Friday.

Another source of prejudice against the potato was its membership in the nightshade family, which includes a number of poisonous members: deadly nightshade (belladonna, which is poisonous), mandrake (known as a soporific and fertility drug), tobacco, and henbane (poison). Some of these substances have traditionally been associated in various cultures with magic and witchcraft. In many folk beliefs there is a grain of truth. Solanine, contained in the tubers and common to all plants in the nightshade family, is indeed a poison. Unlike modern potatoes, which contain only a nonharmful trace amount, tubers of the sixteenth and seventeenth centuries had much higher levels, not enough to cause death, but sometimes a rash appeared. That led to its association with the deadliest disease of the time, leprosy. So great was the fear that, when Frederick the Great of Prussia ordered his people to plant potatoes in 1744, they pulled them up. Frederick was forced to post soldiers to guard the crops. Ten years later, in 1754, the king of Sweden also ordered his subjects to grow potatoes. Yet, when famine struck Kolberg in 1774, wagonloads of potatoes sent by Frederick were rejected.

All over Europe, it was believed that the potato plant would bring disease. In the seventeenth century, the parliaments of Franche Compté and adjacent Burgundy actually prohibited its cultivation. In the early nineteenth century, Ludwig Feuerbach and other German radicals believed that "potato blood" was weakening the people and delaying the anticipated revolution. In Sicily, potatoes were used like voodoo dolls: the name of an enemy was attached to a tuber and buried in the belief that this would ensure his or her death. Even as late as 1928 in America, Celestine Eustis, the author of *Cooking in Old Creole Days*, advised readers to throw out the water in which potatoes had been boiled because it was poisonous.

At the same time potatoes were feared and reviled, and being grown only in the gardens of botanists, there was also a developing literature in sixteenth-century European herbal books asserting that potatoes had some therapeutic effects. Among the diverse claims were enhanced sexual desire, fertility, and longevity, and cures for diarrhea, tuberculosis, and impotence.

The Potato in Time of War

Europeans quickly discovered that the potato afforded them a military advantage; it was ideally suited to combat starvation caused by war. During the Dutch Wars (1567–1609), for example, Spanish soldiers crossed the Alps on foot from Italy, marching north through Franche Compté, Alsace, and the Rhinelands. Villagers along the route quickly discovered that tubers carried by the soldiers could be planted, hidden underground, and dug as needed, unlike grain. Nearly every military venture after about 1560, including World War II, resulted in more acreage being planted in potatoes.

When French, Austrian, and Russian armies invaded Prussia during the Seven Years War (1756–1763), peasants escaped starvation by eating potatoes. As a result, the Austrian, Russian, and French governments all persuaded their own peasants to grow potatoes. In 1778, the

War of the Bavarian Succession was called "the potato war" because most of the action consisted of destroying the enemy's food supplies.

In Russia, crop failure in 1838–1839 convinced people in central and northern parts of the country to raise potatoes. In the course of the nineteenth century, potatoes displaced bread as the principal food for poorer classes from Belgium to Russia. They were cheaper than bread, required less preparation, and were just as nutritious.

Potatoes in England

Potatoes appeared in the British Isles in the 1590s. The historical record is unclear about which of two famous explorers introduced them, Sir Francis Drake or Sir Walter Raleigh. Regardless, the first English potatoes did not, contrary to popular myth, originate in Virginia. This mistaken notion gained credence because the first tubers destined for England passed through Virginia after having been taken aboard in South America.

The tubers were not immediately embraced in Great Britain, remaining a garden crop grown by botanists until 1780. The English, traditionally not fond of vegetables, based most of their meals on meat, and the potato carried a social stigma as the food of savages and peasants. The earliest potato crops in England were produced to feed sailors. By 1700, a stew called *lobscouse*, consisting of potatoes, meat, onions, and strong seasonings, was recorded in Lancashire. When hardtack was added as an accompaniment, lobscouse became the standard dish of choice for shipboard crews. Yet, the tuber was so despised during the reign of George III (reigned 1760–1820) that it took years of botanical experiments before the English conceded that potatoes might be acceptable as cattle feed.

In the 1700s, northwest England began to produce an abundance of potatoes, as many as 13.5 tons per acre. Cultivation occurred, too, in Cornwall and outside London, where industry was beginning. In many ways, the potato fueled the Industrial Revolution; it was good, cheap food for another lowly multitude—workers. This trend was also generated by the simultaneous decline in bread production. In 1832, the Bread Acts were rewritten so potato flour could be used without losing the right to call the product "bread." By 1836, two million people who used to subsist on wheat flour—one-seventh of the population—were living chiefly on potatoes. By 1850, Londoners were consuming 3,000 tons of potatoes a week. Baked potatoes played a special role in London working-class life—they were sold by street vendors both to eat and to use as hand warmers.

The perennial British working-class favorite, fish and chips, reached the streets as two separate dishes, with fish coming at least thirty years before chips. Neither was fried in deep fat until the 1860s. By 1888, there were between 10,000 and 12,000 fish-and-chips shops in the United Kingdom serving the duo wrapped in newspaper and sprinkled liberally with vinegar.

Meanwhile, the elite consumed potatoes in very different forms—disguised as other foods. Unadulterated, naked potatoes were not considered appropriate food for the upper classes, and Queen Victoria's chef carved the tubers into shapes like olives and pears, or buried them entirely in purées and soups. By 1914, however, people in England said they would rather pass up greens, butter, and nearly all their precious meat before they would give up potatoes—quite a change of heart. It was the English who coined the word "spud" for potato, a slang expression that originally referred to a potato-digging spade.

The Great Irish Potato Famine

Ireland was the first country in Europe to accept the potato as a field crop, in the seventeenth century, and to embrace it as a staple in the eighteenth. To the poverty-stricken peasantry, this tuber was a safeguard against unemployment, overpopulation, crop failure, and starvation. Landless laborers rented tiny plots that they sowed with potatoes. One acre could feed a family of six, averaging ten pounds of potatoes per person a day. Potatoes did not replace meat immediately, but other staples like oats, beans, barley, herring, and bread gradually disappeared from the table. Over time, the diet shifted to one of boiled potatoes supplemented by milk, which supplied calcium and vitamins A and D, making the meal nutritionally complete.

As early as 1740, the potato saved Ireland from famine. Between 1780 and 1841, when the potato achieved its dominance, the population doubled in Ireland. According to historic sources, it cannot be said with certainty that the potato was responsible, but surely it played a role. By 1845, about 40 percent of the Irish population was dependent on the tubers raised on 65,000 farms of not more than one acre each. Potatoes were also used to feed pigs.

In 1845, blight struck potato fields throughout Europe, but those most devastatingly affected by the fungus *Phytophthora infestans* were in Ireland. The assumption is that the blight was carried back by ship from North America on a diseased tuber. Livid purple patches appeared, covering whole potato plants—roots, tubers, and foliage—after which they turned brown and rotted. Whole fields went under in a matter of hours, destroying 40 percent of the crop. Yet, few deaths occurred because many people slaughtered their pigs, which normally ate a third of the crop. In 1846, the blight redoubled, killing 90 percent of the potatoes and preventing a new crop from being sown. The fungus was not as virulent in 1847, but reappeared in full force in 1848–1849. About five to six months later, famine set in, and diseases including typhus, dysentery, relapsing fever, respiratory infections, and cholera were not far behind. Ultimately, two million people died, one-quarter of the entire population. One million immigrated to the United States.

How the Potato Twice Changed World History

The historian William H. McNeill (1999) believes that potatoes twice made a critical difference in world history: first, in South America, where the vegetable provided the principal energy source for the Inca and their Spanish successors. There would have been no great Incan civilization, McNeill contends, without *chuno.* Not only was it collected as taxes from the peasant-farmers, it was also disbursed from storehouses to pay labor gangs for building roads, waging war, and erecting great monuments. Once the Spaniards arrived and conquered the Inca, *chuno* is what fed thousands of conscript miners, forced by the conquistadors to work the silver mines in Bolivia. This tremendous influx of silver contributed to worldwide monetary inflation, and enabled Spain to build a powerful naval fleet.

The second way in which the potato changed world history was in northern Europe. The extraordinary strength of the industrial, political, and military changes between 1750 and 1950 could not have taken place without an enormously expanded food supply from potatoes, which served to feed a rapidly growing population, McNeill argues. Germany could not have become the leading industrial and military power of Europe after 1848, and Russia could not have assumed so threatening a stance on Germany's eastern border after 1891. Both events helped set the stage for two world wars.

The Potato Becomes Haute Cuisine

The French were no more enamored of the potato at first than any other Europeans. Legrand d'Aussy, in his 1782 *Histoire de la vie privée des Français* (History of the private life of the French) wrote that the pasty, indigestible tuber should be eliminated from aristocratic households and left to the poor. Also in 1783, a Parisian gourmet expressed outrage that the potato had achieved a certain cachet in the capital. The nineteenth-century French gastronome and author of the esteemed *La physiologie du goût* (The physiology of taste, first published in 1825), Brillat-Savarin agreed that the tasteless potato was good only as a defense against famine.

As in other European countries, the peasantry took to potatoes much more quickly because it could be used in their diet like turnips. Around 1620 (during the reign of Louis XII), the Abbey of Remiremont accepted payments in potatoes. As early as 1673, the tubers were being cultivated on a large scale in Lorraine. By the first half of the eighteenth century, the potato was well established in France, even if it was only among the peasants. By the middle of the century, potatoes began to be grown in the Pyrenees and Dauphiné, both very mountainous areas. By 1780, potatoes were the chief food of the Pyrenean highlands. By 1840, the potato was well established in French cuisine, making its way in through the soup pot, where it added bulk and absorbed flavors.

The person most credited with winning acceptance for the potato in France was eighteenth-century army pharmacist Antoine Parmentier. As a prisoner in Germany during the Seven Years War (1756–1763), he was forced to eat potatoes almost exclusively and became convinced of their virtues. He set about analyzing their chemistry. Then he won a competition sponsored by the Academy of Besançon to identify foods that could stem mass hunger after the famine of 1770. To counter the fear of anything in the nightshade family (more intense in France than in England), in 1771 the Faculté de Paris published a paper stating emphatically that the potato was innocuous. After yet another famine, Parmentier himself wrote in 1789 that, although the tuber was a nightshade, it was not soporific. To further convince the populace of the potato's appeal, he had the tubers planted on the worst possible land on the outskirts of Paris. During the day, the field was guarded by soldiers who left at night. The peasants, intrigued by such an important crop, went into the field and stole potatoes to plant in their own gardens, which is exactly what Parmentier wanted to happen.

Realizing that acceptance of the potato needed to begin at the top, Parmentier is said to have convinced Louis XVI to encourage planting and eating the tuber by throwing all-potato banquets. Even Marie Antoinette was said to wear potato flowers in her hair at court. Although these colorful stories may be apocryphal, between 1770 and 1840 potatoes became widely cultivated in northern parts of the country. When famine struck in 1788 because the grain crop failed, potatoes were available.

In 1793, during the "Reign of Terror," the French people celebrated potatoes as their republican salvation. Even the royal Tuileries gardens were symbolically converted into a potato field. Realizing the political strength potatoes could provide, the Republic published ten thousand copies of a pamphlet on cultivation. A year later, a cookbook, *La cuisinière républicaine*, presented twenty recipes. The annual potato crop burgeoned from 59,640,000 bushels in 1815 to 332,280,000 by 1840. By 1843, France produced almost half a million bushels of potatoes, possibly the largest crop on the continent and in all of Europe.

Potatoes gradually acquired a place in haute cuisine. Collinet, the chef for King Louis Phillippe (reigned 1830–1848), accidentally created the famous *pommes soufflées* (puffed potatoes) when he plunged fried potatoes into extremely hot oil to reheat them when the king was late for dinner. Much to the chef's surprise, the potatoes puffed. *Pommes frites* (what we call french fries) appeared on city streets in the north of France around 1870. The Larousse *Gastronomique*, the encyclopedia of French cuisine, first published in 1938, contains dozens of classic French recipes for potatoes.

The Potato in America

While potatoes migrated from South America to Europe, they failed to travel out of South America to North America or even to Central America and Mexico. In fact, Mexico did not have potatoes before the eighteenth century.

It took about two hundred years—after the tubers made their way to Europe—before they were introduced into North America. This may have happened as early as 1613 in Bermuda, and on the mainland in 1621. The first North American colonial potato growing dates from 1719, when Irish immigrants, escaping starvation from the famine, introduced the potato to New Hampshire.

Americans did not subject the potato to class distinctions, so its popularity grew rapidly. In 1806 the American Gardener's Calendar included only one variety of potato; by 1848, almost one hundred kinds were exhibited at the Massachusetts Horticultural Society fair. By 1860, American output of potatoes was calculated at 100 million bushels, 90 percent produced by the northern states, with New York the single largest producer, followed by Pennsylvania, Ohio, and Maine.

A major step forward in potato cultivation was made in 1872 when the botanist Luther Burbank discovered that the Early Rose potato produced a seed ball, and was able to breed plants with larger tubers whose yield sometimes doubled or tripled that of its parent. The resulting progeny became known as the Burbank potato, which a few decades later mutated into the Idaho (or Russet).

For nineteenth-century farming life, the potato was a real boon for the same reason it became popular elsewhere as a cheap, nutritious, convenient way to feed farmhands and families. The potato, however, was not kept down on the farm; in 1876, some American hotels offered five different potato dishes for breakfast. During the Alaskan Klondike gold rush (1897–1898), potatoes were at times almost worth their weight in gold, so valued for their vitamin C that desperate miners traded gold for them.

In October 1995, the potato became the first vegetable to be grown in space. NASA and the University of Wisconsin created the technology with the goal of feeding astronauts on long space voyages, and, eventually, feeding future space colonies.

Cultivating Potatoes

Potatoes are most often grown in cooler climates in moist, acidic soil (pH slightly less than 6). They must be able to gather sufficient water from the soil to form the starchy tubers that range anywhere from three to twenty in number on any one plant, depending on variety, weather, and conditions. In the United States, most potatoes are produced in Idaho, followed by Washington, Oregon, Maine, North Dakota, California, Minnesota, and Wisconsin. Six varieties account for 80 percent of the crop yield.

Although potatoes are perennials, they are treated as annuals since the edible part of the plant that contains the buds is dug up each year. Farmers grow particular tubers as seed potatoes (not intended to be eaten) for propagating new crops. These potatoes are cut into what are called "sets," small pieces, with at least one eye or leaf bud on the surface, with some of the flesh of the potato still attached to supply the initial energy for the plant. The sets are planted with the eyes facing upward; new plants sprout from the eyes.

The potato plant produces leaves and flowers that can be white, purple, lilac, or violet, depending on variety. If fertilization of the flower is successful, a small green fruit ball is produced containing fifty to two hundred seeds, known as true seed. These can be planted for the next year's crop rather than using seed potatoes. The leaves supply abundant food for the plant's growth, and the generated surplus moves down into the underground tuber for storage. Potatoes can be left in the ground for four to six weeks. They are harvested when all of the leaves and tops of the plants have withered. A potato that is harvested young, usually in the spring or early summer, and sent directly to market instead of being stored, is known as a new potato.

Before potatoes can be sold or shipped, they must be sorted for size and quality. This process is called "grading" and special implements are used. These can be as simple as a wooden slat with a bag on the end for acceptable potatoes, or a more complicated conveyor-belt system that moves potatoes toward the bag at the end as inspection is performed.

Potatoes produce the steroidal alkaloid solanine, which seems to protect the tubers and foliage from some predators and insects. Still, potatoes are vulnerable to such pests as the Colorado potato beetle, red slugs, and blister beetles, and are still attacked by blight. Since 1990, fungicide-resistant strains of blight have struck fields in various parts of North America.

Culinary Preparation of Potatoes

Potatoes figure prominently in many of the world's cuisines, particularly in the Americas, in Europe, and in countries colonized by Europeans: *pommes de terre soufflées* and *pommes Anna* in France; hot potato salad, noodles, dumplings, pancakes, and bread in Germany; as a base for soups and puddings and stuffing for pierogi in Russia and Poland; colcannon—a mixture of potatoes and kale, turnips, or cabbage—and cobbledy, potatoes mashed with milk, butter, salt, pepper, and onions in Ireland; as an ingredient in the Spanish omelette; in the latkes and knishes of Jewish food; for the sauce *skordalia* in Greece; in *raclette* and *roesti* in Switzerland; for gnocchi in Italy; stuffed potatoes and savory *causa*, mashed potato cake, in Peru; for *lefse*, thin potato pancakes in Norway; in fish and chips, mashed potatoes, shepherd's pie, and Cornish pasties in England; potato casserole in Finland (*Imellettyperunasoselaatikka*), a dish that undergoes a malting process wherein the starch of the potatoes breaks down to form a simple sugar; french fries, potato chips, and stuffed potatoes in the United States.

Potatoes can be used in every course of a meal, even dessert. They can be fried, boiled, steamed, braised, roasted, sliced, diced, chopped, and mashed. A large part of their versatility is their neutral taste, which provides a palatable backdrop for almost all other foods. For dessert, potatoes can be used with or without chocolate in cakes, pies, doughnuts, cookies, and candies. Since potatoes contain no gluten, adding some mashed potato to dough makes it particularly tender.

For cooking, potatoes are classified according to starch content—high, medium, or low—which affects the way they cook and the resulting texture. High-starch potatoes (Russets and Idahos), also known as mealy or floury, are the first choice for baking and frying. The use of the microwave to bake potatoes has considerably shortened what used to be a lengthy process. The large starch granules swell up and separate, making for a light and fluffy texture. Medium-starch potatoes (white all-purpose and yellow-fleshed, including Yukon Golds) have a creamy texture and become soft but do not disintegrate when cooked. Low-starch potatoes (round red and white boiling potatoes), also known as waxy potatoes, are the first choice for boiling, steaming, and roasting. They contain more of the starch known as amylopectin, with granules that stay close and dense even after cooking.

Once purchased, potatoes need to be stored in a dark, but dry, place to ensure they do not turn green or sprout. Generally, store-bought potatoes have been sprayed with a chemical that inhibits sprouting. Even a little warmth and light, however, may provoke the eyes to use the stored energy in the tuber for growing.

The substance that sometimes appears as a greenish cast under the skin and in the eyes of the potato is the alkaloid solanine, the natural pesticide that protects the plant as it grows. All potatoes contain trace amounts (1–5 mg). Its appearance on store-bought potatoes means they have been "light-struck," exposed either to natural or artificial light. According to Federal Food and Drug Administration guidelines, levels higher than 20 mg per 100 g of potato make the vegetable unfit to eat. Consequences of solanine toxicity range from minor upset stomach to serious illness. To avoid this, proper storage and cutting away all traces of green on the potato are necessary.

Relation to Human Biology

Potatoes contain anthoxanthins, pigments that produce the white color and act as antioxidants, believed to have some cancer-preventing activity. Specifically, unfried potatoes are among those vegetables containing the highest levels of the antioxidant glutathione. When compared to bell peppers, carrots, and onions, potatoes have the greatest overall antioxidant activity. Only broccoli is higher.

French fries and potato chips, however, may pose a cancer risk. Separate studies by the national food agencies of Sweden, Britain, and Norway have reported high levels of acrylamide, a carcinogen in rats and probably one in humans, in potato products fried at high temperatures. Until there is more evidence, the World Health Organization and the United Nations Food and Agriculture Organization have not been able to determine whether consumers should cut back on their intake of fried potato foods, particularly chips.

Eating unfried potatoes contributes to the minimum goal of five servings of fruits and vegetables a day, recommended by the U.S. Department of Agriculture's (USDA) Food Guide Pyramid and designed to provide optimum good health.

Symbolism of the Potato

In the United States, the potato has found its way into pop culture. A "couch potato" is a sedentary person; "hot potato" indicates a volatile issue or topic; "small potatoes" refers to something that is not a big deal; a "meat and potatoes" person is someone who eats only the basics. Calling someone a "potato head" is not a compliment because it means someone who is dense. A familiar children's rhyme begins, "One potato, two potato, three potato, four." The children's toy Mr. Potato Head®, introduced by Hasbro in 1952, and Mrs. Potato Head®, in 1953, came packaged with plastic eyes, ears, nose, mouth, feet, and hats to insert into a real potato supplied by the buyer. In 1960, the kit also came with a potato-shaped plastic body. The image has been licensed worldwide for a variety of popular uses including T-shirts, clocks, and Halloween masks.

Since its earliest appearance in Europe, the potato has been associated with the poor and the working class. When the Spanish first stumbled on the potato in Peru, they looked down on it as slave food. The exotic sweet potato was brought from Haiti to Europe as soon as it was discovered by Columbus, but it took the conquistadors more than thirty years to bring potatoes to Spain, and then they came as food for sailors. For a long time, the potato continued to be regarded as food fit only for the poor and as animal fodder, useful only in the event of starvation.

In America, where the potato did not have a class barrier to break down, its association with fat and grease—deep frying—has reinstated some of its lowly image. A headline a few years ago in the *New York Times* read, "The Rich Get Richer and the Poor Get French Fries." The irony is that, by cooking it in fat, the 99.9 percent fat-free fresh potato is transformed into a high-fat snack.

Commercialization of Potatoes

An early reference to commercial potato growing dates from 1762, when the tubers became a field crop in Salem, Massachusetts. In the following year, Connecticut valley potatoes were listed as an export, but the buyers were West Indian planters, looking for cheap food for slaves. By 1848, about half a dozen varieties of potatoes were being grown commercially, the same number grown in the twenty-first century.

Processing of potatoes began not long after they began to be grown commercially. In the 1870s and 1880s in both France and America, manufacturers began making equipment for deep frying, which made commercial production of fried potatoes and french fries a reality. Mass production depended on the availability of cheap oils that appeared right after the Civil War. In 2002 in the United States, nearly half of the potato harvest ends up being fried.

Unfortunately, processing takes much of the taste out of potatoes, and undermines their quality as growers shift to varieties demanded by processors rather than those that are best fresh. Potato products are made from potatoes that have been reduced to powder in one of two ways. The first is simple cooking, drying, and grinding, which preserves the solids in more or less their original proportions. This is how potato flour is made. Derivatives of potato flour include instant mashed potatoes, frozen potato products, and potato chips.

The second method involves extracting starch from potatoes by a washing process. This is how potato starch is made, which is commercially packaged to be used as a thickener and to make cakes, biscuits, puddings, pies, and sauces for Jewish Passover to fulfill the religious requirement that no flour be used in their preparation.

The first large-scale production of dehydrated potatoes began in 1942, when the potato processor John Richard "Jack" Simplot, already the nation's largest shipper of fresh potatoes, won a government contract to supply dried potatoes to the armed forces during World War II. By 1945, he had supplied about 33 million pounds of dehydrated potatoes to the military. French's Instant Potato was introduced by the R. T. French Company in 1946. Frozen potatoes came later, at first simply precut for french fries. By 1962, frozen, dehydrated, and canned potatoes accounted for 25 percent of U.S. potato consumption. By 1966, per capita consumption had risen to 44.2 pounds a year, up from 6.3 in 1950.

The Potato Chip

In 1853, that quintessentially American product, the potato chip, was invented serendipitously. Annoyed when Commodore Cornelius Vanderbilt (the railroad magnate) sent back his fried potatoes because they were too thick, George Crum, the chef at the Half Moon Hotel in Saratoga Springs, New York, thought he would teach him a lesson. Crum sliced some potatoes paper thin, deep-fried, and salted them. Vanderbilt loved them.

Potato chips began to be commercially manufactured as early as 1915, when Van de Kamp's Saratoga Chips, a storefront operation, opened in Los Angeles. In 1921, Wise Potato Chips were introduced in Berwick, Pennsylvania, by Earl Wise, a local grocer. Finding himself overstocked with old potatoes, Wise peeled and sliced them, and then followed his mother's recipe for making chips and put them in brown paper bags. In the early 1930s, he switched to the more practical cellophane bags. By 1942, Wise had opened a 40,000-square-foot plant.

In 1969, General Mills introduced Chipos, and Procter & Gamble brought out Pringles, both made from cooked, mashed, dehydrated potatoes that were then reconstituted into dough and cut to uniform size (rather than made from sliced potatoes fried in oil). These new "chips" were packaged in break-proof, oxygen-free containers to prolong their shelf life. The Potato Chip Institute sued to prevent the products from being sold as chips, but lost. The Food and Drug Administration ruled that chip products not made from fresh potatoes must be labeled "potato chips made from dried potatoes." By the time the ruling was to have taken effect in 1977, fabricated chips had already lost their appeal.

In 2001 in the United States, nearly $2.7 billion worth of bags were sold, according to Information Resources, a market research firm. A survey by the Department of Agriculture found that the average American snacker eats 33 pounds of chips per year.

Issues in the Twenty-first Century

To combat the threat of pest damage and fungicide-resistant blight, scientists have experimented with breeding blight-resistant germ plasm and biotechnology that involves placing a gene into an already existing variety to improve its resistance to disease, insects, or stress. For example, resistance to the Colorado potato beetle has been placed into the Russet Burbank potato by inserting genetic material from the bacterium *Bacillus thuringiensis* into the plant. This causes a protein to be manufactured that disrupts the digestive system of the beetle when it feeds on the leaves. The Shepody variety of potato has been improved to make it more resistant to viruses, one of the major causes of declassification of seed in the potato industry. The gene prevents replication of a virus after it has been introduced by aphids. Monsanto's NewLeaf potato is the first genetically engineered potato, designed to protect it from the Colorado potato beetle. It was approved in the United States in 1995, and subsequently in Canada, Mexico, and Japan. The NewLeaf Plus, the next generation from Monsanto, resists both the beetle and the potato leaf roll virus.

Biotechnology is not without controversy. Some critics point out that it gives corporations like Monsanto a profitable monopoly on the seed since it must be replanted each year. Others are concerned that the long-term effects are not known. A major concern is that there is no requirement to label genetically engineered products. There are even larger questions about whether biotechnology offers a reasonable way to feed the world's hungry; most experts maintain that the amount of food is sufficient and it is distribution that is the crucial issue.

Genetic Diversity

Many observers believe that the solutions to the agricultural issues lie in plant breeding and preserving the genetic diversity of potatoes. By planting a larger number of varieties, farmers guard against damage of blight or insects that might destroy one variety but not another. There is some reason to believe that, if Ireland had planted its fields with a diverse crop, the toll from the famine would not have happened.

Today, only half a dozen varieties constitute the vast majority of the nation's crop. In the final decade of the twentieth century, there was a resurgence of interest in potato varietals and their preservation and development. Of particular interest are heirloom potatoes, those developed over centuries for which the seeds have been handed down from one generation to the next.

To protect the genetic diversity of the potato, and to make it available for systematic manipulation, the International Potato Center in Lima, Peru, under the auspices of the Consultative Group on International Agricultural Research, has collected about 5,000 samples of native cultivars from nine countries in Latin America, representing about 3,500 genotypes. Every aspect of the potato and its place in the environment and human society is studied. Recent projects have included an effort to develop tropical varieties for Africa, Hong Kong, and the Philippines.

See also **Biotechnology**; **Central Europe**; **Columbian Exchange**; **Distribution of Food**; **Fast Food**; **French Fries**; **Genetic Engineering**; **Germany, Austria, Switzerland**; **Hamburger**; **Ireland**; **Scurvy**; **Snacks**; **Sweet Potato**; **Vegetables**.

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Linda Murray Berzok

POTLATCH. "Potlatch" is anglicized from the Nootka (Nuu-chah-nulth) word *patshatl*, which means "giving." The Nootka term came to be used in Chinook jargon, a Northwest Coast of North America lingua franca, in the 1860s with the beginning of Euro-Canadian settlement. Potlatch denotes a ceremonial feast and gift giving held in winter, usually marking a rite of passage, such as a funeral, wedding, or elevation to a noble title. Late nineteenth-century Kwakiutl (Kwakwaka'wakw) potlatches described by Franz Boas displayed oratorical boasting and overwhelming quantities of gifts and food, asserting the aristocratic host's wealth and high rank. Neighboring noble houses vied for even more generous potlatches, escalating the competition for status. For example, in 1803, a Nuu-chah-nulth chief gave away 200 muskets, 200 yards of cloth, 100 mirrors, and gunpowder; in 1921, a Kwakiutl chief gave away thousands of dollars worth of purchased goods, including gas-powered boats and boat engines, sewing machines, pool tables, and gramophones. Canada's 1884 Potlatch Law (rescinded in 1951) outlawed these feasts but succeeded only in repressing them, not in exterminating them.

From the point of view of Northwest Coast people, potlatches sustained the reciprocal relationships among noble houses, including their dependent families. In the northern part of the region "houses" or lineages (often called clans in English) were grouped into pairs, such as Ravens and Wolves, that were expected to alternate as host and guest, thus ensuring a balanced series of feasts and gifts. In the central part of the region guests came from neighboring villages, and marriages between villages gave persons noble titles in both parents' lineages, creating a more fluid social order. Throughout the Northwest Coast the emphasis was on visibly recognizing rank by the seating order and the amount of the gift. Anthropologists suggest that late nineteenth-century potlatch extravagances reflected an increase in consumer goods from Euro-Canadian towns and traders that also brought severe decreases in Indian populations from disease epidemics and political instability.

The Danish ethnologist Kaj Birket-Smith, who worked in Southeast Alaska, hypothesized that ancient contacts around the Pacific spread the institution of "feasts of merit" and publicly marked an investiture in higher status. He pointed out similarities between potlatches and such feasts in Southeast Asia and Polynesia. Through trade across the interior mountains, the potlatch may be related to "giveaways," held at powwows among Plains First Nations, that stem from the requirement that leaders must be generous. Giveaways are customary at memorial feasts and on such occasions as a child dancing in a powwow for the first time or a person earning a college degree. In both Northwest Coast potlatches and Plains giveaways, new blankets are the standard gift. Especially honored guests are given embroidered robes or star-pattern quilts, lesser acquaintances smaller items, and visitors who have earned the friendship of the hosts may be recognized with gifts of embroidered jackets or other clothing emblematic of the hosts' style. All guest share in feasting, the gift of food. Potlatches and giveaways share the ethos that giving a gift honors both giver and recipient.

Food at a potlatch must be abundant. Ideally the guests should not be able to finish what is served but should take the surplus home. "Traditional" foods are served, though what is traditional has been modified over time as introduced foods have become standard in the community. Salmon, dried for winter use, has been the prized and usually abundant principal food. Other dishes include berries, seaweed, and meat of mountain goats, elk, moose, bears, seals, small mammals, and halibut, all smoked or dried. Traditionally eulachon, a smelt abundant in early spring, were caught in large quantities and processed into a rich oil used as a sauce at every meal. Potlatches were noteworthy for the lavish outpouring of eulachon "grease," to the point of ladling gallons into hearth fires until the flames roared to the roof. A description of Tsimshian feasts notes, "The foods that were most valued were those that were scarce, available only seasonally, required intensive labor (and entailed organization by a person of rank), 'imported items' (including European foods as they became available), grease, and anything preserved in grease" (Halpin and Seguin, 1990, p. 271).

Dances, both ritual and social, are integral to Northwest Coast potlatches. Elaborately costumed and ingeniously propped dance-dramas, especially those involving a wild cannibal who roared and apparently bit people before the wise elders tamed him, horrified Christian missionaries. When the Canadian government banned potlatches, First Nations protested that the dancing at potlatches was simply "winter amusement," like Euro-Canadians' balls and theatrical entertainments. Furthermore they protested that potlatch feasting provided quality food to their elderly and poor. Most government agents looked away when potlatches were held, recognizing that the First Nations had banned killing slaves and burning houses in favor of conspicuous consumption. By the early twenty-first century potlatches in many Northwest Coast First Nations communities celebrated appropriate occasions without the earlier ostentatious rivalry. Accommodating contemporary employment, twenty-first century potlatches last for a weekend rather than for weeks and are held in community halls. Core practices and foods continue, fostering First Nation identities through public displays of ancient titles, heritage arts, and regional foods.

See also **American Indians.**

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Alice Kehoe

POULTRY. Poultry are domesticated birds raised for food: chickens (including Cornish game hens and poussins), turkeys, ducks, and geese, plus minor species such as squab (young pigeons) and ostrich. Game birds such as quail and Canada geese can also be prepared in much the same ways, although their meat is tougher than that of birds raised on farms. Chickens and ducks are among the most widely distributed food animals in the world and are part of nearly every major cuisine.

Poultry were the last major group of food animals to be domesticated. Humans likely began by raiding the nests of wild birds to steal their eggs, just as nonhuman predators do. Eventually the birds themselves were caught and kept in confinement, or, when thoroughly domesticated, allowed to range around the farmstead or village to find their own food.

PEKING DUCK

An elaborate method of preparing, cooking, and serving duck was developed by cooks in China's capital city and is known as Peking Duck. The cook will inflate the duck's carcass by blowing air between the skin and the body, blanch the duck in hot water, coat it with malt sugar, and pour boiling water into the cavity. The bird is then hung in a special vertical oven and roasted over a wood fire, preferably using the wood of fruit trees. The result is a bird with a taut golden skin and moist tender meat. Often only the skin is eaten at table, and the meat is sent back to the kitchen to make into other dishes. Or the meat can be cut into thin slices and rolled up in thin pancakes. Elaborate ceremony often attends the slicing of the bird.

Chicken, in particular, has had an increase in popularity in the United States in recent years; according to the U.S. Department of Agriculture, sales climbed from 39 pounds per capita in 1970 to 77 pounds per capita in 2000. The surge in chicken's popularity is attributable partly to its low fat content as compared to beef. Three-and-one-half ounces (one hundred grams) of roasted chicken breast with its skin removed has only 120 calories and 1.5 grams of fat, while the same serving of cooked sirloin steak has 170 calories and 6 grams of fat.

Also propelling chicken toward the center of the nation's plate is its versatility and convenience. Chicken is convenient to prepare and less likely to be ruined by overcooking than the competition. Chicken has become a kitchen favorite for cooks who are both pressed for time and somewhat inexpert at cooking.

Cost is also a major factor in the rise of poultry's popularity. In constant dollars, the wholesale price of a whole chicken dropped 50 percent from 1978 to 2000, while the price of skinless, boneless breast dropped 70 percent.

In contrast to chicken and turkey, duck, goose, squab, and other minor species are expensive and are served mainly on special occasions in the home or in high-end restaurants or restaurants specializing in ethnic cuisine. Peking duck is a mainstay of Chinese cookery, for example.

Chickens

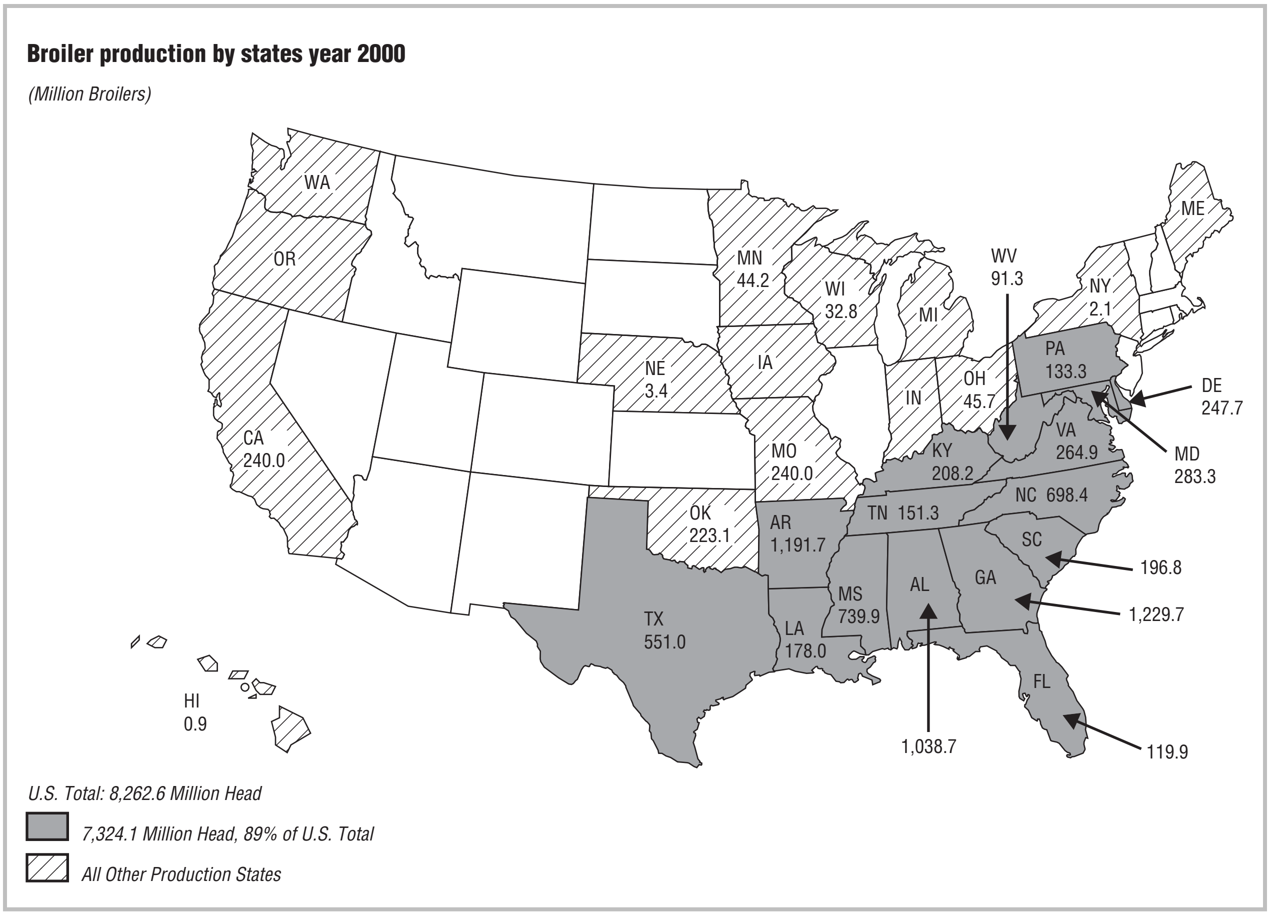
The most prevalent of the domestic fowl worldwide, the chicken is descended from the Red Jungle Fowl, a bird whose native territory stretches from east India to Malaysia. It is not clear exactly where the bird was first domesticated, but it has been raised by humans throughout its range since ancient times. Polynesian explorers took the chicken across the Pacific as far as Hawaii. Chickens were exported from India to China as early as the fourteenth century B.C.E. and spread to the Near East via the trade routes, and thence to Egypt, Greece, and Rome. Domestic fowl are not mentioned in the Old Testament, but the ancient Egyptians kept fowl and developed large ovens capable of incubating thousands of eggs, indicating that they had large flocks. The Greeks had chickens by the fourth century B.C.E., and many a family in ancient Athens kept a hen to produce eggs. The Romans took up the bird and carried it throughout their empire and beyond; the Germanic and Celtic tribes north of the Roman frontier had chickens before the Christian era. Both Greeks and Romans gave chickens a prominent place in their cuisine and recorded elaborate recipes for cooking them. Poultry shops were so well-established in England by the fourteenth century that their proprietors prevailed upon the authorities to prohibit country people from bringing poultry into the city to sell in the streets in competition with them. Medieval and Renaissance banquets featured chickens along with other fowl: Pope Pius V (d. 1572) gave a banquet that included chicken pie—two chickens to each pie—and spit-roasted quails and pigeons.

A hen in her prime will produce from 100 to 250 eggs per year, a remarkable output for the size of the animal, so the chicken has always been kept more for its egg-laying capability than for its value as meat. Since a hen will lay eggs whether they are fertilized or not, and a single male bird can adequately service a large number of females to ensure reproduction of the flock, most of the male birds are superfluous to an egg-laying flock. They are, however, easily castrated when young, and the resulting birds, known as capons, grow fat and tender. From ancient times until quite recently, capons were the best choice for roasting, with older hens sent to the stew pot. Young male birds, known as cockerels, although smaller than capons, were also available for roasting or other forms of cooking.

Production of birds for their meat has traditionally been a sideline to the egg-laying business. Not until the 1920s were large flocks of chickens raised specifically for their meat, which are called broilers or fryers (the terms are interchangeable). Today about 97 percent of the chicken found in a U.S. supermarket consists of broiler-fryers, with most of the balance consisting of stewing hens (older birds) and a few Cornish game hens. The capon, once a prized dish, is now rare.

The chicken has a short generation span, since the female reaches sexual maturity in about a year. Consequently, the development of different breeds can occur rapidly. Poultry keepers bred birds for desirable characteristics, which traditionally included prolific egg production. The Leghorn is the longtime champion of layers. More recent breeding has emphasized abundant

FIGURE 1



Broiler production by states year 2000

(Million Broilers)

U.S. Total: 8,262.6 Million Head

▩ *7,324.1 Million Head, 89% of U.S. Total*

▨ *All Other Production States*

meat production. Specialized breeding companies cross different breeds to attain the right mix of desirable characteristics.

Turkeys

The wild turkey (*Meleagris gallopavo*) is native to the Americas and inhabited northern Mexico and what is now the eastern United States when Columbus arrived. All of the domesticated turkey breeds descended from this hardy bird, which was domesticated by the Aztecs and other Native Americans. Montezuma himself dined on turkeys, ducks, quails, and other birds, according to a Spanish eyewitness. Early in the sixteenth century, the Spaniards took the bird home, where it began a rapid spread through Europe. People were accustomed to eating large birds—swans and peacocks had graced noble tables since ancient times—and the turkey provided an abundance of meat. In this respect, the turkey was very different from the chicken, since the turkey has been prized chiefly as a source of meat rather than eggs.

The name given the bird by Europeans reflected mass confusion about its origins and perhaps a similarity to another bird, the guinea fowl, which had recently been reintroduced into Europe after an absence dating to the fall of Rome. The guinea fowl was called an “India chicken” by many, apparently because it reached Europe from the east and was thought to have originated in India, although in fact it is from Africa. When the turkey showed up, it looked like a bigger version of the same bird and was dubbed the “bird of India” in nearly every language: “coq d’Inde,” cock of India (later *dinde*), in French, “indianische Henn” in German, and variations on the same in other European languages. Eventually the turkey took sole possession of the “India” name and the guinea fowl was renamed after the Gulf of Guinea in west Africa. The only major exception was England, where the bird was called the “turkie cock” (or hen). This may reflect a belief that the bird came from Turkey, since many exotic products, edible and otherwise, had passed through the eastern Mediterranean on their way to western Europe. A more specific theory is based on the fact that English trade to that region was dominated by the Company of Merchant Adventurers Trading to the Levant, popularly known as the Turkey Merchants. Officers of the company reportedly stopped in Spain and picked up some of the birds on their way back to England, and the bird was named after them.

TABLE 1

Production of poultry meat and eggs, leading nations, 2001

In metric tons

Nation	Poultry meat	Chicken meat	Turkey meat	Duck meat	Goose meat	Primary eggs*
WORLD	**70,358,813**	**60,258,645**	**5,085,889**	**2,936,687**	**2,058,969**	**56,594,078**
United States	16,747,600	14,210,000	2,485,000	52,600	Neg.	5,080,000
China	13,286,850	9,401,030	1,990	2,009,980	1,873,850	23,354,520
European Union (15)	8,852,099	6,632,852	1,860,960	343,112	14,075	5,303,441
Brazil	6,394,850	6,222,700	165,000	7,150	Neg.	1,582,700
France	2,077,100	1,100,000	735,000	235,000	6,000	1,047,000
Mexico	1,945,038	1,897,546	27,242	20,250	Neg.	1,881,645
United Kingdom	1,561,700	1,257,500	256,000	45,800	2,400	644,751
Thailand	1,366,500	1,260,000	Neg.	105,000	1,500	810,000
Japan	1,180,012	1,180,000	12	Neg.	Neg.	2,526,000
Italy	1,156,000	816,000	340,000	Neg.	Neg.	707,000
Canada	1,092,300	943,000	141,000	7,400	900	362,800
Spain	1,034,000	1,012,000	22,000	Neg.	Neg.	563,700

*Table eggs of all species, including chicken, duck, and goose.

Neg.: Negligible production

The production of poultry meat and eggs constitutes a large industry worldwide. Nearly every country produces chicken meat and eggs; turkey is popular largely in Europe, North America, and Brazil; duck meat production is found largely in China and Europe; and goose meat is largely Chinese. The United States is the leading producer of poultry products, particularly chicken (14 million metric tons produced in 2001) and turkey (two and a half million tons), in both of which it leads the world. China is second in chicken production with about nine million tons, and dominates the world in goose meat and duck meat production. In fact, 91 percent of all the goose meat produced in the world, and 68 percent of the duck meat, is produced in China.

Other major countries in chicken meat production include Brazil, France, Mexico, the United Kingdom, and Thailand, while the leading turkey producers after the United States are France, Germany, Italy, the United Kingdom, Brazil, Canada, and Hungary. France and Thailand are the leading duck meat producers after China, followed by Viet Nam, the United States, Malaysia, the Republic of Korea and the United Kingdom. The goose meat industry is very small outside China, with the biggest countries being Hungary, Egypt, Madagascar, and Poland.

China produces more than 23 million metric tons of eggs, or more than forty percent of the world's supply, which includes goose and duck eggs as well as chicken eggs. The United States is next with five million tons, followed by Japan with two-and-a-half million tons and Russia, India, and Mexico with about two million tons each. Japan is the leading consumer of eggs on a per capita basis, with China in second place. In the United States, per capita egg consumption has dropped in recent years, largely in response to concern about the cholesterol content of eggs.

SOURCE: United Nations Food and Agriculture Organization Statistical Databases; U.S. Department of Agriculture Foreign Agriculture Service.

Whatever the reason for its odd name, the turkey seems to have taken Europe by storm. It arrived in Spain around 1524, was mentioned by Rabelais in 1548, and was served at a royal wedding feast in France in 1570. In England, the bird was established even sooner, being mentioned in the sumptuary laws of 1541. Turkeys could be raised by peasants and by the turn of the seventeenth century were being husbanded throughout Europe. The Pilgrims recognized the local turkeys when they settled in Massachusetts and learned that the Native American name for the bird was amazingly close to their own. The natives called it a "furkee."

Ducks and Geese

Ducks and geese are distributed worldwide and were trapped and domesticated by humans in antiquity for both eggs—especially duck eggs—and their meat. Ducks were probably domesticated before geese, and both were certainly domesticated in most of the world long before chickens. Ducks were raised in China two thousand years B.C.E. The Incas of Peru kept ducks, and the Spanish brought home what became known as the Muscovy duck (continuing the tradition of naming birds for lands far from their own).

Ancient peoples in Europe and Asia tamed mallard ducks, which were the foundation of most breeds of domestic duck, such as the Pekin (or Peking) of China, the Aylesbury of England, and the Rouen of France. Most ducks consumed are slaughtered at a young age and thus termed ducklings; mature ducks are tough and are used mainly in processed products.

In the United States, modern production began when a clipper ship brought three Pekin ducks and a drake from China in 1873. All of today's Pekins are direct descendents of these pioneers. Strains of the Pekin were used to produce the Long Island Duckling, which became the most desirable breed. Production of these birds in the United States eventually moved largely to the Midwest, but only birds actually raised on Long Island for at least seven days and processed there may be labeled "Long Island Duckling." Birds that are otherwise essentially identical, but raised in Indiana or other states, are labeled "White Pekin Duckling."

Regardless of where it is raised, the White Pekin is a tender and juicy bird and is the most popular choice for the table. The Muscovy has a stronger flavor than the White Pekin. The White Pekin and the Muscovy have been crossed to produce the Moulard, which is raised mainly for the sake of its liver for *foie gras*. (*Foie gras* is a delicacy consisting of duck or goose liver that has been enlarged to many times its normal size by excessive feeding of the birds. In Europe, where goose is preferred, the bird is "crammed" with feed through a funnel put down its throat. [See photo on page 127.] In the United States, ducks are encouraged to overeat but are not crammed.) The familiar, green-headed Mallard is both raised on farms and hunted in its wild state. It is smaller and tougher than the White Pekin and tends to be quite greasy. Ducks are considered "red-meat" birds, and the breast meat when fully cooked will be pink, which in chickens and turkeys would be a sign of undercooking.

Geese have been domesticated since ancient times in many parts of the world, but the Greylag goose of Europe, which is still found in the wild, is the ancestor of most of the domesticated breeds in existence today. The all-white Emden and the all-gray Toulouse are the two most popular breeds in the United States today; many African and White Chinese are also raised. The Chinese goose is descended from the swan goose of Asia rather than from the Greylag.

Goose production is a small industry in the United States, representing only two-tenths of 1 percent of poultry production, and might virtually disappear were it not for the fact that geese also produce down, which is much in demand for its insulating properties. Down is used in ski jackets, comforters, pillows, sleeping bags, and other cold-weather gear.

Both Greeks and Egyptians kept geese and crammed them with grain to fatten them and enlarge their livers. The Romans apparently adopted geese from the Gauls; Pliny wrote of flocks of geese being driven to Rome from what is now Picardy. The goose was the most prized domestic fowl in Europe for hundreds of years after the heyday of Rome, and the Gauls and their descendents, the French, became the acknowledged masters of the art of creating *foie gras* by force-feeding the birds. The goose became a holiday bird in much of Europe and is considered an alternative to the turkey in the United States. The meat is all dark and has the consistency of roast beef when properly cooked.

Squab

Squabs are young pigeons that have never flown, usually slaughtered at four weeks old. If a squab is slaughtered much after four weeks or after it has begun to fly, the muscles will have hardened and the meat will not be as tender as when the bird was in the nest.

Pigeons are widely spread around the world and have been raised for their meat since antiquity. Pigeon keeping was widespread in ancient Egypt; by the first century B.C.E., dovecotes with one thousand nesting places were common. The design of the dovecotes, using earthen jars as nesting places, survived into modern times. Twenty thousand pigeons were served as a feast given by an Assyrian king in the ninth century B.C.E. Pigeons were popular in ancient Greece, Rome, and during medieval times.

Squab is considered a delicacy around the world today. In the United States, squabs are available mainly through specialty food shops or in ethnic and high-end restaurants.

Production and Life Cycle

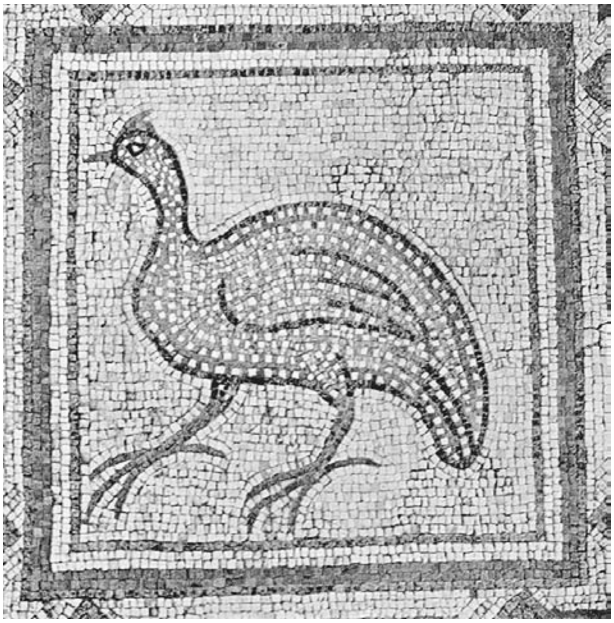
All the major forms of poultry are produced in similar although not identical systems. The model in the United States is the highly efficient broiler chicken sector, which produces the vast majority of the poultry products consumed by Americans. Turkeys and other forms of poultry are raised under conditions that are similar to those of chickens.

The chicken industry was localized, with entrepreneurs buying surplus chickens from egg operations and backyard flocks for the city markets, until early in the twenthieth century, when more organized, long-distance shipping of live poultry commenced. New York and other cities received rail cars of live birds that were distributed to butcher shops or slaughtered and dressed at processing plants for distribution. In the 1920s, farmers discovered that large flocks of chickens could be raised specifically for their value as meat. These farmers needed regular batches of chicks, supplied by large-scale hatcheries, and feed, which they got from commercial feed mills. The hatcheries and mills typically had better access to capital and marketing channels than farmers, and they formed the core of the all-purpose companies that dominate the business today. In the mature industry, a single company typically handles the entire life cycle of a bird, including hatching, feed formulation and production, processing, and marketing. This business model is known as "vertical integration," and there are about fifty such companies in existence in the United States (as of 2001). Breeding of the animals for desirable characteristics is handled by either the integrated company itself or by one of a several specialized breeding companies. Once hatched, the birds are typically taken to privately owned farms, where they are raised to market weight by farmers working under contract to the company.

Production of turkeys is somewhat less centralized than the chicken business, although the turkey industry has been moving in the direction of greater integration. The duck industry is very similar to the chicken model. Most of the squabs in the country are processed and marketed by a cooperative. The goose industry is small and integrated.

Life Cycle

The life cycle of a broiler begins with a specialized breeding flocks, where roosters and hens produce fertile eggs that are collected every day and taken to a hatchery, where thousands of eggs are kept in each incubator under carefully controlled conditions of temperature and



Guinea fowl from a detail of a mosaic floor in the house of Eustolios, Kourion, Cyprus, circa 300 C.E. PHOTO WILLIAM WOYS WEAVER.

humidity. The chicks hatch out on the twenty-first day and are taken to the farm where they will be raised for six to seven weeks. The typical growout facility is a barnlike, one-story structure about forty feet wide and four hundred feet long, which contains about twenty thousand birds. The trend in recent years has been to even larger houses holding up to thirty-three thousand birds. The birds have the run of the building, as cages are not used in broiler production.

Feed is made largely from corn and soybeans with the addition of animal fats for energy, animal protein, amino acids, minerals, and vitamins. Chickens eat almost continuously, pausing to digest each meal before going back to the feeder for more.

When the birds reach market weight of about five and a half pounds, they are collected and taken to the processing plant where they are stunned, killed, defeathered, eviscerated, inspected for wholesomeness by personnel of the U.S. Department of Agriculture, chilled, and either packed for shipment or, more typically, sent to another plant to be cut into pieces, deboned, and processed into a wide variety of products. The finished weight of a whole bird is usually about three and a half pounds, with birds destined for the fast-food market being typically smaller than birds being sold at retail.

Marketing

Poultry companies market their products through supermarket chains, restaurant chains, and independent distributors. The process is highly organized and efficient. Unlike red meat, in which an in-store butcher handles the final cutup, poultry is usually packaged at the plant and shipped to stores ready for sale, with computerized scales at the processing plant weighing the packages and applying the price set by the retailer.

Approximately half the chicken consumed in the country is sold through supermarkets and other retail outlets while half is sold through fast food and other restaurants, cafeteria, and other food service outlets.

Poultry Health

Chickens and other poultry are subject to a wide variety of diseases whether they are kept indoors or not. They are normally vaccinated against certain diseases while they are still in the egg and then again as chicks. One of the most prevalent problems is colonization of the chicken's gut by microscopic, parasitic animals known as coccidia. Most producers, even "organic" or "free range" ones, add chemical compounds to the chicken feed to control coccidia. Poultry flocks are monitored by the farmer and by company representatives for signs of other diseases, which, if they begin to claim more than a certain number of victims, will be treated with antibiotics administered through the feed or water. Some antibiotics, when used in the feed at low levels over a period of time, also result in measurable increases in the bird's weight. The exact mechanism for this "growth promotion" is not known, but poultry experts believe that the antibiotics eliminate organisms in the chicken's gut that would otherwise compete for nutrition. The practice of using antibiotics for purposes other than treating disease is somewhat controversial, and some experts in human health object to it on the grounds that low-level use of antibiotics, some of which are also used in human medicine, can promote the rise of bacteria that are resistant to the drugs. These can be passed to humans either on food products or by entering the environment and could create infections in humans that could be resistant to antibiotic therapy. The National Research Council has found that "there is a link" between the use of antibiotics in food animals and antibiotic resistant infections in humans and recommended further study.

Hormones

Federal law prohibits producers of chickens and other poultry from giving artificial or added hormones to their animals. Producers are allowed to give only those pharmaceuticals or additives that are on the Food and Drug Administration's approved list, and there are no hormones on the list for chickens or other poultry raised for their meat. It would be impractical to give hormones anyway, since they cannot be given in the feed and have to be repeatedly injected as the animal grows, virtually an impossibility in a flock of twenty thousand birds or more.

Alternative Production and Processing Systems

Some have criticized the mainstream industry for its style of mass production, confinement of the animals, and use of antibiotics. The "free range" style of production is intended to address these concerns. In a "free range" system, the birds have access to a pen outside the growout house. Some producers provide a pen as large as the growout house itself, while others provide a much smaller fenced area. The pen gives the chickens the opportunity for exercise, sunlight, and fresh air. Chickens will not necessarily take advantage of the opportunity, however, if the food and water are located only inside the house. Many "free-range" birds thus do little actual ranging.

Since chickens will peck at anything in search of food, a small pen can be quickly denuded of vegetation. Some small-scale producers address this problem by confining the chickens in a covered, portable pen that is moved each day to a different plot of grass; this is called "pastured poultry." Few if any producers will actually turn chickens loose to fend for themselves, although some turkey producers will do so in an area in which forage is available, such as an orchard, in which the turkeys can feed on fallen fruit. "Free range" chickens generally cost considerably more than standard chickens, and they represent only a small portion of total production—probably less than 1 percent.

"Organic" production is another attempt to differentiate the product from those of large-scale producers. The term was used for years on a wide variety of food products without a consistent nationwide definition. The U.S. Department of Agriculture promulgated regulations in 2000, to take effect in 2002, which prohibit the use of the term "organic" unless the production and processing of the product is consistent with the regulation. A qualifying product can carry a "USDA Organic" label. Poultry labeled "organic" must be raised on feed made from organically grown grain that cannot contain animal byproducts; cannot be given antibiotics or anti-parasiticals; and must be given access to the outdoors, among other requirements.

Kosher Processing and Specialized Labeling

"Free range" and "gourmet" chickens are processed in a manner that is essentially identical to standard chickens and are killed by high-speed mechanical devices. Kosher chickens, however, are slaughtered manually by rabbis, not by machine, and are soaked in salt water to draw out the remaining blood to meet the requirements of Jewish law. As a result, Kosher chickens are generally more expensive than standard birds.

In France, the national ministry of agriculture and fisheries operates a program called the "Label Rouge," or "Red Label," which is intended to recognize higher-quality products. Products bearing the red label must employ more traditional methods of production than more standardized products. France offers the red label to qualifying producers of chicken, guinea fowl, turkey, capons, duck, and geese, as well as other animals.

Symbolism

Poultry has long figured in human symbolism and legend. Geese supposedly saved ancient Rome from a surprise attack in the fourth century B.C.E. by cackling loudly when the invaders tried to sneak up on the Capitol. Pigeons were offered as sacrifices by the Hebrews of the Bible. The sixteenth-century Flemish artist Pieter Bruegel the Elder—a great fan of fantastic-looking animals—used the turkey as a symbol of envy in his series of paintings on the seven deadly sins. But the domestic fowl most often used as a symbol is the ordinary chicken.

In ancient Greece, chickens were offered in sacrifice to the god of medicine, Aesculapius, to protect against disease, to thank the god for recovery, or to prepare for imminent death. Aristotle conducted the first known systematic study of embryology by opening hen's eggs at each day of incubation. Less scientific ancients used the birds for magic, sorcery, and divination.

The chicken has always been one of the most familiar domesticated animals since almost any family could afford to keep a hen, and chickens were kept in the city as well as the countryside. Humans therefore had abundant opportunity to observe the chicken at close range. They could hardly help but notice the insatiable sexual appetite of the male bird, which can copulate up to thirty times a day in his prime. The traditional term for the rooster—the cock—was given in slang to the male sexual organ, and the upright, strutting posture of the male, and his domineering behavior toward the females, seemed to symbolize traditional male supremacy.

The rooster's habit of crowing loudly at dawn has made it for centuries the symbol of awakening. The most famous example is the prediction by Jesus of Nazareth that his chief apostle, Simon Peter, would deny knowing him three times before the cock crowed twice. When Peter heard the crowing and realized the prediction had come true, "he went out and wept bitterly." The rooster's role as a herald has continued to this day. A rooster figures prominently in a tapestry hanging in the United Nations headquarters in New York that commemorates the Chernobyl nuclear power plant disaster, presumably as a symbol of the world's need to awaken to the danger of uncontrolled technology.

Food Safety

Chickens, turkeys, and other types of poultry are produced on farms and processed in clean but not sterile plants, so their meat can carry microorganisms that potentially harmful to humans. For example, approximately 10 percent of raw chickens carry *Salmonella*, which can cause illness and even death in humans. Improved processing technology and stricter government regulations have improved the situation considerably in recent years, but consumers should always handle raw meat and poultry with care.

To ensure that poultry products are safe to eat and to avoid contaminating other foods with the bacteria that may be carried on raw poultry, the cook should keep four basic points in mind:

1. **Clean:** Keep working surfaces clean. Wash cutting boards after cutting raw poultry and before using them for other foods, such as vegetables. Wash the hands before touching other foods. Wash utensils in hot, soapy water.
2. **Cook:** Cook foods to the recommend temperature. Proper cooking deactivates bacteria and renders the food safe to eat.
3. **Chill:** Bacteria such as *Salmonella* do not grow well at cold temperatures, so prompt refrigeration at 40°F or below will help control the growth of bacteria on raw foods. After poultry is cooked, in order to control the growth of molds, yeasts, and spoilage organisms, it should not be left out at room temperature for more than two hours. *Listeria* is an exception to the rule, however, since it will grow at refrigerator temperatures. *Listeria* is sometimes found on products that were cooked at the plant, such as hot dogs and lunch meat. Vulnerable individuals—chiefly pregnant women, small children, the elderly, and immuno-compromised people—should reheat such foods until they are steaming hot before consuming them to eliminate the risk of *Listeria* contamination.
4. **Avoid cross-contamination:** Poultry juice can contain millions of bacterial cells. Prevent poultry juice from dripping onto other foods by overwrapping the packages if necessary in plastic wrap.

Selection

Poultry comes in a dizzying array of forms ranging from a package of chicken wings weighing two ounces each to whole turkey weighing twenty pounds or more. The consumer can buy products based on specific meal plans or based on cost consideration, for example, stocking up on boneless chicken breast when it is on sale. In determining quantities, keep in mind that the edible yield from boneless products is far greater than from bone-in; in fact, while boneless chicken costs considerably more than bone-in, the price difference almost disappears when the bones are excluded. On the other hand, much of the weight of ducks and geese consists of fat that will drain off when the bird is cooked. As a rule of thumb, four ounces of skinless, boneless chicken will serve one adult, while a whole chicken will serve approximately one person per pound. For a whole turkey, figure on one pound per person. A whole duck or goose, which has less meat, bigger bones, and more fat than turkey, will serve three persons, or four if there are enough side dishes, while one squab is an individual serving.

Classes of Chickens

Chickens are classified primarily by the size, weight, and age of the bird when processed. Chickens are produced to meet specific requirements of the customer, which can be a retail outlet, fast food chain, or institutional buyer, among others. The weights given here are "ready to cook," that is, eviscerated or "dressed."

Broiler—Chicken raised for meat products; of either sex; usually six to seven weeks old; often labeled "tender young chicken."

Poussin—Less than twenty-four days of age and about one pound or less.

Cornish Game Hen—Less than thirty days of age and about two pounds.

Fast-food Size Broiler—two pounds four ounces to three pounds two ounces, (mostly two pounds six ounces to two pounds fourteen ounces), usually cut-up, without necks and giblets, may have tail and leaf fat removed, and less than forty-two days of age.

3's and Up—three to four and three-quarter pounds, usually with neck and giblets for retail grocery; whole, cut-up, parts, and forty to forty-five days of age. Typical retail size.

Broiler Roaster—five to six pounds, hens usually fifty-five days of age.

Broilers for Deboning—five to six pounds, males usually forty-seven to fifty-six days of age. Deboned for nuggets, patties, strips, and similar boneless products.

Heavy Young Broiler Roaster—six to eight pounds, sold fresh or frozen through retail grocery, both whole and parts, less than ten weeks of age. Typical "roaster."

Capon—Castrated male broilers weighing seven to nine pounds, and about fourteen to fifteen weeks of age. Considered to be very flavorful.

Stewing Hen or Heavy Hen—breeder hens that are no longer commercially productive for laying hatching eggs, usually five to five-and-one-half pounds, about fifteen months of age, used for cooked, diced, or pulled meat. Sometimes sold whole at retail for use in homemade soup. While tougher than younger birds, the stewing hen has developed a deeper flavor.

Turkey

The male bird, or "tom," tends to be bigger than the hen, although there is no noticeable difference between the two in the quality of their meat. Almost all the turkeys in the supermarket are young turkeys, slaughtered at about fourteen weeks of age for hens and eighteen weeks for toms.

Turkey breast is even leaner than chicken and is very widely used in sandwich meat and other delicatessen-type products, as well as sold fresh in the meat case. Turkey dark meat is also widely used in hot dogs, bologna, and other processed meat products. Whole birds are available year round but are especially popular as the main course at Thanksgiving and Christmas. Turkey parts are increasingly popular both year round and at the holidays: whole or half breasts, tenderloins, and legs.

Storage

Poultry is generally sold with a “sell-by” date on the package, which, for chicken, is typically ten to fourteen days from processing. Poultry should be cooked or frozen within a few days of purchase to maintain its quality. Fresh poultry should be kept in its original wrapping and stored in the coldest part of the refrigerator. If the package is leaking fluid, it should be overwrapped with plastic or aluminum foil.

Frozen poultry will keep six months or more in the freezer set at 0°F. Frozen whole birds or parts can be defrosted in the refrigerator, which can take twenty-four hours or more, or in cold water, which should be kept running or changed every 30 minutes. A whole turkey should be defrosted in water because defrosting in the refrigerator takes too long. Whole chickens and all types of parts can be defrosted in the microwave, but a very low power setting should be used and caution exercised to ensure that the product does not begin to cook during the defrosting.

A Note on Doneness.

Poultry parts reach the desired state of doneness at different internal temperatures. Boneless chicken breast cooked on an outdoor grill can be cooked without reaching 150°F (even though 160ºF is usually given as the minimum temperature that breast meat should reach). Yet drumsticks, because of their dark meat and higher fat content, will not be done until they register 180°F. Bones conduct heat, so when taking the temperature of a part or a whole bird, do not let the thermometer rest against a bone.

Generally, boneless white meat such as chicken or turkey breast should be cooked to 160°F, bone-in parts usually need to reach 170°F; and dark meat should hit 180°F.

Poultry will usually be safe to eat before it is done. Any food is safe to eat at 160°F because bacteria are destroyed at temperatures over 140ºF. One exception: it is impossible to make spoiled food safe to eat by heating it because spoilage organisms create toxins; even if the bacteria are destroyed, the toxins remain. Spoiled food cannot be fixed by cooking and must be discarded.

Methods of Preparation: Chicken

As befits its reputation as the most versatile of meats, chicken can be prepared in a host of different ways. Here are the principal methods of preparation and the chicken products most appropriate for them.

Tin bird roaster for open hearth cooking. England, ca. 1860. Small birds such as squab were suspended from hooks inside the bonnet. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Roasting. A whole roast chicken is a magnificent sight, browned to perfection and rich in the promise of tender, juicy meat. Because of its small size relative, say, to a turkey, roasting a chicken takes only a couple of hours and is perfect for a Sunday afternoon dinner. Be sure to remove the giblets (heart and liver) from the cavity if present and discard unless you intend to make gravy with them. The chicken may be stuffed with any type of bread-based stuffing, although this increases cooking time. Some experts recommend cooking the stuffing in a sauce on the stove. To ensure even cooking and present a tidy appearance in the finished product, it is best to truss the chicken, that is, to use kitchen string or other clean white string to ties its legs over the cavity and secure its wings to the body.

Preheat the oven to 325°F and place the chicken on a rack in a roasting pan or a deep baking dish. Use of the rack will keep the chicken from sitting in its own grease.

Roast for about an hour, basting occasionally with the pan juices. The chicken is done when the internal temperature reaches 180°F on a thermometer inserted deep into the thigh without touching bone. Let stand 20 minutes to allow the juices to settle before carving.

Baking. Roasting and baking are essentially the same thing, the difference merely being that a whole chicken is roasted while parts are baked. Any poultry part can be baked, but the method is most appropriate for legs, thigh, and drumsticks. Preheat the oven to 400°F, place the chicken part in a lightly oiled roasting pan or in a deep baking dish, and place in the oven for 40 to 45 minutes. Use of a rack will help keep dark meat parts from picking up too much melted fat; it is not necessary for breast meat.

Broiling. In broiling, meats are placed several inches under the heat. This works well for all chicken parts, but especially for boneless or bone-in breasts. Preheat the broiler and broil the breasts for approximately 15 minutes per side. Bone-in breasts are placed six to eight inches from the heat; boneless breast lie flat and can be placed closer. Cook the rib side of bone-in breasts, or the rough side of boneless breasts, first, and then finish with the skin side of skin-on breasts or the smooth side of skinless, boneless breasts.

Sauté. Boneless parts such as breast or thigh can be cooked in a pan on top of the stove in a little liquid, which can be chicken stock, wine, butter, olive oil, or some combination. The trick is to brown the chicken on both sides before reducing the heat to cook it through. Boneless breast cooked in butter and olive oil and seasoned with lemon and rosemary is a delicious dish. It can be made even more delicate by slicing the breast portion in two with the knife held parallel to the counter, resulting in two breast fillets. A thin piece of breast will cook in just a few minutes on each side.

Fried. Fried chicken is a mainstay of southern cooking, although Southerners clearly did not invent it; a cookbook published in England in the eighteenth century included a recipe for fried chicken that could be used today. Fried chicken has fallen somewhat into disfavor, along with many other types of fried foods, due to its fat content and reputation for clogging arteries. However, the best fried chicken is not greasy and does not have exceptionally high added fat. The key seems to be to keep the frying oil very hot so that the skin of the chicken is sealed quickly, thus keeping the liquid fat out of the meat. Oil tends to lose its frying ability with use, so either start with plenty or keep heating up new batches of oil. Drumsticks and wings are the parts traditionally considered most suited to frying, but breasts and thighs will do just as well.

Southern cooks often recommend soaking the raw chicken in buttermilk and refrigerating for several hours. Then let the excess milk drain off, dredge the chicken parts in seasoned flour, and dunk into hot oil in a deep pan or heavy skillet. Many a cook has found the skillet lid a handy shield against spattering grease. Keep the oil at about 350°F until all the parts are added, then reduce the temperature to around 320°F and cook 10 to 12 minutes per side or until the juices run clear. (Five minutes per side for boneless breast.) The chicken is done when it turns golden brown. Drain on paper towels to get rid of as much grease as possible.

When frying wings, split them at the joints and discard the outermost and least meaty part, which is known as the "flapper." The meaty first joint is known as the "drummette." Wing portions make excellent appetizers.

Soups and stews. The stewpot was traditionally the destination of older and tougher birds that needed long, slow cooking to make them tender enough to eat. Old, tough birds are hard to find these days, although the chicken companies will sometimes market played-out hens in the dead of winter precisely for this purpose. Newer soup recipes, such as those based on Asian dishes, are light and delicate and perfectly suited to the young and tender birds that dominate the market.

Grilled. Chicken has ridden the wave of popularity of both outdoor and indoor grilling in recent years. Dark meat in particular, such as legs and thighs, stand up well to the intense heat of grilling because of its higher fat content and the presence of collagen, which melts and keeps the meat moist. Breasts should be marinated to keep them moist during grilling and will cook in no more than 15 minutes per side. Boneless breast will cook in about 6 minutes per side. Strong favors such as vinegar and soy sauce can be used with chicken bound for the grill. The grill itself should be brushed or rubbed with oil to keep white meat from sticking to it. If barbecue sauce is used, save it until you have turned the chicken skin side up.

Turkey

Norman Rockwell knew his business when he chose a roast turkey as the symbol of abundance in his painting called *Freedom from Want*. There is nothing more American than the Thanksgiving turkey.

Roasting. Roasting a turkey can be a trying experience, especially one that tips the scales in excess of twenty pounds. It is hard to get the dark meat cooked through without overcooking the breast. One approach is to eliminate the dark meat entirely and buy a turkey breast (or two if the whole family is coming). The all-white meat breast is easily cooked according to the package directions, usually in a 350°F oven. If there are dark meat fans in the crowd or if cooking anything less than a whole bird seems somehow un-American, then satisfactory results can be obtained by roasting the bird at 325°F for 10 to 12 minutes per pound, shielding the breast with aluminum foil for the first hour, and continuing to cook until a meat thermometer registers 180°F when inserted into the deepest part of the thigh without touching bone. If the bird is stuffed, the stuffing must reach 160°F to ensure safety. Basting the breast with melted butter can help it stay moist. Another trick is to lay raw strips of bacon over the breast, letting the bacon release its fat to the breast as it crisps. Many turkey processors provide "self-basting" birds, which are injected at the plant with oil to maintain their moistness. If you do not have a thermometer, the pop-up thermometers inserted at the plant are generally reliable. Or you can wiggle the legs and wings to see if they move freely, or insert a knife or fork into he bird to see if the juices run clear. Let the bird sit for 20 minutes after coming out of the over before trying to carve it. And give yourself plenty of time—an eighteen-pound bird that goes into the oven after breakfast will not be ready until early to mid-afternoon.

Turkeys are sold both fresh and frozen. It is a matter of opinion whether one tastes better than the other.

One thing is certain, however—a fresh turkey will not have to be defrosted, which can be a difficult and time-consuming process. Just keep a fresh bird in the refrigerator until you are preheating the oven, when you can take it out, rinse it off, remove the neck and giblets from the cavity, and pat it dry. A frozen turkey should be placed in a clean sink or large pan and defrosted under cold running water. It takes several hours to defrost a large, solidly frozen turkey.

Grill. Turkey thighs and drumsticks can be grilled just like chicken parts. So can turkey cutlets, which are slices of skinless, boneless turkey breast. Turkey breast is the lowest in fat of all the cuts of poultry, however, so breast meat should be marinated or brushed with oil before being subjected to the heat of grilling.

Sauté. Cutlets sliced very thinly are called turkey scaloppini, and they lend themselves very well to being sautéed in a pan and finished with a flavorful sauce.

Other turkey products. Turkey is a major factor in the delicatessen counter, with turkey rolls providing lunch meat and the dark meat used very extensively in frankfurters and other already-cooked products. Since breast meat is tends to be quite dry, processors form breast meat into rolls and inject them with a saline solutions to keep the meat moist and easily carved. Ground turkey is a popular substitute for ground beef in many recipes due to its lower fat content, and turkey is turning up in sausages and other products as processors continue to try to get away from relying on holiday sales to carry them through the year.

Squab

Squab can be roasted, broiled or grilled. The bird weighs only about one pound and will cook quickly whichever method is used. The key is to cook the bird only until the breast meat is medium-rare, with the juices till running pink and the meat still juicy and pinkish. Broiled squab should be turned once and will cook in 15 to 20 minutes. If grilling squab, start with the skin side down to melt the fat under the skin. If grilling is desired, it is best to buy boneless squab and also discard the wings so that the bird will lie flat on the grill. Boneless squab can also be sauteed in a pan.

Cornish Game Hens and Poussins

Cornish game hens and poussins are simply small chickens. They are generally intended to be served whole, or, at most, split in two (although these birds, like other chickens, are marketed in larger sizes then they used to be). They can be roasted at 350°F for 25 to 40 minutes, depending on size. They can also be broiled with the backbone removed so the split bird lies flat on the broiling pan.

Duck

Duck is all dark meat; the breast tastes more like turkey drumstick than it does like chicken breast. Smoked duck, when sliced, is easily mistaken for roast beef. The challenge in cooking duck is that the bird has quite a lot of fat and it is difficult to end up with meat that is moist but not greasy from the melting fat and skin that is crisp and flavorful instead of rubbery. High heat would help get rid of the fat while crisping the skin, but the fat melts quickly and begins to smoke. The cook can find the kitchen full of smoke and can even have a fire in the oven if the rendering process is not controlled.

Poultry farmer in Alsace force-feeding a goose in order to fatten the liver for paté. This feeding method is not legal in the United States. Photo circa 1900. ROUGHWOOD COLLECTION.

Two methods are generally successful in rendering the fat while crisping the skin. The first involves medium heat while the second involves steam as well as dry heat.

Roasting. Prick the skin with the tip of a paring knife, being careful to pierce the fat layer without breaking the skin. This will help drain off the fat during cooking. Roast the bird in a 350°F oven, breast side up on a rack in a roasting pan, for one hour and fifteen minutes. Drain the fat out of the roasting pan and roast for 40 additional minutes at 350°F and then 15 minutes at 500°F to crisp the skin.

Twice-cooked. Chinese cooks use a different method to get rid of the fat and produce a crisp skin. With skin pricked as in the basic roasting directions, the duck is placed on a rack in a roasting pan with half an inch of boiling water in the bottom. The pan is covered and placed over heat to keep the water simmering for about an hour, until the skin pulls away from the wing joints, exposing the meat. The bird is then cooled to room temperature, brushed with soy sauce or other seasonings, and roasted in a 400°F oven for 30 to 40 minutes, or until crisp. For an even crisper skin, rub the raw bird with salt and allow it to dry in the air in the refrigerator for several hours before cooking.

Broiled. Duck parts can also be broiled, although the fat released by the parts can smoke and even catch fire. Remove as much visible fat as possible before placing the parts in a broiling pan four inches from the preheated broiler. Broil 30 to 45 minutes or until golden brown. Drain off fat as it accumulates or sprinkle the melted fat with salt to reduce the chance of fire.

Goose

Goose is typically purchased and cooked whole. The meat is even darker than duck and, when cooked, resembles fully cooked roast beef. The goose is also even fattier than the duck, since it has an even thicker layer of fat under the skin. Dry heat works better than steam to render the fat and produce a crisp skin.

Prick the skin all over with the point of a paring knife, being careful not to pierce the skin. Roast for one and a half hours, breast side down, in a 325°F oven. Remove from the oven and pour off the grease. Return to the oven and roast for another one and a quarter to one and a half hours until the skin has puffed up around the breastbone. Turn the oven up to 400°F, remove the goose from the oven and transfer, with rack, to a clean pan and roast for another 15 minutes until the skin is crisp. Let stand 30 minutes before carving.

Ostrich and Emu

Ostrich and emu are birds originally from southern Africa and Australia, respectively. The ostrich is the largest bird species and can reach eight feet in height. The emu is the second biggest bird species and tops out around six feet. Ostriches were formerly raised for their feathers, which were greatly prized for use in women's hats. When long feathers went out of fashion, the industry collapsed. It has revived in recent years, however, because of an interest in ostrich meat, which has very little fat or cholesterol. Both birds have deep red meat which reminds many people of venison. The meat can be sauteed or grilled and should be cooked only to medium-rare, since overcooking leaves the meat tough and dry.

See also **China: Beijing (Peking) Cuisine; Seabirds and Their Eggs.**

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POVERTY. About 31.1 million, or 11.3 percent, of Americans were poor in 2000. "Poor," as used here, means living below the poverty threshold, a dollar amount determined by the United States Bureau of the Census by taking a family's total income before taxes and then adjusting for the size of the family and the number of related children under eighteen years of age. In 2000, the poverty threshold ranged from $8,259 for an individual sixty-five and older to $33,291 for a family of nine or more individuals, including eight or more related children under eighteen. The poverty threshold for a family of two adults and two related children was $17,463. Individuals sixty-five and older, blacks and Hispanics, people in families with no workers, households headed by women, and people living inside central cities suffered disproportionately higher rates of poverty compared with other Americans.

The federal poverty threshold originated in the 1950s and is based today on the cost of the Thrifty Food Plan, a minimal-cost food plan determined to be nutritionally adequate according to national dietary guidelines, its cost multiplied by a factor of three (based on the assumption that nutritionally adequate food will cost one-third of a family's income) to account for other living expenses. Although it is updated annually according to the Consumer Price Index for inflation, a chief criticism of the poverty threshold is that food expenses have accounted for less than 15 percent of average income since 1965 (10.2 percent in 2000), making the multiplier too small, while other living expenses (such as housing, health care, transportation, and child care) have increased dramatically, especially for the poor.

Quantitative descriptions of the food and nutrient intakes of poor Americans can be found in analyses of national surveys that collect dietary and sociodemographic data from representative samples of the U.S. population. Analysis of the 1994–1996 Continuing Survey of Food Intakes by Individuals (CSFII) showed that poor Americans, defined as adults aged twenty years and older with incomes below 131 percent of the poverty threshold, tended to consume fewer servings of grains, fruits, vegetables, and dairy foods, but more servings of meats and meat alternates and more added sugars, compared with adults with higher incomes. Fewer servings of grains, fruits, vegetables, and dairy foods, and lower energy and nutrient intakes were found for men and women with less than a high-school education, a proxy measure for poverty, compared with men and women who had completed high school and beyond.

Analyses of a number of national surveys conducted between 1977 and 1996 show that dietary intakes of low-income adults have changed over time. For example, overall dietary quality improved among low-income white and Hispanic women, primarily due to reductions in total and saturated-fat and cholesterol intakes. However, fruit and vegetable intakes remained below the recommended amounts, as did those of key nutrients such as calcium, iron, and folic acid.

Poverty, Food Insufficiency, Food Insecurity, and Hunger

Poverty is inextricably linked with food insufficiency (not having enough to eat some or all of the time), food insecurity (uncertainty about or inability to acquire nutritionally adequate foods in socially acceptable ways), and hunger (the physical consequence of not having enough to eat). According to data from the Third National Health and Nutrition Examination Survey (NHANES III), food insufficiency affected 4.1 percent of U.S. households, or between 9 and 12 million individuals. Data from the September 2000 Current Population Survey Food Security Supplement showed the prevalence of food insecurity to be 10.5 percent, and the prevalence of hunger to be 3.1 percent, affecting 11 million and 3.3 million Americans, respectively. Numerous studies of national survey data have shown lower intakes of several nutrients among men, women, and children who experience food insufficiency or food insecurity. Analysis of food intakes and serum nutrients of adults from food-insufficient families has also shown lower intakes of fruits, vegetables, and dairy products, and lower concentrations of serum albumin, serum carotenoids, and serum vitamins A and E. Additional analyses of food-insufficient adults and children reveal a higher prevalence of overweight and obesity, poor health status, and iron deficiency.

Results from qualitative analyses of dietary data, in the form of ethnographic research studies, complement findings from quantitative studies and confirm differences in food choices between poor and nonpoor Americans. Poor Americans tend to consume more starches, fats, and sugars but less of foods associated with good health, like fruits and vegetables, high-fiber grains, and low-fat dairy items. Although specific food choices may differ by ethnicity or geographic location, commonalities in eating patterns exist among poor Americans. Food intakes can vary quite dramatically in the course of a month, with greater quantities and more varied foods purchased immediately after a pay period or allotment of food assistance (such as food stamps) and very limited quantities, of little variety, purchased as funds run out. Also, food intakes are not equal within households. A common occurrence is for the wife or mother of the family to reduce her intake in order to feed her children. Communal dining may also be impossible when income limits available cookware or dining facilities, or sporadic work schedules keep all members of a family from being together at one time. Feelings of deprivation, often rooted in childhood, may lead to buying nonnutritious foods (such as soda and snack foods) that are also attractive because inexpensive. Although studies show that, in theory, consuming a minimal-cost diet in accordance with the latest dietary guidelines is possible, poor Americans are more likely to purchase foods from small, nearby stores that charge an average of 10 percent more than large supermarkets farther from home.

Food Assistance in the United States

Many poor Americans are eligible for federal food-assistance programs like the Food Stamp Program, the National School Lunch and School Breakfast Program, and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). In addition to or as a substitute for government assistance, many poor

Americans also receive charitable assistance from food pantries and soup kitchens. In 2000, 50.4 percent of Americans identified as food-insecure received assistance from one of the three federal food-assistance programs, 16.7 percent received food from a food pantry, and 2.5 percent had family members who ate at a soup kitchen. Although participation in these programs and services may reduce food insecurity, the dietary quality of participants' food may not be better than that of nonparticipants. Given societal pressures to join the dominant culture and eat the most advertised, least expensive, most accessible foods—healthful or not—the challenge is how to improve the diets of all Americans, especially the poor.

See also **Class, Social; Cost of Food; Food Pantries; Food Riots; Food Stamps; Homelessness; Nutrition Transition: Worldwide Diet Change; Population and Demographics; Rationing; Sociology; Soup Kitchens; WIC (Women, Infants, and Children's) Program.**

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PRE-COLUMBIAN AMERICAS. *See* **Inca Empire; Mexico and Central America, Pre-Columbian.**

PREHISTORIC SOCIETIES.

This entry includes two subentries:
Stone Age Nutrition: The Original Human Diet
Food Producers

STONE AGE NUTRITION: THE ORIGINAL HUMAN DIET

Aside from casual interest, there is a reason to appreciate the nutrition that fueled nearly all of human evolution. An increasing number of investigators believe the dietary patterns of our ancestors may constitute a guide to proper nutrition in the present. Early twenty-first-century dietary recommendations run a broad gamut, from the ultra-low-fat Pritikin program, most recently championed by Dean Ornish, to the 30:30:40 (protein:fat:carbohydrate) Zone diet of Barry Sears, to the low-carb, high-fat-and-protein Atkins diet. These popular authors are not the only ones whose recommendations vary widely, however. Academic nutritionists writing in prestigious medical journals advocate a similarly broad range of nutritional regimens, from the low-fat East Asian eating pattern to the much more fat-liberal Mediterranean approach. These conflicting recommendations, especially when they originate in respected professional publications, tend to confuse and dismay health-conscious readers who frequently learn of dietary findings through simplistic and often sensationalized media accounts. Sometimes completely contradictory nutritional findings are announced just a few years apart. For example, beta-carotene appeared to reduce cancer risk in initial studies; then it seemed to increase risk in a later investigation. Dietary fiber was first thought to reduce colon cancer susceptibility, and then it was found to have no such effect. Sodium consumption has been linked to high blood pressure in many studies but not in numerous others. High-fat diets cause coronary heart disease, but consider the "French paradox": the French consume at least as much saturated fat as do Americans, but they have considerably fewer heart attacks and other manifestations of coronary artery disease.

In light of such inconsistencies, it is not surprising that dietary recommendations vary. A logical, straightforward, and understandable starting point from which to develop research protocols and upon which generally accepted recommendations may ultimately be based is highly desirable. The ancestral human diet might provide such a foundation. Even though the Stone Age occurred in the very distant past, eminent paleoanthropologists, geneticists, biologists, and evolutionary theorists believe that human genes have changed hardly at all in the interim. Although many refer to modern times as the "Space Age," genetically speaking, human beings are still Stone Agers. One can argue that the genetic determinants of our current biology were selected not for contemporary circumstances, but for the conditions of life as experienced in the remote past. There are two potential corollaries to this argument. First, that the afflictions of affluence (chronic degenerative diseases such as diabetes, many cancers, atherosclerosis [including coronary heart disease], hypertension, osteoporosis, and obesity) are prompted by dissonance between human genes and the lives of certain groups of people. Second, that the impact of these diseases, which are the major causes of illness and mortality in affluent nations, might be greatly reduced or, in some cases, eliminated altogether by reinstating essential features of the ancestral lifestyle, including relevant nutritional practices, into current existence.

Early humans, who appeared about 50,000 years ago, were hunter-gatherers (or foragers) and were similar in most respects to hunter-gatherer groups studied during the twentieth century. However, there were important differences between these groups. Modern hunter-gatherers have been increasingly restricted to infertile areas that are poorly suited to farming and where the availability of animals for hunting, especially large game, has been much reduced. Also, modern foragers generally have some contact with nearby agriculturists, which affects their culture to some extent. Hunter-gatherer groups that came under observation in the twentieth century were commonly used as models for the prehistoric and pre-agricultural peoples of 25,000 years ago. The modern hunter-gatherer groups were the best available surrogates for prehistoric peoples, but researchers also needed to consider the altered circumstances of otherwise similar people living many thousands of years apart.

Ancestral Foods: Plants

The vegetable foods available to prehistoric foragers grew naturally, without cultivation, and included nuts, leafy vegetables, beans, fruits, flowers, gums, fungi, stems, and other similar items. These had been primate staples for tens of millions of years, but at some point along the hominid (human-like) evolutionary track, the digging stick came into use. This simple implement widened dietary breadth by providing access to roots, bulbs, and tubers, which were plentiful but previously inaccessible sources of food energy. The nutrient values of such foods vary naturally, but if one pools the several hundred representative vegetable foods that hunter-gatherers utilized during the twentieth century and then compared their averaged nutrient content with the mean values of vegetable foods commonly consumed in Western nations, several noteworthy differences emerge. For example, wild-plant foods provide less energy per unit weight. A 3.5-ounce (100 gram) portion of the fruits and vegetables that our ancestors ate would yield, on average, only about one-third the calories that 3.5 ounces of contemporary vegetable food provide. This is primarily because so much of our current plant-food intake is derived from high-energy cereal grains—rice, corn, wheat, and the like. Stone Age humans knew that grains were a potential food source. However, given the technology available to them, the work required to process wild cereals into digestible form was generally excessive compared with the work needed to gather and process other types of wild plants. Foragers generally viewed grains as emergency goods to be used during times of shortage. It was only "late" in the human career, perhaps thirty thousand years ago in Australia and between ten an fifteen thousand years ago elsewhere (for example, the Near East), that evidence of routine cereal-grain use became common.

Another difference between the vegetable foods of the hunter-gatherers and those of Western nations is illustrated as follows. The nutrient content of wild-plant foods is high, especially when one considers the ratio of nutrients to calories. While there is, of course, considerable individual variation among these foods, a mixed grocery bag of the fruits and vegetables available to ancestral humans would provide substantially more vitamins, minerals, and fiber than would a comparably representative collection of contemporary plant foods. In many cases, vitamins and some minerals are artificially added to current foods, making them "enriched." This enrichment process is less successful for adding fiber and is not yet feasible for phytochemicals, which are plant constituents that influence the body's metabolic reactions. Phytochemicals can be considered semi-vitamins, but their total number (at least dozens, perhaps hundreds) is unknown and their mode of action is poorly understood. However, the importance of phytochemicals for optimal health is becoming increasingly well established. Ancestral human biology became genetically adapted to the phytochemicals provided by fruits and vegetables over hundreds to thousands of millennia. The phytochemicals of modern-day cereal grains, in contrast, are relative newcomers to the human metabolism. It is perhaps for this reason that fruit and vegetable intake appears to reduce cancer susceptibility and consumption of cereal grain products has little or no such effect.

Lastly, the plant foods available to ancestral humans afforded a fairly balanced ratio of essential polyunsaturated fatty acids. Like essential amino acids, the body does not synthesize these fatty acids—humans must obtain them from their diet. Polyunsaturated fatty acids are necessary for cell membrane fabrication, especially in the brain, and they are also the basic molecules from which eicosanoids, a large class of important locally acting hormones, are made. Essential fatty acids are divided into two families: omega 6's and omega 3's. Both types are required in mammalian physiology, but they produce opposing biochemical effects, so roughly equal amounts in the diet are desirable. Their effects on blood clotting provide a good example. If there is too much omega 6 in a person's system, their blood clots too easily, which increases the likelihood of coronary thrombosis (heart attack). An overabundance of omega 3 in a person's system reduces blood clotting excessively and increases the risk of cerebral hemorrhage (one kind of stroke). Roughly equal dietary intake of each type of these polyunsaturated fatty acids avoids both undesirable consequences. Unfortunately, in recent decades the use of safflower, corn, sunflower, and cottonseed for spreads and cooking oils has distorted the ratio. These materials contain fifty to one hundred times more omega 6 than omega 3 and, overall, Americans now consume ten to fifteen times more omega 6's than omega 3's.

Ancestral Foods: Animals

The wild game that human ancestors ate differed in important ways from the commercial meats available in the twenty-first century. In the first place, modern commercial meat is fatter. Whether one compares the whole carcass or the most popular cuts (for example, flank, loin, shank, etc.), commercial meat has up to four times more fat than game. For example, 3.5 ounces of regular hamburger provides 268 kilocalories, whereas the same amount of venison yields 126 kilocalories. Even when all visible fat is removed from a T-bone steak, the resulting separable lean portion contains 30 percent more energy than game. These energy differences reflect the greater fat content of commercial meat.

Not only is there more total fat in commercial meat, but the chemical composition of the fat in this meat also varies from that in game animals. In general, fat from commercial meat has a higher proportion of saturated fatty acids (the kind that tend to raise serum cholesterol levels) than does the fat from game. Saturated fatty acids containing either fourteen or sixteen carbon atoms have a special propensity for raising serum cholesterol. Game fat typically has less than one-fifth the content of these substances when compared to an equal amount of fat from commercial meat. Another chemical difference between these two types of meat involves the essential polyunsaturated fatty acids discussed earlier. These fats are present in nearly equal amounts in wild-animal adipose tissue, as compared to the uneven ratios in most commercial meat. Grain feeding appears to be responsible for this difference: the essential fatty acid composition of animals whose feed is based on corn becomes skewed, as their systems contain a far greater amount of omega 6 than omega 3 fatty acids.

Other Considerations

Several categories of foods that are regularly consumed at present were uncommonly used or wholly unavailable for ancestral humans. These "new" foods confer some advantages, but, in several cases, there are important negatives as well.

Grains. Today cereal grains are "superfoods." This term is not a characterization of their nutrient properties, but rather it is recognition that in many parts of the world, members of the grain family may provide from one-third to two-thirds or more of the population's daily caloric intake. The consumption of rice in the Far East, corn in Mesoamerica, and sorghum in parts of central Africa are examples. Such a dependence on one or a few plant foods contrasts with the more broad-spectrum subsistence pattern of hunter-gatherers, who commonly utilize one hundred or more types of food plants during the year. With limited exceptions, which probably did not apply in the remote past, no one of these approaches the "superfood" status accorded cereals today.

It was mentioned earlier that ancestral humans used grains infrequently. Hand milling grains to render them digestible was such hard work that it was not desirable to use grains unless other foods were in short supply. The situation changed when pre-agricultural populations reached a point where a nomadic life was no longer feasible. This shift came about when several groups of people started to migrate towards the same areas. When people were required to settle more or less permanently in a given area, grain consumption became a viable option because other types of plant and animal food became increasingly difficult to obtain. It became apparent shortly that raising grains like wheat or barley could increase the total food energy available from a given geographical area. When people began to farm regularly, population growth accelerated to rates greatly exceeding those before the advent of agriculture. On the other hand, individual health seems to have deteriorated. People became shorter in stature, and skeletal evidence of nutritional stress and infection became more frequent. Average life expectancy also appears to have declined, so the adoption of agriculture may not have been the societal boon it is often considered. In fact, Pulitzer Prize winner Jared Diamond has called it "the worst mistake in the history of the human race" (*Discover* [May 1987]: 64–66).

Dairy foods. For most humans, dairy foods are important constituents of each day's diet, but for free-range non-human mammals, a mother's milk is the only "dairy product" ever consumed. After weaning, milk was not available for any primates, including humans, until the domestication of cows, goats, camels, and the like. However, dairy foods have been an important component of official nutritional recommendations, at least in Western nations, since the first of these foods were introduced. Nevertheless, human ancestors, including behaviorally modern humans during four-fifths of their existence, thrived and evolved without any dairy foods whatsoever after they ceased breast-feeding.

Alcohol. In the United States, alcohol provides from 3 to 5 percent of the average adult's daily caloric intake. It is not clear when the production of alcoholic beverages first developed, but most anthropologists doubt that wine, beer, mead, and especially distilled spirits were manufactured before agriculture. No hunter-gatherer groups studied in the twentieth century made such drinks.

Separated fats. The fats that ancestral human consumed were generally obtained as integral components of whole foods; both animal and vegetable fats came part and parcel with the other nutrients intrinsic to the original source. In contrast, separated fats are staples for contemporary humans. Olive oil, butter, margarine, vegetable oils, lard, and the like are all vital ingredients for today's cooks. Such separated fats enhance our cuisine, but because fat provides about nine calories per gram (versus about 4 calories per gram for protein and carbohydrate), the availability of fat in this form makes it possible to increase the energy density of our food in ways our ancestors could not.

Refined flour and sugar. Like separated fats, refined flours and sugars allow us to create foods with unnaturally high energy density. Essentially, they are nearly pure energy—empty calories with few or no associated vitamins, minerals, or fiber. Although there are essential amino acids and essential fatty acids (required building blocks our bodies need to make necessary structural elements and required hormones), there are no essential simple carbohydrates like those available from refined flour and sugar. Such carbohydrates are a convenient and efficient source of energy, but they provide little if any nutritional benefit over and above their caloric content. Fortified flours have additional nutrients that food manufacturers consider desirable. Our ancestors obtained their carbohydrate together with the nutrients that nature provided.

Processed and prepared foods. Humans are the only free-living creatures that consume foods whose natural origins are obscure. Individuals unfamiliar with our culture would be unable to identify the ultimate sources of bread, pasta, sausage, cheese, and similar items that have been staples for millennia. Less traditional artificially fabricated foods became immensely popular during the twentieth century, to the point that for some people these foods, often laced with gratuitous sodium, fat, and sugar, made up most of their daily intake. The list of ingredients on the wrapper of almost any prepared-food package provides one of the most telling commentaries on the differences between contemporary nutrition and that of pre-agricultural human ancestors.

Artificial constituents. Organic food proponents would quickly point out that there are still other important differences between the naturally occurring plants and animals of twenty thousand years ago and most of those available to today's grocery shopper. Pesticides, hormones, fertilizers, antibiotics, dyes, and other additives are widely used in contemporary food production but were not, of course, considerations in the remote past when humans ate exclusively "organic" food. The pros and cons of these modern innovations are debatable, but there is no question that such innovations are "unnatural," and that humans evolved for millions of years before encountering the adulterated foods that most of us eat at present.

Overall Dietary Patterns

There was no one universal pre-agricultural diet. Our ancestors ate foods that were available locally and focused on those that returned the most food energy for the least expenditure of physical energy—a general rule for all biological organisms. Two important factors affecting diet choices were latitude and rainfall. In the savanna-like environment of northeast Africa, which according to the "out of Africa" theory is thought to have been the epicenter of human evolution, both game and vegetable foods were plentiful. Gathering plant foods in such an environment was an integral aspect of the food quest for both males and females before human ancestors and those of chimpanzees diverged and for an uncertain length of time thereafter. At some point, most likely during the later stages of Australopithicine evolution, scavenging is thought to have become a significant component of hominid subsistence. It is not known whether this was an exclusively male function or whether females participated as well. Because potential competitors for animal remains included hyenas and similarly dangerous beasts, as well as the original predators, scavenging was a little less hazardous than hunting, the main difference being the degree of technological expertise required. Later, most likely for the past 500,000 years and almost certainly since the appearance of behaviorally modern humans about fifty thousand years ago, obtaining food probably resembled the pattern observed among modern foragers: a division of labor according to gender, with men hunting and women gathering.

Where large animals such as mammoths, red deer (similar to elk), horses, megamarsupials (some as large as rhinoceroses), and eland were relatively abundant, hunting them made sense in terms of energy expended. More food energy could be obtained from one such carcass than from many smaller animals, and the physical energy expended by the hunters in such a process is substantially less compared to hunting small animals. Where large animals had become scarce, a variety of sophisticated techniques, including trapping and net hunting, were used to increase the efficiency of obtaining small game. Weirs and nets were used along rivers where fish migrated seasonally (for example, salmon runs). Stone Agers sometimes lived year-round in such locations, abandoning a nomadic life, establishing relatively large communities, and developing an early form of social stratification with elites—as opposed to nomadic hunter-gatherers who were almost always egalitarian.

Gathering was not confined to plant foods: women often brought home shellfish, eggs, small mammals, frogs, turtles, and the like. This process could be physically demanding. Women occasionally walked several miles, dug through hard ground (with a digging stick) to obtain roots or tubers, then walked back to camp carrying twenty to thirty pounds of foodstuff.

The relative contributions of hunting and gathering to a forager economy have been the subject of debate. The respective importance of these tasks almost certainly varied according to season and was surely affected by latitude. In the mammoth steppe of central Siberia, which was surprisingly well populated during the late Paleolithic era of ten to thirty thousand years ago, abundant wild grasses supported great herds of large game, especially mammoths, so hunting flourished. However, edible plant food for humans was scarce. In this region, hunting must have greatly exceeded gathering as a means of acquiring subsistence.

On the other hand, in northeast Africa, both game animals and wild plant foods were plentiful, and in such areas hunting and gathering were of almost equal importance. Early studies of foraging groups inhabiting regions of this sort suggested that about two-thirds of food was obtained by gathering. However, later analyses suggested that hunting actually made a somewhat greater contribution than gathering. The newer interpretation fit well with "optimal foraging theory," an anthropological law that formalizes the common-sense observation that humans, like all other biological organisms, arrange their subsistence activities to maximize return relative to effort expended. When animals are plentiful and hunting techniques are well developed, as seems to have been the case for the past 100,000 years (and probably longer), the average returns from hunting exceed those from gathering. Nevertheless, gathering remained very important because even skillful hunters can experience unsuccessful periods of a sometimes of uncomfortable duration. The practical botanical knowledge of foragers is so great that the women's success rate in finding plant food in fruitful regions approached 100 percent; many times tsi-tsi beans, baobab fruit, water lily roots, and the like would have been our ancestors' only menu choices for dinner.

Macronutrient Ratios

Overall subsistence patterns in East Africa are of particular interest. If the "out of Africa" theory is correct, which seems increasingly likely, what was eaten routinely in this region affected genetic adaptation in the direct ancestors of all living humans, while what was consumed elsewhere, even as late as fifty or sixty thousand years ago, had little or no direct bearing on the contemporary human gene pool. The reconstructed nutritional patterns in this area, beginning perhaps 200,000 years ago, are quite useful to those interested in the original "natural" human diet.

With behavioral modernity came increasingly rapid cultural change, which has, to an ever-greater extent, outpaced genetic evolutionary adaptation. Because of this cultural change, subsequent dietary innovations, including the routine use of grains by everyone and of dairy foods by adults, as well as the Mediterranean, East Asian, and vegetarian approaches to healthy eating have emerged. However, these trends have appeared too recently to have had a marked effect on our genetic makeup. If there is a basic nutritional pattern to which humans are genetically adapted, the constituents provided by foods consumed in East Africa 100,000 years ago arguably define its nature.

During that time, energy intake would have been higher than at present—probably about three thousand kilocalories per day for males and perhaps 2,750 kilocalories for females. Because humans at that time lacked motorized equipment, draft animals, and the most simple machines, caloric expenditure at this level was obligatory. In fact, it is likely that up until the early twentieth century energy expenditure and intake requirements remained substantially above those typical at present.

About 55 percent of nutrients would have come from animal and fish sources, while about 45 percent, on average, would have been of vegetable origin. Total caloric intake was likely partitioned about 25–30 percent from protein, 30–35 percent from carbohydrates, and 40–45 percent from fat. These estimates differ from the contemporary American pattern and also from current orthodox recommendations:

Prehistoric societies

	East African hunter-gatherers*	Contemporary U.S.A.	Current recommendations
Protein	25-30%	15%	15%
Carbohydrate	30-35%	48%	55%
Fat	40-45%	34%	30%
Alcohol	–	3%	–

*Surrogates for our earliest truly human ancestors

The differences are striking and, at first glance, suggest that the Paleolithic diet was unhealthy. A little further analysis, however, is comforting for health-conscious paleoenthusiasts.

Fats

Our ancestors ate more fat than modern humans. Muscle meat from game animals is very lean, but Stone Agers ate everything edible, such as marrow, brain, organ meat, and fat deposits from the thoracic and abdominal cavities, not just muscle as we tend to consume today. Optimal foraging means using the whole carcass. Many different parts of farm animals, such as tripe, chitlins, tongue, sweetbreads, brain, gizzard, etc., were considered standard fare only a few generations ago, and in a few places they still are. However, in contrast to fat from today's cattle, sheep, and pigs, the carcass fat of wild animals has relatively little serum cholesterol-raising effect. Most game fat is of the cholesterol-neutral monounsaturated variety, a substantial proportion is polyunsaturated, and much less is the saturated, cholesterol-raising type. Also, ancestral foods contained little or none of the cholesterol-raising *trans* fatty acids that commercial hydrogenation adds to current diets. That the hunter-gatherer diets are heart-healthy is corroborated by the finding that the serum cholesterol levels of such people from around the world average below 130 mg/dl as opposed to a bit over 200 mg/dl for Americans. Although the available evidence is not ideal (for example, no coronary angiograms and few autopsies), coronary heart disease is virtually unknown among hunter-gatherers, as far clinical data can show. An additional factor that enhanced the heart-healthy nature of Paleolithic diets was the nearly equal proportions of omega 6 and omega 3 essential polyunsaturated fatty acids in those diets. The great preponderance of omega 6's in contemporary Western diets is believed to be a factor contributing to the cardiovascular disease epidemic in countries with such eating patterns.

Carbohydrates

Ancestral humans ate fewer carbohydrates than is typical for contemporary humans, the major difference being the near total absence of cereal grains from pre-agricultural diets. However, the amount of fruits and vegetables consumed in areas resembling east Africa substantially exceeded amounts consumed in any part of the world and was more than double the typical fruit-and-vegetable consumption in western and northern Europe. Contemporary carbohydrates comprise refined flours and simple sugars, which are quickly absorbed and capable of inducing rapid rises in pancreatic insulin secretion. Stone Agers loved honey, but its availability was usually limited and seasonal (as indicated by their relatively cavity-free dental remains). A large proportion of ancestral carbohydrates was in the complex form that had a less adverse effect on insulin secretion.

Protein

As far as nutritionists and exercise physiologists can ascertain, the levels of protein our ancestors consumed are not necessary for health, even for weight trainers and other high-performance athletes. On the other hand, earlier studies that attributed negative health effects to excessive dietary proteins now seem suspect. Initial reports suggested that high protein intake might cause renal failure, colon cancer, and/or elevated blood cholesterol levels. However, more recent investigations have reversed or at least significantly modified scientific opinion about their relationships. High-protein, low-carbohydrate diets have, in some cases, been shown to be beneficial. High-protein diets do aggravate kidney failure once it is established, but they do not appear to initiate the process. Autopsy studies of traditional Inuit (Eskimos) whose protein intake was extremely high did not reveal any extra incidences of kidney disease. It was once thought that high-protein diets were associated with colon cancer. There is a connection here, but this is primarily because Westerns diets that contain a lot of meat provide excess saturated fat along with protein, and it is the saturated fat, not the protein, which seems to foster the development of colonic neoplasms. Diets rich in meat were once thought to raise serum cholesterol levels, but here again, associated saturated fat is the culprit. High-protein diets that contain little saturated fat actually lower serum cholesterol levels, an investigative result that might have been predicted based on findings among hunter-gatherers studied during the last century.

Micronutrients

Americans and many others in affluent nations spend enormous amounts of money on vitamins (and, to a lesser extent, minerals) presumably in the hope that consuming such micronutrients will minimize the adverse effects of an otherwise unhealthy diet and lifestyle. Nutritionists usually decry this practice, arguing that micronutrient intake above and beyond recommended daily allowance (RDA) levels is unnecessary, and that a balanced diet provides all the vitamins and minerals one needs.

From a Paleolithic perspective, there is some virtue to both these views. Nutritionists follow Stone Age practice when they argue that it is better to obtain micronutrients from real foods rather than from capsules. However, ancestral micronutrient intake exceeded RDA levels in nearly every case (sodium and, in some areas, iodine were the exceptions). The greater total caloric intake necessitated by a physically vigorous lifestyle together with a micronutrient:energy ratio much higher for ancestral foods than for those commonly consumed at present means Stone Agers typically obtained from 1.5 to 5 times the RDA levels of vitamins and minerals each day. However, they did not obtain anything near the recommendations of megavitamin enthusiasts, which can be 10 to 100 times the RDA in some instances.

Words like lycopene, anthocyanin, lutein, sulforaphane, isothiocyanate, and indole have begun to appear regularly in popular articles on nutrition. These substances and many others with equally unfamiliar names are phytochemicals, which, as noted earlier, are vitamin-like molecules that affect our metabolism and biochemistry. Phytochemicals in fruits and vegetables seem much more vital to human health than those from cereal grains, presumably because our metabolism became adapted to the former over many millions of years as opposed to the few thousand years during which human biochemistry has routinely interacted with phytochemicals from cereals. There has been little research on the phytochemical content of uncultivated fruits and vegetables, but it is likely that the phytochemical load in such foods would have paralleled their high content of known vitamins and minerals. Based on this supposition, in addition to the fact that Stone Agers in most areas consumed abundant quantities of fresh fruits and vegetables, it is probable that ancestral phytochemical intake exceeded that of the present.

Only 10 percent of the sodium consumed in Western nations is intrinsic to the foods people eat. The remainder is added during processing, preparation, and at the table. For human ancestors, as for all other free-living terrestrial mammals, potassium intake exceeded sodium intake, a circumstance almost certainly relevant to blood-pressure regulation and to maintenance of cell-membrane electrical potential. After salt became commercially available, and especially after it became inexpensive, our diets have inverted the potassium–sodium relationship that characterized human and pre-human evolution, perhaps from the appearance of multi-cellular organisms over 500 million years ago.

Fiber

Since Denis P. Burkitt's research first drew public attention to the value of fiber in human diets, official recommendations for fiber intake have centered on about 0.07 ounces (20 grams) per day. However, our nearest nonhuman primate relatives, chimpanzees, consume about 7 ounces (200 grams) of fiber per day. The fiber intake of ancestral humans would have been strongly influenced by the proportion of fruits and vegetables in their subsistence base because dietary fiber comes exclusively from plant foods. Stone Agers living at high latitudes, where edible vegetation was scarce, would have consumed even less fiber than modern humans. However, in east Africa, where modern human metabolism evolved, Paleolithic fiber intake is estimated to have been between 1.77 and 3.53 ounces (between 50 and 100 grams) per day.

There are two main fiber types, both of which are necessary for optimal human physiological function. Most plant foods provide some of each, but the proportions vary. Whole wheat and brown (unpolished) rice contain predominantly insoluble fiber, which is good for intestinal tract function. Oats, corn, and most fruits and vegetables provide a high proportion of soluble fiber, which is valuable for regulating cholesterol absorption after meals. Modern, refined grain-centered diets generally have too little fiber, but, in addition, they have a disproportionate amount of insoluble fiber. Pre-agricultural diets featuring more fruits and vegetables than at present provided a better balanced insoluble-to-soluble fiber ratio.

Conclusion

The uncultivated plant foods and wild game that nourished ancestral humans and their pre-human predecessors were those to which our genetic makeup became adapted. Increasingly rapid cultural innovations during the past few thousand years have transformed our nutrition such that Cro-Magnons might not recognize many constituents of a typical meal. However, genetic evolution during the same period has been glacially slow; thus human beings' genetically determined biology remains adapted for the literally natural and organic foods of the remote past. This dissonance between human genes and human lives has critical implications for human health.

See also **Agriculture, Origins of; Anthropology and Food; Food Archaeology; Nutritional Anthropology; Paleonutrition, Methods of.**

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S. Boyd Eaton

FOOD PRODUCERS

The more than six billion humans living on earth at the beginning of the twenty-first century were almost exclusively dependent upon a narrow range of domesticated foods produced on some thirty-eight percent of the world's total land surface. More than three quarters of our annual global harvest is cereal-based, the bulk of which is composed of as few as four species. Although humans and their ancestors have inhabited the earth for several million years, food production is relatively recent, spanning the Holocene epoch or last ten to eleven millennia. The two thousand or more species of plants and animals that humans domesticated during this relatively brief period represent only a tiny fraction of the earth's biota, and with some recent exceptions of minor exotic or luxury foods, most of the important dietary items were domesticated relatively early on.

From the beginning of the Holocene, plants and animals have been selectively bred to provide food and medicine, clothing and companionship, draft and transportation, tools and weapons, and fertilizer. Domestication can increase the efficiency and reliability of food procurement, which can further facilitate an increase in human population size and density. While some hunter-gatherers are highly sedentary and many farmers somewhat mobile, food production often provides the necessary foundation that enables larger populations to live in fixed settlements for longer periods of time.

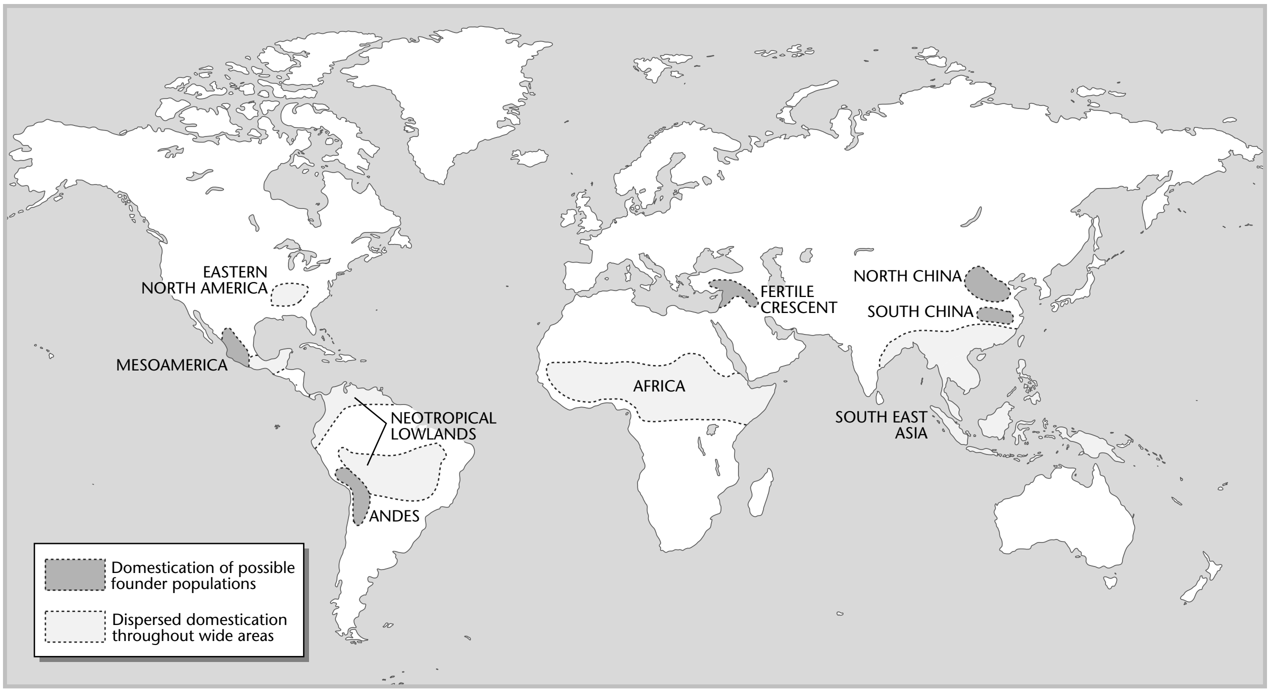
Domestication

Domestication is not a discovery but a process by which humans modify plants and animals by selectively encouraging certain characteristics that they want. In time, the domestication process can so genetically alter a population that it is no longer capable of flourishing in the wild. This dependency is usually bidirectional as humans and domesticates become reliant upon each other for survival. The process of domestication can be deliberate or unintentional as humans select for specific qualities of interest. Certain plants and animals are somewhat preadapted to domestication. Seed plants, for example, often thrive as weeds that colonize sunny clearings exposed by human occupation. Over time, subtle and important changes in the original population structure can be encouraged by inadvertently dropping or intentionally planting selected seeds in and around these open areas.

What characteristics do humans select? Domesticated plants mature simultaneously and lack the botanical ability to self disperse, attributes which are controlled by and for human consumers. Rapidly germinating plants that produce seeds with greater initial reserves and thincoats are desired. Self-pollinating plants that readily adapt to the conditions of human settlement are also favored. Preferred animals include: fast growing herbivores that can be economically raised and consumed; docile taxa that can be bred in captivity; and herding species with a natural dominance hierarchy that humans can readily commandeer. Characteristically, many of the earliest domesticated plants were locally exploited and rapidly growing self pollinators that produced high yields of readily storable edible seeds. Early domesticated animals included locally available generalists that were placid, gregarious, and amenable to confinement.

The Geography of Early Domestication

Where and when were certain plants and animals initially domesticated? The Swiss botanist and geographer Alphonse De Candolle (1779-1841) was the first to document the geographical origins of cultivated plants, a subject that was greatly elaborated by the Russian botanist and geneticist Nikolai Vavilov (1887-1943?), who suggested that the area of origin for a domesticate was likely centered in regions where it is presently most diverse. Currently, with the aid of genetics and molecular techniques, archaeologists, biologists, and geographers attempt to delineate the area in which a plant or animal may have been first domesticated by defining the present



Independent areas of early prehistoric food production.

geographical distribution of its known wild progenitor and studying its subsequent development therein.

The early history of food production is an interdisciplinary undertaking which combines the techniques and methods of archaeology, botany, and zoology. Primary data are often recovered using specialized techniques and methods like flotation devices and pollen corers, and include preserved seeds, pollen, starch grains, phytoliths or mineral impressions of plant cell walls, bones, teeth, horns, and hair. Inferences are also drawn from tools, agricultural infrastructure, cultural implements, artistic portrayals, and written accounts. We can estimate how old our primary evidence is by radiometrically dating associated materials or the preserved organics themselves. Nevertheless, the entire endeavor hinges on the vagaries of sampling, luck of preservation, and intensive fieldwork. As a result, we understand the early origins of food production better in some areas than we do in others.

Much of the earliest evidence for food production comes from sites in arid areas. This may be simply because our primary data preserve better in these settings; however, the bulk of our major contemporary crops appear to have originated in regions with protracted dry seasons. We can identify some relatively circumscribed regions in which a core founder population of local plants and/or animals was originally domesticated. In other areas, the pattern of domestication was likely more diffuse. We can also recognize regions into which all or a few of the founder domesticates were introduced, after which local species were domesticated. Often it is difficult to know precisely whether or not the introduction was through indigenous adoption or direct population invasion from outside. Currently, we can recognize some five to nine early areas of independent food production, from where domesticates, people and their domesticates, and/or the idea of domestication may have spread to other regions.

West Asia

We find our earliest and so far best evidence in a 2000 km arc of southwest Asia, bounded to the north by higher forested terrain and to the south by desert. This Fertile Crescent stretches from the eastern shores of the Mediterranean north of the Negev desert, around present day Syria and Turkey, and into the plains of the Tigris and Euphrates where it is bordered in the east by the Zagros mountains of present day Iran. Here, climatic amelioration at the end of the Pleistocene created local conditions suitable for large stands of wild grasses with abundant forage for various grazing herbivores. This topographically and floristically diverse region was rich in large-seeded and self-pollinating annuals adapted to seasonal rainfall and protracted dry seasons. It also supported a diverse population of mammals which, apart from the dog (*Canis familiaris*), included the world's earliest domesticated animals.

Around 10,000 B.P. (before the present) we find evidence for domesticated barley, first as a two-rowed (*Hordeum vulgare ditichum*) and somewhat later as a six-rowed (*H. v. hexastichum*) variety, along with emmer

(*Triticum turgidum dicoccum*) and einkorn (*T. monococum*) wheats. Possibly after 9000 B.P., sheep (*Ovis aires*) and goat (*Capra hircus*) were domesticated in the north and east respectively, with the subsequent additions of domesticated pig (*Sus scrofa*) and cattle (*Bos taurus*) from present day Turkey. At roughly the same time, the early menu was supplemented with domesticated pulses, especially lentil (*Lens culinaris*), pea (*Pisum sativum*), chickpea (*Cicer arietinum*), and bitter vetch (*Vicia ervilia*), along with flax (*Linum usitatissimum*) for oil and fiber. The protein rich cereals provide an excellent source of carbohydrates but lack an essential amino acid for the manufacture of animal protein. This is provided by the pulses, which can also fix nitrogen into soils when planted alongside cereal crops. Flax was used for textiles and oil, while animals provided a reliable protein source, and were eventually used for dairying, clothing, traction, and transport. Together, this balanced package formed an important founder population of domesticates that variably spread into other world regions.

Archaeological evidence tracks the rapid diffusion of Neolithic food production to the African and European shores of the Mediterranean by 8000 B.P., and a little later into Italy, Greece, and the Balkans. Farming spread quickly throughout temperate Europe after 7000 B.P., reaching Scandinavia and England by around 5000 B.P. We also see the appearance of southwest Asian food production in the Nile Valley by 6500 B.P., and farther abroad into Ethiopia and the Indus Valley. Western domesticates reach China by 3300 B.P.

In most cases, we don't know whether these patterns represent foreign food producers who migrated into new regions, local populations that adopted farming due to external stimulus, or a mix of both. We do know that many important cultivars were subsequently domesticated. A list of some of the more popular and their possible region of origin includes: faba bean (*Vicia faba*), olive (*Olea europaea*), grape (*Vitis vinifera*), fig (*Ficus carica*), and date (*Phoenix dactylifera*) in the Near East and Fertile Crescent; bread wheat (*Triticum aestivum*), rye (*Secale*), hemp (*Cannabis sativa*), lettuce (*Lactuca sativa*), and horse (*Equus caballus*) in western Asia; dromedary camel (*Camelus dromdarius*), and coffee (*Coffea arabica*) in Arabia; Old World cotton (*Gossypium*) in the Indian subcontinent; oat (*Avena sativa*), and poppy (*Papaver somniferum*) in Europe and the Mediterranean; and, donkey (*Equus asinus*) in Egypt.

East Asia

An early center of cereal based food production is found along the Huang Ho (Yellow) River in northern China. Transitionally located between semi-arid uplands to the west and forested plains to the east, prehistoric farmers cultivated foxtail (*Setaria italica*) and broomcorn (*Paniscum miliaceum*) millet by at least 7500 B.P. Although the area was likely warmer and wetter at the time, both plants are somewhat drought resistant. Shortly thereafter, diet was supplemented by domesticated chicken (*Gallus gallus domesticus*) and pig. Although pigs were possibly present in southern China a thousand years earlier, either claim can support an ancient introduction from western Asia or independent domestication. Some later domesticates from north China include soybean (*Glycine max*), hemp (*Cannabis*), popular tree fruits like Chinese pear (*Pyrus pyrifolia)*, peach (*Prunus persica*), apricot (*P. armeniaca*), varieties of apples (*Malus domestica*), species of cherry (*Prunus* spp.), and silk worm (*Bombyx mori*), along with many local derelict cultivars that survive today as weeds.

To the south, wet rice agriculture developed by 8000 B.P. along the Chang Jiang (Yangtze) River. Early evidence comes from the middle and lower reaches of this wet and marshy region, where varieties of long-grained (*Oryza sativa* var. *indica*) and short-grained (var. *japonica*) rice may have been domesticated at a time when temperatures were warmer than today. Some two thousand years after possible pig domestication in south China, water buffalo (*Bubalus bubalus*) is recorded south of the Chang Jiang delta, along with bottle gourd (*Lagenaria siceraria*) and cultivated aquatic plants including water caltrop (*Trapa* spp.) and fox nut (*Euryale ferox*). Other notable domesticates from south China include water chestnut (*Eleocharis tuberosa*), Asian arrowroot (*Sagittaria sinensis*), red bean (*Vigna angularis*), and duck (*Anas platyrhynchos*).

Although domesticated rice is found in India and Southeast Asia as early as 5000 B.P., east Asian domesticates dispersed less quickly into Europe and western Asia. Rice was unknown to much of the West before Hellenistic times, and many domesticates were only introduced through merchant voyaging in the past five to six hundred years. It is unknown whether or to what extent the introduction of rice agriculture into Southeast Asia supplanted an indigenous domestication of root and tree crops, which included yam (*Dioscorea* spp.), bananas and plantains (*Musa* spp.), citrus (*Citrus* spp.), mango (*Mangifera indica*), breadfruit (*Artocarpus* spp.), and various spices. Tantalizing evidence hints at the possibility of early agriculture in Papua New Guinea around 9000 B.P. Many plants were domesticated in the Pacific islands, including sugarcane (*Saccharum officinarum*), coconut (*Cocos nucifera*), taros (*Alocasia*, *Cyrtosperma*, *Colocasia*), sago (*Metroxylon*), kava (*Piper methysticum*), and numerous spices. We can trace a relatively early spread of southeast Asian food production into nearby islands, beginning in Taiwan as early as 7000 B.P. and subsequently spreading to Borneo by 4500 B.P. Subsequent colonization into Polynesia between 3500 and 2500 B.P. introduced fowl, dogs, pigs, and various root and tree crops.

Africa

Before west Asian farming arrived in the Nile Valley, the Sahara was inhabited by nomadic pastoral groups that herded indigenous domesticated cattle along with sheep or goat introduced from the Mediterranean. The southern boundary of this early "pastoral neolithic" was controlled by tsetse fly infestation in the forests and savannas of sub-Saharan Africa, where nagana disease wasted domestic livestock. Early evidence for indigenous African plant domestication in savanna and Sahel regions south of the Sahara include native grains like sorghum (*Sorghum bicolor*) around 4000 B.P. in Niger, pearl millet (*Pennisetum glaucum*) after 3000 B.P. in Mauritania, and African rice (*Oryza glaberrima*) after 2000 B.P. in Mali. Other important African domesticates with possible savanna origins include cowpea (*Vigna ungulata*) and African yams (*Dioscorea* spp.). Finger millet (*Eleusine coracana*) and tef (*Eragrostis tef*) were locally domesticated in the highlands of eastern Africa, as were ensete (*Musa ensete*), noog oil (*Guizotia abyssinica*), and narcotic chat (*Catha edulis*).

Forest zones contributed oil palm (*Elaeis guineensis*), kola nut (*Cola nitada*), and guinea fowl (*Numida meleagris*) in the west, and okra (*Hibiscus esculentus*) and robusta coffee (*Coffea canephora*) in equatorial Africa. The somewhat misnamed Arabian variety (*C. arabica*) actually originated in mountain forests of southern Ethiopia and Sudan. Desertic regions contributed cantaloup (*Cucumis melo*), watermelon (*Citrullus lanatus*) possibly after 3000 B.P. in Mauritania, and perhaps date (*Phoenix dactylifera*). The house cat (*Felis catus*) may have been domesticated in Egypt, where we also see early evidence for bottle gourd around 5500 B.P. Archaeologists have traced the later diffusion of pastoral groups into southern Africa as they reached the Cape coast by the time of Christ.

North America

Early evidence for a nutritionally balanced founder population of domesticated squash, beans, and maize is found in Mesoamerica. Orange pumpkin squashes (*Cucurbita pepo*), that today include acorn and zucchini varieties, appear around 10,000 B.P. in Mexico. Ancient farmers may have selected squash for their seeds rather than pulp, later adding winter (*C. moschata*), cushaw (*C. argyrosperma*), and fig leaf cultivars (*C. ficifolia*). The chayote (*Sechium edule*) was more recently added, while ancient evidence for the bottle gourd suggests that it may have rafted across the Atlantic from Africa. The common bean (*Phaseolus vulgaris*) was independently domesticated twice, once in Mexico as early as 6000 B.P., and later joined by members of the same genus including tepary (*P. acutifolius*), runner bean (*P. coccineus*), and botil (*P. polyanthus*). Maize (*Zea mays*) was likely domesticated from a wild teosinte in southwestern Mexico. Direct dating of maize remains suggests its earliest appearance around 5500 B.P., after which it spread rapidly throughout the hemisphere. The common chile pepper (*Capsicum annum*) is also found very early in Mesoamerica. Later domesticates of note include grain amaranths (*Amaranthus* spp.), tomatillo (*Physalis philadelphica*), tree crops like cacao (*Theobroma cacao*) and sapote (*Pouteria sapota*), hairy cotton (*Gossypium hirsutum*), various species of Agave for hennequen and sisal fiber, as well as fermented drink, and a domesticated bird, the turkey (*Meleagris gallopavo*).

Maize appears in the American Southwest by 3500 B.P., but becomes a major staple with squash and beans much later. By 2000 B.P. maize eventually enters the southeast, where independently domesticated squash (*Cucurbita pepo*), sunflower (*Helianthus annuas*), marsh elder (*Iva annua macrocarpa*), and goosefoot (*Chenopodium berlandieri*) were all already under cultivation, possibly by 4500 B.P. Some 2000 years later, erect knotweed (*Polygonum erectum*), maygrass (*Phalaris caroliniana*), and little barley (*Hordeum pusillum*) assume greater dietary significance, but only after roughly 1000 B.P. does maize-centered agriculture dominate eastern North America.

South America

An early complex of domesticates that may have developed by 5000 B.P. in highland areas from south-central Peru to Bolivia, eventually dispersed throughout the ancient Andean world by the time conquering Spaniards arrived. Included were quinoa (*Chenopodium quinoa*), kaniwa (*C. pallidicaule*), and kiwicha (*Amaranthus caudatus*), all high altitude pseudocereals that provide flour for baking, soups, and beverages. Indigenous tuber crops like oca (*Oxalis tuberosa*), mashua (*Tropaeolum tuberosum*), ullucu (*Ullucus tuberosus*), and potato (*Solanum tuberosum*) are also adapted to the cold conditions of high elevation.

The only native New World mammalian domesticates, llama (*Lama glama*), alpaca (*L. pacos*), and cuy or guinea pig (*Cavia aparea porcellus*) round out the highland package. Direct dating of archaeological specimens indicates that domesticated South American common (*Phaseolus vulgaris*) and lima (*P. lunatus*) beans were added somewhat later, possibly at slightly lower elevations in the southern highlands. Other Andean domesticates included roots like maca (*Lepidium meyenii*), and arracacha (*Arracacia xanthorrhiza*), and tree crops as pepino (*Solanum muricatun*) and tree tomato (*Cyphomandra betacea*).

Phytolith evidence could suggest the appearance of maize around 7000 B.P. in northern neotropical lowlands; however, others argue a more recent introduction around 4000 B.P. in accordance with Mesoamerican data. Early lowland contexts also reveal domesticated jack beans (*Canavalia plagiosperma*), cotton (*Gossypium barbadense*), and the root crops achira (*Canna edulis*), leren (*Calathea allouia*), and arrowroot (*Maranta arundinacea*). Phytolith evidence also supports early use of bottle gourd and squash; indigenous domesticated squash include the hubbard (*Cucurbita maxima*) originally from Argentina, and possibly the relict *C. ecuadorensis* of southwestern Ecuador. Many domesticates come from areas of the lowland neotropics, including: manioc (*Manihot esculenta*), cocoyam (*Xanthosoma* spp.), yam (*Dioscorea trifida*), sweet potato (*Ipomeoea batata*), peanuts (*Arachis hypogaea*), capsicum peppers (*Capsicum* spp.), various drug and medicinal plants, tree and palm crops like cashew (*Anacardium occidentale*), avocado (*Persea americana*), guava (*Psidium guajava*), and peach palm (*Bactris gasipaes*), and the muscovy duck (*Cairina moschata*).

Why Domesticate?

Ancient agriculturalists customarily attributed their origins to an act of divine intervention. As scientists began to seek alternative explanations for the beginnings of food production, they persisted in the teleological assumption that domestication was initially a discovery. Cultural innovation took place especially in areas where resources were concentrated, either naturally or as unintended consequence of human behavior. It is, however, reasonable to assume that humans everywhere possessed, from earliest times, a sophisticated understanding of the plants and animals that surrounded them. This is easily confirmed in the detailed knowledge of hunter-gatherers who, moreover, actually spend less time procuring food than their agricultural brethren. Bioarchaeological study of skeletal assemblages also indicates that early agriculturalists may have suffered poorer health than hunter-gatherers. So, why bother to produce food? Causation came to be viewed as a response to stress or disequilibrium; humans began to produce food in order to keep up with unceasing population growth and/or as an adaptation to their changing environment. Some view the adoption of food production as the product of rational economic decisions in which optimizing foragers weighed costs against benefit. Others seek social origins for early agricultural, suggesting that early cultigens were originally prestige items used in specific, highly politicized contexts.

Whatever the ultimate cause, it appears that food production antedated the appearance of sedentary village life. It likely took place in settings where populations were neither internally nor externally threatened, and evolved out of a lengthy mutualistic association between plants, animals, and humans. The distinction between domesticator and domesticated is simply a matter of perspective, as food and food producers eventually launched a trajectory that would irreversibly change the way we live.

See also **Agriculture, Origins of**; **American Indians: Prehistoric Indians and Historical Overview**; **Food Archaeology**.

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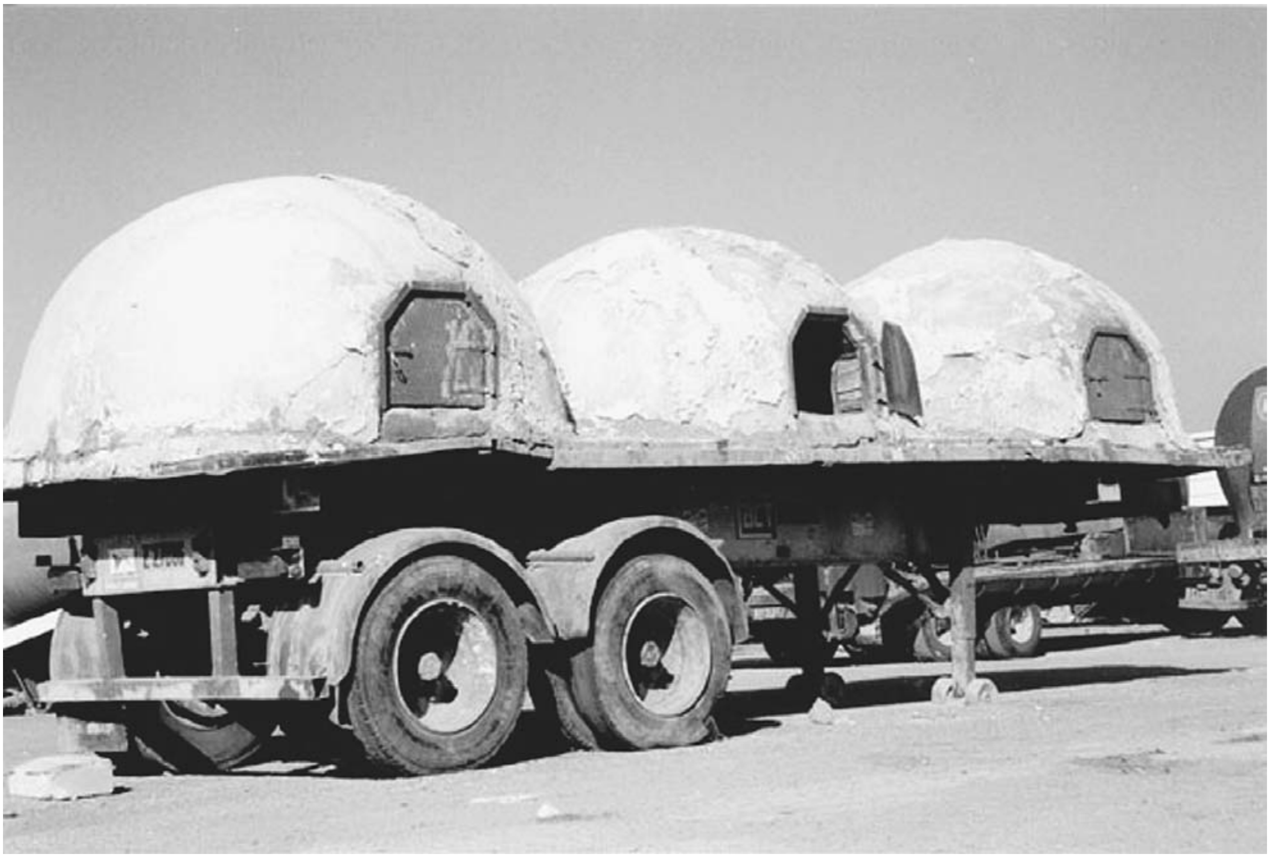
Peter W. Stahl

PREPARATION OF FOOD. Food preparation has been a constant chore since the first human beings picked up cutting and mashing stones. In return, this effort to make food edible, preserve it, and transform its character has sustained an ever-increasing population. Many techniques, including grinding, sifting, drying, salting, sealing, fermenting, and applying heat, are extremely ancient. Few fundamentally new techniques have been introduced in the past two centuries, among them microwaving. The main long-term change has been the shifting of tasks from the domestic hearth to centralized factories.

The processes of food preparation might be divided according to their primary science, whether physical (such as extracting nuts from their shells), chemical (adding salt), or biological (brewing beer). Perhaps more helpfully, they might be categorized according to their intended purpose. Some foods are toxic until prepared properly. Others are scarcely edible until softened. Preparation can bring together nutritional variety. It can add intriguing flavors. Food preparation can also have negative impacts, especially on nutrients.

Viewed socially, food preparation has typically been female work, requiring hours of often hard and repetitive effort. Over history, it has gradually been shifted out of the home and typically made a male concern. Butchery, milling, baking, and brewing are among the oldest extradomestic industries, conducted by specialists for thousands of years. These and most other tasks have been more scientifically and centrally managed over the past two centuries.

Preparation is a core human activity that can be examined from the perspectives of many biochemical, nutritional, technical, cultural, social, historical, and economic sciences. Many aspects of food preparation are treated in greater detail elsewhere in this work. This entry outlines its purposes, its history and social position, and provides snapshots of people at work, from an an-



Large-scale food preparation requires large-scale solutions. In the traditional culture of Cyprus, entire villages are invited to wedding feasts, which necessitates moveable ovens, since all of the food is baked in earthenware pots. The blending of tradition and modern technology is evident in this catering invention, which will feed about six thousand people. PHOTO ILYA LOYSHA.

cient Roman peasant making a *moretum* (suggestive of an Italian pesto) to global corporations preparing hamburgers.

Defining "Preparation"

In *Cooking, Cuisine, and Class*, social anthropologist Jack Goody distinguishes five basic phases in the process of "providing and transforming food": namely, production (growing on the farm), distribution (market activities, including storage), preparation (cooking in the kitchen), consumption (eating at the table), and disposal (clearing up) (p. 37). While such a production chain might seem straightforward, it can be misleading. Traditionally at least, food preparation included preservation and storage. Preparation thus came immediately after food "production" in the sense of hunting, gardening, and farming.

It is even harder to define where preparation ends, giving way to such possible next steps as "consumption," "cooking," "serving," or "eating." Just the word "consumption" has two basic meanings. It can be eating, in which case preparation includes the fullest possible range of food handling. Consumption can also mean purchasing in the modern market, which possibly leaves some cooking to be done in the domestic kitchen. "Cooking" introduces further complications, because this can mean the transformation of food with heat (the usual dictionary definition) or something more all-encompassing.

These definitional problems arise because food preparation is viewed as a transformation of a plant or animal into food to the neglect of some basic social considerations, in particular, distribution. Central institutions, markets, and meals can distribute food at any point between "raw" and "cooked." For example, the breaking down of an animal carcass into small cuts of meat almost seems to come before "preparation" (because the nutritional change is marginal), but its social implications are crucial, for the best serves have typically gone to the most powerful people. Restaurants distribute food not even as semiprepared products but as finished meals. Accordingly, restaurant preparation (often called just "the prep") is done before the customer arrives—the food is taken from its packages, neatly chopped, and perhaps partly cooked. When the cooks turn their attention to "service," they concentrate on last-minute stove work and assembly, which might be translated as "serving out in the kitchen."

The appearance of "preparation" thus largely depends on which stage of its distribution the food is being prepared for. For the purposes of this discussion, "preparation" comes early in the raw–cooked continuum. It is closer to the farm, whereas cooking is found nearer the table. Preparation's transformations are oriented toward nutrition and palatability rather than more purely social and cultural aspects, such as presentation and serving.

Basic Techniques

Food preparation techniques range from chopping up through fermentation and emulsifying to pressure-cooking, vacuum packing, and homogenizing. One way to understand them is to examine immediate purposes, which can be categorized as separating out edible foods; removing toxins; softening and otherwise making ingredients more edible and digestible; distributing foods; storing them; and making them into new compositions.

Separation. The immediate need for preparing food is the separation of edible from inedible parts. This includes simple shelling, peeling, husking, and sifting. Sometimes such hazards as small stones need removing. The separation of cream may involve machinery, but the tools and techniques are generally not complicated. Some steps in meat butchery come under this heading.

Detoxification. Some foods have to be made safe to eat. Among important examples is the root, cassava, which forms prussic acid that can be dispelled by soaking and cooking. The green color appearing near the skin of potatoes is simply cut off. Expert cutting is also required with the notorious Japanese delicacy, the *fugu* or puffer fish. Communities have traditionally been amazingly adept at dealing with local dangers, because learning to recognize and treat hazardous species must have necessitated long, life-threatening trial and error.

Making edible and digestible. The next major purpose of preparation is making food more easily chewed and digested. This can achieved by a range of techniques, such as grinding, pounding, soaking, and cooking in the sense of heating, which includes boiling, roasting, baking, steaming, shallow and deep frying, and microwaving.

In the case of wheat, for example, the heads of grain must be threshed to break them up, then winnowed to separate the wheat from the chaff. After that, it is probably ground into flour, which can again be separated and perhaps soaked or turned into a paste. The flour mixture can then be poured on a plate and fried, shaped into a loaf to be fried, baked or roasted, or pulled, extruded, or rolled out as noodles or pasta, when it is commonly boiled.

Distribution. Food is transported in the arms, bark containers, pots on the head, baskets, panniers on donkeys, ships, trains, and refrigerated trucks, all of which involve various kinds of preparation. Food is also physically divided up, especially with the use of knives and cleavers, and the central social role of knives is outlined by Michael Symons in an essay in historical sociology called "Cutting Up Cultures."

The butchery of meat can be viewed as distribution; for example, everything is used of a pig "but the squeal." A small festival occurs during the division of a household pig into numerous parts, washing the intestines for sausage casings, preserving legs with salting and drying as ham, making pancakes from the blood, and so on. Commercial pig distribution is known in France as charcuterie.

Storage. Some foods such as grains and roots are more readily storable without preparation. They might just need to be kept in a cool, dry, airy place or left buried, and protected from pests. Others can be prepared to greatly extend their storage life. Preservation methods include drying, salting, pickling, sealing, cooking (heating), smoking, candying, fermenting, and freezing. These mainly rely on making a hostile environment for microorganisms that produce decay. For example, sealing keeps air away by placing the food perhaps under oil, in a tight container or under a vacuum. Through the changes introduced by fermentation, milk can be kept as cheese, soybeans turned into soy sauce, grain and fruit made into beer and wine.

Composition. Some preparation techniques amalgamate more than one ingredient into a composition: what might aptly be called a new preparation. A variety of foods might be simmered together to make the family of sauces, stews, and soups. The use of yeasts in dough makes breads rise. A sophisticated technique is emulsification (effectively, the mixing of oil in water), which is employed to make a range of sauces, such as hollandaise.

History

In social terms, food preparation has largely been done by women. Among the numerous tasks, women have carried the water. They have tended the fire, fetched firewood, and found a light. They have ground and pounded with stones. Spanish gastronomic author Alicia Ríos spoke of the mortar and pestle as an everyday contrivance at the Oxford Symposium on Food and Cookery in 1988. She extolled the "rhythmic drumming of pestles pounding in mortars, coming from the kitchens of city tower blocks and quiet village houses. The familiar sound is the hint of aromas to come." The pestle originally made grains edible, its crushing action replicating the human jawbone. As a second main task, "a variety of sometimes opposing elements are mixed together," achieving an "integration." For Ríos, "the use of the mortar is universal," although she accepted that a "question mark hangs over the continued survival of this instrument which is at the same time practical, magical and symbolical."

If the first social generalization is that food preparation has largely been done by women, then the second is that this labor has through history been taken over by industry, shifting the work to the public, male-controlled sphere. That is, the homely pounding and "integration" that Rios found all around her have, for many others, disappeared behind factory walls.

The basic methods of food preparation are extremely ancient. Some techniques, such as podding and peeling, are shared with other animals. The use of tools suggests distinctively human behavior, the pestles augmenting the jawbones and various cutting implements extending the claws and teeth. The earliest social groups are thought to have been essentially opportunistic omnivores, who could scavenge in a range of habitats. Food preparation further increased the available species through detoxifying and softening, in which fire eventually played a crucial role.

When people adopted the settled, agrarian way of life around 10,000 years ago, they constructed shelters for food that became shelters for themselves as well, for the secret of the agrarian mode of production was food storage. Initially, this meant collecting and then growing basic foods, such as seeds, roots, and tubers that had intrinsic keeping qualities. Early settled societies also kept otherwise perishable foods through drying, sealing under oil, fermenting to make cheese, and so on. The keeping qualities of foods often make them less humanly digestible, too. Accordingly, the settled, food-stockpiling way of life required a range of basic preparation techniques to "pre-chew" and "pre-digest."

The settled mode was also marked by increased division of food preparation among specialists. Men had long hunted, cut up, and roasted meat, leading some anthropologists to characterize roasting as "male" as opposed to "female" boiling. Other tasks then went to artisans, including millers (using human, animal, water, and wind power and eventually engines), bakers, and brewers. Most of these were male tasks, although taverns were often run by women.

Pre-industrial food preparation was often done within close domestic groups, villages, temples, and palaces. But this compactness of production, distribution, preparation, and consumption broke down. Salt was among the earliest traded commodities. Spices were light and considered desirable enough to carry over vast distances. Such trade might have originally been between chiefs and kings, but markets opened up, and an increasing range of prepared foods exchanged.

As an illustration of women's domestic manufacture for medieval markets, Swedish rural historian Janken Myrdal has described the spread of the plunge churn for butter making. Butter fat had long been separated by shaking milk in a skin, pot, or wooden vessel. By about 1,000 years ago, the plunge churn had taken over across a wide area of Europe and Asia. Myrdal found much the same plunge churn, a cylinder usually of wood and up to about 3.3 feet high, from Ireland to Tibet. The plunging of the milk of cream with a staff above a cross or disk causes the fat to coagulate. Since the plunge churn requires a relatively large amount of liquid, Myrdal suggests that its introduction must have accompanied a widespread stimulus to commercial production. At least in Europe, this probably came from the entrenched feudal social structure, with tenants having to pay rents and taxes, which they did in a luxury food, butter.

The trade routes eventually brought the so-called New and Old Worlds together. Ocean voyages depended on salted and pickled foods, along with ship's biscuits. These became some of the earliest industrial food products. Bottling or canning was developed by Nicolas Appert in France at the close of the eighteenth century, aimed initially at seafarers, the armed forces, and other mobile populations.

The effects of refrigeration have long been applied through the use of cool, dry spaces. In China, ice was employed in transport at least by the seventeenth century, because Frederick W. Mote observes in *Food in Chinese Culture*, edited by K. C. Chang, that "refrigerated shipping also seems to have been taken for granted in Ming times, long before we hear of such a development in Europe" (p. 215). During the nineteenth century, ice was carried across oceans from New England lakes, and railway networks adopted ice for food transport. In 1850 an Australian, James Harrison, designed the first practical ice-making machine.

"Roller" flour mills were used from the 1870s, quicker and easier than grinding between flat stones, as well as producing whiter flour. Breakfast cereals were developed in United States to meet needs of vegetarian groups, notably Seventh Day Adventists. From that time, artisanal businesses that had grown into regional ones became national and finally global corporations. Capital had been invested first in agriculture and from the mid-nineteenth century in food preservation and distribution. The third major step reorganized the final cooking of food in the second half of the twentieth century.

Food Quality

The need to supply the rapidly expanding cities of the early nineteenth century made more room for food adulteration. Various writers sought to draw public attention to this practice, Frederick Accum causing the greatest stir with a *Treatise on the Adulterations of Food and Culinary Poisons* in 1820. The considerable work then done by Dr. Hassall and others to improve the honesty of food preparation in the 1850s is also described by Jack Drummond and Anne Wilbraham in the *Englishman's Food.*

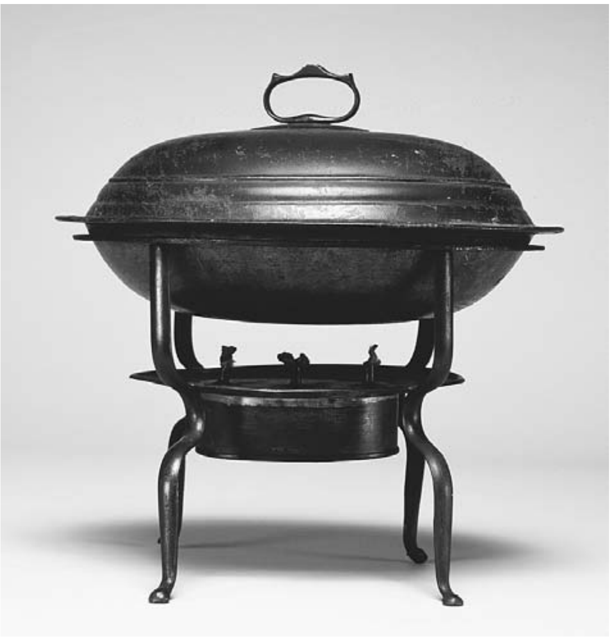
The rush to industrialize food preparation could not be stopped, however. Writing under the initials "M. M." in 1851, Mary Allen Meredith complained in her article "Gastronomy and Civilisation" in *Fraser's Magazine* (no. 264) that "[w]e have let the beer of the people disappear, and have grown ashamed of roast beef. . . . Draught ale has vanished, and all the bottled compounds that go by that name are but unwholesome concoctions of drugs and camomile. We have brought chemistry into our kitchens, not as a handmaid but as a poisoner."

Nineteenth-century gourmets sometimes hailed bottled fruits out of season, and believed that some mass-prepared items such as packet spaghetti (or *pastasciutta*) could maintain high quality; other oddities such as jellies and sweet corn in cans gained nostalgic appeal. However, these were exceptions, and in the early twenty-first century the balance of gastronomic opinion is against factory preparation. The food processing industries that so effectively supplied armies and, increasingly, urban populations generally degraded quality. The main trouble seems to be the drive to reduce costs. Highly processed foods are then brought back to life, so to speak, through cosmetic means, supplemented by vivacious marketing.

A writer specializing in Jewish cooking, Evelyn Rose, told the Oxford Symposium of Food and Cookery in 1987 about her experiences in recreating "homemade" flavor for a commercial supplier of kosher products, Rakusen's Ltd., in Leeds, England. She worked with the firm on canned soups since they presented relatively minor processing challenges. Any use of additives put canned soups "into a different category" from homemade ones, she found. For example, "modified starch" thickeners gave a glutinous texture and diluted flavor, and flavor enhancers left a synthetic taste. Accordingly, to thicken Rose's Tuscan bean soup, they puréed half the solids. To stop her Dutch pea soup from becoming the color of "mud," they used new technology and top quality split peas. To ensure chunks of vegetables were neither so large as to be unsightly nor so small as to melt away, she specified precise dimensions. While the homemade flavor was "universally acknowledged," she reported that the soups had to be sold at the same "luxury" price of game soup and lobster soup.

With the transfer of food preparation from households and local artisans to commercial factories, using increasingly complex processes, the ordinary person lost skills and knowledge. This was accompanied by an enormous inrush of information of other kinds. On one hand, this was dietary, with increasingly obese and otherwise unhealthy populations concerned about the quantity of fat and sugar, especially in so-called junk foods. On the other hand, the lack of real knowledge was replaced by commercial image making.

The resulting consumer confusion can be illustrated by the scandal when Snow Brand milk poisoned more than 16,000 people in Japan in the summer of 2000. The cause was publicly revealed to be contaminated nonfat dry milk (NFDM). This drew widespread attention to the fact that much "milk" was not raw (fresh) milk but powdered milk, which gave manufacturers much more flexibility in their operations, bulking out supplies in the off-season and adjusting the chemical balance of special milks. Ironically, the contaminated NFDM in Japan went into just those types of milk preferred by "health conscious" people who had been persuaded to purchase calcium-enriched, lowfat milk and yogurt drinks.



Food is often prepared at the table, as in the case of this curious old implement called Passmore's Patent Conjurer made by Thomas Passmore of Philadelphia, circa 1797. Constructed of sheet iron and wrought iron, the conjurer permitted small articles of food such as oysters or lamb chops to be cooked over oil lamps in the manner of a pressure cooker. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

An Early Account of Food Preparation

The Latin poem *Moretum* is perhaps the oldest surviving detailed account of a person preparing food. Scholars used to think it was written by Virgil, but now credit an unknown successor between 8 and 25 B.C.E. The poem, which has been translated and introduced by classicist E. J. Kenney, describes the preparation of a basic meal in order to convey the hand-to-mouth grind of peasant life.

On a winter's morning, while still dark, the rustic cultivator, Simulus, gropes for the hearth and eventually coaxes the embers into fire. He fetches some grain from a "miserable heap" in a cupboard. His right hand turns the grinding stone rapidly, with the left feeding it, until he reverses arms from weariness. Singing an uncouth country song, he sieves the meal, the black siftings staying on the upper surface, the unmixed flour sinking through the holes. He piles it on a smooth board, pours on water warmed by the flame, and works the mixture until it becomes cohesive, occasionally sprinkling with salt. He smooths the kneaded dough into regular rounds, marking each with the characteristic eight segments of a Roman loaf. He inserts it into a swept part of the hearth, covers it with crocks (pieces of broken pottery), and heaps fire on top.

So that bread alone should not displease his palate, Simulus finds an accompaniment. He has only a round cheese pierced through the middle with a string. So our "far-seeing hero" contrives another resource, the poet tells us. He has a kitchen garden next to his hovel, where he leads water from nearby streams to his cabbages, beet, sorrel, and other plants. However, these are for selling at the local market. For his own use, he chooses garlic, parsley, bushy rue, and coriander.

Simulus sits again beside the bright fire and, with mortar and pestle, mashes the herbs, along with salt, the hard cheese, a little olive oil, and vinegar. Round and round goes his right hand, the original ingredients gradually losing their own properties and becoming one (or, in the poet's Latin, *e pluribus unus*). Often the sharp smell goes right up his nostrils, so that he passes judgment on his dinner, while with the back of his hand he wipes his streaming eyes. He mixes and thoroughly remixes the mass. Finally, he wipes it out into a single ball, to produce a perfect *moretum*. With bread and *moretum*, he can leave to do the plowing, "with the fear of hunger banished, and free from care for that day."

Simulus is an unusual domestic cook in being a man (perhaps the poet wanted a man to do women's work to emphasize the lowliness of the scene). He appears to cook merely for himself (although he might live with an African woman, mentioned in the poem). He uses no obvious cooking pot. Otherwise, much else is universal. So much cooking throughout the world for perhaps 10,000 years has been done with a small fire, storage bin, water jug, stones for milling grain, and mortar and pestle for preparing herbs and spices.

Commentators have called the *moretum* a "country salad" and "herbed cheese." However, the closest equivalent known to many these days is probably the Italian sauce of basil, parmesan cheese, pine nuts, and olive oil called pesto. His is a typical agrarian meal of two parts. The basic element is the staple, such as rice, potatoes, or cereals, which make the bread here. This is accompanied by a tastier, nutritional complement, which has commonly been something like the *moretum* prepared from vegetables and perhaps a little protein.

Wealthier people employed cooks to serve elaborations of such a meal. The foods have been more numerous, and more luxurious. Rather than a sauce accompanying the staple, it might have accompanied meat. Sauces not unlike the *moretum* are called the "trademark of the Roman chef" by classical scholar Jon Solomon (p. 115). Of the nearly five hundred entries in the Roman cookery book of Apicius, *De re coquinaria* (The Art of Cooking), he finds that nearly four hundred are devoted to the preparation of a sauce. They begin with the pulverizing of herbs and spices in a mortar. Fruits and nuts are then added, and finally, liquid such as water, honey, oil, milk, mustard, or *liquamen* (a fermented fish sauce also known as garum). This mixture is often boiled over a fire, and sometimes thickened with wheat starch, egg, rice, and so on. For example, the dozen different sauces for lamb (or kid) include a simple bread and oil sauce, a sweet milk and date sauce, and a vinegar and plum sauce.

Medieval Recipes

In some of the oldest recipes in English, numerous sentences instruct the cook to take one or more ingredients, using such archaic words as "tak," "nym," and "recipe" (giving the name for culinary prescriptions). Once cooks have "taken," the same medieval recipes call on them to "grind," "dyce," "shred," "mince," "bray" (crush with mortar and pestle), "quarter", "quare" (cut into squares), "swyng" (swinge or beat), "alye" (mix), and "medle" (mix). Heat is then used to "frye," "parboile," "boyle," and "seeth in gode broth" (seethe or boil in a good broth). The recipes conclude with "serve it forth" or, which means the same, "messe it forth." In summary, cooks "take" and, having "meddled" (mixed), they "send."

Babylonian Dishes

Babylonian scribes impressed the oldest surviving recipes onto three clay tablets in cuneiform 3,700 years ago. The tablets, which their French translator Jean Bottéro describes in an essay entitled, "The Most Ancient Recipes of All," reveal a cuisine of striking refinement for such an early period.

The best-preserved tablet takes just seventy-five lines to give twenty-five recipes. One name, "Assyrian stew," suggests it has come from the northern part of the country and another, "Elamite stew," ascribes it to neighboring people. Most headings, however, indicate various bouillons of such meats as deer, gazelle, kid, lamb, pigeon, and perhaps rat. The instructions typically start with the meat of the title with other meat added, then water and fat, along with condiments and often thickeners. Here is an example:

> Lamb bouillon. You need other meat too. Place in water. Add fat, salt as you wish, crumbed cereal cake, onion and *samidu* [not yet translated], coriander, cumin, leek and garlic. Serve. (Bottéro, p. 251)

The compressed style suggests aides-mémoirs for professional chefs. The other readable tablet devotes 250 lines to just 7 recipes for various kinds of birds, both domestic and game. The recipes indicate many steps, numerous utensils, complex combinations, and sometimes as many as ten different seasonings.

From a tantalizing glimpse of a vast gastronomic literature around 4,000 years old, it seems that the ancient Babylonians took great care in balancing flavors in complete dishes. They did not just throw birds on the fire, but followed complicated recipes calling for as many as ten seasonings. Historian Jean Bottéro acknowledges that this was the cuisine of rich people, who had the "skilled personnel, requisite cooking vessels and stoves, and money for expensive provisions" (p. 254). While the recipes were probably prescriptions for some kind of ritual, he presumes that domestic cooks turned out tasty and imaginative dishes, even if not quite so complex or varied.

The LoDagaa

The ordinary meal of the LoDagaa people in West Africa consisted of one dish, "a single but filling dish," which was much the same from day to day. The preparations were observed by anthropologist Jack Goody and summarized in his wider study of *Cooking, Cuisine, and Class* in 1982 (especially pp. 69–78). He reports that the dish came in two parts, which he calls "porridge," made from guinea corn or millet, and accompanying "soup," usually made from ground nuts or leaves of one type or another.

The preparation of meals, largely done by the women, took a long time because produce had to be transformed all the way from its original state. In the case of guinea-corn or millet, the grain had to be removed from the head, husked, and winnowed. The grinding was especially hard, and the women would lighten their work by singing songs and chatting. Other laborious tasks were the processing of shea nuts to make oil and the turning of cassava into a safe food (the prussic acid formed in cassava dissolves readily in water and is driven off by heat).

One advantage of the cassava root is that it can be kept in the ground. Women also laid out the fruits of the okra, pepper, and soup leaves on the roofs to dry before being packed away in pots and baskets for the empty season. The LoDagaa sometimes stored grain in its malted form for brewing beer later.

The women could now use matches for lighting the fire, although men might still make fire using a stone, a piece of iron, and kapok for rituals. "Like yeast, fire was one of those marvels passed down from hand to hand, the embodiment of communal living, difficult to start, easy to keep going, especially if one has kin and neighbours on whom to rely," Goody writes (p. 70). The usual hearth consisted of three stones, on which the pots balanced. Virtually all the food was boiled. Fish and meat were occasionally smoked for preservation above the fire. Some frying was done, although more often in market for delicacies such as bean cakes. Corn cobs might be roasted, but roasting was more typical of meat and carried out by men. Baking was done in the new bread ovens in market towns.

Beer could be purchased in any of the LoDagaa markets. In fact, the evening markets seemed only to exist for beer and cooked food. Beer was also brewed daily at someone's house. Women spread their days over their six-day week, so that today Brumo would brew, tomorrow Popla, and so forth. The men would often go to buy a pot, partly for the company.

Goody found that a conspicuous new feature of many African villages was the grinding mill, established by some enterprising trader and powered by a diesel motor. "Here women queue up to have their grain ground into flour, preferring to try and earn a little extra money in the market or by brewing beer, rather than undertake the heavy work of grinding by hand" (p. 69).

Numerous anthropologists have made similar field observations as those of Jack Goody. They have found tribal women devoting much of their day to fetching water, pounding roots, grinding grain, maintaining a fire, boiling a staple and its slightly more varied accompaniment, and perhaps using fermentation, as when brewing beer. Anthropologists have often noticed some tasks being done by specialists, such as bakers and tavern keepers, and the very presence of outside observers also suggests that agribusiness and related food industries will soon bring an even more centralized mode of preparation.

Fast Food

According to one picture, the modern preparation of food is conducted by sophisticated corporations that employ advanced technologies to supply plentiful, healthy, tasty, and often "fast" food without tedious labor. According to an alternative version, high-pressure marketing promotes junk food that makes everyone fat, resulting from the heartless unloading of unskilled and dangerous work on youthful racial minorities.

Corporate historian John F. Love says in *McDonald's: Behind the Arches* that the fast-food firm showered the "lowly hamburger, french fry, and milk shake with more attention, more study, and more research than anyone had dreamed of doing" (p. 120). But quality would appear to have lost out to other considerations. The main effort went into making the food easily handled and cheap. For example, all McDonald's ground beef was frozen after 1968 (p. 130).

When McDonald's System, Inc., was formed, french fries account for fewer than 5 percent of all potatoes sold in the United States, Love reports. By the mid-1980s, they accounted for more than 25 percent (p. 121). To maintain consistency, potato processors added sugar in one season and leached it out in another. This is one of the many findings described by investigative journalist Eric Schlosser in *Fast Food Nation* (p. 131). Fast-food chains abandoned skilled bakers in favor of automated factories, replaced farmers with scientifically managed batteries of chickens and feed lots of cattle, and coped with the uncertainties of chefs by doing away with them. For example, the firm of IBP (Iowa Beef Packers) led the revolution in meatpacking in the United States, by centralizing the slaughterhouses, by using cheap, often immigrant labor and, in Schlosser's words, "by crushing labor unions and championing the ruthless efficiency of the market" (p. 164).

Armed with gas chromatographs and mass spectrometers, chemists synthesized a vast number of food flavors by the mid-1960s. They manufactured the taste of Pop Tarts, Bac-Os, Tab, Tang, Filet-O-Fish sandwiches, and thousands of other new foods, according to Schlosser. When he toured the laboratories and pilot kitchens of International Flavors and Fragrances (IFF) in Dayton, N.J., he found a snack and savory laboratory responsible for the flavor of potato chips, corn chips, breads, crackers, breakfast cereals, and pet food. The confectionery laboratory devised the flavor for ice cream, cookies, candies, toothpastes, mouthwashes, and antacids. In one pilot kitchen, Schlosser saw a pizza oven, a grill, a milk-shake machine, and a french fryer "identical to those I'd seen behind the counter at countless fast food restaurants" (pp. 120–131).

Schlosser writes that "more than half of all American adults and about one-quarter of all American children are now obese or overweight. Those proportions have soared during the last few decades, along with the consumption of fast food. . . . The rate of obesity among American children is twice as high as it was in the late 1970s" (p. 240). One factor is the increasing size of fast-food servings. During the late 1950s the typical soft drink order in a fast-food restaurant contained about 8 ounces; now a "child" order of Coke at McDonald's is 12 ounces; a "large" Coke is 32 ounces.

"Every day in the United States, roughly 200,000 people are sickened by a foodborne disease, 900 are hospitalized, and 14 die. According to the Centers for Disease Control and Prevention (CDC), more than a quarter of the American population suffers a bout of food poisoning each year," Schlosser reports. "Although the rise in food-borne illnesses has been caused by many complex factors, much of the increase can be attributed to recent changes in how American food is produced. . . . [T]he nation's industrialized and centralized system of food processing has created a whole new sort of outbreak" (p. 195). The "rise of huge feedlots, slaughterhouses, and hamburger grinders seems to have provided the means" for the deadly *E. coli* 0157:H7 pathogen to become widely dispersed (p. 196).

See also **Baking; Beer: Production and Social Use; Boiling; Broiling; Cooking; Crushing; Distribution of Food; Fast Food; Frying; Grilling; Hamburger; Marinating and Marinades; Recipe; Roasting; Storage of Food; Women and Food**.

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Michael Symons

PRESENTATION OF FOOD. The presentation of food often refers to its visual composition on the plate, in a state of readiness to be eaten. Modern color photography has promulgated enticing artworks that have come to be the signatures of stylish cooks. All manner of theater is employed in the careful display of food to consumers, appealing to all senses, not just sight, and appearing not just at meals, but throughout the entire marketplace for food.

Plate Presentation

Cooks often pay close attention to plate presentation, choosing ingredients and techniques to suit a desired effect, following a standard arrangement and wiping away drips. Some foods are included mainly to set off others, such as a parsley garnish, and such elements as shells are not to be consumed at all. Checking the food's appearance, which is the cook's last task, becomes the eater's first. Diners are often transfixed by the food when it arrives at the table, as if taking in the whole meal. Yet even the most impressive sculpture collapses at the strike of a knife, fork, or spoon, so that plate presentation is evanescent.

Vision is crucial in identifying ingredients, their quality, and the techniques used, and even has a bearing on the perception of flavor. A dish not displayed traditionally may "not taste the same," and an unfamiliar color, such as blue, may be off-putting.

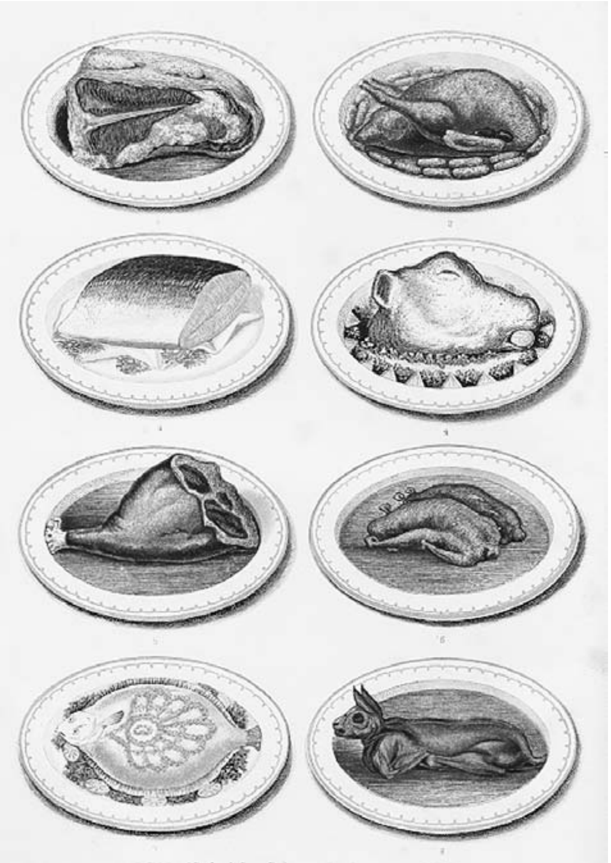
Japanese diners recognize the importance of eye appeal, to the extent of photographing their meals at restaurants around the world. Their cooks display fanned slices, neat parcels, sculpted vegetables, and noodles placed in soups. Cut fish displayed without sauces contributes to a clean look. Chefs might "spend the day considering the aesthetics of arranging three sardines," according to Richard Hosking in *A Dictionary of Japanese Food* (p. 209). *Moritsuke* (food arrangement) follows seven basic patterns, including *sugimori* (strips and slices of food in a slanting pile), *kasanemori* (overlapping slices), *tawaramori* (blocks or rounds placed horizontally in a pyramid), and so on. Illustrating invention within a highly regulated framework, the *shojin ryori* cookery tradition arranges food like a seasonal landscape—perhaps blue mountains in summer, red in autumn, brown in winter, and flowery in spring. The resulting scene is so abstract that it may appear as one or two objects on a plate to the untutored eye.

As Japanese cooks and diners also appreciate, food is framed by the plate, which might be a beautiful object in its own right, and by the table setting; by other foods, including drinks; by decorations, such as flowers; and by a garden outlook or streetscape.

By contrast, some gourmands in the European tradition worry that an overemphasis on appearance downplays food's other qualities, notably taste and flavor. These cooks may contend that the visual aspect is food's most superficial and that the eyes are quickly contradicted by the tongue.

Atmosphere and Setting

Even before seeing the food, diners might be enticed by menu descriptions. Cooks sell their efforts through sizzling sounds and enticing aromas, so that food is presented at the right temperature and dish covers removed to release captured smells. A charming dining room is comfortably warm and filled with the right music (which might be only the clink and chatter of dining itself). Presentation is also social, and servers participate through such means as well-spoken descriptions, the use of elaborate platters, and carving at the table. Food is also generally enhanced by a convivial circle; many good meals are enveloped in conversation.



The appearance of food on the table has changed greatly over time to reflect shifts in custom and tastes. In this plate from *Cassell's Household Guide* (London, circa 1878), various meat and fish dishes are displayed according to proper Victorian presentation—with heads attached. Garnishing is minimal because this style of food is intended for home cookery rather than for hotel fare. All of the meats except the calf's head are served in lakes of gravy. ROUGHWOOD COLLECTION.

Much effort goes into presentation away from the table, too. Market stall-holders stack food showily, shopkeepers arrange eye-catching window displays, and confectioners design luxurious-looking chocolate boxes. Hot bread, roasting chestnuts, and coffee sell themselves through aroma.

Food Fabrication and Marketing

The modern industry fabricates foods from non-traditional ingredients and additives to look like a familiar product (margarine masquerading as butter; emulsifiers, thickeners, and artificial flavors masquerading as ice cream, and so on). Teams of brand managers, flavorists, marketing specialists, graphic designers, and others devise new products, whose acceptance hinges on presentation. Advertising programs, promotions through free samples, discounts and prizes, and point-of-sale materials and packaging provide the final sales pitch. Marketing relies on supermarket shelf exposure, which is boosted by multiple sizes and flavors, and on food's photogenic qualities, which are geared to be so mouth-watering as to induce sales.

Purpose of Presentation

The drive toward balancing colors and textures in front of the eater, experienced in all cuisines at least rudimentarily, has a nutritional basis: providing a healthy variety. Responding to contemporary dietary trends, cooks may include, for instance, green and orange colors in their presentations. Another source of the cooks' aesthetic impulse is the mixture and distribution of ingredients according to a routine or pattern. This repetition can lead to a pared-back elegance.

Cooks who want to show off ingredients find that presentation encourages inspection. Alternatively, in search of amusement, cooks may make foods look like something else, such as a fish made out of vegetables. Cunning cooks can contrive the look of expensive, forbidden, or unobtainable ingredients, and war-time rationing has encouraged such subterfuge. The profit motive comes in here, too, with growers and manufacturers employing many scientific means—from growth hormones to artificial flavors—to improve the appearance especially of cheaper and more readily handled products. Presentation can hide food's origins; some vegetarians contend that meat-eaters only find meat palatable when it no longer resembles "dead animal."

In *The Civilizing Process* (1939), German sociologist Norbert Elias argues that the increasing complexities of society are accompanied by more self-restrained, courteous, and sophisticated culture, including refined food presentation. Demonstrating social power with extravagant displays is captured in American sociologist Thorstein Veblen's phrase "conspicuous consumption" (*The Theory of the Leisure Class*, 1899). Presentation can also symbolize a seasonal festival or other occasion, as in the historical development of the white, possibly tiered, and carefully decorated cake as the nuptial centerpiece. Cakes were first used for weddings in the seventeenth century and became the familiar gleaming structure in the nineteenth.

Food is styled to look good in photographs for mass-circulation newspapers, magazines, and cookery books. Many cooks also follow an artistic impulse beyond mainstream lifestyle publications, seeking to avoid last year's accents and playing a competitive game through fashion. Because the pressures to achieve elegance, pretense, camouflage, and artistic expression can spoil the final effect, critics have long demanded that presentation be simplified and that food should look more "real."

Ancient Lavishness

Elaborate presentation has its roots in ancient times. The Greek epicure Athenaeus describes lavish feasts, not uncommon in third century B.C.E. Macedonia, at which as many as twenty guests were crowned in gold tiaras and presented with silver cups to keep. Mountains of food were pressed upon them, accompanied by musicians, dancing girls, and drinking. A large pig was then carried in, its belly disclosing numerous birds and fishes. After more drinking, guests were served a piping-hot kid, with another silver platter to keep, as well as spoons of gold, and ivory bread baskets. Naked women tumbled among swords and blew fire from their mouths before crystal platters arrived with baked fish.

Such excesses were also frowned upon. Some of the mightiest medieval minds, including St. Thomas Aquinas, considered *gula*, or gluttony, the foremost of the seven deadly sins, and Chaucer's Parson inveighed characteristically against the "apparelling," or dressing up, of food, which included pastry and aspic designs, marzipan armorial quarterings, meat dishes such as Cockentrice (the front half of a chicken sewed to the back half of a suckling pig, and vice versa), and "musician" pies that contained live instrumentalists.

Most famously, at seventeenth-century Versailles, under the "Sun King" Louis XIV, court life consisted of vast dinners enlivened by musicians and fireworks and the arts of conversation and good manners. The king, as the head of the household, lived in semi-public ("in state"), a crowd watching as he arose (*lever*), went to bed (*coucher*), and had meals in between. Parisians and provincials would come to admire Louis XV's fine bearing and elegance, and his deft striking off of the top of a boiled egg with the back of his fork.

Adapting the royal family's grandeur, the ambitious French chef Marie Antonin Carême published in *Le pâtissier pittoresque* (1815), one of the earliest of his several books, more than a hundred depictions of *pièces montées*, elaborate architectural pastry follies.

At table during the London "season" early in the nineteenth century, conversation was prevented by a "huge centre-piece of plate and flowers." It was "strange that people should be invited, to be hidden from one another," wrote the English advocate of a simpler "Art of Dining," Thomas Walker, in his weekly newspaper, *The Original* (2 September 1835; 1928, p. 11), noting that fashionable tables required "excessive breadth" to hold the cumbrous ornaments and lights, the dessert with side-dishes. He opposed fussy cooking, especially "a very inconvenient love of garnish and flowers, either natural or cut in turnips and carrots, and stuck on dishes, so as greatly to impede carving and helping. . . . But there is a still worse practice, and that is pouring sauce over certain dishes to prevent them from looking too plain, as parsley and butter, or white sauce over boiled chicken" (1928, p. 14).

Perhaps all the singing, dancing, fabulous table displays, glamorous surroundings, and networks of diners and servants meant that presentation had overwhelmed the food. However, lavishness lent importance to the entire social and cultural event, a point recognized by the Parisian restaurant of the late eighteenth century, which attracted customers with mirrors, upholstery, and elegant service. Here individuals could order anything from a list at any time and even for a table of one, thereby narrowing the focus to what appeared immediately in front of them and giving rise to the modern fixation on the plate. In *The Invention of the Restaurant*, Rebecca Spang finds "a world in which eating was not a biological imperative but an artistic passion, and in which food came not from farm or field but from ornately decorated boutiques." The new gastronomic writers hailed "the grand restaurant's ability to stimulate and satisfy any desire" (pp. 150–151).

Modernism

Fashionable food presentation moved toward a simplifying modernism during the twentieth century. Worshiping "the geometric splendor of speed," the Italian branch of the Futurist movement under Filippo Tommaso Marinetti turned food into art in the 1930s. The Futurists advocated "optimism at the table," accompanied by "experimentation with new, apparently absurd mixtures." Believing that "form and color are just as important as taste," they struggled against "puddles of sauce, disordered heaps of food, and above all, against flabby, antivirile pastasciutta" in an appeal to Italians to abandon pasta that captured headlines around the world (Marinetti, pp. 21, 36, 38, 67, 133).

French semiotician (scholar of signs) Roland Barthes ridiculed "ornamental cookery" in one of his *Mythologies* essays written between 1954 and 1956. The color photographs in *Elle* magazine sold a "dream of smartness" to the working class, he wrote. Shown from a high angle, at once near and inaccessible, the food could be consumed "simply by looking" by people who could dream of partridges but not afford them. Any actual food was "no more than an indeterminate bed-rock" beneath "sedimentary layers" of smooth "coatings and alibis." For the "primary nature of foodstuffs, the brutality of meat or the abruptness of seafood" was buried beneath sauces, creams, icing and jellies. These coverings were the blank page for a "fairy-land reality" of chiseled mushrooms, carved lemons, shavings of truffle, and arabesques of *glacé* fruit.

French restaurant cooking returned triumphantly to the basics with nouvelle cuisine in the mid-1970s. The waiters were less likely to serve from silver platters ("flats"); instead, cooks positioned the food carefully in the kitchen and on plates about one-third larger, accentuating the lighter portions. The food was more geometrically laid out, relying on the natural colors of the primary ingredients with sauces underneath rather than on top. This less laborious food required more genius, and so was often copied badly. But the trend spread quickly, largely because of its striking, somewhat Japanese look, originally photographed from above but increasingly from the side to benefit its often elevated constructions.

Food for the Camera

Food that is cooked for the camera is captured by specialized photographers attuned to the fashion demands of art directors for billboards, television advertisements, magazines, and cookbooks. The focus, color, shine, and unreality of food photo spreads have earned the epithet "gastro-porn." Because posed food will wilt, shrink, go soggy, dry out, and lose its gloss under the lights, "food stylists" are just outside the shot, coaxing food into pleasing shapes with tweezers, syringes, sprayers, and dry-ice. They employ refillable butane blowtorches and paint strippers to help with "cheese melts" and browning. The stylists employ hairspray and jars of Aqua Gel to make realistic-looking water droplets or to thicken sauces. Since the food is to be seen and not eaten, mashed potato might masquerade as ice cream.

Dishes, such as one-pot stews, that do not photograph well may have their recipes excised. Cuisines, such as those of India, may be considered unfashionable, because they have typically been arranged in several dishes, any one of which might look somewhat nondescript.

In turn, cooks can become overly inspired by brilliant photography. But they should be careful not to make food seem too good to eat, as if it were some untouchable work of art, as the German sociologist Georg Simmel warned in his 1910 essay on the meal. Good presentation can contribute greatly to, but should not be allowed to distract from, either conviviality or the appreciation of the food's natural roots.

See also **Advertising of Food**; **Art, Food in: Film and Television**; **Chef, The**; **Cookbooks**; **France: Tradition and Change in French Cuisine**; **Japan: Traditional Japanese Cuisine**; **Luxury**; **Marketing of Food**; **Restaurants**; **Sensation and the Senses**; **Serving of Food**; **Styling of Food**; **Waiters and Waitresses**.

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PRESERVING. Food preservation conserves food for future use. Most of the basic processes have been employed throughout the world for millennia. The primary methods of salting, canning, drying, pickling, smoking, salting, fermenting, cold storage, and freezing all provide an extreme environment in order to stabilize the food for later use. Although most of these methods are used both commercially and in the home, the basic techniques are the same.

Early Methods of Preservation

The idea of preserving food for future consumption was probably first practiced by storing it in a secure place. Original practices mirrored natural processes, such as cold storage, freezing, drying, and even fermentation, which can naturally occur in fruit. Food preservation is evidenced in the archaeological record and in early written records, which indicate the use of salt, snow, smoke, pickling, drying, and fermenting. Ancient Mesopotamia, Egypt, Greece, and Rome all practiced many of these methods of food preservation. Evidence from a Chinese tomb dating prior to 2,000 years ago gives instructions on inscribed bamboo for salting, drying, and pickling. Sixteenth-century records from the observations by the European conquerors of the Maya indicate the use of smoking to preserve peppers and other foods. Methods of preservation like sun drying, smoking, and salting might have been used very early on to preserve the most perishable types of food, such as fish.

Salt, naturally occurring in deposits or as evaporated seawater, could have been dissolved in water as a brine, or in combination with other processes, like drying and smoking, could have preserved many foods. Some foods were not edible in their natural state, like certain tubers or olives, and would have required brining. Grains in particular, once harvested, were probably kept for consumption throughout the year and as protection against the failure of a future harvest. Storage in a dry and cool environment would have prevented molds and sprouting of grains. Fermentation of grain to make beer and of grapes to yield wine can preserve a large and perishable crop.

Early food preservation included simple “banking” in pits, which were dug in the ground and lined with various substances like wood, straw, and leaves to create a barrier between the soil and the food. Caves and storage vessels that were buried or sunk into the ground were also used to create a secure storage environment for the food. Food could be stored in skins, baskets, pottery vessels, or special structures built for certain commodities like grain. Liquids required a much more specialized container, and large supplies of certain commodities, like olive oil, beer, and wine, while difficult to transport, were valuable trade items, and required secure seals to protect the quality of the contents.

Pests, insects, damage from weather or moisture, molds, fungus, decomposition, or a combination of these factors lower the quality of or even destroy the food, and these factors had to be taken into account. Whether the food preserved is being held to guard against future crop or harvest failures, for trade or barter for other commodities, or to divy out certain foodstuffs as part of the yearly diet, the quality of the food preserved had significant impact upon the future quality of life.

Canning

Canning refers to a technique used both commercially and in the home to preserve food in sealed containers. In the early twenty-first century, metal cans are used commercially and glass jars are used in the home. The concept of preserving foods by cooking them and then sealing them in a container is ancient. Olive oil, lard, wax, pitch, clay, and skin have all been used to seal vessels containing food, but are not very reliable. In the late eighteenth century, France offered a monetary award for a method that could be used to preserve food for soldiers. After years of experimentation, Nicholas Appert successfully used sealed glass jars, whose contents had been thoroughly cooked in a water bath, to create portable and potable food. He was awarded the prize in 1809 for his work and went on to publish his findings in “L’art de conserver pendant plusieurs années toutes les substances animales et vegetales” (The art of preserving all kinds of animal and vegetable substances for several years). In 1810, Englishman Peter Durand received a patent for the same process but included tin containers as well as glass.

Tin containers had been used for food storage previously, but it was the combination of the water bath and the sealed container that was so successful. Initially made by hand, tin-plated cans sealed with lead solder were used. By 1819 the Arctic explorer William Edward Parry had included canned foods with the expedition supplies, but the discovery in the 1980s of some of the bodies of those lost on John Franklin’s last Arctic expedition in 1847 and their analysis in the 1980s and 1990s indicates that they were suffering from lead poisoning from the lead seals in food cans. Food cans manufactured in the United States have not used lead solder since the mid-1990s, but canned food products from other countries could contain lead solder.

In the United States, various individuals worked on streamlining tin can production, improving the methods of canning various foods, like corn, tomatoes, and lobster. During the mid-nineteenth century in the United States, both commercial canning and home canning expanded, driven by the demand for product by the westward expansion of settlers. The armies of the Civil War used canned goods. Another significant milestone was canned condensed milk, which provided canned milk that was safe to drink, and was developed by Gail Borden in the mid-nineteenth century.

As more foods became available in cans, home cooks "canned" in glass a wide variety of products using basically the same techniques. In both commercial and home canning critical factors were sufficient temperature, sterile containers, and an effective seal. John Mason patented a glass jar with a screw cap to seal it in 1858; numerous patents followed for a reliable and effective seal. The consequences could be illness and even death from bacteria that could grow inside the container, generally the naturally occurring botulism bacteria (*Clostridium botulinum*). Invented in the early twentieth century, the new and most common jar closure used today has two parts that separate the jar cover from the threaded ring. Commercial canned goods created a dependable and transportable food, and are used extensively by consumers all over the world. Canned soup, tuna, juice, corn, tomatoes, and condensed milk are some of the most popular canned foods. In the United States, the cooperative agriculture extension service of the USDA is a source of accurate and inexpensive advice on all types of home preserving. Home canning has diminished in the United States as families moved away from their source of food, but in a 1996 survey, 56 percent of all U.S. households said they had canned in the past, of whom 28 percent had canned within the last two years. Although pressure canners are considered safer, many still use the conventional water bath for home processing.

Drying

Drying occurs naturally with food left in the sun, or on the vine, like beans, or grapes. Some foods, like apples and tomatoes, are generally cut into smaller pieces for drying, a practice which allows the moisture to uniformly evaporate. Herbs are frequently dried whole and on the stem. Low humidity, heat, and air circulation are important so that mold does not occur. Meats and fish can be dried to the point of extreme desiccation, resulting in a product usually called jerky. Drying racks, screens, bags, strings, and bunches can be dried outdoors or in a warm dry spot indoors. Ovens or specialized equipment like dehydrators can be used to create the low temperatures necessary. Once dried, foods can keep for up to a year in a cool and dry environment. Dried foods are sometimes additionally smoked or salted.

Dry storage is usually used for grains, whole vegetables, and fruits like potatoes, onions, carrots, apples, pears and turnips, herbs, and chilies. By keeping the food whole, at certain temperatures, with low humidity, in the dark, and pest-free, supplies can last for months, or years. While dry storage is sometimes in separate structures, dried food can also be stored in root cellars and cold rooms below ground or partially below ground.

Ceramic preserve jar depicting General George Washington, Pennsylvania, circa 1870. PHILADELPHIA MUSEUM OF ART, BAUGH-BAKER FUND.

Fermentation

Fermenting produces beverages like wine and beer and foods like cheese and bread. Fermentation can occur naturally and with naturally occurring yeasts, or lactic acids. Early records in the Sumerian language indicate the manufacture of both beer and bread. Ancient wine making uses yeast and bacteria to transform raw material into the fermented beverage. Fermentation is the result of enzyme activity, naturally occurring proteins present in the food, or can be introduced into it. Sauerkraut and fermented vegetables, like the Korean dish *kimchi*, are produced with lactic acids. The cabbage, vegetable, or mixture is salted and placed in a container where it will ferment, creating an acid environment that will preserve it. This fermentation process is called pickling, just as the use of vinegar and the use of brine are also called pickling.

Vegetables can be very difficult to preserve without processing, but a wide variety of vegetables can be preserved by the addition of salt, after which the juices then drain from the vegetables and ferment. Certain sausages, vegetables, yogurts, and cheeses are all preserved by fermentation. Louis Pasteur's wide-ranging research, which included studying the fermentation process in wine and beer making, led to pasteurization and also to the theory that bacteria existed. The presence of harmful bacteria explained why food preservation had to follow very strict aseptic guidelines, or the food could become spoiled, inedible, or at its worst deadly.

The origins of yogurts and cheese are frequently explained as the result of milk being stored in a skin and warmed, which caused the milk to ferment, and separate into solids and liquids, or curds and whey. Through the use of lactic acid, salt, and heat, and by draining the liquids, cheese is created. By draining, application of pressure to remove the moisture, and by aging cheese can be held for years. Butter can also be preserved with salt. The quantity of salt necessary to preserve butter was such that early instructions required that the butter be washed before use. Unsalted butter is more perishable and has a different flavor.

Cold Storage

Cold storage or refrigeration slows down decomposition of food. Initially, cold storage used natural snow and ice usually kept below ground and covered with straw, or branches. Snow was usually compressed to slow melting. In much of the ancient world, snow and ice were harvested, stored, usually in pits, and used in the summer.

Melting and storage were continuing problems. Much time and effort were devoted to solving these problems over the centuries, but it was in the nineteenth century that many technological advances occurred. In 1803, a Maryland farmer patented an insulated icebox using layers of insulation with charcoal dust. Icehouses were generally below ground structures, although circular brick ones were also used, and filled with layers of ice. In 1827, a more efficient horse-drawn ice cutter was invented for cutting natural ice off lakes and rivers. By the 1840s refrigerator railroad cars were in use in the United States. Around that same time various advances were made in artificially creating ice and refrigeration. John Gorrie, a physician in Florida, received a patent for ice manufacture in 1851. The technology existed, but the product was too expensive compared to natural ice. However, after the blockade of the South and the Civil War, artificial icehouses began to open. For example, the steam-operated Louisiana Ice Manufacturing Company opened in 1868, selling ice for $1.75 for a hundred pounds. By the 1880s ice plants were located throughout the United States, but natural ice was still sold as well. In the twentieth century, ice became universally accessible. In 1913, the first home refrigerator became available and by the 1940s, 56 percent of all U.S. kitchens had electric refrigerators.

Freezing

Freezing food originally took advantage of natural freezing, or below freezing temperatures, but artificially freezing food is an ancient practice as well. Frozen foods are quite stable, although flavor and texture may change. Experiments in compression and condensation led to mechanized ice production, and improved efficiency eventually dropped the price of artificial ice, so it was competitive with natural ice. Home machinery initially stored the ice needed to cool the food. Today, automatic ice and frozen food storage are present in most homes. Clarence Birdseye is generally credited with creating the commercial market in frozen foods, based on his experience with fish in the Arctic. After some years of experimentation mainly with fish, he had perfected his process by 1924, and coupled with advances in freezer cases in stores, frozen foods became widely available.

Freeze-drying is thought to have originated in Peru where the potato has been cultivated for about nine thousand years. At high altitudes, the potato harvest was spread on the ground and exposed to extreme cold and then pressure was applied to remove all moisture. Like other dried products, water is used to reconstitute the dried potato. Freeze-dried coffee was developed in the 1930s, and the United States space program used freeze-dried foods because of their light weight and stability for the astronauts' meals.

Irradiated Food

Irradiated food is exposed to radiation from gamma rays or electron beams or X-rays to kill bacteria, insects, and parasites and reduce spoilage. NASA irradiates food used by its astronauts. Irradiation of food began in 1963, and in addition to the United States, a variety of countries use irradiation for food, including Russia, France, China, and South Africa. Currently, some fruits, vegetables, spices, and meats are irradiated and must be marked with an international symbol called a radura and sometimes a statement such as "irradiated to destroy harmful microbes."

Pickling

Like many of the terms used in food preservation, the term "pickling" can mean several things. It can be used for preserving vegetables, fish, or meat with an acetic acid, or a vinegar. It can also be used to refer to a salt solution, or brine. Generally, it is used to describe the use of vinegar, spices, and salt to preserve vegetables, herbs, and fruits.

Salt is used as a dry packing material or dissolved in water as brine. In both cases it removes liquid from the meat, fish, plant, or dairy product, and prevents decay. To salt for preservation is to use salt to remove the moisture from the fish, meat, or vegetable. The brining method uses salt that has been dissolved in water. The salt is sometimes mixed with sugar and spices. Fish may be hung to dry afterwards, and can then be smoked. Salted codfish is still popular and widely available in spite of pressure on the diminishing population in the Atlantic Ocean. Cuts of meat can remain in the dry cure for a period of time based on weight, usually about twenty-five days, and then are frequently smoked.

Brining is a similar process, with water, salt, sugar, and spices as usual parts of the brine. In brining, it is very important that the meat stays below the surface of the liquid. Time in the brine is related to weight, and the brine must be checked regularly to ensure that it is stable. Temperature fluctuations or insufficient salt can result in the loss of the ability of the brine to preserve the food, and decomposition can begin. The first evidence of this is usually the formation of a mold or "scum" on the surface. Early directions all indicate that the barrels or containers should be checked daily for this reason. Vegetables can also be preserved in brine, or with a dry salt coating. Anchovies, butter, capers, lemons, and herbs, even eggs are also commonly preserved with salt. Salt is also used to produce extremely concentrated and highly flavored sauces, particularly of soy, and/or fish, which have been in use since antiquity and were extremely important for flavor. The Romans had *garum* and other sauces, and the Chinese had soy sauce, for example. These condiments have modern counterparts in soy sauce, hot pepper sauce, fish sauces, and Worcestershire sauce. The purpose of all of these concentrated sauces, ancient and modern, is to carry an extremely dense flavor and saltiness into foods. Sweet flavors, in preserved fruits, were intensified by the combination of sugar and concentration through cooking.

Smoking

Smoking is frequently used in combination with salting. For example, the ancient Mayans preserved chilis, as well as fish and meat, by smoking; in his treatise "On Farming," Cato describes salting and smoking a ham. Smoking takes two basic forms, hot and cold. In cold smoking, the purpose is to impart flavor, not to cook the food, whereas in hot smoking, the appropriate temperature for the fish or meat is necessary to "cook" it.

Sweeteners

Early sweeteners included honey and syrups made from grapes, figs, or dates. Sugar made from cane was costly, but it became more available by the sixteenth century when the sugar plantations that were planted in the Caribbean and South America became major producers. Beet sugar was also in production by the nineteenth century. In preserving with sugar, fruit and a sweetener are cooked together until thickened and then packed into containers. Sometimes are included pieces of the fruit, and other times the mixture is strained and just the resulting liquid is kept. Whole fruits can also be cooked in syrup, until they have completely absorbed the sugar, and then left whole and eaten as a confection.

Our sense of taste identifies flavors as sweet, sour, salty, bitter and some say, *umami* (or savory). The major preservation techniques utilize these very flavors, creating the core of our palate.

See also **Beer; Birdseye, Clarence; Cheese; Fermentation; Fermented Beverages Other than Wine or Beer; Fish, Salted; Fish, Smoked; Food Safety; Frozen Food; Jam, Jellies, and Preserves; Meat, Salted; Meat, Smoked; Microorganisms; Packaging and Canning, History of; Pasteur, Louis; Soy; Storage of Food; Wine**.

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PROFESSIONALIZATION. Professionalization in food preparation, food media, food styling, restaurant training, and food production assures the consumer that professionals incorporate current educational and practical experience in foods, and possess unique knowledge and skills that solve particular problems facing the food industry. The food professional's goal is to take a body of abstract knowledge and effectively convert it into comprehensible terms for the public. Through the ages, specific knowledge about food was passed first from families, through guilds, and then to professional associations.

In the third century B.C.E., Rome's citizens handed grain to professional bakers (a practice that continued through the thirteenth century), yet bread baking also continued to be done at home. Before the second century B.C.E., Greek observer Athenaeus reported seventy-two kinds of bread in Greece. Rome's culinary advantage was based on outlying regions with efficient trade and transportation; it benefited from pickles from Spain, lemons from Libya, and peaches from Persia. In Rome a good cook was considered an artist, manipulating out-of-season foods. Yet after the appearance of the cookbook of Marcus Gavius Apicius, a first-century Roman epicure, no European cookbooks were issued until the thirteenth century. Historian Michael Symons associates this lapse with the influence of Plato, who warned against taking an interest in cooks. But by the twentieth century, Western scholars had become food specialists writing for public consumption.

Apicius's emphasis on the over-dramatization of the act of eating is what professionals are continually in danger of reproducing. Romans cooked for the eye, not the palate. In the fourteenth and fifteenth centuries, an emergence of food-related trades was represented by guilds that secured exclusive rights to prepare and sell food products previously managed by journeymen. The French Revolution of the eighteenth century gave birth to the modern restaurant, transferring the art of cooking from courts to the middle and working classes, which signaled the death of the guilds. Modern-day restaurants have become, according to food historian W. K. H. Bode, "dormitories for the food manufacturing industry" that "sell their wares under long-established and well respected culinary language which have taken chefs . . . much toil" (Bode, pp. 233, 237). Modern man eats better, but he knows less about the preparation and presentation of food.

During the 1800s and 1900s, increases in population and food production stimulated the world economy with automated technology and mass-production marketing. Georges-Auguste Escoffier's introduction of the brigade system in kitchens broke down the craft barrier and gave rise to the appearance of assembly lines. Cooks became highly specialized, and cooking was corporatized. In eighteenth-century Britain, James Boswell, the literary biographer, defined man as a "cooking animal," noting that it is not tool making, but cooking that separates humans from nature. In pre-Christian Rome, sixth-century Italy, seventeenth-century Europe, and the present millennium, Western consumers did not worry about regional or seasonal limitations because with affluence and a good chef one could have what one wanted all year around.

The influence of cooks on society includes the areas of arts and technology. Before 4000 B.C.E, food was gathered by cooks; later, it was distributed by cooks; and in the last century, cooks organized foods, their efforts garnering professional recognition. Professional cooks were born from home cooks, a tradition that has been replaced with science and technology, a manipulation of foods. The advances that man has devised have changed the shape and taste of food consumed. Taste buds are no longer educated to distinguish the purity of foods.

Over time, food professionals have practiced by creating a recipe, consuming time and money, and refining it for specialized consumption. In the evolution to saturating foods with sauces and producing presentations merely for display, many food professionals disregarded primitive tastes based on indigenous products and cooking equipment made of local wood, fiber, and clay. Artisan work, craft in all phases of food preparation, fell more and more to cultivated specialists, who closely guarded their craft. As specialists begin to exert their knowledge more broadly, professionals may no longer dominate the foreground. The more knowledge is shared, the larger the impact on the profession that was founded on formalized techniques and apprenticeships.

Specialists who share their skills contribute to decisions on dietary needs by emphasizing less, but better-quality, healthy, safe, ecologically sound foods that exhibit global concern and may re-awaken consumers' faith. Professionals "revisiting" food through the specialist "eye" learn from the past, and from global, urban, and rural foods.

Some philosophers contend that thinking of food as a movement changes its significance. The recognition by other professions of the significance of making food can dispel ignorance and disrespect of food and enable research into such subjects as bioterrorism in the food supply. Our identity with food is transformed at the speed of technology, and food specialists, by sharing skills and information, help manage this transformation that shapes our history and forms our future.

See also **Apicius; Chef, The; Cookbooks; Escoffier, Georges-Auguste; Restaurants.**

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PROTEINS AND AMINO ACIDS. The average human body, weighing 65 kilograms, contains about 11 kilograms of protein, 40 kilograms of water, and 9 kilograms of fat. The protein provides the "machinery" of the body, including not only the voluntary muscles and the heart muscles, but also the walls of the gut and the blood vessels, as well as the enzymes, the skin, and the hair. The word "protein" is used to describe a group of different compounds with varying properties—soluble, insoluble, and so on. Originally they were classed together because, unlike fats and carbohydrates, proteins also contain nitrogen in addition to carbon, hydrogen, and oxygen. Now, we know that they are all composed of chains of "amino acids" linked together like enormous necklaces of thousands of individual beads. To continue the analogy, there are twenty different varieties of "bead" (or amino acid). The chemists' shorthand representation of the common formula for each amino acid is "$H_2N.CHR.COOH$," where "—H_2N" is the basic amino group, "COOH" is the organic acid group, and "R" the general symbol for whatever additional group is present for that particular "bead." Amino acids can form chains by reaction between the amino group of one molecule and the acidic group of another to give:

—HN.CHR1.COO—HN.CHR2.COO—

The body makes its own proteins and obtains amino acids from the digestion of the proteins in the foods that we eat. These large protein molecules cannot be absorbed through the gut walls into the bloodstream, but a series of digestive enzymes (which are proteins themselves, having these special digestive functions) break down the chains of amino acids into the individual amino acids, which are then absorbed. A small proportion of protein may remain undigested, especially with the more fibrous plant foods such as bran, where the cellulosic cell walls are not easily broken down in the tissues, but, for most mixed human diets, one can assume at least 90 percent protein digestibility.

The final nutrients that we obtain from our foods are thus amino acids rather than proteins, and we build our own protein "necklaces" up from the pool of free amino acids circulating in our body. This pool is also derived in part from body proteins that are continually being broken down and resynthesized. Our bodies are in a dynamic state and are constantly turning over.

Each protein in our body has a specific function and is made up of a predetermined succession of amino acids that, when the protein is being synthesized, are added one by one to the chain. If a particular amino acid is missing from the site of synthesis, the process stops. Of the different varieties of amino acids, some are termed "essential," which means that our bodies are unable to synthesize them by modification of another molecule. Four amino acids in this category are lysine, methionine, threonine, and tryptophan. Others, the "nonessential" amino acids, can be made in the body from other nitrogenous compounds.

Protein Functions

Obviously, a growing body needs dietary protein in order to increase its own body tissues. This is particularly clear in species where the young grow quickly, such as calves and particularly piglets, and it is interesting that the dams' milk in these species is considerably higher in protein than is human breast milk, the natural food that meets the needs of much more slowly growing human infants. It is also obvious that older children need protein for their continued growth and that pregnant and lactating women need it to provide for the growing fetus and then for the suckling infant. The protein needs of other adults are not so obvious, except for the slow but continuous growth of hair and fingernails, the replacement of rubbed-off skin, and other minor losses. However, adults require much greater amounts of protein than would be expected to replace these losses—something like 50 g/day.

It is true that living tissue is in a dynamic state, with protein being continually broken down to its constituent amino acids and resynthesized, but this should not increase requirements because the amino acids are fully available for reuse. However, there are enzymes in the liver whose function is to break down an excess of circulating amino acids. These enzymes allow the elimination of nitrogen in the form of urea and the utilization of the carbon-containing side-chains of the amino acids as energy sources for the tissues. It appears that what we might call the "idling rate" of these enzymes sets the requirement for amino acids to replace those lost in this way. In the course of evolution there has presumably been no advantage, in general, in selecting for individuals with lower "idling levels" because protein intake was not a limiting factor. However, evolutionary selection may explain the apparently lower protein requirements of natives in an area of Oceania with a traditionally low-protein diet.

At one time it was thought that the muscular contractions required in any kind of physical work consumed protein, as if the muscle used itself up or was its own fuel. We now know that this is not the case, and that carbohydrate and fat are the normal sources of the energy required for physical work. The erroneous belief that physical work uses up protein has, in the past, been of some practical import since it meant that traditional working-class families would give a large proportion of what meat was available to the "breadwinner" father because of his greater physical labor, so that little remained for the others even when the wife was pregnant and her requirement for more concentrated sources of nutrients was actually more critical.

Protein Levels in Foods

From the preceding discussion, it is obvious that meat from other animal species is a rich source of protein. The only qualification is that fat can seriously dilute the concentration of protein available. Lean muscle has a 3:1 ratio of water to protein, whereas fats are laid down without associated water. Thus, a cut of meat with 20 percent fat will also have only 20 percent of protein (that is, 1/4 of 80 percent). Further, since fat provides 9 Calories of energy per gram and protein only approximately 4, it follows that 9/13, or approximately 70 percent, of the energy provided by the meat will be coming from animal fat. (Note that the dietitian's Calorie, spelled with a large "C," is one thousand times the standard "calorie" and is the heat needed to raise 1 kilogram of water by 1°C).

The working parts of plants, principally enzymes, also consist of proteins; and seeds always include protein that will be required for the synthesis of new tissues when the seed germinates. In general, the concentration of protein is lower than that in animal tissues because the structural components consist of fibrous carbohydrates and, for seeds or root stores, large amounts of starch and sugars are usually also present as a reserve of energy.

There are several different ways of comparing the relative richness of different foods in protein. The simplest way would be a straight comparison of the percentage of protein in each food. Thus, whole milk contains just over 3 percent while white bread contains 8 percent or a little over, that is, more than twice as much. Yet the dietitian's practice when considering adult-type menus is to compute the quantity provided by a typical "serving." Thus, for milk the standard serving is 1 "cup" (245 grams), which provides 8 grams of protein. If we take two slices (50 grams) as the standard serving for white bread, this provides only 4 grams of protein, that is, less. So, there is a contradiction. Milk, of course, is nearly 90 percent water. Dried whole milk contains 27 percent protein and dried bread only 13 percent. This is perhaps a fairer comparison since one would consume more water with a meal if one were not drinking fluid milk, and it leads to one finally regarding milk as being the richer source of protein.

Common refined cereals (white flour, white rice, and de-germed cornmeal) all contain about 10 g protein per 100 g dry matter, with wheat providing a little more and rice a little less, as do potatoes. Lean fish and meat have up to 60 percent protein in their dry matter and skim milk has 40 percent. Among plant products, the legume crops (peas and beans) have the highest values, commonly 20 to 25 percent of dry matter. Legumes that are rich in fat (the so-called oil-seeds) can be processed to remove the oil, and the residues have even higher protein values. Extracted soybean meal has 45 percent protein and materials of this type have been used to make vegetarian substitutes for meat.

One would expect that the wealthier countries, with their greater use of animal products of high protein concentration, would have overall diets of higher protein content, but this is not always the case. Wealthier population groups also consume higher levels of fat and sugar, much of them in fast foods and "cola-type" drinks. These dilute the protein concentration of the diet to the levels of those poorer countries whose diet is based on cereals with less in the way of supplementary foods of either high or low protein content.

A particular problem exists where a poor community has plantains and/or cassava (manioc) as its staple foods. These have only about 2 to 4 percent of their dry matter in the form of protein, that is, values much lower than the corresponding value for grains. In addition, these foods are so bulky that young children being reared on them are commonly unable to consume enough to meet even their energy needs. They are thus at constant risk of both protein and energy deficiencies and should be given more concentrated foods.

Protein Quality

As mentioned above, if a human diet were to be totally deficient in one essential amino acid, a child would immediately cease to grow and even an adult would go into decline. In practice this never happens. Even though one can extract from some plants an individual protein that is of this kind (for example, the gluten present in wheat), the total mixture of proteins in any natural food contains some of each of the amino acids, though not usually in the exact ratio in which the human body will use them. This is not a problem so long as the essential amino acid is present at the lowest level that is adequate to meet the body's need for it. The remaining amino acids will conversely be present in excess, and, as explained in the previous discussion, mechanisms exist to metabolize these amino acids to provide an additional source of energy.

Providing fast-growing young rats with wheat flour as their sole source of protein in a diet that is otherwise well balanced, will result in relatively slow growth; rats fed on the same diet supplemented with a small quantity of the amino acid lysine will grow considerably faster. Under these experimental conditions, the protein of wheat flour is said to have a low "biological value" and its "limiting amino acid" to be lysine.

Mixtures of foods that have different limiting amino acids can supplement each other. Thus, if one protein source, such as a grain, is limited by its lysine content, but has methionine in excess, and another protein source, such as a legume, has a good level of lysine but is short of methionine, a mixture of the two will have a better balance than either alone. This phenomenon can be clearly demonstrated in experiments where young growing rats, for example, are fed a mixture of wheat flour, primarily deficient in lysine, and navy beans, primarily deficient in methionine. Young rats grow faster when they are fed with both wheat flour and navy beans, as opposed to being fed with either protein source separately, but still not as well as when they are fed with well balanced egg protein because the mixture is still partially deficient in a third amino acid, threonine.

There has been a great deal of research and controversy about how serious partial deficiencies of individual amino acids are in human diets. In poor communities in North Africa wheat has been the traditional staple food, with only small quantities of supplementary foods. When synthetic lysine became available at a reasonable cost, a trial was carried out to determine if fortification of the traditional diet with lysine at the time the grain was milled would result in improved vigor in people and in improved health among children. However, there was no evidence of any benefit. Nor was any benefit seen in comparable trials in Thailand.

It is clear that the young rat can be a misleading model for humans. A child grows much more slowly to its adult size then a small animal and, at its fastest rate of growth, adds no more than 3 grams of protein to its tissues in a day—a very small amount in relation to its protein intake, which would normally be ten times as great even with a diet containing no more than 10 PCal%. A more common problem than diet based on grain that is deficient in an essential amino acid, is the fact that people do not eat enough to cover their energy needs—in adults, because of poverty in most cases; and in young children in the developing world because their food is too bulky for them to be able to consume all they need. In such cases adults can lose muscle power and general vigor and small children can develop kwashiorkor, a potentially fatal disease that appears to be a combined deficiency of energy and protein, because what protein is ingested has to be used as additional fuel.

Vegetarian Diets

It is clear from what has been written already that vegetarians can have an adequate intake of protein, particularly if they are willing to consume milk and eggs which provide good supplements to the protein of grains, and do not require animals to be killed. Vegans, who eliminate all animal products from their diets, commonly ensure that, in addition to consuming grains, they have a good intake of legumes as a supplementary source of proteins relatively rich in lysine. The legumes may not always be essential, but the supplementation provides a useful safety margin. The long-term problem for vegans is that they will become deficient in vitamin B_{12}, unless they take a special vitamin supplement, because this vitamin occurs naturally only in animal tissues or from the fermentation of certain bacteria.

Protein Requirements.

The recommended daily dietary allowance for an adult of average build is 0.8 grams of protein per kilogram of body weight, equivalent to 0.36 grams of protein per pound of body weight, regardless of sex. Since "average" men and women in the United States are assumed to weigh about 170 and 130 pounds, respectively, these standards give us an intake of 61 grams protein for the average man and 47 grams of protein for the woman, with a further addition of 15 grams of protein per day for women during pregnancy and lactation. These standards were designed to be adequate for diets containing protein of average quality and to contain some margin of safety. Virtually all American diets contain more than this amount of protein.

Despite children's need for growth, their requirement for protein as a proportion of their total food is lower than that of adults, because their energy expenditures in relation to their size are greater than those of adults, and their growth is so gradual. However, if a child's appetite is very poor and/or the diet is very bulky, the diet can become protein deficient because some of the small amount of protein consumed will be used as an energy source.

See also **Assessment of Nutritional Status; Caloric Intake; Calorie; Disease; Lactation; Malnutrition; Nutrients; Nutrition.**

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PROVERBS AND RIDDLES. Proverbs and riddles are pithy verbal expressions handed down over the course of many generations. Both forms are grounded in the familiar, but in opposite ways. While proverbs tend to re-familiarize the familiar, riddles tend to de-familiarize the familiar. More specifically, proverbs function like mini-allegories by embodying an abstract truism in concrete imagery drawn from familiar experience; the truism is thus reified and made "extra-familiar." For example, in the sixteenth century, the abstract truism "change occurs gradually" was reified in a vivid proverb that invoked a familiar domestic situation: "Little by little the cat eats the bacon." In contrast, riddles cause their reader to see an ordinary object in a new and extraordinary light. For example, the riddle "A little white house without door or window" prompts the reader to reapprehend the thing implied by the riddle: "an egg." In the moment that this solution is guessed or given, the egg is perceived not merely as something to fry or hatch, but as a home or shelter, an analogue to the reader's own house. Because riddles and proverbs alike are grounded in the familiar (albeit in different ways), food and culinary situations supply the raw material of many of them.

Food Proverbs

The study of proverbs is called paremiology. Some paremiologists distinguish proverbs from maxims, saws, sententiae, and other kinds of folk sayings, but in practice these distinctions are hard to maintain. In this article, the term "proverb" is employed in its widest sense.

Over the centuries, food proverbs have enjoyed and suffered the same vagaries of popularity as proverbs in general. In ancient times, proverbs were much esteemed, as evidenced by the Old Testament Book of Proverbs, which includes many food-based maxims such as "Eat thou not the bread of him that hath an evil eye, neither desire thou his dainty meats" (23:6). Aristotle, too, is reputed to have written a work on proverbs, now lost. During the Middle Ages, sermons and other didactic works popularized hundreds of proverbs, such as "He must have a long spoon that shall eat with the devil," first recorded in 1395. During the sixteenth century, numerous ancient Greek and Latin proverbs were revived thanks to the Dutch humanist Erasmus, who published a collection of three thousand proverbs derived from classical literature, including "You are decorating a cooking pot" (meaning "You are doing needless work") and "When offered turtle-meat, either eat or don't eat" (meaning "Make up your mind, one way or another"). The popularity of proverbs among learned authors increased through the seventeenth century, but then began to decline in the eighteenth century, when they came to be seen as evidence of vulgarity rather than erudition. In 1741, for example, Lord Chesterfield belittled "common proverbs" because they were "proofs of having kept bad and low company. For example, if, instead of saying that tastes are different . . . you should let off a proverb, and say 'that what is one man's meat is another man's poison' . . . everybody would be persuaded that you had never kept company with anybody above footmen and housemaids." (461)

Proverbs about food reflect, naturally, the gastronomic and culinary norms of the culture in which they arise. For example, the proverb "from eggs to apples," meaning "from beginning to end," originated in ancient Rome, where it was customary to begin a meal with eggs and end it with apples. In China, proverbs abound that mention rice or tea, including "Talk doesn't cook rice" and "Better to be deprived of food for three days than tea for one." In Azerbaijan, many proverbs refer to yogurt and halva, including "He who burns his mouth on milk will blow on yogurt when eating it" and "Your mouth won't get sweet just by saying 'halva.' " In Germany, where wine-making is common, one encounters the proverb "Big and empty, like the Heidelberg tun," an allusion to a wine cask renowned for its 58,000-gallon capacity. In England, the prevalence of proverbs involving eggs attests to the long-standing importance of that foodstuff in that nation's diet; *A Dictionary of the Proverbs in England in the Sixteenth and Seventeenth Centuries* cites twenty-seven egg proverbs. Some of those egg proverbs are still current, such as "Don't put all your eggs in one basket" and "As sure as eggs be eggs." Others are less familiar, such as "Better an egg in peace than an ox in war," "It is hard to shave an egg," and "Who means to have the egg must endure the cackling of the hen." Other food proverbs survive only by virtue of their being used in Shakespeare, such as "to take eggs for money," meaning "to exchange something valuable for something worthless." Still others have been obsolete for centuries, such as "to come in with five eggs," meaning "to interrupt with an idle story," while others have been rendered obsolete by changing social conditions, such as inflation: "as dear as two eggs a penny."

On the other hand, some proverbs persist even when they cease to make literal sense. The proverbial phrase "to bet dollars to doughnuts" is still current even though the rising cost of doughnuts has diminished the original disparity of the wager. Likewise, the proverbial phrase "to eat humble pie," meaning "to be forced into apologizing in a humiliating manner" remains current even though it has been largely forgotten that "humble pie" was originally "umble pie," and that the umbles were the innards of a deer, often cooked into a kind of meat pastry. The proverbial phrase "to dine with Duke Humphrey," meaning "to go hungry," is still heard occasionally, even though the origin of that expression has been lost even to paremiologists.

Like proverbs in general, many food proverbs have changed their form over time. The early-sixteenth-century proverb "Many things fall between the cup and the mouth" evolved, by the mid-nineteenth century, into the more familiar "There's many a slip 'twixt cup and lip." The use of rhyme in the latter proverb is one of several literary devices that characterize many proverbs, including food proverbs. These literary devices make proverbs easier to remember, and also signify their special ratified status, rather like placing a frame around a picture. Other literary devices include alliteration (as in the fifteenth-century proverb "the more crust, the less crumb"), parallelism (as in the fourteenth-century proverb "the nearer the bone, the sweeter the flesh"), and antimetabole (as in the sixteenth-century proverb "while one wastes drink, the drink wastes him").

Proverbs, including food proverbs, continue to be invented up to this day, though perhaps not at the rate they were centuries ago. One recent addition, often heard in the more northern parts of the United States and Canada, is the ironic maxim "Don't eat yellow snow."

Food Riddles

While proverbs re-familiarize the familiar, and riddles de-familiarize the familiar, the distinction between the two forms is sometimes unclear. For example, the seventeenth-century proverb "An egg will be in three bellies in twenty-four hours" has the declaratory form of many proverbs, but in substance it is much like a riddle: the three bellies are the belly of the hen that lays it, of the oven that bakes it, and of the human who eats it. Other proverbs can easily be converted into riddles by suppressing, rather than declaring, the familiar element: the sixteenth-century proverb referred to above—"while one wastes drink, the drink wastes him"—becomes a riddle when expressed in this form: "As you waste it, it wastes you." Aristotle noted that riddles are also closely allied to metaphors: "Metaphors imply riddles, and therefore a good riddle can furnish a good metaphor" (*Rhetoric* book 3, chapter 2). Put another way, many riddles are merely incomplete metaphors: one half of the identity relationship is deliberately elided. For example, this Filipino riddle—"A trunk of a king; if opened it cannot be shut"—becomes a metaphor once the missing element is reinserted: "An egg is a trunk of a king; if opened it cannot be shut."

MISCELLANEOUS FOOD PROVERBS

Hunger is the best sauce.
He is an evyll coke that can not lycke
his owne lyppes.
Don't cry over spilt milk.
The proof of the pudding is in the eating.
Butter wouldn't melt in his mouth.

Also like proverbs, riddles are ancient in origin. In the ancient Greek legend of Oedipus, the Sphinx terrorized the people of Thebes when they could not solve its riddle. In the Old Testament, Samson successfully antagonized the Philistines by challenging them to solve this riddle: "Out of the eater came forth meat, and out of the strong came forth sweetness" (Judg. 14:14). The solution to the riddle was a lion, Samson having previously encountered a lion carcass that bees had filled with honey. Ninety-one ancient riddles are also preserved in the Exeter Book, a late-tenth-century manuscript collection of Anglo-Saxon literature. Of these ninety-one riddles, ten are food- or drink-related, including this one, whose bawdy double-entendres de-familiarize the everyday thing implied by the riddle:

> I am a wondrous creature: to women a thing of joyful expectation, to close-lying companions serviceable. I harm no city-dweller excepting my slayer alone. My stem is erect and tall—I stand up in bed—and whiskery somewhere down below. Sometimes a countryman's quite comely daughter will venture, bumptious girl, to get a grip on me. She assaults my red self and seizes my head and clenches me in a cramped place. She will soon feel the effect of her encounter with me, this curl-locked woman who squeezes me. Her eye will be wet.

The solution to this ribald riddle is "onion."

Inventing new riddles continues to be a popular activity among some authors and educators. In the nineteenth century Lewis Carroll devised riddles, including a long and elaborate food-related one, for *Through the Looking Glass*. In the twentieth century, J. R. R. Tolkien created many riddles for *The Hobbit*, including this one: "A box without hinges, key, or lid. Yet golden treasure inside is hid." The solution is familiar: "an egg."

See also **Art, Food in; Folklore, Food in; Magic; Metaphor, Food as; Myth and Legend, Food in; Religion and Food; Symbol, Food as**.

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Mark Morton

PUDDING. *See* **Custard and Pudding.**

PULSE CROPS. *See* **Legumes.**

PYTHAGORAS.

Pythagoras (c. 580–c. 580 B.C.E.) was a Greek mathematician, philosopher, and mystic. He wrote nothing himself, so his ideas survive through the writings of others, including Aristotle. Many people are familiar with him as the mathematician who formulated the Pythagorean theorem in geometry that relates the lengths of the sides in a right triangle. Others know him as a mystic and the first person known to be motivated by moral and philosophical concerns to adopt a vegetarian diet.

The schools and societies Pythagoras founded in the southern Italian area of Magna Graecia flourished for a while, and they developed and spread many of his concepts, which were later adopted and expanded by others. These concepts include bodily humors (evident in modern descriptions of melancholic and phlegmatic personalities), a tripartite soul, reincarnation, and the numerical ratios that determine the concordant intervals of the musical scales. Permeating all of his thoughts was the idea that all things are numbers. Numbers (individuals, groups, and series) were imbued with mystical properties that were carefully guarded and only shared among initiates to the Pythagorean schools founded by him or his disciples.

Pythagoras and his followers practiced one of the first recorded diets known as vegetarianism. He advocated a diet devoid of the flesh of slaughtered animals partially because he felt food influenced the distribution of the bodily humors and thereby the health of the individual and partially because it would prevent the killing of a reincarnated individual and its transmigrated soul. Up until the late nineteenth century non–meat eaters were generally known as "Pythagoreans."

Pythagoras is also alleged to have admonished his disciples to abstain from eating beans. Ancient and medieval writers ingeniously ascribed this pronouncement to the belief that beans contained or transmitted souls. The Greek phrase supporting this gastronomic recommendation, however, could also be construed to imply that his followers should avoid politics. Black and white beans were used as counters in voting in Magna Graecia. The school Pythagoras founded there became actively involved in the populist political views that gained ascendancy in the town of Kroton, where he lived for many years. Later an opposing aristocratic party gained control of the city and banished him and his followers for their political views and activism. Pythagoras died in exile. His supposed warning to "abstain from beans" is therefore thought to have meant "avoid politics." Alternatively he may have realized that eating undercooked broad (fave) beans (Vica faba vulgaris), a common food of the Mediterranean region, produced a severe hemolytic anemia (favism) in some people. Interestingly the same mutant gene that makes people sensitive to favism also increases their resistance to the malarial parasite, possibly accounting for the widespread presence of the mutant gene in regions with endemic malaria.

See also **Greece, Ancient**; **Vegetarianism**.

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Mikal E. Saltveit

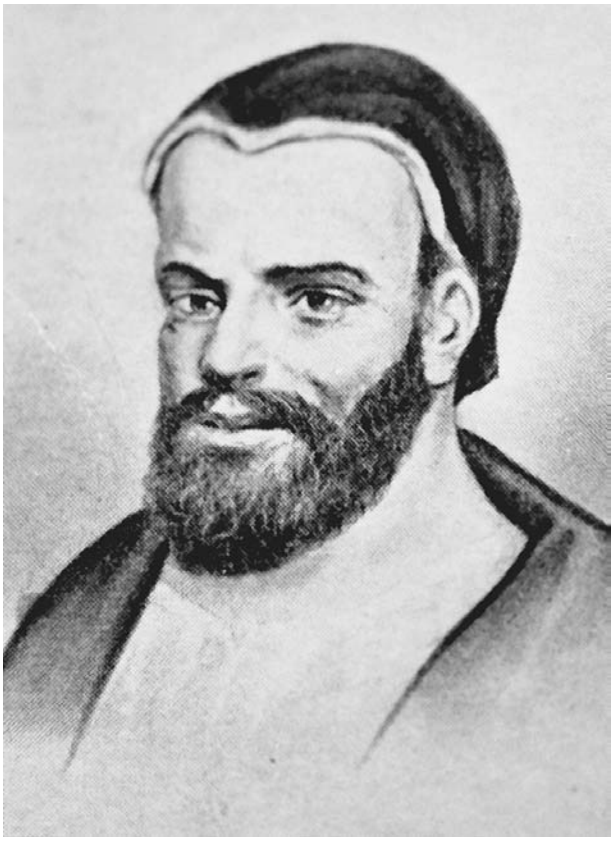
R

RABELAIS, FRANÇOIS. Little is known with complete accuracy about the life of Rabelais (1483 or 1494?–1553). Born in or near Chinon, France, where his father was a lawyer, he entered the priesthood as a novice of the Franciscan order. Here he was able to study languages, literature, and the sciences. Abandoning holy orders, Rabelais traveled to Montpellier, where he obtained a degree in medicine and became a physician at Lyons Hospital and a professor of medicine. It is here that he began writing the series of satirical books for which he is best remembered today. The four books (the fifth is of doubtful authenticity) tell the bawdy, rollicking tales of the giants *Gargantua* and *Pantagruel*. Often difficult to read, and frequently misunderstood as works of gross indecency, the stories are strewn with references to eating, food, and drink that help paint a vivid picture of Renaissance life. But it is in the use of food as part of satirical allegory that Rabelais is at his most inspired. Food imagery helps create a cloak of laughter to thinly conceal his pointed comments on important contemporary issues of the day.

One example of the vivid food imagery founds in Rabelais' works occurs in the fourth book of *Gargantua and Pantagruel* when, in the course of an epic voyage, his heroic characters, Pantagruel and the ship's company, go ashore on the Wild Island, ancient abode of the Chitterlings. Here they encounter sausage-people who are locked in an irreconcilable war with their enemy Quaresmeprenant (Shrovetide). Learning that Chitterlings are preparing to ambush the heroes, Friar John orders the construction of a giant sow, similar in principle to the Greeks' Trojan horse, and mans it with a company of noble and valiant cooks ready to do battle in a "culinary war." In the midst of battle, the cooks spill forth and rout the Chitterlings, handing victory to Pantagruel.

> "Chitterlings are Chitterlings, always duplicitous and treacherous."
>
> *Book 4, Chapter 36*

Exemplifying the difficulty people have with the interpretation, this episode has been viewed as either a representation of the battle between Carnival and Lent; as a satire on Church and State, specifically on the German-



François Rabelais, a medical doctor and master of languages, was one of the most learned men of his time. In his exaggerated and irrepressible *Gargantua and Pantagruel*, he attacked the monks' ideal of self-denial with detailed depictions of eating—thousands of cattle must be slaughtered to satisfy the giants' appetites—and of bodily functions. Although he is assumed to have been a great lover of food and drink, as Balzac observed, Rabelais "was a sober man who drank nothing but water." PORTRAIT COURTESY OF THE LIBRARY OF CONGRESS.

speaking Protestants and the Council of Trent; and as a moral message supporting moderation.

Rabelais remains often misunderstood. But his books continue to inspire as literary masterpieces of satire, full of wit and wisdom, and displaying both a genuine humanist love of life and a quest for truth.

See also **Art, Food in: Literature**; **Christianity: Western Christianity**; **France**; **Metaphor, Food as**.

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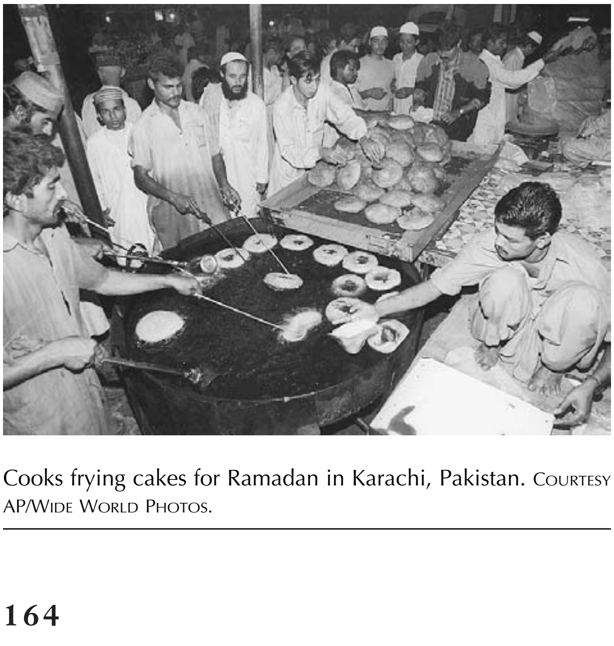
Colin Sheringham

RAMADAN. Ramadan, the major fast of the Islamic year, falls in the ninth lunar month. Traditionally, Ramadan commences and ends with the sighting of the new moon, though now a standard calendar is more commonly used.

The month-long fast involves abstinence from food, liquids, smoking, and sexual intercourse between the hours of sunrise and sunset, but at night the holiday has turned into a feast in many Arab countries, each of which has its favorite special Ramadan foods and recipes. Moreover, fasting must be undertaken with spiritual intent (*niyyah*), and this intent must be renewed each day before dawn. Mean-spirited words, and thoughts and deeds such as slander, lying, and covetousness negate the value of fasting. The fast commences each day at dawn, immediately prior to which an early morning meal, *suhoor*, should be eaten. It usually includes a special bread called *mushtah* and a sweet cream-filled pastry called *kilaj*, which are served only during Ramadan. During the day no food or drink may be taken, which can be a severe test when Ramadan falls during the hot summer season. The day's fast is broken with a small meal, *iftar*, taken as soon as possible after sunset. Traditionally, this is dates and water in remembrance of Muhammed, who always broke his fast by first eating dates, followed by lentil soup and salad. A larger, often quite elaborate meal may be eaten later at a mosque or shared with visiting friends and family. There are no particular rules governing what should be served for the main course. Sweets are very popular during Ramadan.



Cooks frying cakes for Ramadan in Karachi, Pakistan. COURTESY AP/WIDE WORLD PHOTOS.

Although the fast is obligatory for all sane adult Muslims in good health, a number of exemptions are allowed. These are seen as proof of Allah's wish not to place too onerous a burden on His people.

1. Children are not required to fast until they reach the Age of Responsibility (twelve years for girls; fifteen years for boys). Children from the ages of six to eight may fast for half the day, gradually increasing the duration until old enough to fully observe the fast.
2. The elderly and the chronically ill whose health may be compromised by fasting may substitute the feeding of one poor person for each day of fasting missed.
3. Pregnant and nursing women, women in post-childbirth confinement, and menstruating women may postpone the fast and make up the days later.
4. Those who are sick, traveling, or engaged in hard labor may make up missed fast days later.

Unintentional breaking of the fast is not punished, and Muslims are enjoined to break their fast if there is a threat to health. Other types of infractions require restitution. This is of two kinds: *Qada*, which involves making up missed days, and *Kaffarah*, which additionally exacts a penalty from the transgressor.

Fasting in a religious context is often undertaken for reasons of self-denial, penance, or mourning. In contrast, the Ramadan fast is a festive occasion of gratitude and thanksgiving to God. It has also acquired moral, social, and physical virtues. Observance of the fast is commonly seen as a way of receiving pardon for past sins; it creates empathy with the plight of the hungry, and it teaches self-control and endurance of deprivation.

Following Ramadan there is a three-day festival of prayer and feasting known as ʿAl Id-Fitr. Special sweet dishes are prepared, giving the festival its other name of Sweet Id. Muslims give thanks to Allah for enabling them to perform their duty of fasting, and there is much visiting and exchange of gifts, including food, with family and friends. Charitable giving is also encouraged.

See also **Africa: North Africa**; **Fasting and Abstinence: Islam**; **Islam**; **Middle East**.

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Paul Fieldhouse

HORSE FLESH SOLD HERE
PASSED AS FIT FOR HUMAN CONSUMPTION

Food rationing often occurs during times of national crisis, as in England during World War II. These English housewives are queuing up at a meat shop that sells horse meat which is, according to the sign near the door, "Passed as Fit for Human Consumption." © AP/Wide World Photos.

RATIONING. Food rationing is a program by which governments or private organizations oversee the allotment of food to citizens, usually during times of war or scarcity. By ensuring that all people get enough to eat or at least have a chance to purchase highly desired foods, mandatory rationing of food helps maintain citizens' physical health and psychic well-being. In doing so, it helps secure public allegiance and compliance, factors critical to institutional welfare during wartime or in the midst of a food crisis. In addition to ensuring an equitable distribution of scarce resources, rationing accompanied by price controls is designed to combat fierce inflation that often occurs with heightened demand and inadequate supply. Items distributed through such systems are often referred to as rations. Goods bought and sold illicitly outside of rationing and price control programs are said to be on the black market. Rationing is arguably a more democratic system of distributing food and other scarce resources. Theoretically, its most distinct function may be that of leveling economic and class inequality. Those on the lower end of the economic spectrum, for example, and those without the luxury of time to wait in long lines or to scout out caches of available goods, are allowed an equal chance to purchase high-status foods.

Rationing has also been used for more complicated or nefarious reasons. At one point, food allowances given to indigenous peoples in Australia and the United States, among other places, functioned as a form of social control. For Australian Aborigines, food rations were used as a tool to draw people to certain areas; their removal was intended as a form of punishment. Adolf Hitler, convinced that the German public had turned against the Weimar Republic because of food shortages, employed rationing in the 1930s to avoid domestic food emergencies. Occasionally, rationing has been implemented to ensure the unequal distribution of food, as when World War II concentration camp inmates voluntarily rationed food according to age and physical state (in the hope that this would allow the most able-bodied to survive). In early-twentieth-century China, rationing was controlled by elite "team leaders" who were allowed to distribute food and other goods according to personal discretion, which in turn afforded them power and control over local peasants. Most often, however, rationing has been employed to allow a relatively equal dispersal of food among citizens (with some reduction in allotment to infants and young children, and occasionally the very elderly). In Great Britain, World War II rationing is credited with improving the health of many by allowing the economically disadvantaged access to a stable, nutritious food supply. Currently, food rationing is most frequently implemented in countries that are the targets of international sanctions, including Cuba and Iraq.

Food rationing has been practiced in virtually every society of record, from antiquity to the present, in countries all over the globe, including Argentina, Australia, Bangladesh, Canada, Chile, China, Cuba, France, Germany, Great Britain, India, Iran, Iraq, Israel, Japan, Mexico, the Netherlands, Pakistan, Russia, and the United States. Rationing was practically universal during World War II, and continued for several years afterward in many parts of the world, including industrialized countries, which traditionally have had a more stable food supply than developing countries, whose governments have tended to implement food rationing more frequently out of necessity.

Foods deemed critical to ration can be either staples or luxuries. Staple foods—those vital to basic survival and the central elements in a cuisine—often vary according to culture, region, and tradition, and may include rice, flour, bread, milk, meat, cooking oil, canned goods, and salt. Highly desirable, psychologically important items such as cheese, butter, sugar, coffee, tea, and tobacco are arguably as important as staples to ensuring public contentment and cooperation, and thus are regarded as essential to ration. Such nonfood items as shoes, clothing, gasoline, heating oil, and tires are typically rationed in times of scarcity as well.

Food rationing tends to be implemented through two methods, the coupon system or the point system. During World War II, for example, sugar and coffee were rationed in the United States according to the coupon method, under which consumers would relinquish a coupon to purchase an allotted amount every few weeks. For rationing meat, butter, and canned goods, the government introduced the more complicated point system. Each month the federal Office of Price Administration (OPA) issued each person five blue and six red stamps worth ten points each, a total of fifty blue points for processed foods and sixty red points for meat, fats, and some dairy products. Each item—canned pineapple or pork chops, for instance—was assigned a point value determined by both availability and consumer demand. The point values were periodically reevaluated; for instance, the OPA lowered the point value of canned peaches to encourage increased consumption following a 1943 bumper crop of the fruit. The point system maintained government control over rationing but at the same time allowed the consumer a reasonable amount of control over the family's diet. With such a system, a consumer could choose to spend some of the family's points on more highly desired and scarcer items with high point values, such as beefsteak, knowing that fewer points would be left that month to buy other meats and fats. The system had its flaws, but consumers in general consistently supported it, and some even campaigned to continue rationing through the postwar years in order to allow more food to be distributed to war-ravaged and famine-stricken countries overseas.

The success of rationing in any country is highly dependent on efficient and effective administration and on unyielding honesty of and cooperation among government officials, farmers and food processors, wholesalers, grocers, and consumers. Rationing can break down at any level and through a variety of means: theft of ration books and favoritism in their distribution; lowering or misrepresenting the quality of products produced (shrinking the size of bread loaves; adding inferior grain); selling goods for higher prices or without collecting ration points; hoarding food; or bribery. While rationing has been deemed ineffective in many places, as in the Soviet Union during its early period, it is remarkable that, given its potential to break down at any point, the system has succeeded so much of the time. For the city of Lyons, France, in the Great Winter of 1709, food rationing along with other forms of public relief successfully averted widespread famine. Israel in its early years of statehood relied heavily on rationing to equitably apportion meager supplies of food.

Politics of Rationing

Because voluntary compliance is crucial to the success of rationing, concerted propaganda campaigns, even in openly democratic countries, are designed to urge people to feel personally invested in complying with rationing. Food is politicized, whether consumed in public or in private spaces. With wartime rationing, the grocery store, the kitchen, and the family meal—where food is purchased, prepared, and consumed—become public spheres as rhetorically important as the battlefield. Farmers with pitchforks and gardeners with trowels are likened to soldiers bearing rifles. Women, as traditional food procurers and preparers, become akin to soldiers at the battlefront. Wasting or hoarding food is characterized as aiding the enemy. Sacrificing food in order to send more to the military, or growing one's own food so that commercially prepared food is more available to distribute to citizens under enemy rule, is seen as performing one's patriotic duty.

Food rationing can become a positive site for communal expression of democratic obligation. Preventing waste, avoiding black markets, producing food, and abiding by rationing, however trivial they may have seemed, allowed American citizens during World War II to contribute to, and feel a part of, the war effort daily and communally. By sacrificing some of their abundant food supply to send more to the military and to those in desperate need, people could exhibit their patriotism and support of the war. Rationing not only ensured a sufficient, if at times unexciting, diet but also helped instill a sense of public commitment to the war, community involvement, and patriotism. These same sentiments have prevailed in other countries and times as well.

Despite its potential for positive meanings and uses, the implementation and eventual dismantling of rationing can be highly political. Food producers and processors may exert extreme pressure to lift rationing, arguing that consumer demand for goods should be unfettered. Those opposed to centralized food distribution see rationing as placing too much power in hands of government. Government officials benefiting from the program in any number of ways may be reluctant to disassemble the system. While some consumers have regarded food rationing as too restrictive and anticapitalistic, most, in times of crisis, have considered it as the (albeit imperfect) guarantor of their entitlement to a stable food supply.

See also **Food as a Weapon of War; Food Pantries; Food Riots; Food Security; Food Supply, Food Shortages; Government Agencies, U.S.; International Agencies; Military Rations; Political Economy.**

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Amy Bentley

RECIPE. A recipe is a set of instructions or advice for preparing food. The English word comes from the Latin imperative *recipe* for "take," because recipes typically used to start, "Take one pound of flour. . . ."

The modern recipe often follows this format: (1) a title or a brief announcement of what is to be achieved; (2) a list of necessary food ingredients and sometimes special equipment; (3) the method, which spells out the steps to achieve the finished dish or component; and (4) serving instructions. A recipe can also include explanatory notes, which might give advice about ingredients, including possible substitutions; tips on method; snippets of historical and cultural background; and an acknowledgment of the source of the recipe. Particularly in collections, a recipe might come with comparative data, such as difficulty rating, total time necessary, and likely cost of ingredients.

An effective recipe requires maximum accuracy, minimum ambiguity, and an appropriate level of detail for its audience. Omitting one step or ingredient can be catastrophic, and imprecision can leave the cook frustrated. Barbara Gibbs Ostmann and Jane L. Baker help authors, particularly Americans, in *The Recipe Writer's Handbook* (2001).

The form of a recipe has been broadly consistent for thousands of years, although older recipes usually provide less detail because cooks had command of the techniques, which tended to be less demanding. The ancient Greek cookery writer Philoxenus of Leucas wrote, "For [seafoods] the casserole is not bad, though I think the frying-pan better." Elsewhere he advised, "The wriggling polyp, if it be rather large, is much better boiled than baked, if you beat it until it is tender" (Athenaeus, vol. 1, 1927, pp. 21, 23). If these are typical, they help explain why the vast gastronomic compilation *The Deipnosophists* (Philosophers of dinner) made by Athenaeus about 1,800 years ago includes so few recognizable recipes. Philoxenus's advice presumably helped with novel foods in the flourishing Greek marketplace.

Another common purpose for a recipe is as an aide-mémoire (memory prompt) for occasional or complicated procedures, and a cook's shorthand can be difficult for others to decipher. A recipe can be prescriptive, particularly in religious and medical uses. It can provide an ethnographic record, and gourmets have brought notes back from their travels since ancient times. A recipe can play an important part in culinary reproduction, as when a delighted guest takes home a copy. It might be a teaching device, as in the great compilations of household management. It might promote a chef, restaurant, cooking school, or commercial product, such as a proprietary ingredient or a generic food like beef. A recipe can even become literature in its own right and be read for pleasure.

While a recipe is a powerful aid, it never replaces actual experience. Without some knowledge, the maker of a beurre blanc sauce could never be confident of having succeeded. No two cooks ever produce identical results from the same recipe. Julia Child and her colleagues Simone Beck and Louisette Bertholle required lengthy detail to introduce solid technique to many Americans with *Mastering the Art of French Cooking* in 1961. While recipes seem to promise the whole world of cooking, there is pressure to rely on a standard repertoire of techniques. Successful recipe writers are advised to restrict themselves to readily available ingredients. Recipe-based cooking favors smart-seeming compositions over untouched foods, however excellent.

An Ancient Invention

Written recipes are presumably as old as literacy, which emerged to control food supplies in the earliest civilizations. Recorded instructions had the advantages of wide and accurate transmission and archival retrieval. The power of naming, discussing, and borrowing was reserved to the tiny literate elite for thousands of years, contributing to the separation of high cooking, investigated by the social anthropologist Jack Goody in *Cooking, Cuisine, and Class* (1982). In general, traditional societies did without recipes in the sense of formal accounts, usually written, of food preparation. A girl watched and helped her mother with familiar routines, and an apprentice was shown trade secrets.

The oldest surviving recipes are probably those impressed into three clay tablets 3,700 years ago somewhere in what is now Iraq. Held in the Yale University cuneiform collection and previously mistaken for pharmaceutical formulas, the recipes would have been recorded by Babylonian scribes on behalf of the male cooks of a temple or palace. Their translator, Jean Bottéro, said the best-preserved tablet fits twenty-five recipes into just seventy-five lines. The recipes list the chief ingredients, the basic steps, and the name, which is derived from the chief ingredient or appearance when served. The only other readable tablet devotes 250 lines to seven recipes for various kinds of birds, both domestic and game. The recipes indicate many steps, numerous utensils, and complex combinations.

Some of the earliest Chinese recipes, at least 2,500 years old, are contained in the sprawling text *Li Chi*, which originated in the Chou dynasty. Reprinted by K. C. Chang in a chapter in *Food in Chinese Culture* (1977), they instruct: “For the (Soup) Balls, they took equal quantities of beef, mutton and pork, and cut them small. Then they took grains of rice, which they mixed with the finely cut meat, two parts of rice to one of meat, and formed cakes or balls, which they fried” (Chang, 1977, pp. 51–52).

Europe’s oldest recipe collections were written at the end of the fifth century B.C.E. by Greeks in southern Italy, and the first of these was probably *The Art of Cookery* by Mithaikos of Syracuse. Athenaeus has handed down only one recognizable recipe, which says, “Clean the insides of a ribbon-fish after cutting off the head, wash and cut into slices, and pour cheese and oil over them” (Athenaeus, vol. 3, 1929, p. 465).

The oldest surviving collection in the West is the *De re coquinaria* (Art of cooking), which was attributed to a Roman gourmet called Apicius and was compiled around the year 400 C.E. More of than half of the nearly five hundred entries are devoted to the preparation of sauces. Recipes flourished during other periods of gastronomic ferment, such as the Arab culinary excitement after the advent of the Abbasid dynasty in the eighth century and Chinese cookery with the Sung period from the tenth century.

In medieval English manuscripts, numerous sentences begin “Tak wyte wyn” (Take white wine) and “Tak partrichys rostyd” (Take roasted partridges). Others instruct “Nym water” and “Nym swete mylk,” using the archaic “nim” (or “nym”), which means “take.” Yet others start “Recipe brede gratyd, & eggis” (Take grated bread and eggs), borrowing the Latin verb *recipere* (to take). Medieval recipes generally did not include measurements and times, providing a challenge for modern interpreters, who often are divided over how spicy the original dishes tasted.

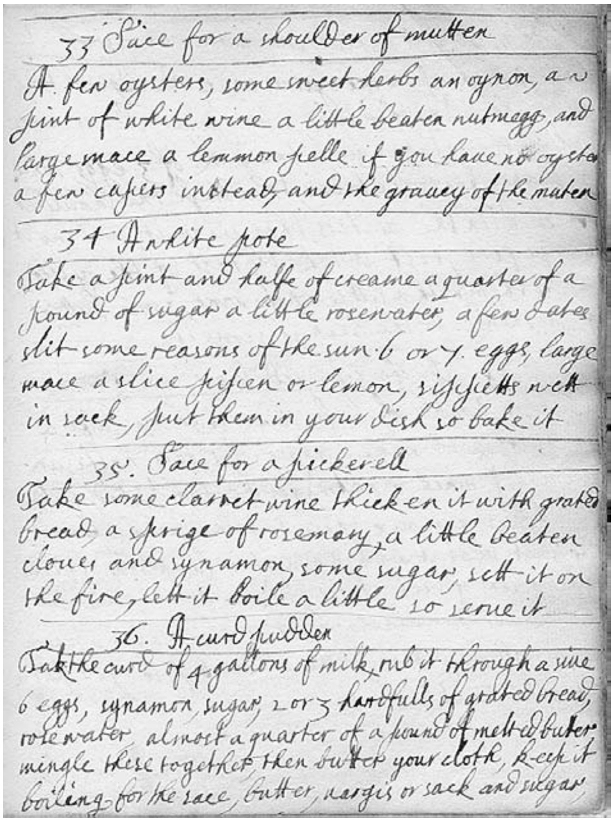
The proliferation of recipes in Europe was boosted by the advent of the printing press (using the principle

HOW TO READ AN OLD (HANDWRITTEN) RECIPE

Old manuscript recipes are frequently difficult to interpret because they were often written as personal memory aids for the cooks, and for their eyes only. Added to this is the difficulty of archaic language and the fact that writers spelled words as they pronounced them, as in the case of the following recipes from the cookbook of Francis Boothby, dated 1660. (Francis was either the wife or daughter of Sir Thomas Boothby of Essex, England.) Her recipes can be adjusted to modern English in the following manner.

> 33. Sace [Sauce] for a Shoulder of Mutton
>
> A few oysters, some sweet herbs, an onion, a pint of white wine, a little beaten [ground] nutmeg, and large [whole] mace. A lemon peel [grated zest]. If you have no oysters, a few capers instead, and the gravy of the mutton.
>
> [The oysters were pickled in brine, which is why capers can be substituted.]
>
> 34. A White Pote [A White Pot: Baked Custard]
>
> Take a pint and a half of cream, a quarter of a pound of sugar, a little rosewater, a few dates slit, some reasons [raisins] of the sun, 6 or 7 eggs, large mace [whole mace], a slice of pippin [tart cooking apple] or lemon, sippets wett in sack [slices of toast softened in white wine]. Put them in your dish. So bake it.
>
> 35. Sace [Sauce] for a Pickerell [pickerel is a fish]
>
> Take some claret wine [any red Bordeaux wine], thicken it with grated bread. [Add] a sprig of rosemary, a little beaten [ground] cloves, and synamon [cinnamon], some sugar, [then] set it on the fire, let it boil a little [boil up until it thickens]. So serve it.

William Woys Weaver



33 Sace for a shoulder of mutten
A few oysters, some sweet herbs an oynon, a
pint of white wine a little beaten nutmegg, and
large mace a lemmon pelle if you have no oyste
a few capers instead, and the gravey of the mutten
34 A white pote
Take a pint and halfe of creame a quarter of a
pound of sugar a little rosewater, a few dates
slit some reasons of the sun 6 or 7. eggs, large
mace a slice pipen or lemon, sippetts wett
in sack, put them in your dish so bake it
35. Sace for a pickerell
Take some clarret wine thicken it with grated
bread a sprige of rosemary, a little beaten
cloves and synamon, some sugar, sett it on
the fire, lett it boile a little so serve it
36. A curd pudden
Tak the curd of 4 gallons of milk, rub it through a sive
6 eggs, synamon, sugar, 2 or 3 handfulls of grated bread,
rosewater, almost a quarter of a pound of melted butter
mingle these together then butter your cloth, keep it
boiling for the sace, butter, nargis or sack and sugar

A page from the manuscript cookery book of Frances Boothby, dated 1660. Frances Boothby was either the wife or the daughter of Sir Thomas Boothby of County Essex, England. ROUGHWOOD COLLECTION.

of grape and oil presses) around 1440. The relatively ready availability of recipes facilitated social emulation and gastronomic discussion and broke the nexus of master-apprentice. Early modern cooks may have been reticent to publish arcane information, but the dearth of French publication ended in the 1650s. As Barbara Ketcham Wheaton suggests in *Savoring the Past* (1983), "Perhaps the balance shifted, and secrecy became less valuable than fame" (Wheaton, 1983, p. 113).

How to Write a Recipe

The elements of effective recipe writing vary according to the recipe's intended purpose and audience. For example, a personal reminder by a working cook will be very different from a travel writer's evocation of the flavor of an exotic dish. Yet some requirements are relatively constant, including the need for accuracy, completeness, and lack of ambiguity. Like a rotten apple, just one missing ingredient, mistaken measurement, or misleading instruction can spoil the whole recipe, and one faulty recipe can spoil a whole collection. Seeking to maintain a reputation for reliability, many publishers provide authors and editors with recipe style guides, and expect recipes to be tested in test kitchens.

Food businesses and industry associations that use recipes for marketing purposes also go to great lengths to ensure that the writing is effective. Such marketers want newspaper cookery writers and others to relay the recipes, which they will do more readily if they have confidence in the source.

The (U.S.) National Cattlemen's Beef Association keeps its recipe style guide up-to-date, and revised it in accordance with the the results of research (Gatten & Company, Chicago, 1992) regarding consumer preferences in recipe formats. This study found that consumers primarily desired "ease of preparation." Recipes should not merely "eliminate guesswork," but also appear easy, something accomplished by a simple format and style.

Based on this research, the recipe style guide of the Beef Association's test kitchens includes these recommendations:

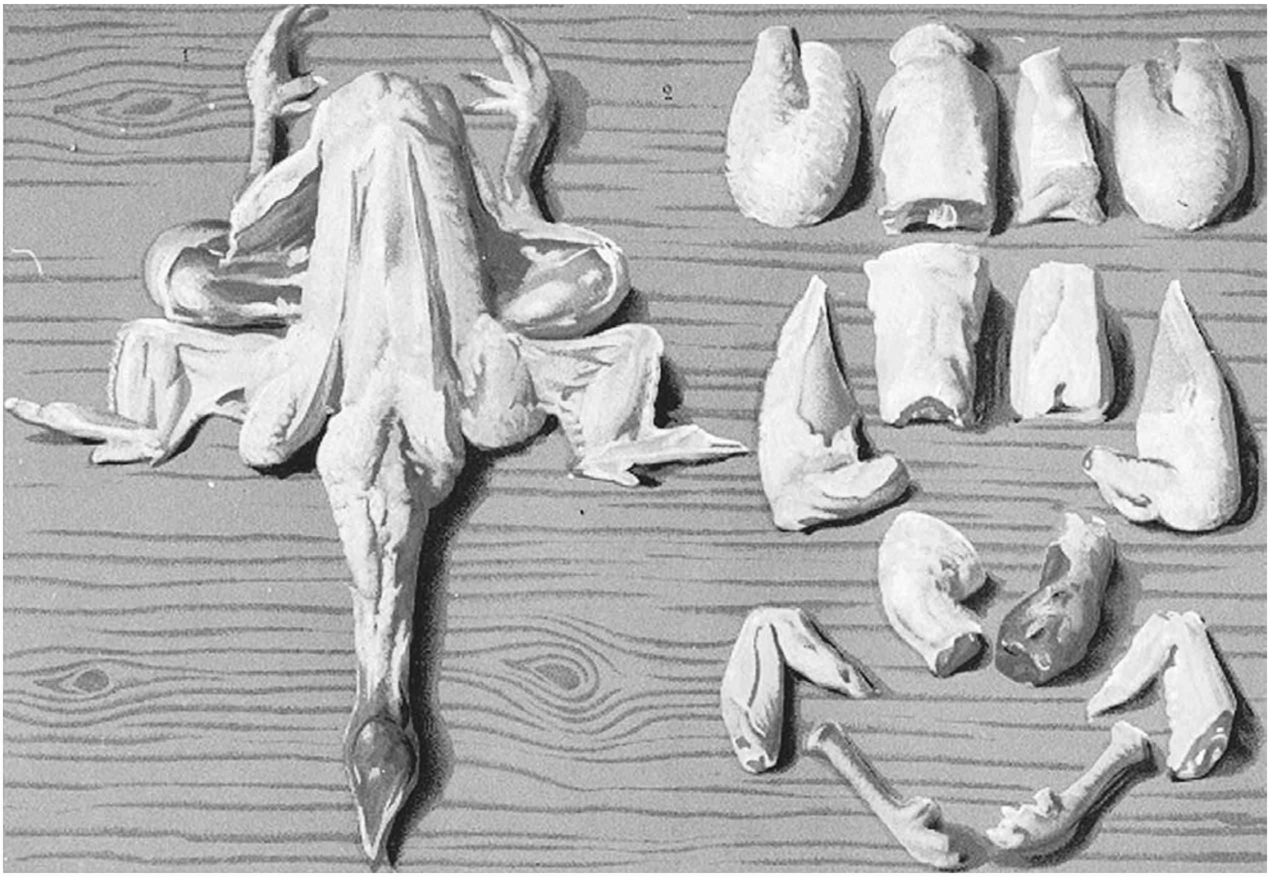
- Use a straightforward descriptive name for the finished dish, rather than a name that is fun or creative.
- Indicate preparation and cooking times at the beginning.
- List ingredients separately at the top of the recipe.
- List the main ingredient (such as meat) first.
- Group other ingredients according to the part of the recipe for which they are needed.
- Choose readily available ingredients or substitutions.
- Try to give more than one measure for each ingredient, for example, "4 cups cooked shell macaroni (8 ounces, uncooked)."
- Avoid abbreviated measures, for example, "teaspoon" rather than "tsp."
- Specify the equipment and utensils when possible.
- List the preparation steps with numbers or bullet-points, since this makes the recipe look simpler.
- Do not "divide" an ingredient (for example, "mix half the flour"); provide a precise measurement for each use.
- Do not write "one teaspoon each of sugar, cinnamon, and nutmeg"; repeat the measurements for each ingredient.
- Provide preheating directions.
- Make the recipe easier to read by using large print.
- Provide a photograph of the finished dish.

Michael Symons

Several modern features were established around the middle of the nineteenth century. Until then the more usual English word was "receipt," from the feminine past particle of the same Latin verb, *recipere*. "Recipe" had predominantly been used for medical prescriptions (leading to the abbreviation R or Rx), with which culinary prescriptions had overlapped. It has been suggested that "recipe" eventually won out because it appeared more learnedly Latin.

In the early 1800s the title was often still of the descriptive form, announcing what would be achieved; for example, Priscilla Hazehurst explains in the *Family Friend* (c. 1810), how "To make a Bride Cake" (p. 76), "To preserve Damsons another way" (p. 107), "To disguise a Leg of Veal" (p. 147), "To boil Artichokes" (p. 161). The concern was to treat individual foods properly rather than to transform them into a higher order of creation, that is, into named "dishes" (or "made dishes," as they were called).

The most important change early in the nineteenth century was toward numerical rigidity. Instructions such as "do it till it is done" can be unsettling. However, traditional cooks knew when "it is done" better than they knew "twenty-five minutes." Abstract time measurement and punctuality only became ingrained in industrial, urban society. The preoccupation with precise recipes belongs to "rationalization," the shift from hands-on,



This plate from Jules Gouffé's *Royal Cookery Book* (London, 1868) shows the proper method for cutting up a chicken into serving-size pieces. This is an example of how a written recipe could never convey in words the carving process that is obvious at a glance from the picture. ROUGHWOOD COLLECTION.

traditional methods to calculation, measurement, and control.

In 1817 the English author William Kitchiner claimed that his book *Apicius Redivivus; or*, *The Cook's Oracle* introduced scientific precision. Writing for the "rational Epicure" (Kitchiner, 1821, p. xi), he rejected obscure expressions like "a little bit of this—a handful of that." His recipes were the "results of experiments carefully made, and accurately and circumstantially related" (Kitchiner, 1821, pp. 30–31). The time requisite for dressing was stated and the quantities set down in number, weight, and measure. "This precision has never before been attempted in Cookery books," he boasted, not entirely accurately (Kitchiner, 1821, p. 31). Even then, an English cookery book did not require many measurements. The bulk of Kitchiner's recipes explained each of the main methods, which for him were boiling, baking, roasting, deep frying, and broiling. The few recipes for accompanying sauces specified quantities. The category of "Broths, gravies, and soups" also occasioned some precision. This left merely the final one-eighth of the book to cover expressly "Made Dishes, &c.," prescribing the likes of Haricot of Beef, Broiled Rump Steak with Onion Gravy, and Bread and Butter Pudding. As many cooks can confirm, recipe measurements have remained imprecise and inconsistent. American writers tend to use volume rather than weight, so measures of even sugar and flour are given in "cups." "Teaspoon" and "tablespoon" are hangovers from a less-finicky era. Many recipes contain vague statements such as "low heat."

With mass literacy and the mass production of cookery books from the mid-nineteenth century, enormous treatises extended to a thousand pages and by the early twentieth century exceeded two thousand pages. Meanwhile cooks exchanged innumerable recipes on scraps of paper and in exercise books.

Since the late nineteenth century, recipes have been a widespread marketing device, intruding into domestic culture on behalf of new products from gelatine to electric stoves. Incalculable numbers of recipes arrive on packaging; supermarket leaflets; in newspapers, magazines, and books; and on the Internet. Customers are invited to "send a self-addressed envelope for a free copy of our recipe booklet." With much at stake, food manufacturers and marketing bodies rely on highly experienced writers and "test kitchens" to generate promotional recipes that are readily understood and immediately successful. In turn, many cookery writers in newspapers and elsewhere rely on these recipes.

Recipes as History

Old recipes provide clues as to how others dined, but their relationship with actual practices is far from straightforward. The existence of a recipe might even be misleading, because the need for an aide-mémoire suggests rarity; common procedures did not need spelling out. Printed texts have often represented a sometimes idiosyncratic or idealized version of reality. For such reasons, culinary historians have shown an interest in personal recipe manuscripts. Relatively little concerted effort has yet gone into recording actual foodways before they are lost, however.

As recipes shifted in identification from seemingly ageless traditions to individual creativity, plagiarism became an issue. Eighteenth-century authors commonly protested their own originality against others' piracy. Reviewing his predecessors, Kitchiner declared that "cutting and pasting seem to have been much oftener employed than the Pen and Ink" (Kitchiner, 1821, p. 24). Eliza Acton was honest enough to boast in *Modern Cookery* in the mid-nineteenth century that she relayed "carefully tested recipes," and she appended the occasional notation "Author's Receipt" and "Author's Original Receipt" rather than see "strangers coolly taking the credit and the profits of my toil" (Acton, 1868, p. ix).

Contributors to the cookery history journal *Petits propos culinaires* have meticulously tracked down and exposed particular eighteenth-century plagiarists, such as Vincent La Chapelle, who stole from François Massialot's *Le [nouveau] C[c]uisinier roïal [roya]l et bourgeois* (1691); Hannah Glasse, who purloined extensively; and John Farley, who lifted from Glasse and Elizabeth Raffald. Yet meticulous sleuthing, such as Fiona Lucraft's in "The London Art of Plagiarism" on Farley "the fraudster," can be seen as a misplaced preoccupation with property rights in an unashamedly collective form, in which everyone borrows from everyone. A recipe might almost be the better for not being original, for having proved itself. In the converse of plagiarism, cookery authors acknowledge a source and then provide a "modernized, adapted" travesty.

Recipes remain essentially in the public domain. Belonging to no one, they are free and innocent. Or they would be, except for recipes as commercial promotions, which are quickly joining the scarcely traceable pool.

See also **Apicius**; **Cookbooks**; **Preparation of Food**.

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Michael Symons

RELIGION AND FOOD.

There are almost as many ways to define religion as there are religions, but scholars basically tend to think about it in two ways. Some concentrate on religion's functions in societies while others focus on grasping its mysterious, universal essence. This essay will examine how food factors into these ways of understanding religion. The connections between religion and food vary widely and are often quite complex. There are, however, several common connections between religion and food that scholars have begun to document in recent decades.

Function

In the functionalist view, religion provides meaning, identity, and structure within what Geertz has called "cultural systems." Religion reflects the human desire for order, but it provides order because people believe it has its origins in the divine. Food often figures prominently in functional interpretations of religion. Lévi-Strauss described food as a type of language that helps human beings express their basic perceptions of reality. He observed that rules about eating cooked and raw foods in some cultures are dictated by sacred stories (myths) and prohibitions (taboos). These rules reflect underlying notions about differences between nature and culture.

Mary Douglas has shown how food communicates ideas about holiness that provide identity and order. The ancient Hebrew dietary laws functioned as controls on identity in a context in which incursion by other tribes and their gods was a frightening possibility. To be holy, in this context, is to be wholly separate. Israelites were "clean" because they remained within the bounds of God's covenantal order, not mixing with outsiders, their gods, or their ways. This separation was reinforced by dietary restrictions such as the prohibition against eating pork. Pigs are "dirty" because their physical characteristics are abnormal according to the way in which the ancient Israelites understood types of animals (i.e., they have cleft hooves and do not ruminate, unlike the edible animals otherwise similar to them like cattle and sheep). A pure and separate people does not make an animal that is not clearly like other grazing animals part of itself by consuming it. Purity of food and body help to strengthen the boundaries of Israelite society and religion. The laws of kashruth have continued to be among the distinguishing marks of Jewish identity and lifestyle through the centuries.

Functionalist understandings are especially helpful for exploring the relationships between religion and food in particular contexts like ancient Israel. They also illumine the connections between religion, food, and other culturally constructed systems such as gender norms. Scholars have shown how Graeco-Roman table etiquette affected the development of women's roles in early Christianity and may help to explain the tension around women's leadership in early Christianity (Corley). Focusing on gender and food expands our understandings of the scope of religion. Feminist scholars have shown that women may be religious experts through their control of food in societies where previous scholarship has focused on the male exclusivity of sacred knowledge. Among the Thai Buddhists that Van Esterik studied, it is the women whose feeding of monks and deities primarily determines attainment of merit and thus shapes the eternal destiny of their people both dead and living. Bynum's study of medieval Christian mysticism shows that women exercised control and spiritual power through refusing to eat or eating only in a spiritual manner.

Religious food rules may also be codes for class distinctions. The Hindu caste system, for example, is communicated primarily in terms of who can cook for and who can eat with whom. Religious purity is attached to the maintenance of social boundaries. Brahmans, the highest caste, maintain their purity by avoiding foods touched by those of lower castes. Yet Brahman-prepared food is permitted to all. In ancient sacred myth, Brahman created the world by cooking it in sacrifice, thus performing a priestly act. A Brahman's privileged status in society still is still enforced by his role as priest. He stands between the gods and rest of the world. As the ancient texts declare, the world cooked by the Brahman is to fulfill its duties to him (Malamoud).

Essence

Here, religion primarily refers to the human encounter with an irreducible sacred such as a god. Scholars such as Mircea Eliade map this experience through universally recognizable types of orientation (sacred time and sacred space), narrative (myth), and activity (ritual). Religion in this view essentially concerns the otherworldly expressed and responded to through patterns, which often involve food.

Those patterns are still important for describing and understanding religion, even if their universality has been questioned. As Jonathan Z. Smith puts it, they serve the observer as "maps," but should not be confused with the vast diversity of "territories" known to believers. They are more like recipes written by a food professional based on traditional dishes that community cooks make from scratch by heart. Sacred time, sacred space, ritual, and myth as categories only give the general flavor of a religion.

Sacred space and time. Sacred space often focuses on food and table setting. The most holy point of some Christian churches is the altar where the sacred meal of Christ's body takes place. In others, a pulpit might replace the altar; however, it is from that point that Christians are fed God's word. In Hindu temples, devotees are often separated from images of the deities by a rail from which they offer food to the gods and receive it in turn. Sacred space is the place where the divine and human communicate, very often over a meal.

Domestic eating spaces can be sacralized as well. Hindu and Buddhist homes may have shrines that are miniature temples for deities who are fed daily. Chinese kitchens contain a shrine to the stove god. In Sicily and Sicilian communities in the United States, families construct elaborate altars of food to celebrate St. Joseph's Day. During *Sukkoth*, tent-like dwellings outside their homes remind Jews of their nomadic ancestors as they celebrate the harvest's bounty.

Sacred time is also often delineated by food. In many religions, time is marked by periods of eating and abstention. Fasting during Ramadan is one of the five pillars of Islam, and the cycle of eating and abstaining from food marks its days. These are holy times, where one's relationship to food expresses one's connection to holiness through a balance of disciplined avoidance of carnal pleasures and partaking in Allah's bounty. Both feasting and fasting, in different ways, are concerned with submission to Allah.

Ritual, myth, and symbol. Eating in sacred space and at sacred times is a primary mode of ritual activity. Ritual unites believers with the holy as they carry out patterned activities that parallel those of gods or ancestors. The Passover meal commemorates and reconnects Jews with the ancient Israelite ancestors through the bitter herbs, the sacrificed lamb, and the quickly made unleavened bread. "You shall observe this rite as an ordinance for you and for your sons forever," Exodus 12 admonishes the Israelites about this practice. "Do this in remembrance of me" is evoked each time Christians reenact Christ's last supper with his disciples. By commemorating Christ's last meal, repeating his words and gestures, Christians re-create the sacred time of Christ and his disciples and eat with him again as they eat in community as his body. Or, Christians believe that they actually eat Christ's sacrificed body in the form of the bread host and in so doing are incorporated into it "to live forever" with God. It is first of all feeding the deity, rather than feeding on the deity, that sanctifies Hindus who present foods to the gods for their consumption. The gods then return the leftovers as sacred *prasadam* for devotees to eat.

Sacred boundaries of time and space and ritual activities are narrated in sacred stories or myths. For the believer, mythic truth is truer than fact; it is the way the gods did it. In the Christian Eucharist, the priest begins with the words of sacred myth: ". . . the Lord Jesus the same night in which he was betrayed took bread: And when he had given thanks, he brake it, and said, Take, eat: this is my body, which is broken for you: this do in remembrance of me." (1 Corinthians 11) Following the mythic pattern correctly in ritual is of utmost importance since it is a recreation of cosmic order; however, religious communities often disagree about details of performance as well as interpretation. Rituals generally represent beginnings that come out of chaos or involve a change of state. Food, as something that changes state or that can create new identity in communal consumption, is often the centerpiece of ritual controversy. A familiar example is the debate over the real or symbolic presence of Christ in the Eucharist that became the most divisive theological issue of the Christian reformations of the sixteenth century.

The preparation and consumption of food are common in myth. As in the Hindu scriptures already discussed, creation and food are often related in myths of origins. In the Abrahamic religions (Judaism, Christianity, and Islam), the origin of sin takes place in a forbidden act of eating. And it is eating the sacrifice of the Passover lamb or "Christ, Lamb of God," that restores their relationship with God for Jews and Christians respectively. For Muslims, God rescues their progenitor Ishmael from thirst by a miraculous spring in the desert. Muslims fulfilling the hajj reenact Hagar and Ishmael's quest for water as part of the pilgrimage into sacred time and space.

Food plays a significant ritual role in all of the world's religions as well as in the religions of the past. This bronze Celtic bucket discovered near Aylesford, England, was used to hold the ashes of a cremated noble. Around it were placed various foods the deceased was to partake of in the afterworld. The bucket is in the collection of the British Museum, London. © Werner Forman/CORBIS.

When myths no longer function to order human activity, when they cease to speak of the holy, they are myths in the more common sense of the term. Myths are, however, quite resilient, especially ones involving food. An underground Christian sect in Japan that survived the suppression of Christianity in the seventeenth century accommodated its situation by celebrating sacred meals with fish and rice wine rather than unavailable bread and wine (Whelan). When the buffalo were erased from the North American landscape, the Oglala Sioux accommodated by treating the cattle forced on them by the United States government as if they were buffalo, hunting them ritualistically. This not only preserved their myths, ritual hunts, and feasts, but also quickly changed their dietary preferences. Whereas they had previously avoided beef as unsavory, it quickly became an accepted food staple (Powers and Powers).

Japanese Christians and the Oglala were able to adapt and survive through shifts of symbolism. Symbols are the building blocks of myth. Food symbols are among the most powerful because they connect the reality of life in a place to the holy in tangible and vital ways. Ghee, clarified butter from the sacred cow, feeds deities and humans in India. Survival in Japan depended on rice and rice was already sacred in indigenous religious traditions there. The Christian minority initially took bread and wine as identity markers that differentiated it from the dominant culture; but when survival was threatened, they christianized an older symbol, rice wine. While food seems to be a universal sacred symbol, meanings can vary broadly. The cow so sacred to Hindus that it must not be killed, is the "spotted buffalo" sacralized in its killing and consumption by the Oglala.

Symbols are also powerful because they communicate the holy through what they are. Wine and bread remind believers of Christ's blood and flesh by their physical properties. Christianity has debated whether the Eucharistic meal is a perpetual sacrifice, is like a sacrifice, or recalls a final sacrifice. Some early Christian vegetarians interpreted Christ's death as the end of all sacrifice, including the slaying of animals for human consumption. They marked their sacred meals with water, rather than the blood-like wine. Medieval theology, however, reinforced the sacrificial understanding of the Eucharist; a bleeding host was a common element in medieval devotional stories told to emphasize the sacrifice of Christ's flesh in every ritual meal performance.

Some scholars hold that sacrifice, which literally means "to make holy," is at the root of religion. Much mythic vocabulary associates death and food in the service of life. Many religious groups deal with the death-giving-life paradox by sanctioning killing as a gift to the gods, of which humans may share and become holy themselves. Others, like the Jain of India, deal with the reality of suffering by trying to avoid it. For them, eating from plants not killed in the process of harvest and totally avoiding meat are major forms of achieving a meritorious existence. Buddhist monks avoid getting mired down in the world of suffering by refusing to kill animals for food. They may, however, eat whatever is provided for them by householders as long as they remain detached from the desire for it.

Sacred rituals reintegrate believers with each other as well as the gods; this is often accomplished in commensality. Eating the same foods, often from common vessels, draws boundaries around community, making it holy and like family. Early Christians adapted the kin-based Jewish Passover to bond spiritual brothers and sisters. Food exchanges or ceremonial meals are common in marriage rituals. The ancient Jewish wedding was essentially a meal that brought together husband, wife, and their kin. Hindu marriages still involve elaborate exchanges of food. Extension of the community through eating is not always a hospitable occasion. Again, death is often involved in a shared sacrifice. For the ancient Aztecs, eating from the bodies of human victims was a way of incorporating their strength as well as feeding with the gods (Carrasco).

Rituals often extend outside the bounds of community through food. The Christian Eucharist concludes by sending believers who have been fed "into the world in peace" to help sanctify it. Making the world holy is often accomplished by the extension of community through charitable feeding. Devotees of Lord Krishna, for example, are famous for their temple feeding programs. By feeding the outsider, they serve Krishna by extending his presence through food that has been sanctified by him (Singer). Muslims are required to practice charity and often do so by giving food to non-Muslims. *Bakra Eid* commemorates the sacrifice of Ishmael and is a day on which Muslims worldwide bind community through sacrificing at the same time. But the community is extended in this event, in which sacrificed meat may be portioned out not only among family and the poor, but also to non-Muslim neighbors (Murphy).

Food, Religious Performance, and the Body

Religious peoples are more likely than scholars to appeal to essential experiences of holiness when they articulate religious foodways. That is, when they consciously articulate them at all. Helpful here is the work of Katherine Bell and Ronald Grimes, who emphasize the performative character of religious behavior. This is particularly important for understanding the relationships between religion and food. Most people harvest, kill, eat, cook, serve, hunger for, or otherwise encounter food and holiness primarily through physical action and sensation, rather than through belief and interpretation. The power of foods to evoke strong memories and feelings, essential to the efficacy of religious ritual, is related to the sensory experience of food. Food rituals recall not just abstract ideas, but smells or tastes that bring back another time or place. Passover offers Jews the opportunity to reconnect viscerally with their ancestors through tastes of what their lives were like on the Seder plate.

It is important to underline this embodied nature of the connection between religion and food. Because religious experience via food is a physical experience, it can vary widely even while following the same ritual practices. This does not make ritual less powerful; rather, it helps to bring it alive for devotees. Paradoxically, religious expression is all the more real, meaningful, and transcendent because it is new each time even if it is as old as the world. Each time a religious act involving food is performed, it is experienced by the body in the moment of receiving, smelling, and tasting, and this strengthens feelings and beliefs about the presence of holiness in the activity.

Because of the ambiguities in some traditions associated with the body, food and eating can be powerfully complex signs of both the profane and the sacred. The "perfect ones" in dualistic groups like the ancient

Manichees and medieval Cathars starved themselves to death in rejection of the body and all things earthly. Fear of the female body particularly has driven the ascetic impulse in several religious cultures to sanctify the renunciation of food. Some early Christian writers associated female fasting with rejecting the sexual body, holding that the fasting body made virgins "more attractive" to Christ, their bridegroom (Shaw, 250–252). Lelwica and Griffith have noted parallels between traditional female holiness and dieting among contemporary American women.

Food, Meaning, and the Secular World

While it is a common observation that religious tradition and belief have shaped diet and foodways in the past, modern observers tend to focus on the waning of religious influences on eating. Reformed Judaism, which does not require adherence to the dietary laws, is an example often cited. The persistence of irrational dietary traditions, as among the strictly kosher Hasidim, is viewed as a rejection of modernity.

Even people with a disenchanted, scientific worldview may unconsciously act according to sacred meanings. Ordinary profane experiences of eating may be meaningful bases for memory, reflection, and orientation and can be recognized as such to the extent that they are patterned on hidden sacred structures. Indeed, what constitutes a meal is often based on unconscious associations with primordial meals. Meals can return even the most secular person to another time and place. The language often used to describe such experiences is the religious vocabulary of symbol, myth, and ritual. American Thanksgiving, a secular holiday that celebrates consumerism as much as anything else, still centers on a meal modeled on sacral elements: sacrificial fowl and harvest fruits. What remains of its semireligious origins is perhaps a quick prayer and traditional dishes (some of rather recent origin). As anyone who has tried to vary a Thanksgiving menu knows from familial reaction, the sacred survives in turkey, stuffing, and mashed potatoes.

Furthermore, postmodernity has seen many conscious attempts at re-enchantment through foodways by those exhibiting what Eliade called "nostalgia for origins." Elizabeth Ehrlich's recent memoir of her progression from being a secular Jew to keeping the kosher kitchen of her foremothers is a good example.

Summary

Examining connections between food and religion helps to illumine how religion functions in cultures, and why religious experiences are powerful for believers. It can also underline the fact that food feeds many hungers. Scholars have only just begun to examine the myriad ways in which this is true for religious peoples. It is safe to say that most scholars of religion would agree that religions provide humans with meaning-making structures that often involve food. These structures reveal the essence of the sacred through eating, sacrificing, preparing, or serving food to believers. They may serve as paradigms for all ordinary foodways as well. This domestication of sacred foodways in turn helps to perpetuate the process of meaning-making that is the function of religious practice and belief. Believers may or may not reflect on the importance of food for their religious identity. Knowledge of food's centrality for meaning-making is not limited for believers to theological abstraction. To use Ronald Grimes's phrase, it is more often felt "deeply into the bone" through the rites of preparation and consumption that help to order life every day as well as to mark special occasions. Brillat-Savarin's "Tell me what you eat and I'll tell you who you are" translates in the words of one woman recently interviewed after cooking a family meal, "Food is Judaism for me. I don't think about it. It's who I am."

See also **Buddhism**; **Christianity**; **Fasting and Abstinence**; **Feasts, Festivals and Fasts**; **Gender and Food**; **Hinduism**; **Islam**; **Judaism**; **Last Supper**; **Sin and Food**; **Women and Food**.

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Corrie E. Norman

RENAISSANCE BANQUETS. The banquet, as a particular form of festivity, flourished in Renaissance Europe from the mid-fourteenth century to the early seventeenth century. It began as a specifically secular celebration; in medieval times the "feast" (French *fête*, Italian *festa*) referred primarily to religious celebrations, special days in the church calendar—Easter, Christmas, saints' days—although it also denoted a sumptuous meal. As a lavish, ceremonial meal in honor of an individual or exceptional occasion, such as a wedding, the new banquet observed no such periodicity, and in its conspicuous consumption tended toward a blatant demonstration of wealth and power. It was distinguished not only by its extravagance and ostentatious scale but also by its theatricality and use of symbolism.

In the sixteenth century a banquet could also refer to the less ostentatious—though no less lavish, in relative terms—annual ceremonial dinners of *confréries* or guilds, groups of men linked through their craft or their parish. Usually held on a relevant saint's day, these were not only a ritual celebration but also a demonstration of goodwill.

Origins and Etymology

Elaborate, extravagant, ceremonial meals had been offered before the adoption of the word "banquet." Descriptions of the dinners in honor of Pope Clement VI in the mid-fourteenth century, which included a centerpiece of a fountain spurting forth five different types of wine, show that lavish entertainment was nothing new. Nevertheless, the "banquet" must have differed in some way if a new word had to be brought into the language.

Initially, it appears, the banquet was a lavish meal presented in a different style, with various dishes set out on a long table, as would be a buffet today. Both the term and the event had their origins in fourteenth-century Italy. The Italian word *banchetto* derives from *banco*, 'a long bench or table'. "*Insieme disinano e cenano con banchetti molto abondevoli di varii cibi e bonissimi vini*," wrote the Italian Matteo Bandello in the early sixteenth century ("Together they dine and sup, the tables displaying a great abundance of diverse dishes and excellent wines").

The French term *banquet*, which entered common usage around the middle of the fifteenth century, and the Spanish *banquete* (documented early sixteenth century) were both borrowed from the Italian; in England the word "banketti," derived directly from the Italian, predated the French term *banquet*, adopted early in the sixteenth century. By this time the form of the banquet had evolved considerably, according to the accounts of Christoforo di Messisbugo, and included theatrical and musical performances.

In his capacity as steward at the court of the dukes of Este, Messisbugo orchestrated many banquets and in his book, *Banchetti: Compositioni di vivande et apparecchio generale* (1549), he describes, in unparalleled detail, the management and staging of these lavish, formal, ceremonial feasts, from the setting of the tables with several tablecloths and ornamental figures of sugar or marzipan to the accompanying music and the dances performed during the course of the meal.

In sixteenth-century England the banquet evolved in two different directions. As well as an opulent and stage-managed feast, it became an elaboration of what had previously been the final course of a grand dinner, the dessert, an array of sweetmeats often served in purpose-built banqueting houses in the parks of great houses, or in an outside arbor or summerhouse.

Banquet Food

One of the most striking features of banquet food was the presence of sugar, for both visual and symbolic effect, the lavish use of this expensive ingredient underlining the host's magnificence. The banquet menus appended to the printed edition of the *Viandier* of Taillevent (c. 1315–1395) in the last decade of the fifteenth century suggest an extravagant and incongruous application of sugar to roast quail, chicken and pigeon. (Originally compiled in the fourteenth century and attributed to the royal chef Taillevent, *Le Viandier* represents one of the few records of the cuisine of medieval northern France. The late-fifteenth-century printed edition contains additional material not included in the early manuscripts.) The chapter titled "Banqueting and made dishes with other conceits and secrets" in Gervase Markham's *The English Hus-wife* (1615) is composed of recipes for essentially sweet dishes such as fruit tarts, marmalades, preserves, marzipan, and jelly.

Sugar was used in dishes such as jellies, blancmange, and quince paste, and on dishes such as fritters and pies (Italian *torte*). It was an essential ingredient in the candied nuts and spices offered at the end of the meal, in jewel-like glazed fruits often hung on miniature trees of silver, and in decorative marzipan figures and in sculpted sugar table ornaments. For a banquet given by don Ercole, son of the duke of Ferrara, to a group of nobles including his father, Messisbugo ordered a sugar model of Hercules and the lion, colored and gilded, to decorate the table; with the final course of *confetti* came more sugar models representing Hercules defeating the bull, together with Venus, Cupid, Eve, and other mythical figures.

Because the banquet was itself an exceptional meal, banquet food had to be out of the ordinary (out-of-season asparagus, gilded and silvered calves' heads). This typically translated as the most prestigious, most expensive ingredients—meats such as veal and capons—prepared in the most elaborate, spicy ways so as to emphasize the art and skill of the cooks (which, in turn, reflected glory back on the reputation of the family). It also meant many services, each usually composed of several dishes, although it was not expected that everyone would eat something from every service—dishes were to be admired as much as consumed. The banquet offered by Gaston IV, count of Foix, in honor of the ambassadors of Hungary in 1458 was comprised of seven services punctuated by four entremets; some of Messisbugo's menus ran to ten services, each composed of six or more dishes.

La Condamnation de banquet

In the late fifteenth-century French morality play *La Condamnation de banquet, banquet* was an additional meal, differentiated from *dîner* and *souper* by the absence of servants; an array of food was set out on the table and guests helped themselves. It was also differentiated from the other two meals by the refined, elaborate dishes on offer, including a selection of sweet tarts, custards, fruits and nuts together with sweetened spiced wine.

Since the purpose of this play was probably to demonstrate the price of overindulgence, it should not be assumed that in fifteenth-century France the banquet was a supplementary evening meal, following the two standard meals of *dîner*, around midday, and *souper* in the early evening. In the play, the three meals are personified; after enjoying the hospitality of Dîner and Souper, the happy group of revellers—rejoicing in such names as Gourmandise, Friandise, Bonne Compagnie (Good Company), Passe-Temps (Leisure)—are led on, by Banquet, to a banquet. Here, however, they find they have been double-crossed as a horde of maladies (Gout, Colic, Jaundice, Quinsy) attack them. Those guests who escape bring a case before Dame Experience who finds Banquet, and to a lesser extent, Souper, guilty of corrupting the guests. Banquet is executed, and Souper is ordered to keep a respectable distance from Dîner. It is clear that the banquet was seen as promoting a pleasure-seeking lifestyle which, given the importance of the sin of Gluttony, would hardly have met with church approval.

Especially when elements of performance were included, banquets could last many hours, and often led into a ball. At don Ercole's dinner, after all the courses and all the performances, the guests danced until daybreak, "*fino al giorno chiaro*" (until the light of day).

Entremets

Designed to appeal to all the senses, banquets increasingly incorporated musical and theatrical elements. The entremets, the between-courses divertissements, were spectacles incorporating elements of surprise and trickery to amaze and impress the guests. Often elaborated to honor the occasion or the guest of honor, they were additional elements inserted in the structure of the meal.

In the fourteenth and fifteenth centuries, entremets were often the product of the kitchen, elaborated under the charge of the head cook, although they might well have involved carpenters and costume makers as well. The cooks' contributions included pastry castles, pies filled with live birds, gilded roast chickens and sucking pigs and fire-breathing roast swans and peacocks, re-dressed in their plumage. Almost invariably, music in some form accompanied the presentation of these entremets.

By the sixteenth century the entremets had undergone a transformation, with the culinary and theatrical elements separated. The between-course entertainment consisted almost entirely of performance—music, mime, dance, and acrobatics—leaving cooks free to devote all their skills to culinary artistry and visual display.

The banquet for don Ercole, for example, began with the performance of a comedy by Ariosto, after which guests moved to another room where they were entertained with music while tables were being set with silver candelabra, silver salt cellars, and intricately folded serviettes, or napkins. On their return they washed their hands in perfumed water before the dishes of the first service were presented, to the accompaniment of music and song. Messisbugo specified precisely the vocal and instrumental complements to each of the services, continuing through the interval between services, as well as the performance of a group of Venetian jesters.

Banquet Symbolism

Since the raison d'être of a banquet was to honor an occasion such as a marriage involving powerful and wealthy families, or the visit of a noble guest, or the arrival or departure of a prince (when it was often associated with the dramatic ritual of a procession), then it was necessary to highlight this purpose, typically through the entremets and table decorations. The sugar sculptures of Hercules at don Ercole's banquet were a clear reference to his strength and power, just as the recurring theme of a castle symbolized might and authority.

If the role of the banquet were to promote or strengthen strategic alliances (and marriages could easily fall into this category), the entremets might be designed to flatter the guests of honor. Thus at the dinner offered the Hungarian ambassadors the entremets presented paid homage to the guests and their mission. The first, a large castle atop a rocky peak, was decorated with the banners

Banquet of the Pheasant

Because of their political significance, banquets often attracted the attention of chroniclers. One of the best known is the Banquet of the Pheasant, held at Lille in February 1454, which was thoroughly documented by Olivier de la Marche, who helped organize the event for Philip the Fair, Duke of Burgundy. The ostensible purpose of this banquet was to inspire knights to join a crusade to recapture Constantinople, recently taken by the Turks.

The chronicler says little about the food and wine, but a great deal about the visual effects. The banquet took place in a large room, decorated with tapestries depicting the life of Hercules, in which were three tables, each displaying a series of entremets. On the first was a delicately constructed church, a model of a naked young boy pissing rosewater, a ship laden complete with cargo and sailors, and a fountain, fashioned partly of glass, and surrounded by trees, fruit, and flowers of glass. On the second table was a large *pasté* (a pastry case) in which were twenty-eight musicians, while from another castle jets of orange-flower water sprayed into the moat and the figure of a man atop a barrel in a vineyard invited guests to help themselves. On the third table was a forest with wild animals, moving as if they were alive, according to Olivier de la Marche. On a tall dresser were displayed platters of gold and silver, together with crystal jugs decorated with gold and precious stones. Near the wall were two high pillars, one supporting the figure of a woman whose right breast gushed spiced wine, and the other a lion, guarding the woman.

After admiring these, the guests were seated and a series of musical and other diversions followed, culminating in the presentation of a white-clad lady, representing the church, who pleaded to be rescued, her speech incorporating the motto of the Crusades, *Dieu le veut* (God wills it; or, God's will be done). At the end of her lament a live pheasant, richly ornamented with gold and jewels, and the duke (who, noted our diarist, knew exactly his purpose in organizing this banquet) made his vow to save Christianity, whereupon other nobles followed his example. After yet more music and spectacle, the dancing began, hippocras and candied spices were served, and guests enjoyed themselves until two or three in the morning.

SOURCE: *Mémoires de Messire Olivier de la Marche. Collection complètes des mémoires relatifs à l'histoire de France.* Edited by Claude B. Petitot. Paris: Foucault, 1820.

An Italian Renaissance Wedding Banquet

Banquet celebrating the marriage of the Marquis Gian Giacomo Trivulzio with Beatrice d'Avalos d'Aragona, Milan, 1488.

1. Rosewater-scented water for the hands
   Pastries of pinenuts and sugar
   Other cakes made with almonds and sugar, similar to marzipan
2. Asparagus (to the amazement of the guests, since it was enormous and out of season)
3. Tiny sausages and meatballs
4. Roast grey partridge and sauce
5. Whole calves' heads, gilded and silvered
6. Capons and pigeons, accompanied by sausages, hams and wild boar, plus delicate "potages"
7. Whole roast sheep, with a sour cherry sauce
8. A great variety of roast birds—turtledoves, partridges, pheasants, quail, figpeckers—accompanied by olives as a condiment
9. Chickens with sugar and rosewater
10. Whole roast sucking pig, with an accompanying "brouet"
11. Roast peacock, with various accompaniments
12. A sweetened, sage-flavored custard
13. Quinces cooked with sugar, cinnamon, pinenuts, and artichokes
14. Various preserves, made with sugar and honey
15. Ten different "torte," and an abundance of candied spices

SOURCE: Mario Bendiscioli and Adriano Gallia. *Documenti di storia medioevale, 400–1492.* Milan: Mursia, 1970, pp. 267–268.

and coat-of-arms of the king of Hungary and the visiting nobles while the second, a fire-breathing tiger, bore the royal coat-of-arms on its collar.

Banquets also served to demonstrate, on a grand scale, the generosity of the host and, obliquely, his wealth and influence. Commenting on the growing popularity of banquets in northern France in the second half of the fifteenth century, Olivier de la Marche notes that their splendor accrued as each noble who gave a banquet wished to outclass the previous one. Their political importance meant that an element of social obligation was also involved; Messisbugo records the banquets don Ercole gave as well as those at which he was a guest.

Sumptuous, wealth-displaying spectacles involving food and performance continued into the seventeenth century. Vatel, a French counterpart to Messisbugo, was responsible for the organization of one such event in 1661 at the chateau of Vaux-le-Vicomte, to which the young Louis XIV was invited. Later at Versailles, Louis himself entertained on an even grander scale but by this time the term *banquet* seems to have referred simply to formal dinners, the Versailles extravaganzas being known as *fêtes*.

See also **Medieval Banquet**; **Taillevent**.

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Barbara Santich

RESTAURANTS. Throughout much of recorded history, eating away from home and in a public place has been experienced as a burden rather than a pleasure. The emergence of restaurant going as an enjoyable, leisure time activity and of restaurants as spaces clearly distinct from cafés, taverns, inns, or brothels is a comparatively recent development. In the West, restaurant culture is no more than 250 years old (and, in many localities, it is much younger). In southeastern China, restaurants were already part of urban culture in the thirteenth century; Marco Polo was astonished by the lavish eating establishments he found in Hangzhou, where regional cuisines such as Szechwan and Honan were readily available. Yet if some cultures have a centuries-long history of public, commercial, gastronomy, many others do not. In many parts of the world, businesses clearly identifiable as restaurants have developed only in the past fifty years. They are the products of post-1945 developments in travel and trade, such as the emergence of global tourism and the spread of multinational corporations.

Europe: Ancient, Medieval, and Early Modern

There were no restaurants in Europe or North America until the mid-eighteenth century, but food was often eaten away from home. In a time when people had neither running water nor refrigeration nor gas nor electricity, and when journeying between cities was a matter of weeks rather than hours, people often ate away from their places of residence. Yet, they did not rely on restaurants. Travelers expected either to carry their own food or to depend on private hospitality; public eating establishments were viewed largely with suspicion and disgust. Since antiquity, numerous writers have accused innkeepers of fraudulent trade practices and unsanitary preparations: the classical medical authority, Galen, claimed that the innkeepers of Rome substituted human meat for pork! In a less spectacular vein, countless patrons over the past two millennia have complained of being served vinegar mixed with water rather than the wine for which they had paid. Affluent travelers therefore preferred to stay with friends along the way or to purchase raw ingredients and have meals prepared by the servants who accompanied them. This was the case even when traveling great distances, such as from London to Scotland during the Middle Ages. In the eighteenth and nineteenth centuries, the existence of many recipes for traveling sauces and portable soups attests to the continued disrepute of public eateries.

Throughout antiquity and the medieval period, shops or stalls selling hot food therefore catered not to the gastronomically adventurous but to the urban poor, whose rudimentary living arrangements made food preparation nearly impossible. In the southern Italian city of Pompeii (destroyed by volcano in 79 C.E.), taverns and *popinae* (foodselling establishments) clustered around the baths and gladiators' dormitories but were not to be found in the more prosperous parts of the city. Members of the Roman elite preferred to recline on couches while eating, but most food-retailing establishments were furnished only with tables and chairs. Ceremonial meals of many sorts played a significant role in the political and social life of Greece and Rome, but these were always held in private residences. Moreover, women were prohibited from these exclusively male events. In these and other ways, the food culture of Mediterranean antiquity was very different from that of the West today, in which restaurants play such a major role.

During the Middle Ages, the large numbers of religious pilgrims who traveled across Europe and into the Near East sought food and shelter in monasteries and in the hostels and hospices run by religious orders. In some areas, inns and taverns provided commercial hospitality but such establishments were rare outside of cities. Nor did even the most reputable inns fully escape stigma and suspicion. Taverns and alehouses were also common in much of western Europe, but these drinking places served only a few foods to soak up the alcohol. The association of public sociability with riotous drinking meant that these were also largely male institutions, at least in theory and imagery. In the seventeenth and eighteenth centuries, they were increasingly avoided by social and cultural elites of both sexes.

Well into the 1800s, inns and cookshops primarily served meals at a single large table, known in English as an "ordinary" and in French as a *table d'hôte* (literally, "host's table"). These shared meals provided travelers with the opportunity (not always desired) to meet each other, but they were better suited to the regular habits of local patrons than to the erratic schedules and varied preferences of passing voyagers. Service was "French style," that is, all the different dishes were placed on the table at once and customers were expected to help themselves to whatever was in front of them. This arrangement worked well for any assertive patrons seated near the roast at the middle of the table, but it could be frustrating for shy or foreign-language-speaking guests positioned with the condiments at the far corners. Given that the food was all placed on the table simultaneously, it was also inconvenient for travelers who arrived fifteen minutes after the meal had begun.

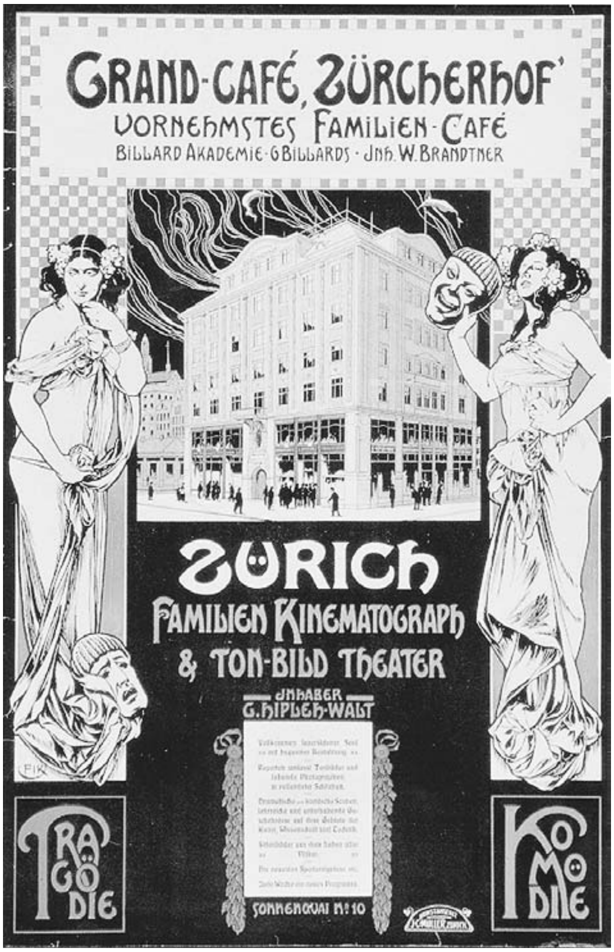
The First Restaurants

Scholars agree that the first self-styled "restaurateurs" opened for business in Paris during the 1760s, but there is some disagreement as to the significance of these establishments. For many years, a man named Boulanger has been credited with having been the first to have sold a wide variety of choice dishes and to have served them at small, oilcloth-covered tables in his shop on the rue des Poulies. Since the early nineteenth century, it has also been usual to cite the tale of Boulanger's dispute with the city of Paris's guild of cook-caterers (*traiteurs*) over the precise status of his signature dish, sheep's feet in sauce. Lore and legend says that in 1765 the cook-caterers tried to shut down Boulanger's shop because the dish infringed their legal monopoly on the sale of all *ragoûts* (dishes cooked in a sauce). Some authors claim that the cook-caterers won their lawsuit and others say they lost, but all use this story to support the broader contention that restaurants were largely impossible until the French Revolution of 1789.

The Boulanger story has been repeated and embellished until it has become one of the most familiar items in the culinary-history, but its sources are largely apocryphal. First briefly noted by P. J. B. Le Grand d'Aussy in his 1782 *Histoire de la vie privée des françois* (History of the private life of the French), an early, encyclopedic venture in writing the history of food and eating, Boulanger's adventures were a popular subject with nineteenth-century antiquarian scholars keen to show how much Paris had changed since the Revolution. However, this account of the origins of restaurant going assumes that the desire to "eat out" has been largely constant throughout history and needed only the cookery talents of one man and the legal changes of one Revolution to take the form familiar today. It cannot explain how the restaurateurs of the 1760s overcame centuries of prejudice against "public cooks" and tells us little of the real importance of this new form of service. Recent scholarship, therefore, places the development of restaurant culture within broader social and historical contexts. It looks for changes not only in what was being cooked and by whom, but in the entire social and cultural framework. The first self-defined restaurateurs built on Enlightenment ideas about science and sentiment; in doing so, they created a cultural institution distinct from the eating-houses and inns of earlier periods.

Restaurateurs in mid-eighteenth-century Paris took their name from the "restorative bouillons" in which they specialized. Made by sweating large quantities of veal, game, and poultry over high heat, these bouillons were concentrated meat broths deemed beneficial for those who were too weakened by illness or exertion to eat an entire solid meal. As they were also costly to prepare, it is hardly surprising that these bouillons were most often recommended to members of the urban elite (both male and female). Within the fashionable culture of the day, the inability or reluctance to eat a full meal was a sign of emotional and intellectual, as well as physical, sensitivity. The first restaurateurs did not cater to customers who were hungry and hurried; rather they provided a milieu in which people could make public show of their private sensibility. Opulent furnishings, mirrored walls, and porcelain consommé dishes all ensured an environment distinctly different from the hurly-burly of the tavern or inn.

In the long run, the most important innovation of the 1760s and 1770s was in the form of service. Restorative bouillons had vanished from most restaurant menus by the 1820s but the basic features of restaurant service remained. These included seating groups of patrons at their own tables, serving meals at unspecified times, and providing a menu from which customers made their own choices. All these elements created the impression that restaurants provided individual and personalized service. Restaurants were public places, insofar as they had neither membership fees nor admission requirements, but they were public places where people went for privacy. Many Paris restaurants, such as the Maison Dorée and the Cadran Bleu, were especially distinguished by their private rooms (*cabinets particuliers*) that were ideally suited to romantic trysts and other secretive meetings.



Poster advertising the Grand-Café Zürcherhof in Zurich, Switzerland. Large establishments such as this, with the added amenities of a billiard academy and theater, became popular in many parts of Europe at the turn of the twentieth century. Art Nouveaux lithograph by P. Krawutschke, 1908. ROUGHWOOD COLLECTION.

Restaurants in Nineteenth-Century Paris

Though they first emerged in the eighteenth century, restaurants are most commonly identified as institutions of nineteenth-century Parisian life. It is often said that they were instrumental in democratizing formerly aristocratic privileges: the one-time chefs of princes and dukes found themselves unemployed after their titled patrons fled France during the Revolution. A few early nineteenth-century restaurateurs made much of their aristocratic connections, but most restaurateurs had no such ties and were more closely linked to the other retail food trades. Antoine Beauvilliers, former pastry chef to the king's brother, did open a well-known restaurant, but he did so before the Revolution and much of his fame came from the cookbook, *L'art du cuisinier* (The cook's art) that he published in 1814.

One important development of this period was the distinction of two types of service: *prix fixe* (fixed price) and *à la carte* (from the menu). In the former, the customer ordered from a restricted number of items but was guaranteed to have a two- or three-course complete meal for the price specified. With service *à la carte*, the diner had the freedom to order anything listed on the menu but may have been surprised at the size of the final bill. In the 1820s and 1830s, these were two separate types of establishments (the latter usually being more prestigious), but today it is not uncommon to find both forms of service available in a single restaurant. Indeed, since the 1970s, a shift has occurred, such that a comparatively brief menu, restricted to locally available, seasonal ingredients, is now often seen as the mark of an upscale restaurant, while the lengthy menu parading hundreds of items is looked at with derision.

Based on early nineteenth-century texts, a short listing of the most famous first restaurants would have to include the following: Véry's (at the peak of their fame, the Véry brothers ran two prominent restaurants, one in the Palais Royal and the other in the Tuileries Gardens); the Rocher de Cancale on the rue Montorgeuil (famous both for oysters and for the epicurean singing societies that met in its private rooms); the Trois Frères Provençaux (three business partners who introduced some of the cookery of southern France to the capital—they were especially known for their *brandade*, a dish of puréed salt cod, traditionally eaten on Good Friday); Méot's and Robert's (two well-known establishments of the late 1790s); the Café Hardy (despite its name, a restaurant noted for its grilled meats); and LeGacque's (home to a famous eating club, the Wednesday Society). Many restaurants of a slightly later period play a significant role in the realist novels of the 1830s and 1840s, especially those of Honoré de Balzac. At the end of the century, restaurant and café scenes featured prominently in the works of some Impressionist artists.

Two businesses currently in operation often make claims to be the oldest restaurant in Paris. These are the Tour d'Argent, housed in a sixteenth-century inn, and the Café Procope, a famous meeting place for eighteenth-century intellectuals. Since neither actually started as a restaurant *per se*, some may dispute their right to this title. Other old restaurants still in operation include the Véfour in the Palais Royal (converted from café to restaurant in 1817) and LeDoyen's on the Champs Elysées.

The Spread of the French Model

The use of French names for restaurants in many parts of the world indicates the nineteenth-century predominance of the Paris model. Two of the first restaurants in Sydney, Australia were named after two of the most famous ones in Paris, the Trois Frères Provençaux and the Café-Restaurant de Paris. Another famous Paris restaurant name, Véry's, was replicated in central London, where Verrey's was a Regent Street fixture from the 1850s to the 1920s. In Mexico City, the Tivoli and Maison Dorée restaurants borrowed their names and their menus from the French capital.

By the first decades of the nineteenth century, restaurants may have been fixtures in the Paris landscape but they were still uncommon in the French provinces and even more rare elsewhere. As late as the 1850s, American and British visitors to Paris remarked on how strange and marvelous it was to be offered the choice of dozens of different dishes and to eat those dishes in an ornate dining room surrounded by groups of both men and women. Many of London's exclusive gentlemen's clubs were famous for their chefs (Louis Eustache Ude at Crockford's Club and Alexis Soyer at the Reform Club are just two examples) but these clubs, restricted to members only and forbidden to women, were not the same as restaurants. An important British institution, gentlemen's clubs were copied in the colonies, especially India, where the Bengal Club (Calcutta) was founded in 1827. For members of the Victorian middle class, domestic comfort played a central part in defining their own national, social, and gender identities. Many Britons therefore looked askance at restaurants as offering proof that the French had no real home lives and, hence, no sense of family.

Hotel Restaurants and "International" Cuisine

The luxurious hotels of the late nineteenth century played an important part in introducing restaurant culture to the British and North American upper classes. These sumptuous hotels with their grand entrance lobbies and ornate dining rooms were made possible, in part, by the greatly expanded travel habits that developed with the railroad and the steamship. The French model remained preeminent in hotel restaurants for several reasons, including that country's long established reputation for luxury goods and Paris's international appeal. The standardization of a *haute cuisine* (high cookery) that came to be identified with "French" food and the rise of hotel training programs may also have played a role. Georges-Auguste Escoffier, a chef who worked closely with the hotel entrepreneur, César Ritz, is often credited with having rationalized restaurant kitchen work in a fashion that made it easier to teach and replicate. His cookbooks and menus were often copied and his way of organizing kitchen work became standard practice.

Until the nouvelle cuisine and fusion foods of the last third of the twentieth century, Escoffier's version of "international cuisine" dominated the hotel restaurants and so-called "fine dining" establishments of much of the world. This cuisine was international insofar as it was served to diners in grand hotels around the globe, but the recipes, ingredients, and seasonings were western European in inspiration. In many parts of the world, the introduction of this so-called "international" cookery and Western-style restaurant service went hand in hand. Organizations such as the Japanese Travel Bureau (a joint venture between government and private railroad, steamship, and hotel companies, founded 1912) actively encouraged the establishment of "European restaurants" where Western travelers would find forks and knives, printed menus, and meals served in several courses. Teahouses (frequented only by male customers) and Japanese restaurants (*ryōri-ya*) were already widespread, but concern to show Japan as a "civilized" (i.e., Western) country led to new businesses that were furnished with tables and chairs, served large quantities of meat, and severed all ties to prostitution. During the following decades, and especially with the Allied occupation after World War II, businesses and government alike were keen to promote an image of Japan as a country that foreigners would find both reassuringly comfortable and pleasantly exotic. This demand was met by restaurants in which service duplicated that to be found in Paris, Chicago, or

New York, but where the dining room was decorated with chrysanthemums, bamboo, and cherry blossoms and the menu might include a few notionally Japanese dishes.

Early Restaurants in the United States

As was true of Europe, colonial North America had taverns and boarding houses, but no restaurants. Coffee houses and oyster houses began appearing in the late eighteenth century, but the word "restaurant" was not commonly used until the 1830s or 1840s. Delmonico's, which opened in Manhattan in 1831 and occupied several different locales until it finally closed during Prohibition, is often cited as the first American restaurant but this is far from certain. Nonetheless, whether it was the first or the fifty-first, Delmonico's became a model throughout the nineteenth century. In 1868, the first railway restaurant car in the United States was named "Delmonico's" even though it operated on the Chicago-Alton line, half a continent away from New York. Charles Ranhofer, chef at Delmonico's from 1863 to 1895, helped spread the restaurant's fame in the pages of his enormous cookbook, *The Epicurean*, which also included anecdotal stories about the famous patrons he had met and the great meals he had cooked.

Scenes of adulterous dalliances and tipsy festivities, restaurants such as these were as infamous for scandal as they were famous for food (lobsters and champagne were the usual fare). Central to one stereotype of New York nightlife, they were largely irrelevant to many of the city's inhabitants. It should not be forgotten, however, that the lavish scale of turn-of-the-century restaurants and hotels depended on the existence of a largely immigrant underclass from which staff members were drawn. Indeed, the East Coast restaurant and hotel labor market at this time was effectively segregated by ethnicity and gender. Eastern and southern European women worked as maids, and African-American women were employed as chambermaids in the grandest hotels, while most waiters were men of French or Italian descent. Although the food served was French in name or inspiration, most of the chefs were German; French men worked as waiters or as specialized cooks, such as pastry chefs.

Mass Market Restaurants in the United States

The grand hotel restaurants of the late nineteenth century were fixtures in major cities, but they fed only a small percentage of the American population. Unlike earlier taverns or oyster houses, the lobster palaces and cabarets welcomed both men and women but this gave them an air of promiscuity that worried cultural conservatives, religious leaders, and prohibition activists. Levenstein has argued that Prohibition, by dissolving the association of eating out with alcohol consumption, did much to make eating away from home acceptable for single women and members of all social classes. It is certain that the 1920s witnessed both the closing of many of the most luxurious barrooms and the opening of numerous luncheonettes and tearooms. (It remains unclear, however, whether Prohibition caused these changes or whether Prohibition and luncheonettes were both responses to other, more fundamental, changes in American society.)

By the 1930s, the U.S. Bureau of the Census counted 200,000 food-retailing outlets, including 124,000 restaurants and over 45,000 lunch counters. The latter category included drugstore soda fountains, sandwich shops, and diners as well as hot-dog stands and box-lunch companies. It is interesting to note that the Census Bureau included automats and self-service cafeterias under the heading of restaurants.

According to Richard Pillsbury, the postwar period did not see an immediate boom in the number of restaurants, but it did witness the transformation of American culture that was crucial to their eventual growth. Changes in family life, increased urbanization, the omnipresence of the automobile, and the affluence of the middle classes all contributed to making restaurant meals a regular part of life for many Americans. Drive-in restaurants made it possible to "eat out" within the comfort of one's very own automobile. Yet variation by region and by socioeconomic class should not be overlooked. Nor should it be forgotten that eating places in the South were often segregated, and that interracial "dine ins" played a significant part in the Civil Rights movement of the 1960s.

In the last quarter of the nineteenth century, Fred Harvey developed one of the first restaurant chains, in cooperation with the Atchison, Topeka, and Santa Fe Railroad. Along the route, he built and operated seventeen Harvey Houses, which were recognizable by their décor and by the waitresses' identical uniforms. The menus were coordinated, however, to guarantee that the restaurants' pleasing familiarity did not extend to the food served, and the traveler was guaranteed of never being served the same fare two meals in a row. This show of variety under an umbrella of uniformity has been the hallmark of restaurant chains ever since.

Prior to World War II, chain restaurants were comparatively novel, accounting for only 15 percent of all restaurant business. (In contrast, chain grocery stores in the 1930s were already responsible for nearly half of all grocery sales.) Howard Johnson's, initially a New England ice cream chain, expanded along the highways of the 1930s and 1940s much as Harvey House had along the railroads.

In the late twentieth century, franchised businesses have accounted for much of the U.S. restaurant industry's expansion. In 1994, nearly 60 percent of the total 406,000 U.S. restaurants were chain units and 200,720 restaurants belonged to chains that included over 200 units. Many of these were fast-food establishments such as McDonald's, Burger King, or Kentucky Fried Chicken, but many others were full-service restaurants such as the Outback Steakhouse, the Olive Garden, Bennigan's, or Denny's. The success of these chains suggests that customers value familiarity. Eating out has become routinized.

Ethnic Restaurants

So-called "ethnic" restaurants may seem a logical outgrowth of the waves of immigration to the United States in the late nineteenth and early twentieth centuries, to Australia in the same period, and to Great Britain in the period since World War II. In part, they are, for economic marginalization and racism have often caused recently arrived immigrants to concentrate in businesses requiring comparatively small capital investment, such as catering. Moreover, recruitment of new workers for these enterprises is usually done informally, through family and community connections, and further concentrates the members of an ethnic group in a few businesses. Since most restaurant employees do not actually speak to the customers, it is seen as an ideal line of work for recent immigrants who feel uncertain about their linguistic abilities.

Yet it should not be imagined that these restaurants have simply been transplanted from the immigrants' home country. Nineteenth-century Greece had few, if any, restaurants (and the inns were as disreputable as they had been two thousand years before), but late-nineteenth-century Greek immigrants to the United States quickly became concentrated in the restaurant industry.

The food served in ethnic restaurants often constitutes a distinct cuisine. In all cultures and contexts, there are some foods that are almost exclusively eaten in restaurants and others that never are. (For example, one would have to read a great many U.S. restaurant menus before finding those two staples of the American diet, peanut-butter-and-jelly sandwiches and popcorn.) If we consider Indian restaurants in the United Kingdom, we find that by the 1990s, they employed more people (roughly 70,000) than the shipbuilding and steel industries combined. Many of these were staffed by immigrants from the province of Sylhet in the northeastern corner of Bangladesh, but the food served had its roots in other parts of the subcontinent. Ingredients and cooking methods from the northwestern region of Punjab dominate "Indian" restaurant food in much the same way that one version of "French" cooking was once the norm in Western restaurants. This may be because the 1947 partition caused many Punjabis to migrate to Delhi and other cities where they started running food stalls. When the Indian government established catering colleges in the 1960s to train employees for the tourist industry, the instructors came from these Punjabi families. Since they taught north Indian cooking, this was what the students learned, regardless of the students' own ethnic or regional background.

Working in Restaurants

Restaurants combine characteristics of both production and service industries. Since William Foote Whyte's classic study, *Human Relations in the Restaurant Industry* (1948), social scientists have recognized that this combination leads to a conflict of interests between kitchen and dining-room employees. While the waitstaff must be constantly attentive to the demands and desires of the customers, the kitchen workers have their own distinct priorities. If a few famous chefs such as Paul Bocuse, Joel Robuchon, or Alice Waters seem to set the standards to which gourmets aspire, many other chefs and kitchen employees see themselves as ordinary, working-class, people, who have little in common with their middle-class and upper-middle-class patrons (see Fine, 1996).

Labor historians have long puzzled over the very low rates of unionization in restaurant work. One explanation is that the industry has largely institutionalized a system of informal rewards that would be lost with formal contracts: tipping encourages competition among members of the wait staff, rather than solidarity. Furthermore, waiting tables is commonly casual work rather than a lifelong career. Finally, the antagonistic, often combative, relation between kitchen and dining-room employees means that no single union has ever had much success in reaching both groups of workers.

It may be difficult to imagine that the first restaurant kitchens were fueled by coal or wood, but so they were. Smoke-filled, sooty, and with little in the way of refrigeration, the restaurant kitchens of the early nineteenth century would appall any health inspector today. The Belle Epoque restaurant boom in Australia and elsewhere was made possible by the increasing ease of railroad transportation and the availability of refrigeration techniques, while it was made further profitable by the expansion of advertising. The steakhouses so popular in the Anglophone world of the 1950s and 1960s (such as the Steak & Ale chain in the United States or the Berni Inns of Great Britain and Japan) served Argentinean beef and a limited number of simple side dishes, all easily prepared by semiskilled labor. Today, much of the inexpensive food consumed in restaurants, like the convenience food prepared at home, is made possible by the introduction of microwave technology. Any account of the spread and standardization of the industry should also consider the growth of restaurant-supply firms.

Restaurant Guides and Reviews

A. B. L. Grimod de La Reynière (1758–1837) is generally credited with having invented the restaurant review. His yearly *Almanach des gourmands* (Gourmands' almanac), published in the first decade of the nineteenth century, pointed its readers to the finest restaurants, pastry cooks, and gourmet shops of Napoleonic Paris. A bestseller in its day, it also set the precedent for later ventures in restaurant reviewing. The advent of rail and automobile travel expanded the market for restaurant guides. The Michelin tire company published its first hotel/restaurant guide to France in 1900 and awarded its first stars in 1926. Since then, airlines and automobile manufacturers have often ventured into the guidebook/cookbook business, though none have had the enduring importance of the Michelin guides and their rankings. Governments keen to promote tourism have also entered the business of publishing guidebooks and encouraging the hospitality industry.

In the mid-twentieth century, a somewhat different form of restaurant guide emerged, written neither by a lone gastronome nor by a faceless corporation. Duncan Hines (*Adventures in Good Eating*) in the United States and Raymond Postgate (*Good Food Guide*) in the United Kingdom both promised to publish recommendations sent by their readers. Postgate did this much more than Hines, but both contributed to the idea that members of the ordinary eating public might have their opinions heard. In the early twenty-first century, thousands of amateur reviewers made their opinions known on their own websites.

Why People Do Not Go to Restaurants

The idea of voluntarily going out to eat sits uneasily with the teachings of many religions. People who obey Jewish, Moslem, Jain, or Hindu dietary laws may find it no easier to eat in a Michelin three-star restaurant than in a stockyard or petshop. Both Jewish and Moslem law prescribes how livestock should be slaughtered. Unless an eatery is run by a known member of the community, observant patrons may not be willing to eat the meat served there. Brahmans, members of the highest Hindu caste, are forbidden to eat or drink anything prepared by a member of another caste. In addition, only other Brahmans are supposed to see them eating. Many Orthodox Hindus of all castes are highly reluctant to consume food (or even drink water) prepared and brought by unknown hands, even when traveling long distances. Jains are so profoundly vegetarian that they refuse to eat food prepared by someone who is not, even if the meal includes no animal products. None of these dietary laws can be obeyed in a restaurant where the cook remains unknown to the diner. In such a context, a restaurant meal can be only an ordeal.

As mentioned above, British middle-class culture, with its emphasis on domesticity, was slow to adopt the custom of eating out. In the late 1800s, the famous grillroom, Simpsons in the Strand, tried to attend to cultural norms by offering separate dining rooms for men and women. Lower down the social scale, working-class Britons in the early twentieth century might sometimes rely on takeout from local fish-and-chip businesses, but the association of restaurants with upper-class Francophilia meant that they, too, were unlikely to go out to eat. In many respects, then, it was not until the 1950s and 1960s that restaurant culture became a significant part of British life.

Why People Go to Restaurants

In many parts of the world, certain specialty foods are rarely, if ever, prepared at home and the chance to eat them may be one incentive for eating out. For example, local businesses limited to the time-consuming and messy business of preparing tripe are common in France, Greece, and Portugal. In Japan, only licensed chefs in specialist restaurants are allowed to prepare the highly poisonous blowfish (fugu). In China, snakes are never eaten at home but they are nonetheless considered a great delicacy when served by restaurants that specialize in them.

TODAY'S MARKET OF ENGLISH LAMB
ENGLISH
LEG PORK 3·49
LOIN PORK 6·49
ROLLED PORK 3·75
PORK CHOPS 6·49
PORK FILLET 10·35
PORK STEAKS 5·50
BELLY PORK 3·05
SALT BELLY PORK 2·65
HAND PORK 2·05
BLADE BONE PORK 2·65
American SPARE RIBS 4·30

Many large department stores feature restaurants where shoppers may take lunch or dinner. The restaurant at Harrods, Knightsbridge, London is both a fashionable eatery and retail shop for gourmet food products. © BO ZAUNDERS/CORBIS.

It may seem paradoxical, but food is rarely the only reason that people go out to eat. The evidence of the past several centuries indicates that restaurants may serve many different functions. Even within a single dining room, some customers may be celebrating a wedding anniversary and others may be cheating on their spouses. By entertaining guests or meeting friends in a restaurant, people can shield their domestic lives from others; in France today, only the very closest friends are ever invited into the home. In moments of domestic conflict, eating in the comparatively public space of a restaurant may be a way to reestablish the outward forms and appearances of civility.

As publicly accessible places in which patrons are seated at their own tables and eat their own meals, restaurants seem to provide a window into other people's private lives. The elaborately mirrored dining rooms of many nineteenth-century restaurants made it especially easy to observe one's fellow patrons without staring at them directly. Diners could preserve the illusion of their own privacy, even as they peered into that of others. Since the 1980s, there has been a brief trend toward very large and loud restaurants where the crowded atmosphere may further blur the distinction between private and public. There has also, however, been a renewed interest in intimate private dining rooms far from the eyes of star-struck strangers and the ears of curious waiters.

The various "ethnic" restaurants found in American cities in the 1930s were distinguished more by their furnishings and music than by their cuisine. Today's cult of culinary authenticity may scoff at the notion that red lacquer walls and a Pekingese under the table suffice to make a restaurant "Chinese," but it is important to recognize that many supposedly national cuisines have been produced by the demands of restaurant culture.

See also **Chef, The**; **Delmonico Family**; **Escoffier, Georges-Auguste**; **Fusion Cuisine**; **Grimod de La Reynière**; **Kitchens, Restaurant**; **Nouvelle Cuisine**; **Places of Consumption**; **Waiters and Waitresses**.

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Rebecca L. Spang

RETAILING OF FOOD. In agricultural societies all over the world, food marketing took place in central marketplaces in towns and cities. In larger cities, specialized merchants operated temporary stalls and permanent warehouse/stores alongside farmers who brought produce and animals directly to market. The Greek agora is an example of such a marketplace. The ruins of Pompeii provide examples of merchant's streetfront stores.

Expanding industrialization in the late nineteenth century ushered in mass consumerism in the United States and Europe. New forms of food purveying transformed the structure of the food business, the nature of retail ownership, and the social relations of food shopping. Innovations in food shopping that developed in the late nineteenth and early twentieth centuries spread throughout the world with varied significance and direction.

Victorian Food Halls, Public Markets, and Local Family-Owned Stores

Mass production created both new commodities and a new professional-managerial consumer class in the late nineteenth century. Grand emporia, called "department stores," developed in response to this new type of customer. Centrally located, these palaces of consumerism used elegant, monumental ambience to display commodities. Early department stores usually incorporated food halls in which high-end customers were introduced to new products at separate stations in sanitized settings. Samples and demonstrations of new products were offered.

At the same time, large public markets continued to purvey fresh produce and meat brought directly from the country to central markets where they were purchased by the working classes, servants to the middle classes, and the small-scale vendors of raw and cooked foods who served dispersed communities.

Corporate Chains and Supermarkets

During World War I and the interwar years, the inflation of food prices made the high cost of living a major political issue. In the 1920s and 1930s new forms of food stores were invented in the United States to rationalize costs. This occurred in a two-step process, with centralized chain stores followed by the new self-service supermarkets. The Atlantic and Pacific Tea Company (A&P) was the largest of the early chain stores. Expanding from a chain of tea stores to encompass all food products, A&P was concentrated mostly in the Northeast. Other pioneering chains were Safeway in the West and Krogers in the Midwest. Chains achieved economies of scale through buying in bulk and a higher volume of sales. A&P also relied on its own production of house brands to cut wholesale costs.

The first chains in the United States retained the same spatial/social organization as family-owned counterparts. Clerks still presented wares over the counter and helped make selections, gave product information, often bargained over price, and arranged for such services as credit and delivery. This changed with the advent of self-service marketing. Michael Cullen, an employee of Krogers, opened his first self-service King Kullen store in New York in 1930 when Kroger executives rejected his new concept. Recognizing that larger stores were necessary to achieve profitable sales volumes, self-service emerged as an adaptation to size. Cullen's stores were ten times larger in square footage than chain stores. As James Mayo reports (p. 117), the term "supermarket" came into use in the 1930s and was defined by a threshold sales volume, parking lots, and self-service.

FOOD HALLS IN JAPAN

In Japan, where efficient public transit has forestalled reliance on cars, supermarkets are less developed, and small family-owned stores and chain-owned convenience stores near neighborhood public transit are heavily used. In addition, department stores located at major transit junctions devote much space to food halls. These food halls provide offerings ranging from perishable produce and sushi to a broad selection of cooked dishes representing traditional Japanese, other Asian, and European cuisines. Hawkers use traditional calls to attract customers to their stands, reproducing the ambience of the old urban marketplace for middle-class housewives and office workers within this modern, sanitized site of overconsumption.

T.WALTON (LONDON) LTD
LONDON'S LEADING FRUITERERS · Nº 222 ·

Window display of a high-class London fruiterer, 1918. All of the produce shown in the window is sourced by country of origin and name of fruit variety. ROUGHWOOD COLLECTION.

Showcasing the product is an important aspect in retailing food. Here forty-eight flavors of ice cream are displayed behind fancy chocolates (under the glass). PHOTO FROM THE 1940S COURTESY OF H. WILLIAM ISALY AND BRIAN BUTKO.

In self-service stores, goods were displayed to allow the consumer to make autonomous choices based on fixed prices. Also referred to as "cash and carry" stores, they did not provide the conveniences, such as credit or delivery, that formerly bound merchant to customer. Instead they provided an often desirable anonymity and private decision-making. The grocery cart was developed in 1937 and expanded the possibilities for bulk shopping. Increasing automobile and refrigerator ownership enabled infrequent bulk shopping to replace frequent or daily shopping..

These enterprises were important sites in the development of a mass market of middle-class consumers. The United States, unlike Europe, lacked a history of aristocracy and strong class distinctions in taste. Media advertising used specials and brand imaging to shape consumer desire for standardized, reliable mass-produced foods and to foster trust in corporate chains.

In contrast, Europe retained clearly marked class distinctions in taste and consumption. An active food co-op movement was at the center of debates about food prices. Traditional wholesalers and their shopkeeper allies had considerable political clout. They promoted the benefits of artisan production over mass production in food processing. Independent grocers and wholesalers fought successfully for protectionist legislation to thwart chain-store development and the food co-op movement. According to Victoria de Grazia in her article, "Changing Consumption Regimes in Europe" (pp. 71–74), this protest occurred particularly in Germany, France, Austria, and Italy, in contrast to Great Britain and Sweden.

Post–World War II Global Trends

Supermarkets became the dominant sites for food shopping in the United States during the post-World War II era of abundance. As technology was fetishized to symbolize modernity, supermarket architecture and design became strikingly modern, emphasizing service by machines rather than people. Innovations in shelving, lighting, open refrigerator cases, and newly designed promotional displays highlighted the abundance of products and encouraged impulse shopping. Furthermore, as mass ownership of automobiles enabled the sprawl of suburban settlements, new stores in developing suburbs were less densely distributed and much larger in size, drawing customers from long distances.

In the postwar era in Europe, traditional state-protected food distribution was rapidly transformed. Self-service stores in Germany increased in number from 39 in 1951 to 17,132 in 1960 and 35,000 in 1965. At the same time in France, the "hyperstore" was invented, joining food with other consumer goods in even larger stores. Promodes, a provincial Normandy food wholesaler, merged with two rival family firms in the 1960s and within a decade developed a multinational retail network.

ETHNIC MARKET SUCCESSION

In Philadelphia, a multiblock area called the "Italian Market" served originally as a site where Italian immigrants could purchase fresh seasonal produce grown by Italian truck gardeners in southern New Jersey, as well as imported cheese and oil. Butchers slaughtered pigs in the fall and made sausages for Christmas Eve celebrations and the long winter. In spring, paschal lambs were available. Today, the area is still identified on tourist maps as the Italian Market. Yet aside from the remaining cheese and sausage purveyors and a few venerable restaurants, most vendors and consumers are Vietnamese who are now dominant in this area and have special ethnic food needs.

THE SUPERMARKET IN DEVELOPING COUNTRIES

Supermarkets require private transportation for bulk purchases. In developing nations, chains such as Carulla in Colombia develop as soon as automobile suburbs emerge. Aspiring middle-class people without cars often pool their resources to use transportation such as unlicensed taxis and buses to take them shopping in these outlets.

Another major French chain, Carrefour, opened its first North American hyperstore in Montreal in 1973, and by 1989, there were eighteen European-style hyperstores in the United States. Today many supermarket chains are truly global in ownership and in the commodities that are purveyed. In 1979, A&P itself was bought by Tengelmann, a German-owned multinational. At the same time, U.S. corporations such as Pathmark have created "superstores" that sell more than food.

Post-Industrial Reaction and Counterreaction

Today, many consumers see drawbacks in corporate food distribution. Centralized stocking practices are far removed from local customer needs as they rely more on corporate relations with food manufacturers and formulas for profit margins. In spite of the illusion of unlimited choice, variety in packaging and a parade of "new" products that are minor variations of existing ones, provide a limited veneer of novelty. Long-distance produce, cultivated for preservation and not for taste, is limited in its variety. Moreover, supermarket shelves are dominated by the products of a few large conglomerates whose power facilitates shelf preference and agreements to exclude competing products.

As corporations cut back on labor costs, workers are fewer and less knowledgeable. Meats once handled by skilled butchers are now packaged in the processing plant. As service declines, work is transferred to the customer. Huge stores mean a longer time spent walking down the aisles and waiting on checkout lines. Surveillance cameras limit one's privacy.

However, for certain urban populations, small stores remain central. Post-industrial capitalist elites who aestheticize food and leisurely eating, as those in the Italian-initiated "Slow Food" movement and their global counterparts, eschew mass-produced foods and long-distance produce. They are served by artisan bakeries, homemade-pasta shops, and local farmers markets. Increasing numbers of global immigrants are served by small shops that have ethnic foods and merchants who speak their languages. In addition, poor people in inner cities avoided by chains are dependent on small high-priced stores.

Seeking a broad customer base, corporate chains are continually responding to new demands. As people become more and more pressed for time, dispersed convenience stores allow quick purchases by people on the run. Prepared-food offerings and salad bars have expanded in supermarkets. Chains of upscale markets, such as the Whole Foods network in the United States, have developed to address high-end consumer desire for fresh quality produce and gourmet take-out foods. At the other extreme are chains of huge stores like Costco and Walmart, which sell mass quantities at near wholesale prices. Some chains try to resocialize the impersonal space of food stores by providing eating spaces, sponsoring singles nights for young professionals, and reaching out to local communities through promotions for local schools.

See also **Farmers' Markets**; **Food Politics: United States**; **Marketing of Food**.

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Judith Goode

RIBOFLAVIN. *See* **Vitamins.**

RICE.

This entry includes three subentries:
The Natural History of Rice
Rice as a Food
Rice as a Superfood

THE NATURAL HISTORY OF RICE

Rice has fed more people than any other crop has for thousands of years. The ancient Indian name for rice, *Dhanya*, means "sustenance for the human race." Especially in much of Asia, life without rice has been unthinkable. Rice feeds more than half of the world population, but most rice is consumed within ten miles of where it is produced.

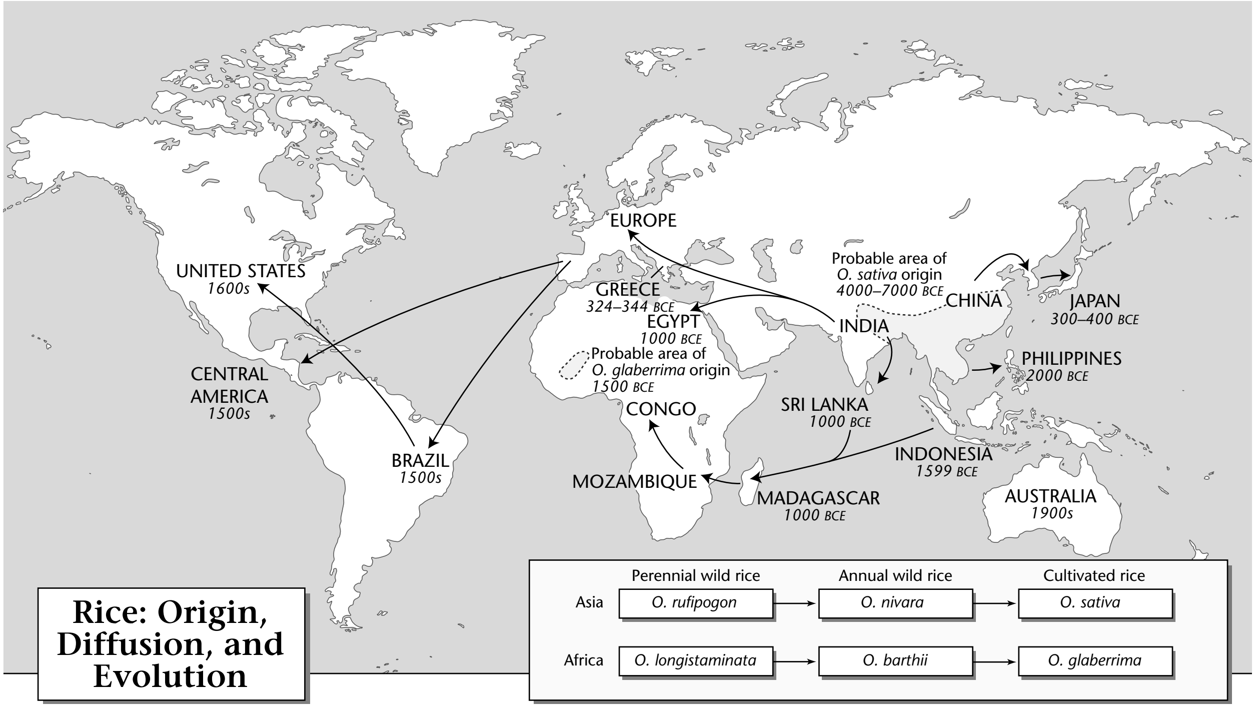
Rice is the second largest crop in planting acreage after wheat. Global rice production was 596.5 million tons from 155 million hectares (ha) in 1999. The major rice growing regions are found in more than a hundred countries in Asia, Latin America, and Africa. But major rice exporting countries only include Thailand, the United States, Vietnam, Pakistan, and India. About 85 percent of total rice production is for human consumption. Rice provides 23 percent of the global human per capita energy and 16 percent of the per capita protein (IRRI, 1997). In Asia, where people typically eat rice two or three times a day, 250 million rice farms (the average rice land per farm is less than 1 ha) produce more than 90 percent of the world's rice. For example, Myanmar consumes 195 kg of rice per capita per year, whereas the average annual rice consumptions in Europe and America are 3 kg and 7 kg, respectively. The three most populous nations, China, India, and Indonesia, are rice-based countries, which together have 2.5 billion people (about half of the current world population).

Rice can be processed into rice bran oil, wine, rice cakes, and other foods. Rice flour can be used as the main component of face powders and infant formula or for polishing expensive jewelry. Rice bran oil can be used in cooking, making soap, and as an ingredient in insecticides. Silica-rich rice husks can be used as raw materials for construction materials such as insulation, as a conditioner for commercial fertilizers, as an ingredient in hand soaps and furfural (a chemical used in synthetic resin manufacture), as mulch, as an abrasive, as a fuel, or as an ingredient to make thermoplastics (Yekani Amonollah: United States Patent: 6,172,144). Rice straw has been used for livestock feed, bedding for livestock, straw mushroom production (in China and Thailand), and in industries for arts and crafts. In early times, rice straw was also used for thatching roofs in Asia, and to make ropes, mats, paper, baskets, and bags. Now rice straw is mostly used for animal feed or as field manure.

Rice Biology

Classification. Rice has 120,000 varieties, the richest gene bank in the plant kingdom. There has been great progress in rice genome sequencing projects recently by using both *Indica* (9311) and *Japonica* (Nipponbare) varieties. This will greatly enhance rice improvements in the near future. From the taxonomy of rice, Asian rice belongs to the grass (Gramineae) family and genus *Oryza.* Wheat, corn, and barley also belong to the grass family. *Oryza* has twenty-three species, which can be classified into four groups. The *O. ridleyi* complex and *O. meyeriana* complex contain species in lowland swamp forests and upland hillside forests, respectively. The *O. officinalis* complex consists of perennial species throughout the tropics. The *O. sativa* complex includes two cultigens and the wild relative of these two cultigens. Only two *Oryza* species, the tetraploid *O. schlechteri* and the diploid *O. brachyantha*, are different from these four groups. Based on another classification method for *Oryza* species, the common wild rice or so-called *O. perennis* complex includes Asian wild rice (*O. rufipogon*), African wild rice (*O. longistaminata* or *O. barthii*), and Oceanian wild rice (*O. meriodinalis*) (Chang, 1976). *O. rufipogon* is the wild relative of *O. sativa* and a noxious weed in rice-growing countries. This wild rice has the characteristic of easy shedding to facilitate easy dispersal and easy crossing with the Asian cultivars, which results in the degradation of the variety and contamination of red-grained plants. The wild rice (or Indian rice or water oats) of North America (*Zizania palustris* or *Z. aquatica L.*, 2n = 30) belongs to a different genera and even a different tribe of the grass family. It was traditionally harvested by native Americans in the Great Lakes region, and now is commercially produced in Minnesota, Wisconsin, northern California, and Manitoba, Canada. It has nutty and rich flavor and boasts a pleasant chewiness. It is high in protein and B vitamins but low in fat.

Rice has only two cultivated species, *Oryza sativa* Linn. (the Asian cultivated species) and *Oryza glaberrima* Steud. (the West African cultivated species). *O. sativa* is by far the more widely utilized of the two. By contrast, *O. glaberrima* has much less diversity because of a relatively short cultivation history and a narrower dispersal than *O. sativa*. The main differences in botanical morphology between these two cultivated species are the ligule size and glume pubescence. Most of *O. glaberrima* varieties have fewer hairs, short ligules, and fewer or no branches, and also have red-hulled grains on the shattering panicle. They are generally more resistant to flood, alkaline soils, and blast than *O. sativa* varieties. Another difference is that *O. glaberrima* is strictly annual, whereas *O. sativa* is potentially a perennial. It is generally thought that there are two major subspecies in *O. sativa*: *indica* (or *hsien*) and *japonica* (sometimes called *sinica* or *keng*). *Japonica* is generally short, less leafy, and has a strong culm and short grains. *Japonica* varieties are grown in temperate areas such as northern China, Japan, Korea, Spain, Australia, and California. When cooked, *japonica* rice is sticky. *Indica* rice generally has long, slender, and fluffy grains, many tillers, and is tall, leafy, and tolerant of


Rice: Origin, Diffusion, and Evolution
EUROPE
UNITED STATES
1600s
GREECE
324–344 BCE
EGYPT
1000 BCE
Probable area of
O. sativa origin
4000–7000 BCE
CHINA
JAPAN
300–400 BCE
INDIA
Probable area of
O. glaberrima origin
1500 BCE
PHILIPPINES
2000 BCE
CENTRAL AMERICA
1500s
CONGO
SRI LANKA
1000 BCE
BRAZIL
1500s
INDONESIA
1599 BCE
MOZAMBIQUE
MADAGASCAR
1000 BCE
AUSTRALIA
1900s
Perennial wild rice
Annual wild rice
Cultivated rice
Asia
O. rufipogon
O. nivara
O. sativa
Africa
O. longistaminata
O. barthii
O. glaberrima

drought. It does not stick when cooked. *Indica* rice is usually grown in hot (tropical or subtropical) climates such as in India, Thailand, Vietnam, and Southern China. The so-called *javanica* can be classified as a tropical *japonica* and is mostly grown in Indonesia and the United States. *Javanica* was originally grown in equatorial areas with abundant water and is generally vulnerable to drought.

Morphology. Rice has the following three main developmental phases: the vegetative phase (from germination to panicle initiation), the reproductive phase (from panicle initiation to flowering), and the ripening phase (from flowering to maturity). A typical rice plant during reproductive and ripening stages has the following organs: roots, a main stem and a number of tillers (or side shoots), leaves, panicles, flowers (or florets) when flowering, and grains when maturing. The edible part of a rice plant is in the rice grain, which includes glumes, endosperm, and embryo. Some varieties have awns at the tip of the grain. More detail about rice morphology can be found in literature by Chang and Bardenas (1965) and by Grist (1986).

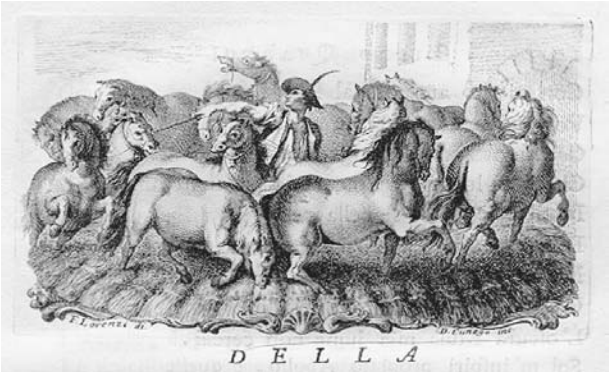
Rice has a fibrous root system, that is, it has temporary seminal roots or embryonic roots, then secondary adventitious roots. The fibrous roots only last for a short time after seed germination. An alternative is the classification of rice roots based on the spatial pattern as crown roots (including mat roots) below the soil and nodal roots above the soil. The function of rice roots is to absorb water. It is estimated that it takes 5,000 liters of water to produce 1 kg of irrigated rice. Owing to the great consumption of water in rice production, future rice cultivation will face the looming water deficiency in some countries.

Plant height can range from approximately 0.4 m to more than 6 m (in floating rice) depending on the rice variety or environmental conditions. The rice culm is round, hollow, jointed, and hairless. A maturing rice plant has a main stem and a number of tillers depending on the variety and cultural conditions. Each stem has a certain number of nodes (generally ranging from 13 to 16 nodes) and internodes under a certain environmental condition for a rice variety.

Rice leaves are rather flat. The first rudimentary leaf or prophyllum is at the base of a tiller and, with only a two-keeled bract, has no blade. The uppermost leaf immediately below the panicle is called the flag leaf. The leaf blade and leaf sheath are attached at the node, where there is an auricle (a pair of claw-like appendages encircling the stem), and the ligule (a thin, upright papery and triangular structure) immediately above the auricle. When young, the major difference between rice and a common grassy weed (*Echinochloa* spp.) is the presence of auricles and ligules.

Rice has a terminate panicle having the following structures: the base, axis, primary, secondary, and sometimes tertiary branches, pedicel, rudimentary glumes, and spikelets. Each panicle generally bears from 50 to 300 flowers or spikelets.

The rice panicle is a perfect and determinate inflorescence. A rice spikelet has two sterile lemmas, the



Horses threshing rice in the Italian Veneto. From a copper engraving in Gian Battista Spolverini's *La coltivazione del riso* (The Cultivation of Rice) printed at Verona in 1758. ROUGHWOOD COLLECTION.

rachilla and the floret. A rice floret includes six stamens and a pistil having stigmas, styles, and ovary, enclosed by the lemma and palea, sometimes with an awn. Even though rice is pollinated by wind, the natural crossing rate is low (less than 3–4%) because of the floral characteristics. The stigma (a plumose structure) functions to catch pollen for fertilization. This function is important for the out-crossing rate in hybrid rice seed production.

The rice grain generally refers to rough rice or paddy consisting of brown rice (or caryopsis) and the hull. Brown rice consists of the endosperm, embryo, and several thin layers of differentiated tissues—the pericarp (the ovary wall), the seed coat, and the nucellus. The seed coat consists of six layers of cells, with the aleurone layer the innermost. The rice embryo is small and contains the embryonic leaves (plumule) enclosed by a sheath (coleoptile), embryonic primary root (radicle) ensheathed by the coleorhiza, and the joining part (mesocotyl). Rice endosperm consists mostly of starch granules in a proteinaceous matrix, together with sugar, fats, crude fiber, and inorganic matter. Hull weight is about 20 percent of the total grain weight. The hull of a typical *indica* rice variety has the palea, lemmas, and richilla, but the hull of *japonica* rice usually only includes rudimentary glumes and perhaps a portion of the pedicel. The lemma is usually tough, archmenlike, sometimes awned, and bigger than the palea. Generally, pigmentation in rice does not cause any problems except for the pigmented apiculus or hull, which may stain the endosperm during parboiling, thus affecting the marketing value. Grain ripening stages (15–65 days) can be subdivided into milky, dough, yellow-ripe, and maturity stages based on the texture and color of the growing grains.

Nutrition. According to the U.S.A. Rice Federation (May 2002), half-cup servings of white rice and brown rice contain 103 calories and 108 calories of energy, respectively. The composition of typical brown rice, milled rice, rice bran, and germ or embryo are indicated in Table 1. Although the nutritional value varies with different varieties, soil fertility, fertilizers applied, and other environmental conditions, the following trends still exist by comparison with other cereals: lower fat content after the removal of the bran, lower protein content (about 7–10 percent), and higher digestibility of proteins. Fresh harvested rice grains contain about 80 percent carbohydrates, including starch, glucose, sucrose, dextrin, fructose, galactose, and raffinose. Polished rice grains have an insufficient supply of iron, considerable Vitamin E content, rich pantothenic acid, pyridoxine of Vitamin B complex, low riboflavin content, negligible vitamin A and D content, and an unfavorable calcium to phosphorus ratio.

Milling, rinsing before cooking, and boiling reduce the nutritional value of rice. For example, milling removes about 80 percent of thiamine from brown rice, thus causing beriberi and other dietary deficiencies. However, most rice consumers still prefer well-milled rice since brown rice has an unfavorable chewier texture and flavor.

Protein: Crude protein content in rice can be measured using micro-Kjeldahl analysis and other methods. In addition to varietal differences, protein content is affected by environmental conditions, such as soil and nitrogen fertilizer application. Protein is mainly distributed in the bran and periphery of the endosperm. The central part of the rice grain only contains a small proportion of rice's protein. Rice protein has all essential amino acids, in rather a well-balanced proportion, for the human body. Though the amount of protein is not high, the quality of rice protein is one of the highest. Rice protein has a biological value of 86, compared to 75 to 90 of the biological value in fish fillet protein. Rice is unique in the richness of alkali-soluble proteins or glutelin (about 70 percent), whereas the other cereals are rich in alcohol-soluble proteins or prolamin (rice has only about 3 percent prolamin in its gross protein content). The other components of rice proteins include 4 to 9 percent water-soluble proteins or albumins and about 10 percent salt-soluble proteins or glubulins. Rice proteins are rich in arginine and contain tryptophan and histidine, but are poor in lysine and threonine. However, by comparison with other cereals, rice protein is one of the most nutritious because it contains about 4 to 5 percent lysine (higher than that in wheat, corn, or sorghum). Efforts have been made to improve protein content through conventional breeding, but so far, it has not been successful. Rice varieties with high protein contents tend to have worse flavor, are less tender, less cohesive when cooked in the same amount of water, and longer cooking times are needed because of lower water absorption.

Carbohydrate: More than ninety percent of the energy in rice comes from carbohydrates. Rice contains both simple and complex carbohydrates. Simple carbohydrates or sugars include glucose, fructose, lactose, and sucrose.

Complex carbohydrates in rice are starch and fibers. As for fiber, one-half cup cooked brown rice and the same volume of cooked white rice have 1.6 grams and 0.3 grams of dietary fiber, respectively. About 85 percent of the rice grain weight is starch. Amylose is the linear fraction of the rice starch, and is negatively correlated with the cohesiveness, tenderness, color, and the gloss of the cooked rice. The rice starch has to be gelatinized during cooking or else rice is too firm to be eaten comfortably. Glutinous or waxy rice, sometimes referred to as "sweet" or "mochi," contains 1 to 2 percent amylose, has white and opaque kernels, and often is used for such ethnic foods as mochi cake and crackers, desserts, puffed rice, and parboiled rice flakes. The nonglutinous rice varieties can also be classified as low-amylose (8–20 percent), intermediate (21–25 percent), and high-amylose (>25 percent) types. Generally *Japonica* has low amylose content and the amylose content of *indica* varies widely. Environmental conditions can greatly influence amylose content as much as 6 percent for the same variety in the different seasons. Intermediate amylose content is preferred by the major world rice market. For high-amylose rice varieties, a gel consistency test can complement the amylose test by separating these varieties into three categories: hard gel consistency for very flaky rice (<40mm for the length of gel), medium gel consistency for flaky rice (41–60 mm), and soft gel consistency for soft rice (>60 mm).

Fat: Rice contains a trace of fats (0.9 and 0.2 g of fats in a half-cup of cooked brown rice and a half-cup of cooked white rice, respectively). Rice is a health food because it does not contain any cholesterol, but it does contain linoleic acid, accounting for 30 percent of the total rice fats that cannot be converted from carbohydrates, proteins, or other fats.

Vitamins: Rice contains several kinds of vitamins (Table 1). Thiamine (vitamin B_1) has positive health effects for the brain and heart, but unfortunately it cannot be stored in a human body and must be supplied in the daily diet. One half-cup of cooked brown rice and a half-cup of cooked white rice contain 7 percent and 6 percent of the U.S. Daily Value (D.V.) for thiamine, respectively. Riboflavin (vitamin B_2) is important for energy production and the health of skin and eyes. Rice has a very small amount of riboflavin, about 1 percent of the D.V. in one half-cup of cooked brown rice. Niacin (vitamin B_3) is essential for healthy skin, digestive, and nervous systems. One half-cup of cooked brown rice and the same amount of cooked white rice have 8 percent and 6 percent of the D.V. for niacin, respectively. Pyridoxine (vitamin B_6) indirectly helps to control amino acids in the body. A shortage of pyridoxine has negative effects on the central nervous system. The folate or folic acid is important for the manufacture of DNA and hemoglobin. Rice also has traces of vitamin E that protects vitamin A and essential fatty acids from oxidation. Recently, scientists in Switzerland and Germany developed "Golden Rice™" through genetic engineering and substantially increased vitamin A content in rice (Ye et al., 2000).

Minerals: Iron is important in humans for oxidation and other enzymatic reactions. One half-cup serving of cooked brown rice and one-half-cup serving of cooked white rice have 8 percent and 7 percent of the D.V. for iron, respectively. Phosphorus is critical for healthy bones and teeth and other metabolisms. Phosphorus in rice can be best absorbed when supplemented with milk or vegetables. One half-cup of cooked brown rice and a half-cup of cooked white rice have 8 percent and 3 percent of

TABLE 1

Nutrients in rice

Nutrient	Brown rice	Milled rice	Rice bran	Rice embryo	Polished rice
Percentage of total					
Protein (%N x 5.95)	7.1–8.3	6.3–7.1	11.3–14.9	14.1–20.6	11.2–12.4
Crude fat	1.6–2.8	0.3–0.5	15.0–19.7	16.6–20.5	10.1–12.4
Crude fiber	0.6–1.0	0.2–0.5	7.0–11.4	2.4–3.5	2.3–3.2
Crude ash	1.0–1.5	0.3–0.8	6.6–9.9	4.8–8.7	5.2–7.3
Available carbohydrates	72.9–75.9	76.7–78.4	34.1–52.3	34.2–41.4	51.1–55.0
Starch	66.4	77.6	13.8	2.1	41.5–47.6
Free sugar	0.7–1.3	0.22–0.45	5.5–6.9	8.0–12	
Micrograms per gram					
Vitamin A	0.1	Trace	4.2	0.3	0.95
Thiamine	2.1–4.5	Trace–1.8	10–28	45–76	16–30
Riboflavin	0.4–0.9	0.1–0.4	1.7–3.4	2.7–5.0	1.4–3.4
Niacin	44–62	8–26	241–590	15–99	228–385
Pyridoxine	1.6–11.2	0.4–6.2	10–32	15–16	10–31
Pantothenic acid	6.6–18.6	3.4–7.7	28–71	3–13	26–92
Biotin	0.06–0.13	0.005–0.07	0.16–0.47	0.26–0.58	0.14–0.66
Folic acid	0.20–0.60	0.06–0.16	0.50–1.46	0.9–4.3	0.4–1.90
Vitamin B_{12}	0.0005	0.0016	0.005	0.0105	0.003
Vitamin E (tocopherols)	13	Trace	149	87	63

the D.V. for phosphorus, respectively. Rice also has traces of calcium, potassium, and sodium.

Rice grain quality. The aroma of rice can be detected in rice leaf tissue, rice kernel, and cooked rice. It was reported that 2-acetyl-1-pyrroline was a major aroma component in aromatic rice. There is an excellent description about the evaluation of rice grain quality in a book chapter by Webb (1985). Grain quality is determined by the appearance (milling quality), texture and ease of cooking (cooking quality), flavor and smell (eating quality), nutritive characteristics, cleanness, and purity. For parboiled rice, light-hulled (straw-colored) rice is preferred and bran color should have uniform light color. Rice can be classified, based on the grain length on the traditional U.S. market, as follows: extra long (>7.50 mm), long (6.61–7.50 mm), medium (5.51–6.60 mm), and short (<5.50 mm). Rice also has the following classification based on the grain shape (measured as length/width ratio): slender (>3.0), medium (2.1–3.0), bold (1.1–2.0), and round (<1.1)

Endosperm is preferred to be bright, clear and translucent by the market, with the exception of waxy rice having an opaque endosperm. Excessive chalkiness is undesirable because chalkiness greatly affects the milling yield and milling quality. Chalkiness can be categorized as white belly, white core, and white back depending on the location of the chalkiness on the rice endosperm. Chalkiness is influenced both by the variety and by environmental factors such as weather conditions when harvesting, and by different agronomic or field managements.

Milling quality is determined by the following factors: size and shape of the grain, ripeness, drying method, age, moisture content, and the method of storage. High head rice and high milled rice are critical for the commercial success of a rice variety. To determine the milling quality, the rough rice percentage is measured after removing the foreign materials (dockages). After removing hulls and most of the bran layers and germs, total milling yield and head (or whole-grain) rice yield can be measured. Total milling yield includes the whole (head) rice and broken rice yield from total unclean rough rice.

The economic value of rice depends on its cooking and processing quality, which can be measured in terms of major methods: amylose content, alkali spreading value, gelatinization temperature, gel consistency, and protein content. Sometimes, parboiling-canning stability and specific brewing cookability with malt diastase need to be measured for specific purposes. The gelatinization temperature is the temperature at which 90 percent of the starches in the rice have gelatinized or turned liquid and lost their crystalline structure. Gelatinization temperature can be evaluated by measuring alkali spreading value (ASV). Gel consistency is used to differentiate among the high-amylose rice varieties with different amylograph pasting viscosities. The major factors affecting gel consistency are fat (lipid) content and degree of milling.

History

Origin and diffusion. Origin and diffusion of rice are still unsettled issues (Huke and Huke, 1990). Asian cultivated rice originated in the region from south China to the Ganges in South and Southeast Asia, including the river valleys and deltas of the Brahmaputra of northern India, the Irrawaddy of Burma, the Mekong of Vietnam, and the Yangtze of China. Based on the number of wild rice species and the evidence of rice glumes in the burnt clay from the late Neolithic period, Ting (1949) concluded that rice might have originated in South China and then spread northwards. Copeland (1924), Chang (1975) and some Japanese rice scientists asserted that rice might have originated from South or Southeast Asia, including India, China, Thailand, and Indonesia. Thermoluminescence and carbon-14 tests of the pottery shards with the imprints of rice grains in Thailand indicate that rice could be dated back to at least 4000 B.C.E. (IRRI, 1997). The three oldest pieces of archaeological evidence for rice origin are from Maharaga of India (6500–4500 B.C.E.), Non-Nok-Tha of Thailand (about 6000 B.C.E.), and Pen-tou-shan of China (7150–6250 B.C.E.) (Abrol and Gadgil, 1999; Chang, 1998). Great diversity of rice and linguistic evidence support the argument for Southeast Asia as the origin of rice cultivation. It was believed that the early spread of rice was from southern China or northern Vietnam to the Philippines about 2000 B.C.E., and then to Indonesia about 1599 B.C.E. by Deutero-Malayans. Most likely, the techniques of rice cultivation radiated outward from the Yangtze delta of China towards Korea and then Japan. Japan became known as *Mizumono kuni* (the Land of Luxurious Rice Crop) about 300–400 B.C.E., but rice did not become the staple Korean dish until the 1930s. Sri Lanka had rice as a crop as early as 1000 B.C.E. Rice was introduced to Greece and the neighboring Mediterranean c. 344–324 B.C.E., and then gradually to Europe and Africa (IRRI, 1997). There have been debates about the introduction of Asian rice into Africa. *O. sativa* was believed to have been introduced to Africa primarily from Malayo-Polynesia a few centuries B.C.E. or from Sri Lanka and Indonesia. It was postulated that at different times *O. sativa* was introduced to Egypt from India, to Madagascar from Indonesia as early as 1000 B.C.E., to Mozambique and East Africa from Madagascar, and finally to West Africa by Portuguese spice traders between the fifteenth and seventeenth centuries, or by traders or Muslim missionaries in the ninth or tenth centuries. Lu and Chang (1980) argued that Asian rice entered into the Congo from Mozambique in the nineteenth century. The other possibilities for the introduction of rice into Europe are from Persia, central Asia, or directly from China. Later the Portuguese brought rice to Brazil, and the Spanish introduced rice to Central and South America. The Malays brought rice to Madagascar. The United States might have been first introduced to rice from the Malagasy Republic, Europe, or the Far East. It was often cited that a storm-battered ship from Madagascar had brought rice seeds "Golde

Seede Rice" to South Carolina in 1694. Not until 1888 did the first large-scale growing of rice plants occur in Louisiana and Texas, although rice was introduced to Virginia as early as 1609. Later the Gulf Coast grew rice because of the popularization of mechanical farming. The current major rice-producing states in the United States include Arkansas, California, Louisiana, Texas, Mississippi, and Missouri. Rice was first commercialized in Australia in 1924, even though in as early as 1892 experimental planting of rice took place in New South Wales.

It was believed that *O. glaberrima* originated in the central Niger river delta of Mali about 1500 B.C.E. (Portères, 1956). Two secondary centers of diversity are located to the southwest near the Guinean coast. *O. glaberrima* has two ecotypes, deepwater and upland, and is now only grown in the flooded area of the Niger and Sokoto River basins. *O. glaberrima* in some parts of the Africa was gradually replaced by *O. sativa*. The ongoing rice improvement project of the West Africa Rice Development Assocation is also targeting these regions by substituting new varieties for *O. glaberrima* through *glaberrima-sativa* interspecific crossing.

Domestication. Chang (2000) made exhaustive descriptions on the evolution and early spread through several routes for rice, especially Asian rice. In his review the pattern for rice evolution was suggested as from perennial wild to annual wild and then to cultivated. Therefore, the evolution for *O. sativa* is *O. rufipogon* to *O. nivara* to *O. sativa* in Asia. In parallel, the evolution for *O. glaberrima* is *O. longistaminata* to *O. barthii* and then to *O. glaberrima* in Africa. It is believed that rice originated in the marsh areas and spread toward the dry lands and hills. The domestication of rice, including such cultural practices as puddling and transplanting, might have first taken place in China. The ancient Chinese cultural practices for rice then shifted to Southeast Asia and other parts of the world (De Data, 1987). Only in the twentieth century did systematic rice improvement start. For example, IRRI scientists Peter R. Jennings, Te-Tze Chang, and Henry M. Beachell developed the semi-dwarf variety "IR8" in 1966, which initiated the "Green Revolution" (Lang, 1996). China also successfully developed hybrid rice in 1973. These achievements have greatly increased the rice yield so as to feed the increasing world population, especially in Asia.

Oka (1988) indicated that domestication of rice involves decreased seed dormancy, increased seed shattering and selfing rate, and other adaptive characteristics. Wild rice usually has one month or more of seed dormancy resulting in nonsynchronous germination. This is an adaptive characteristic to increase the probability of regenerating success under changing environments. Seed maturity on a panicle also does not synchronize and the flowering for wild rice can last more than one month instead. Grain dormancy protects rice grains from sprouting on panicles because of frequent raining during ripening. Generally, *Japonica* has little dormancy, but *Indica* has some degree of dormancy. The tropical *Indica* in particular has quite strong dormancy. But grain dormancy is affected by the weather. For the same variety, sunny and dry weather will make the grain less dormant than humid weather. It was deduced that the substance(s) for grain dormancy exist mainly in the flowering glumes and the hull (palea and lemma) because dormancy was broken by simply removing the hull from the seed. Grain dormancy can be broken by chemicals, such as fungicides or diluted nitric acid, or by heat treatment (50° C for four to six days or even longer).

These Vietnamese rice paddies are not only used for growing rice, they are sometimes flooded for fish farming, and ducks can be raised in the paddies while the rice is young. PHOTO COURTESY OF THE NATIONAL ARCHIVES AND RECORDS ADMINISTRATION.

Grain shattering is affected by the strength of the spikelet attachment to its pedicel. The requirements for the resistance to grain shattering vary with the environmental and cultural conditions in the modern rice cultivation. Regions with strong winds at rice maturity require non-shattering varieties. Intermediate-shattering types should be grown for mechanical harvesting using a combine. If harvested by hand harvest and threshing, the intermediate type with resistance to shattering is preferred. In Asian rice, *Japonica* is highly resistant to shattering, but most *Indica* varieties have intermediate resistance to shattering. Wild rice has easy shedding or shattering and thus easy dispersal. Also, some wild rice has awns on the tip of the grain. Some rice varieties are either fully awned or partially awned among spikelets on the same panicle. This characteristic might be favorable for dispersal through water. The cross-pollinated feature of wild rice (similar to that of wild barley) might be favorable for rice evolution.

Hybrids. Before the 1970s, rice breeders extensively studied the utilization of rice heterosis after they realized the great potential of using heterosis to improve crops such as corn. Generally speaking, hybrid rice has more than 15 to 20 percent yield advantage over the best conventional rice varieties in China, Bangladesh, Brazil, Colombia, Ecuador, India, Indonesia, Malaysia, Myanmar, the Philippines, Sri Lanka, and Vietnam. Unfortunately, no large-scale planting of hybrid rice was successful until China developed a three-line (cytoplasmic male sterile line, male sterile maintainer line, and restorer line) system hybrid rice in 1973 and commercialized this technology in 1976. This was because of the very small reproductive organs and difficulty in finding or developing a cytoplasmic male sterile line in rice. China has greatly increased its rice production by the utilization of hybrid rice technology and therefore has been able to feed its rapidly growing population in the last quarter of the twentieth century. Now China is trying to increase the rice yield by employing the two-line system hybrid rice (male sterile line and restorer line) and intersubspecific heterosis (i.e., the heterosis between *Indica* and *Japonica*) utilization. By following China's success, other countries, including India, Vietnam, Myanmar, and Bangladesh, are currently learning to use the hybrid rice technology to boost the rice yield. FAO is also providing financial support to activities of networks on hybrid rice such as the International Task Force for Hybrid Rice and the Working Group on Hybrid Rice in Latin America and the Caribbean (GRUTHA). Outside China, the planting acreages under hybrid rice in Vietnam, India, and Bangladesh in 1998 were 250,000 ha, 120,000 ha, and 20,000 ha, respectively.

Production and Processing

Distribution. Generally speaking, the rice paddy is adaptable to regions that have sufficient rainfall, high temperature, and prolonged solar radiation. Rice has evolved into four major ecosystems based on different ecological or environmental conditions: irrigated (53 percent of the total rice crop area, exemplified by China), rain-fed lowland (23 percent), deepwater (11 percent), and upland (13 percent, exemplified by Latin America). Rice is cultivated on all continents except Antarctica. Recent estimates list 112 rice-growing countries, including all the countries in Asia and most of the countries of West and North Africa, some countries of East and Central Africa, most of the South and Central America countries, and Australia (De Datta, 1987). Geographically, current rice cultivation regions range from latitudes 53° N in Moho, China, to latitudes 35° S in central Argentina and New South Wales, Australia, from sea level in Bangladesh to an altitude of 3,000 m in Nepal. Asia produced 90.6 percent of the total rice production in 1999; Latin America, 4 percent; Africa, 3 percent; Europe, 0.5 percent; Australia, 0.2 percent; and the United States, 1.6 percent. The ten countries with the largest rice production in 1999 were China, India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, Brazil, Japan, and the Philippines, in descending order. Outside Asia, rice is consumed as a staple food in Guyana, Guinea, Liberia, Sierra Leone, and Madagascar. Based on the above geographical distribution of rice, currently there are three major international rice research centers from Consultative Group on International Agricultural Research (CGIAR), including the International Rice Research Institute (IRRI) in the Philippines, Centro Internacional de Agricultura Tropical (CIAT) in Columbia, and West Africa Rice Development Association (WARDA) in the Ivory Coast.

Cultivation. Rice can be grown in many ecosystems from upland to deepwater conditions. For the irrigating system, fields are plowed with a wooden plow, and then a harrow drawn by a docile and reliable water buffalo in most Asian countries. Some Asian countries, such as India and China, are still practicing transplanting the rice seedlings to suit for the double cropping or multiple cropping systems. Developed countries in Europe and America, such as the United States, employ direct seeding cultivation without transplanting, to avoid the cost of expensive labor and to take advantage of the advances in the mechanization of rice production. There are two methods for direct seeding: (1) dry seeding before sprouting, followed by a flow of water in Louisiana and Texas, and (2) wet seeding by low-flying aircraft in California and Arkansas because rice is unique, among cereals, in being able to germinate when submerged in water. In rice cultivation, the most serious pests include stem borers and leaf hoppers. The most dangerous diseases are rice blast, bacterial blight, sheath blight, and seedling blight. These pests and diseases can be controlled at the proper stage by chemicals or other measures. Now more efforts are being focused on breeding for resistant rice varieties through conventional approaches or through modern biotechnology, such as Bt. rice. The most persistent weeds in rice cultivation are barnyard grass (*Echinochloa spp.*), water hyacinth (*Eichhornia crassipes*), *Eleocharis acidularis*, *Typha* spp., and red rice. These weeds can be controlled by cultural approaches or by herbicides.

Harvesting and post-harvest operations. Rice is considered to be a photoperiod or daylength sensitive crop, although there are daylength-insensitive rice varieties. Short photoperiods or daylengths (less than 11 hours) will shorten its growth duration, which ranges from 90 to 160 days or even longer depending on the photoperiod sensitivity, the basic vegetative phase, and the temperature sensitivity. The approximate duration from flowering to maturity is thirty days. Photoperiod-insensitive rice varieties, such as most of the current rice varieties in tropical Latin America, are increasingly preferred because of their greater adaptability to a wide region and the flexibility in planting dates. But in some rice-growing regions, the strong photoperiod sensitivity of rice is used to grow rice in the rainy season; it is then harvested after the rainy season and before the dry season water shortage. The maturity of rice is also influenced by air temperature, planting methods, and nitrogen fertilization. The best time for mechanical harvesting is when panicles become yellow but the stem and leaves still have green color. At that time the moisture contents of grains should be 20 to 25 percent. By visual inspection in the field, rice can be harvested when the kernels on the upper part of the panicle are fully ripe and the ones in the lower part reach a hard-dough stage. For some rice-growing regions with some extra time beyond one rice-growing region, ratooning of the first rice crop is possible by using the varieties with high ratooning ability for maximizing the annual rice yields without too much investment. Currently, harvesting can be done with a combine in the more developed countries. However, most Asian and African countries are still harvesting rice by hand sickles, scythes, or knives, because of scarcity of capital, availability of inexpensive labor, and the topographical limits, such as small rice fields, mountainous fields, or deep-water areas. A rice combine threshes the harvested paddy after cutting. Hand threshing or threshing by animals or simple foot- or gasoline-powered threshing machines is still being used in some countries.

Storage. Before storage, the moisture content of rice grains should be reduced to below 14 percent. The most convenient method is sun drying if the weather permits—drying rice grains in the open air and under strong sunshine for one to two days. But the sun drying method can produce "sun checks," which reduce the head rice and increase the rice bran percentage; this method also requires intensive labor. Therefore, artificial drying such as batch dryers in Japan and the hot air dryers in the United States became an alternative to sun drying. The artificial drying can avoid rapid dehydration, which causes reduced head rice. The cleaning of rice grains is important to remove foreign seed and trash before storage. There are three major cleaning methods: air cleaning by using a hand winnower, mechanical cleaning by using sieves, and gravity cleaning. In rice mills, all impurities, odds and ends such as stones, and pieces of soil and straw must be removed by a screening or riddling process and a fan. Further removal of nails or bits of iron can be done with a magnet. Since aging through storage increases water absorption and paste viscosity and reduces solids dissolved in cooking water, cooked fresh rice tastes worse than rice with six to twelve months of storage because rice grains cooked immediately after harvesting tend to disintegrate and to be more cohesive. The curing process can be completed through keeping the rice in heaps of straw for several days or through domestic curing methods. However, long storage time should be avoided, especially for undermilled rice. Cooked rice, after several months of storage, becomes less sticky and more flaky. In addition to moisture, metabolisms of grain tissues, microorganisms, insects, and mites also causes storage losses.

Milling. Milling in the rice industry can refer either to the overall operations that include cleaning, hulling, pearling, polishing, and grading; or simply to one operation, removal of the rice bran or outer layers. Typically, the pericarp accounts for 1 to 2 percent of the weight of the whole rice caryopsis, seed coat and aleurone 5 percent, embryo 2 to 3 percent, and endosperm 89 to 91 percent (Wadsworth, 1994). The edible part of rice grain is enclosed in the glumes, which need to be first separated by hulling. The most primitive implement for hulling is the system with wood mortar and pestle or a treadle or watermill. These hulling methods are still used in some of rice growing regions in Asia and Africa. Now mechanical hulling or milling is popular in most of the rice growing countries. The hulled rice grains are then winnowed in order to remove the chaff and bran. Rice with the hulls removed but the bran left on is called "brown rice." "Milled rice" refers to the rice after removing all hulls, bran layers, and germ. After hulling, the removal of germs or outer coats—the so-called polishing—is necessary by using mechanical hulling or milling for better appearance to meet the market's need, with sacrifice of the flavor and healthy constituents in rice grains. Rice is generally marked either as polished rice or as coated rice with talc and glucose. Rice grains after polishing contain portions of broken grains that have to be separated and sorted to meet market standards. This separation can be accomplished by passing through a series of sieves or cellular cylinders or trieurs. Some discolored rice grains can be removed by electric sorting.

Enrichment. For restoration of vitamins and minerals lost during milling, the enrichment of rice is important for better nutrition. There are two major approaches: powder enrichment and coated kernel enrichment. For preblended powder enrichment, mixes include thiamine, riboflavin, niacin or niacinamide, and ferric orthophosphate (white iron), ferrous sulfate (yellow iron), or reduced iron. This is an easy and less expensive approach for enrichment of rice. But the disadvantages of the powder enrichment are that the nutrients are easily washed off by rinsing, less stability of vitamins and minerals, and their reaction with the food components. An alternative approach is the coated kernel enrichment. This method integrates the powder-blended enrichment with the insoluble food-grade coating. This coating is broken down and the enriched vitamins and minerals are released when the coating reacts with the acid environment of the stomach. This method has the advantage of more efficient use of the enriched vitamins and minerals.

Global and contemporary issues

In the first quarter of the twenty-first century, another 1.2 billion new rice consumers will be added in Asia. Currently, less than 5 percent of world rice production is traded internationally. Therefore, rice production in Asia must be increased by one third from today's 320 million tons to 420 million tons, even though rice land is decreasing.

For future rice production, there are also the following challenges: (1) genetic erosion because of the popular adoption of the high-yielding varieties (for example, *javanica* rice germplasm suffered significant losses in Java and Bali, Indonesia); (2) water pollution by chemical pesticides, herbicides, and air pollution; (3) less cultural management afforded to rice because more rice farmers, especially the young farmers, are moving to work in industry and metropolitan areas, particularly in such countries as China and Japan; and (4) decreasing water resources and increasing land salinity. Global warming might make this trend even more significant.

See also **Africa; China; India; Japan; Korea; Southeast Asia.**

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Jiming Li

RICE AS A FOOD

There are some countries with high annual rice consumption per capita (up to 130–180 kg, equal to 55–80 percent of total caloric source) such as Bangladesh, Cambodia, Indonesia, Laos, Myanmar, Thailand, and Vietnam (Chang 2000). Even in most parts of Africa, rice is a secondary staple food next to cassava, yams, corn, and millet. However, in the following African countries rice is consumed as a staple food: Liberia, Sierra Leone, Guinea, Ivory Coast, Ghana, Madagascar, and part of Nigeria. By comparison with the rice production and consumption in Asian countries, Latin America is often overlooked. However, annual rice consumption in the following countries exceeds more than 32 kg per capita: Brazil, Columbia, Ecuador, and the Dominican Republic.

Rice is the best cereal crop in terms of food energy per production area and is consumed in various forms, including plain rice, noodles, puffed rice, breakfast cereals, cakes, fermented sweet rice, snack foods, beer, wine and vinegar. Rice starch is used as a thickener in baby foods, sauces, and desserts or can be made into sweet syrup. However, most consumption of rice is as cooked rice served simultaneously with vegetable, poultry, beef, seafood, and other dishes. Rice as a comfort food is economical, delicious, nutritious, versatile, easy to prepare, and bland enough to pair with other foods. Rice is convenient to store on shelves in cupboards and pantries.

Preparation and Consumption

Rice consumption falls into the following three categories: direct food use, processed foods, and brewer's use. Detailed methods and recipes for rice food preparations were described by Bor S. Luh (1991), Sri Owen (1993), Jeffrey Alford and Naomi Duguid (1998), and Bor S. Luh (1999).

Direct food use. Rice is easy to prepare, has a soft texture for the human palate and stomach, and has the ability to absorb flavors while retaining its texture. Therefore, rice has gained popularity as "the pasta of the 1990s" in the West. Both the short-grain *japonica* and the long-grain *indica* rice include non-glutinous and glutinous types. Non-glutinous rice is somewhat transparent and is less sticky than glutinous rice when cooked. There are some rice varieties with an attractive aroma, such as basmati. Parboiled rice was originally produced in Asia, but the parboiled rice produced in the United States now, such as by the company Uncle Ben's, is of high quality. Arborio rice has large tan grains with central white dots and, because of its creamy, chewy texture, can be used to make risotto.

American wild rice is a coarse grass (not a true rice by taxonomy), and now has become more and more popular in the United States and Canada. It is grown in shallow waters and has medium to long grains and a nutty flavor.

Rice is cooked by heating (either boiling or steaming) soaked rice for full gelatinization of the kernels and evaporation of excess water. Generally there are three rice cooking methods: large-amount-of-water method, absorption method, and steaming method. The lot-of-water technique is good for arborio, basmati, or parboiled rice, but not for Thai jasmine or japonica rice with low amylose content, which should be cooked by steaming. Rice cooking methods also include rinsing, boiling, baking, roasting, frying, and pressure-cooking. It is customary to wash rice before cooking to remove dust, husks, insects, and other impurities. American-grown rice does not require washing or rinsing before cooking because these “cleaning” processes further remove nutrients, including vitamins and minerals that were added before packaging by fortification or enrichment.

Juliano (1985) indicated that rice cooking methods vary with different countries. Either uncooked rice or fully cooked rice combines well with other protein-rich foods such as meat, poultry, fish, cheese, and eggs because rice is bland in flavor and carries the flavor of the mixed ingredients. People in the Middle East lightly fry rice before boiling. Americans often add salt, butter, or margarine to soaked rice. People in China, Korea, and Japan add extra water to cook rice into porridge (thick gruel) or congee (thin soup). Rice can be cooked with curries (in India and Malaysia) or sauce (in the Philippines) or combinations of various ingredients, including pork, shrimp, chicken, and vegetables (in China) (Boesch 1967). Steamed rice is preferred in some countries because more vitamins and minerals are retained. Rice can be steamed in a bamboo steamer or, currently, in an electric metal steamer. Steamed rice can be served plain or mixed with other ingredients. Mixed steamed rice also varies among countries. For example, Malaysians steam glutinous rice with mixed meat in a bamboo joint over a fire. Cambodian *kralan* is steamed rice mixed with grated coconut and beans. Iranians steam rice with oil or with butter, and sometimes with yogurt, while rice is cooked with water and oil in Brazil, Chile, Ecuador, Germany, Mexico, and Peru. Some countries, such as France, Korea, Burma, Thailand, Japan, and the Philippines, add rice to cold water for cooking. Presoaking is a common practice in India. Detailed descriptions of recipes from different countries for cooked rice are provided by Virmani (1991). Rice can be kept as long as five days in the refrigerator. The leftover rice is good for stir-frying into egg fried rice with chopped carrots and the like. Rice can also be cooked with certain amounts of water and meat, seafood, vegetables, or other additions in clay pots or high-pressure metal pots to make thin or thick congee (or *juk*) or gruel (*okayu*, in Japanese).

Parboiled rice: Parboiling is popular in India, Sri Lanka, Pakistan, Brazil, the United States, and Italy. Parboiling changes rice starch from the crystalline form to an amorphous form by a series of procedures including cleaning, grading, soaking, steeping, steaming, drying, tempering, milling, color sorting, and finally packaging. It involves the treatment of grains in cold water and then hot water with low pressure. The treated rice can be dried by the steam or sun. Problems of off-color and off-flavor that resulted from conventional parboiling procedures have been overcome by various inventions, such as the H. R. Conversion and Malek Processes (D. H. Grist, 1986). Major advantages of parboiling over ordinary milling include easier dehulling; less breakage in milling; higher retention of nutrients after milling, washing, and cooking; and better resistance to insect and fungus infestation, which makes it possible to store the rice for longer periods of time. Also, parboiled rice gelatinizes the starch and makes better consistency, greater hardness, and better vitreousness of the kernel. The main disadvantages of parboiling include greater rancidity during storage, longer cooking time, greater difficulty in milling, and additional cost (De Datta, 1987).

Rice-flour products: Rice flour does not contain gluten and therefore its dough cannot retain gases during baking as wheat flour does. Therefore, rice flour is widely used in making baby foods, breakfast cereals, unbaked biscuits, snack foods, pancakes, and waffles. For example, a composite baking flour, made by adding 10 percent rice flour to wheat flour, is used to make pastry products in Italy.

Rice-flour products are exemplified by the following foods: *yuan zi* (or *tong yuan*) is a popular food in China. It is made from glutinous rice flour and water by adding sweet or savory fillings to the rice dough. The quality of *yuan zi* preparation depends on the amylopectin content, the flour particle size, and the recipe for the fillings. (The higher the amylopectin content, the softer and more sticky the rice flour becomes when the same amount of water is added.) *Yuan zi* is fried with vegetable oil or thoroughly cooked in boiling water and served with sugar or other condiments.

Rice bread is a good substitute for other gluten-containing cereal flour, as some people are allergic to these flours. The medium- and short-grain rice varieties are preferable to the long-grain type for making rice bread. Formulation is important in making rice bread by adjusting the levels of sucrose, yeast, water, nonfat dry milk, and other additives.

Processed foods. *Rice noodles:* Rice noodles are called *mi fen* in Chinese, *sen mee* in Thai, and *harusame* in Japanese. *Mi fen* is often produced from non-glutinous rice by soaking, grinding, steaming, kneading, and drying. If dehydrated, it can be stored up to two years. In Thailand, mung bean is added to rice to make a special rice noodle called *fung-shu* (or *tong-fun*) that is more resistant to texture changes during reconstitution. In Asia, rice noodles are consumed in soups or as snacks. *Mi fen* is served with water, meat or chicken, green vegetables, soy sauce, and other ingredients.

Rice snacks: Rice snacks have an attractive taste, flavor, texture, and aroma.They are often made from glutinous rice because of its sticky characteristics and easy expansion into a porous texture. However, non-glutinous rice also can be used for making some rice snacks.

The rice cracker is a typical rice snack. The Japanese soft rice cracker made from glutinous rice is called *arare* or *okaki* in comparison with the less popular and tougher *senbei* (the rice cracker made from non-glutinous rice). The production process involves washing, grinding, steaming, kneading, cooling, pounding, drying, baking, seasoning, cutting, and packing. The production of rice crackers is now developed as a continual process that takes place within 3–4 hours. To add flavors and color to rice crackers, the following ingredients are often added: seaweed, sesame, red peppers, sugar, food pigments, and spices. Moreover, high-quality, refined oil should be used for oil-fried crackers.

Rice fries can even compete with the French fries made from potatoes because rice fries have a crisp exterior crust and fluffy interior. To make rice fries, rice should be fully cooked with butter, salt, and other seasonings.

Rice cakes: Rice cakes are popular in China, Japan, and other Asian countries. They can be made either from glutinous or non-glutinous rice by soaking and steaming. Before steaming, various ingredients can be added for more flavor, such as sugar, salt, monosodium glutamate, crushed radish, crushed mung bean (for *lu du gao*, a special cake in China), and crushed taro.

Glutinous or waxy rice is very sticky when cooked and is mainly consumed in northern Burma, northern Thailand, Laos, and Vietnam. It is often used to make rice cakes. However, fermented rice cakes, such as *fakau* in China and *bibingka* in the Philippines, can also be made from non-glutinous rice.

Puffed rice cakes are popular in China and the United States because they are rich in taste, low in calories, and free from cholesterol. To make puffed rice cakes, some minor ingredients, such as sesame seed, millet, and salt, should be added to brown rice.

The Chinese rice cake *zong zi*, the same as *chimaki* in Japan, is made from glutinous rice and soda ash, wrapped in bamboo leaves to form a tetrahedron, bound with string, and served with honey or sugar. There are two main categories of *zong zi*: *chien zong* and *rou zong*. The difference between *chien zong* and *rou zong* is that pork or ham and other ingredients are added to *rou zong* to enrich the flavor and nutritional value. Other ingredients include mushrooms, soy sauce, monosodium glutamate, sugar, black pepper, sherry wine, fried garlic, cooking oil, and shrimp meat.

Neng gao or *nian gao* (*mochi* in Japanese) is also a special rice cake for the celebration of the Chinese Lunar New Year. It is produced either from glutinous rice or from nonglutinous rice. The main production procedures involve soaking, steaming, kneading, and packing. For better taste and flavor, *neng gao* is sometimes sweetened with sugar or enriched with lard and cinnamon flour.

In Japan, sushi is a rice cake or roll or cube topped with raw fish or other delicacies and served with wasabi (Japanese horseradish). Fresh raw fish used in sushi include tuna, bonito, shrimp, squid, and shellfish. Vegetables such as cucumber and seasoning gourd also can be put in the middle of the rolls, which are then wrapped with seaweed (*nori*). Sushi usually is served with rice vinegar and soy sauce (*shoyu*).

There are many other types of rice cakes made in Asia. For example, *biko*, *cuchinta* (or *kutsinta)*, *puto*, *suman*, and other rice cakes are made in the Philippines.

Rice puddings: Rice can be made into creamy puddings by mixing cooked rice with milk and sugar. Indian consumers sweeten rice pudding with palm sugar. Rice puddings were served to the rich during the time of the ancient Romans. Now, rice pudding has become a popular dish for children. A delicious Chinese pudding is the Eight Jewel Rice Pudding, prepared from eight different kinds of fruit and steamed glutinous rice with honey.

Quick-cooking rice: The preparation and cooking of conventional rice take about one hour. Now, quick-cooking rice product is popular in developed countries, such as Japan, the United States, and other Western countries. Completely precooked rice requires no further cooking. However, quick-cooking rice often requires five to fifteen minutes for cooking. To produce quick-cooking rice, rice should be precooked by gelatinizing the rice starch in water and/or steam and then dried. Quick-cooking rice mainly is produced by the soak-boil-steam-dry, freeze-thaw-drying, expansion–pre-gelatinization, and gun puffing methods.

Canned and frozen rice: For convenience of consumption, canned and frozen rice are produced in Japan, Korea, the United States, and other countries. After precooking, canned rice is sold by wet pack and dry pack. The preparation of frozen cooked rice includes soaking, draining, steaming, boiling, and freezing. To serve the frozen cooked rice, microwave heating is a common practice. Frozen rice also can be made into freeze-dried rice by sublimation under high vacuum. This rice has a long storage life of one to two years.

Rice breakfast cereals: Some rice breakfast cereals require cooking before eating, while others can be eaten directly. They commonly are fortified with minerals and heat-stable vitamins, such as niacin, riboflavin, and pyridoxine. The ready-to-eat breakfast cereals include oven-puffed, gun-puffed, extruded, and shredded rice. Oven-puffed rice is made from short-grain rice with sugar and salt by cooking, drying, tempering, enriching, and packaging. Gun puffing is a traditional method and is still practiced in some Asian countries, such as China. The procedure consists of heating, cooking with high pressure in a sealed chamber or gun, and suddenly releasing the high pressure. Because of the lack of continuity in processing, gun puffing is less popular in developed countries. Instead, making extruded rice has high and continuous production rates, great versatility in product shape, and ease of controlling product density. The production of extruded rice can be accomplished by extruding superheated and pressurized doughs. Shredded rice is produced by washing, cooking, drying, tempering, shredding, fortifying, and packing.

Baby foods: Rice has highly digestible energy, net protein utilization, and low crude fiber content. Therefore, it is suitable for baby food. Although baby foods can be in the form of rice flour or granulated rice, precooked infant rice cereal is the most common use of rice for baby food. The key to making this type of cereal is ensuring the ease of reconstitution with milk or formula without forming lumps. The starch is converted from crystalline to amorphous form by the addition of amylase, which breaks down starch into dextrin and oligosaccharides. Ingredients in this baby food include rice flour, rice polishings, sugar, dibasic calcium phosphate, glycerol monostearate (emulsifier), rice oil, thiamine, riboflavin, and niacin or niacinamide. Sometimes, fruit is added to these precooked rice cereals.

Rice-bran products: Rice bran can be sprinkled on a dinner salad or used as a major ingredient of ready-to-eat cereals, baked products, pasta, and other foods. Like oat bran, rice bran has high-quality protein, laxative properties, and dietary fiber components. Rice bran can lower serum cholesterol in humans and reduce the risk of cardiovascular disease and colon cancer. The bran also contains most of the vitamins in the rice kernel, including 78 percent of its thiamine, 47 percent of its riboflavin, and 67 percent of its niacin. The major carbohydrates in the rice bran are cellulose, hemicelluloses (or pentosans), and starch.

Rice bran has hydrolytic rancidity after milling. Therefore, the following treatments are necessary before it is processed as a food: indigenous lipase inactivation by parboiling, or moisture-added or dry extrusion, or other alternative methods.

Rice bran has 16–32 percent oil, including palmitic, oleic, linoleic, and other fatty acids. Therefore, rice bran can be processed into rice oil of the highest quality in terms of cooking quality, shelf life, and fatty acid composition. Oil extraction can be carried out with a variety of solvents using a hydraulic press or specially designed extractors before refining by dewaxing, degumming, neutralization, bleaching, winterization, and deodorization. After these steps, rice bran oil has greater stability than any other vegetable oil. Rice oil also can be used in cosmetics and paints.

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MOCAMBIQUE

Women processing rice at a cooperative in Mozambique. © ADRIAN ARBIB/CORBIS.

Brewer's use. Rice alcohols include rice beer and rice wine, which is usually served at weddings and other annual rituals. Rice wine is distilled spirits having about 20 percent alcohol content. China has a long history of making rice wine, such as *wang tsiu* ("*Shao Shing* rice wine"). Nepal also has a slightly sweet rice wine called *nigar.* Other rice wines include *tapuy* in the Philippines, *mukhuli* in Korea, *lao rong* in Thailand, and *moonshine* rice wine and *ba-xi de* (a glutinous rice wine) in Vietnam.

In China, *tian jiu niang* is a popular mixture of rice grains, alcohol, lactic acid, and sugar. It is made from steamed glutinous rice. *Jiu qu*, containing *Rhizopus*, *Mucor*, *Monilia*, *Aspergillus*, and in some cases, yeast or bacteria, is used to ferment the steamed rice.

Sake is a brewed alcoholic beverage having 14–16 percent alcohol content. The production of sake began in third century Japan. Sake is made from highly-polished rice, water, *koje*, and sake's yeast. *Koje* are microbes similar to those used in the production of cheese, *shoyu* (soy sauce), and miso (soy bean paste). *Sakamai* or *shinpakumai* rice should be selected for sake production for better quality because of its high starch content and its large and soft grain. Another important ingredient is the spring water, which leads to rich flavor.

The processes to make sake can be summarized as the following: (1) saccharification: conversion of the starch in cooked rice into glucose with *koje* or *koji*; (2) fermentation: conversion of the rice sugar into alcohol by sake's yeast. Fermentation for 20–25 days (three or four times longer than the fermentation in normal wine production) produces a balanced taste and fresh flavor from a wide variety of amino acids and low alcohol content (8–15 percent); and (3) further steps including filtration, setting, heating, aging, and bottling. Sake should be preserved in a cool and dark place without any exposure to light and open air.

Nutritive, Health-related, and Psychopharmacological Value

Rice ranks high among the most nutritious foods available because brown rice provides high levels of fiber, complex carbohydrates, certain B vitamins, vitamin E, lysine, calcium, iron, and phosphorus. Furthermore, many fewer people are allergic to rice than to wheat or other cereals. Rice can be included in a weight-loss diet because it has no cholesterol, a trace of fat, and about 160 calories per cooked cup.

Recent studies have indicated that rice hull or bran contains antioxidants such as isovitexin (a C-glycosyl flavonoid), and it has been demonstrated that rice bran oil can lower both the total and the low-density lipoprotein cholesterol in non-human primates (Nicolosi et al., 1990). Some health problems, such as beriberi (thiamin deficiency), growth retardation, marasmus, and vitamin A deficiency, can result from consumption of only white rice, from which a portion of the proteins and most of the fat, vitamins, and minerals are removed. Rice bran (*tiki-tiki*) is used to cure beriberi in the Philippines.

Since rice is low in sodium and fat and free of cholesterol, it can help relieve mental depression. Rice starch can substitute for glucose in an oral rehydration solution for infants suffering from diarrhea caused by a spleen-pancreas deficiency (Juliano 1985). Rice oil is believed to reduce the likelihood of ischemic heart disease.

Although not scientifically proven, rice is believed to have medicinal uses. Powdered rice is used to treat certain skin ailments, and boiled rice "greens" are used as an eye lotion in Malaysia. A thick paste made from rice grains and water is used in India for massage for curing arthritic pain. The Chinese believe that rice can increase appetite and cure indigestion. Rice water (a decoction of rice) is prescribed as an ointment for skin inflammation. Glutinous rice is believed to strengthen the kidneys, spleen-pancreas, and stomach because of its easier digestion compared to regular rice. The Chinese also believe that rice mixed with honey butter and water can build energy and blood and counter emaciation and other disorders (Wood 1999).

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Jiming Li

RICE AS A SUPERFOOD

Widely adapted to diverse environments, rice is an important part of culture, traditions, and subsistence in some countries, especially those in Asia. There is a wealth of literature on the rituals and traditions of rice consumption throughout the world (Virmani, 1991; Piper, 1993; Newman, 1999).

Languages and Symbolism

In Asian languages, daily or important events are expressed in terms of rice. In many Asian countries, such as Thailand (*tarn kao*), Bali (*ngajengang*), Laos PDR, and Bangladeshi, the phrase for eating rice is synonymous with eating food (Williams, 1996). More directly, Chinese and Japanese people refer to breakfast, lunch, and dinner, as morning rice, afternoon rice or noon rice, and evening rice, respectively. Chinese say, in addition to "Happy New Year," "May your rice never burn!" at the beginning of the Chinese Lunar New Year. A common daily greeting in China, Thailand, and Bangladesh is "Have you eaten rice today?" instead of "How are you?". A Japanese proverb says "a meal without rice is no meal," just as the Chinese think that if their friends who are invited to dinner do not eat rice, they have eaten nothing. Rice is so important in Malagasy that the Malagasy word for rice is used as a unit of measurement for time and distance, and in expressions, proverbs, and riddles. Malagasy people refer to "friendship" as rice and water, and to "perfection" as rice with milk mixed with honey.

Rice generally is a positive symbol. In ancient Japan, rice was considered most important next to the emperor. Any wasting of rice was not allowed. In the Japanese feudal period, the chiefs were ranked based on their rice yield. In some Asian countries, such as the Philippines, rice cakes are used as ceremonial foods because they mean long life, happiness, abundance, prosperity, and good fortune. Koreans also believe that a baby will become rich if the child chooses rice from among all the objects put on the table in a "choosing" ceremony.

Rice has other meanings. In Chinese culture, death is symbolized by sticking chopsticks into a mound of rice. Chopsticks are placed on the rice bowl at one end as a memorial of the dead at festivals or important family gatherings. In addition, rice grain symbolizes devotion, affection, generosity, and respect in Nepal, and it is symbolic of a man's body to Thai villagers.

Cultural Preferences

Preferences for rice vary from culture to culture, and from person to person. Most of the major rice-consuming countries eat plain or mixed rice prepared from regular or parboiled rice. Korean rice consumers prefer new rice because of its fresh taste and white color. Laotians prefer the sticky, short-grain varieties and often cook them plainly. In Pakistan, a large quantity of rice is consumed typically as biryani, which is cooked in a meat sauce with other ingredients. In Thailand, *khao tom* (a soft soupy rice gruel) is served as breakfast with other dishes, but the most popular rice dishes include garlic rice, saffron rice, rice colored with coconut milk, and fried rice with meat and tomato ketchup or fish paste. In the Middle East, sautéed rice with vegetables, fruits, and nuts is popular. People in Central Asia consume rice as a festival food and eat rice prepared as rice pilaf. For example, Iranians eat boiled long-grain rice with grilled meat and soup or tea. Most African people also eat plain boiled rice with soup, meat, and seafood. But in some regions in Vietnam, mixing rice with several other dishes is socially unacceptable. India has the following common preparations for rice meals: plain boiled rice, *khichri* (rice cooked with mung beans), *pullao* (fried rice), and *kheer* (rice pudding). Parboiled rice is also important in India. In the Philippines, rice is served at each meal in the form of steamed rice with meat or seafood. In Indonesia, rice is eaten all the time, either as a main dish or as a side dish with other vegetables, fruits, or meat. Many Indonesian consumers eat red rice and unpolished rice. *Ketuput liontong* (rice rolled and steamed in banana leaves), *nasi goreng* (fried rice sprinkled with saffron or turmeric), and *nasi tumpeng* (a cone of white rice garnished with red, black, and yellow food) are specialty rice foods in Indonesia. Rice can be prepared or served in banana or palm leaves in Malaysia. In Japan, non-glutinous rice is used in daily meals, together with pickles. Pot rice, prepared with rice, soy sauce, fish sauce, and sometimes seafood, meat, or vegetables and mushrooms, has become a popular rice food in Japan. In Korea, the daily meal consists of steamed rice and vegetables, fish, meat, soup, and *kimchi*. A popular Korean dish is *pah jook* (a combination of rice and beans). Pakistanis generally eat aromatic rice, either plain or cooked with meat.

Cultural preferences for different rice varieties also exist. Rice consumers in Peru prefer long-grain and non-glutinous rice prepared with oil, garlic, and salt. Brazilians like soft, non-glutinous, and aromatic rice prepared in various ways. In Australia, rice consumption reflects an increase in the influence of Asian culture, and people generally prefer long-grain rice despite domestic production of short-grain *japonica* rice.

Rice is served as other forms of foods. Vietnamese usually steam soft rice with extra water and make rice noodles or pancakes. For their breakfast, they usually eat a large bowl of noodle soup, sometimes with sticky rice gruel. In the south of India, the common rice foods include steamed rice muffins and rice pancakes for breakfast. In Myanmar, favorite dishes include *mohinga* (rice noodles served with fish, eggs, and other ingredients), rice cooked with coconut milk, and rice with hot and sweet vegetable soup. *Nasi dagang* is a traditional Malaysian food made from unpolished glutinous rice with coconut milk and other ingredients. In Thailand, rice is also consumed as rice balls, rice cakes, rice pudding, and rice noodles.

Rice is sometimes indirectly consumed. In the Middle East, rice is used as a stuffing in other foods. Iraqis prefer short-grain rice in the form of plain boiled rice or rice stuffed in peppers or in chicken or turkey. In ancient Japan the rice wine sake was consumed primarily in the imperial court, larger temples, and shrines. Today, it is served at traditional ceremonies in Japan. In South and North America, rice is a supplemental food in Mexico, Peru, and Brazil. Rice is consumed as rice noodles, fried rice, rice cakes, and rice pudding (in Mexico). European people prefer rice cakes and rice puddings made from long-grain and aromatic rice.

Cooked rice can be served and eaten in different ways. Bowls and chopsticks are used for eating rice and other foods in China and Japan. But flat plates, spoons, and forks are used in Thailand instead. In India, rice is served on a banana leaf, a plate, or a metal tray, and eaten with the hands.

Rituals

There are many rituals for each stage in the production of rice. When opening a water channel, holy water from central lakes is sprinkled onto the field and the priests from the mountain temple make blessings. After sowing the seeds, a dance feast is held in Borneo, in which masks are worn to frighten away the rice evil spirits. Rice seed development is considered as if it were a pregnancy. Therefore, there are birth rituals in which people sing to the baby rice. Harvest is celebrated with dances as a Thai tradition. During rice harvest in Bangladesh, *pithas* (a popular dish) are made from new rice flour. The Iban farmers of Malaysia will whisper an apology or make amends with a special ritual for any rice grain wasted.

Customary Beliefs

The origin of rice is believed by Malaysian people to be associated with the sky (Sri Owen, 1993). It is believed in some countries that rice is holy and therefore should be well treated, protected, and honored. For example, men are usually not allowed to carry rice to the granary and cook it. Women also should show deference to rice. They should enter the rice granary at night or noon when rice spirits are sleeping, and be properly dressed without making noises by talking or chewing. Their breasts should be covered and they should enter the granary with right foot first. In China and Singapore, a good job is symbolized by an iron rice bowl, and a broken rice bowl means "out of a job." It also is considered bad luck to upset a rice bowl.

Festivals and Holidays

Rice is an important ritual food to celebrate the New Year. To celebrate the Japanese New Year, *Oshogatsu*, *mochi* (a glutinous rice cake) is prepared by toasting over a fire (a similar tradition to the current practice in central China) and served to begin the year on the "right foot." A special spiced rice wine, *toso*, is used for the celebration of the New Year. The New Year ends with special rice porridge. Similarly, to celebrate the Chinese New Year, *nieu koay* (a sweet and sticky rice cake) is offered to the deities in Malaysia, and *Tet* (the Lunar New Year) is celebrated with glutinous rice cakes in Vietnam. *Nien gao* (glutinous rice cakes of different shapes and colors), sounding like "going high" in Chinese, is served in China for the celebration of the Chinese Lunar New Year as a good luck symbol. To celebrate the Lunar New Year in Thailand, sticky rice cakes are prepared with mortar and pestle and cooked in the fire until a golden brown color is obtained.

Rice plays an important role in other festivals or ceremonies. In Sri Lanka, for the first day of every month and for festivals, *karibath* is served with milk and curries. On May 15 every year, the small town of Lucban in Quezon Province, the Philippines, celebrates the *Pahiyas* (precious offerings) Festival by decorating the outside of the houses with *pahiyas* made of rice flour paste. For the Chinese *Duan Wu* (Dragon Boat) Festival on the fifth of the fifth lunar month, *zong zi* (triangular and leaf-wrapped rice cakes) is prepared and dropped into the river or sea for appeasing the soul of an ancient minister, *Qu Yuan*, before the boat races. *Zong zi* is often eaten before the family-union feasts for celebration of the *Duan Wu* festival. In the Philippines, *pagdidiwata* (a thanksgiving festival) is celebrated by sharing rice wine with spirits. Rice is involved in other ceremonies or festivals in India, including naming ceremonies (*namkaran*) and birthday celebrations. Rice also is important in India during the *Bhai Dhooj* (sister-brother day), *Diwali* (festival of light), *Makar Sakranti* (January 13), and *Pongal* festivals.

In Thailand, the Royal Plowing Ceremony has been a great event in front of the Grand Palace in Bangkok for more than 700 years. In the ceremony, the *Phraya Raek Na* (Lord of the Festival) performs a rite to predict the weather during the coming season, plows the field with a pair of ceremonial bulls, and scatters the rice seeds into the field with the help of the four *Nang Thepis* (consecrated women). People will rush to the field to pick up the sacred rice grain to take home. In the past, the traditional dance *Rabam Mae Posop* was performed to honor the rice goddess. Cambodia also has a similar royal plowing ceremony to mark the beginning of the rice-growing season.

Social Behavior

Rice (scented rice, colored rice, or rice alcohol) also can be served to family and friends to cement relationships or to enhance status. These ceremonies include the following situations: at marriage, at births, before building a house, before a major hunt, and before the start of a new season.

Rice is popularly used in wedding ceremonies because it is the symbol of life and fertility. In Indian wedding ceremonies, a handful of rice is tied to the corner of the sari of the bride when newlyweds take their vows. Upon arrival at the groom's house, she will step on a pan full of rice and the rice spilled out of the pan will be kept by the family for remembrance. In India, Sumatra, the United Kingdom, and some parts of the United States, rice grains are showered on the newly wedded couple for good luck and a fruitful marriage. It is suggested that this tradition might originate from China (Boesch, 1967). In wedding ceremonies in Myanmar, colored rice grains are showered on relatives and friends, as well as on the newlyweds, for good wishes. During Japanese weddings, the newly wedded bride and groom are required to take three sips of sake from each other's cup. Rice grains or rice flour are served during wedding ceremonies. In *pokok nasi* (a wedding ceremonial offering in Malaysia), glutinous rice is used as bedding for the artificial tree made of boiled eggs, leaves, and stems. In Bangladesh, *biryani*, a spicy dish consisting of rice and goat's meat, is served at wedding receptions in the urban areas. Special rice cakes called *nakshi pithas* also are prepared for wedding ceremonies. In the later part of wedding ceremonies in Sumatra, the newlyweds will "pull chicken from yellow rice" by custom.

Rice is an essential ingredient of offerings at birth celebrations. In Perak, Malaysia, rice is traditionally used to present the newborn to the spirit of the river by making offerings (rice packets, betel, and eggs) at the river side; rice dust and parched and yellow rice are sprinkled and scattered on the water. In Korea, *Yakbap*, glutinous rice steamed with nuts and honey, is served on festive occasions, such as birthdays and New Year's. Rice cakes or rice meals and *bobju*-wine (a rice wine) are served during wedding ceremonies and the celebration of births. The sharing of rice cakes among one hundred people symbolizes good luck and long life for the baby.

Rice can be found in other significant events. Special sweet and mild sake is used to celebrate *Hinamatsuri* (the Japanese Girl's Day). Rice paste is involved in purification ceremonies in Malaysia and other countries.

Spiritual Beliefs

There are many origin myths and much folklore about rice (Sri Owen, 1993). It is believed that there are many gods or goddesses related to rice. The gods or goddesses gave rice to humans and taught them how to grow rice. Religious use of rice takes place in India, China, Thailand, Indonesia, Sri Lanka, and Malaysia. In Asia, the rice spirit is female and often a mother figure. Cambodian rural villagers believe that *Yiey Tep* (a female guardian spirit) stays in the rice field. Therefore, they offer food (often sweet rice porridge) at the corners of rice fields (Solieng Mak, 1998). The Chinese believe that, in order to save hungry people, the goddess Guan Yin squeezed her breast so hard that her milk and blood went into the rice grains. That is why we have both white and red rice. In the northern Himalayas, the goddess *Pavarti* is believed to be the first to have grown rice. Indians worship rice as *Lakshmi*, the Hindu goddess of wealth. For Indians in Malaysia, rice flour is used to decorate the entrances of houses to welcome Lord Krishna and the goddess *Lakshmi* at *Deepavali* (the Festival of Lights). Indonesian people perform rituals to honor the goddess *Dewi Sri*. The "first fruits ritual" occurs before the harvest, in which rice dolls symbolizing *Dewi Sri* and her partners are made and placed in the rice granary or at home to ensure a bumper harvest. The Balinese honor *Dewi Sri* by offering dyed rice paste at celebrations. The *jaja*, which is made from colored rice paste of different shapes and prepared in different ways, is used for decorating offerings of fruits and flowers at merry or solemn Balinese ceremonies or festivals. At many other festivals, cooked and colored rice cakes are offered, decorated with flowers and palm leaves. The Balinese believe that *Indra* (Lord of the Heavens) taught men how to grow rice and rice is the soul of man. When the Balinese plant the first rice seedlings in the field, a special planting pattern is followed for the first nine seedlings after offerings are made to *Dewi Sri* (the goddess of rice). Multicolored cones of cooked rice are used for recalling the *nawa sanga* (rose of the winds) (Piper, 1993). In Japan, it is said that the sun goddess *Amatereshu-Omi-Kami* first grew rice in the field of heaven, and Prince Ninigi brought it for human culture. Japanese classic records also indicated that rice came from the eyes of the food goddess *Ohegetsu-hime*. The goddess for rice is *Bok Sri* in Java. The union of *Bok Sri* with *Djaka Sudana* (the male rice spirit) is celebrated by people working in the nearby fields. In Thailand, the rice goddess or rice mother, *Mae Posop*, is worshiped and believed to bring good harvest. Therefore, no men, loud noises, or talk of death or demons are permitted before harvest since *Mae Posop* is shy and easily frightened; miscarriage of her pregnancy during harvest time might occur. *Khao Chae* in Thailand also originated from the celebration of the first day in the lunar calendar when the Mon people offered *Kao Songkran* (*Songkran* rice), later *Khao Chae* modified with ease to be soaked (*chae*) in water, to the female guardian spirit of the New Year. The Rungao people in Vietnam believe that the shadow on the moon is the goddess heaping rice.

Other religious beliefs include the following: *Pulang Gana* is the spirit for rice growth in the beliefs of the Iban people. In Nepal, *tika*, the holy mark made from rice grains and yogurt, is put on the forehead of youngsters by elders for blessings during religious occasions. Similarly, at the *Durga Pcoja* festival, rice sprouts are offered to youngsters as good blessings from the goddess *Durga*.

People believe that rice spirits are involved in rice production. For the Iban, *padi pun* (the sacred rice) is protected by prohibitions, acts of respect, and deference. For example, it is not handled by men and never sold to others. It is harvested last after harvesting other rice without any break in the path of harvesting. Sometimes, the bamboo pole is used as a bridge to the gap between harvesting locations with singing, prayers, and offerings so that the spirits from all harvested rice eventually come to the *padi pun*. When the Iban people harvest rice, they use a concealed knife in order not to offend or scare away the rice soul. The Brou people in Cambodia have a similar tradition when clearing the forests for growing rice. They show their respect to the local *arak* (minor spirits having a particular location) with offerings and ceremonial articles such as a knife, axe, banana shoot, and chick legs on which chicken blood is poured. When harvesting, beer and chicken are placed in the rice field as thanks. Both Iban and Brou people pray for an increase in the quantity of rice in the granary.

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RICKETS. *See* **Vitamins.**

ROASTING. Roasting is a dry-heat method of cooking whereby meat or poultry is cooked on a spit over a fire or in a pan in an oven. Roasting began in prehistoric time when the first human stuck a piece of meat on a stick and held it over a fire. Spit-roasting fowl and game was common in ancient societies. In the Middle Ages, hunting was a prime occupation of the noble classes, and the game was usually roasted on a spit. Suckling pigs were also candidates for the spit. Beef, however, was not; it was considered "vulgar" because cattle did not have to be hunted. Not until the seventeenth century did roast beef became widely accepted in Europe.

Roasting, perhaps because it requires prodigious amounts of fuel and large pieces of meat, has always been considered the most prestigious form of cooking. The world's largest and oldest gastronomic society, the Confrérie de la Chaîne des Rôtisseurs (The Brotherhood of the Chain of the Roasters), was founded in Paris in 1248 by masters in the art of roasting geese (called "rotisseurs"). The object of the Guild was to perpetuate the standards of quality befitting the royal table under Louis IX, King of France. The king loved his roast for the same reason people still love roasted meat: roasting develops and improves the flavor, color, and aroma of food. Properly roasted meat is tender, delicious, appetizing, and easier to digest than meat cooked by other methods.

The roasting method is one of the simplest ways to cook fine cuts of prime beef, lamb, pork, and veal, but, as any culinary student can tell you, simplicity in the field of culinary arts can be tricky. In cooking, as in all of the arts, simplicity is the sign of perfection. Roasting is often the method of choice because it yields a tender pink interior and crisp browned exterior through prolonged oven cooking. Before beginning the oven-cooking phase of the roasting process, the meat must be trimmed, tied, seasoned, and, if possible, seared.

A roast begins as a piece of meat either on the bone or with the bone removed. A roast can range in size from a small pork loin, boned and rolled, that can feed four, to a beef round on the bone that can serve up to one hundred people. Such large, or primal, cuts are usually cooked by the roasting or rotisserie method. As a verb, "to roast" means to oven-cook food in an uncovered pan, over indirect heat. A "rotisserie," the noun, cooks food by slowly rotating it over direct heat.

A rotisserie contains a spit fitted with a pair of prongs that slides along its length. Food (usually meat) is impaled on the spit and the prongs are screwed tightly into place to hold the food securely. Roasting and rotisserie cooking produce the best results with reasonably tender pieces of meat or poultry. Tougher pieces of meat usually require moist cooking methods such as braising or pot-roasting. When time allows, less tender but larger, fatty meat joints can also be cooked rotisserie style to achieve the same results as tenderer cuts.

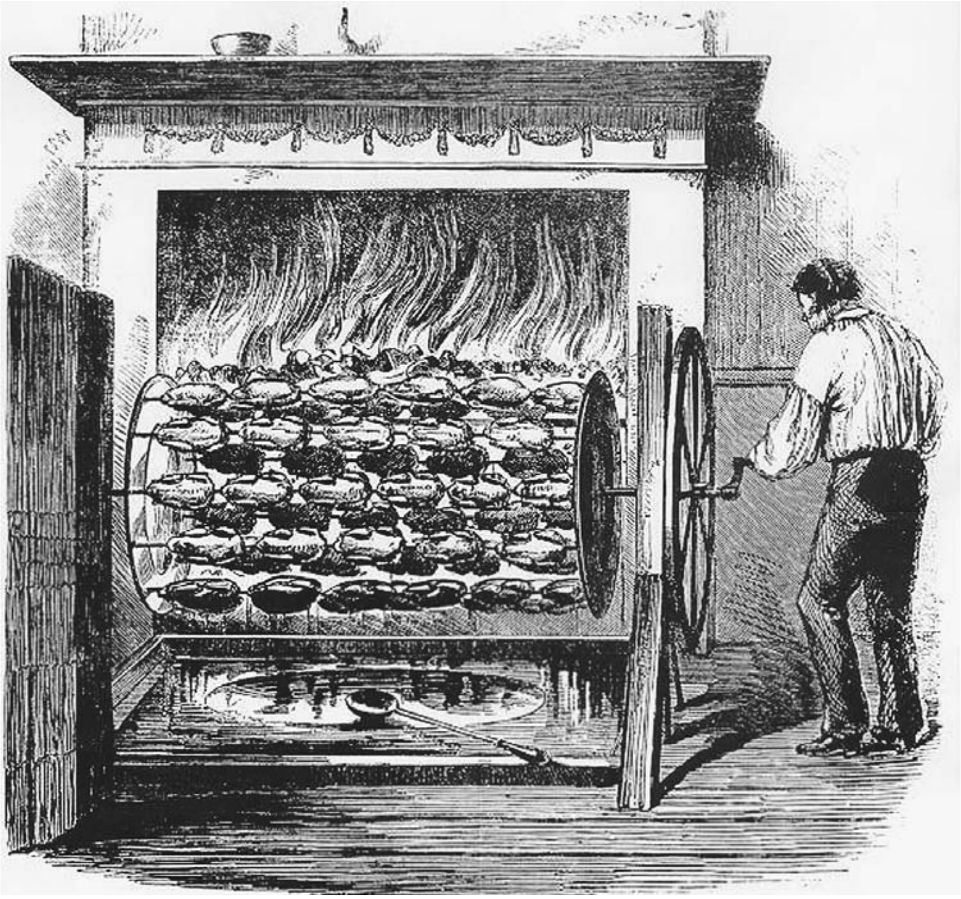
TABLE 1

Roasting times and temperatures (temperature in degrees Fahrenheit)

Food	Oven temperature	Roasting time	Doneness and temperature
Beef:			
Whole tenderloin (4 lbs.)	400	35–45 minutes	Rare 120–130; medium rare 130–140
Top loin (4½ lbs.)	425 for 15 minutes, then 350	1¼ –1½ hrs.	Rare 120–130; medium rare 130–140
Prime Rib(5-rib, 12-lb. roast)	325	5-rib (11–13 lbs.): 2¼–2¾ hrs. 3-rib (7–8½ lbs.): 1½–1¾ hrs.	Rare, 120–130; medium rare 130–140
Leg of lamb (8 lbs.)	350	1hr.–1½ hrs.	Rare 120–130; medium rare 130; medium 140
Pork loin boneless (4 lbs.)	350	2¼–2½ hrs.	Cook to 160
Chicken (4–7 lbs.)	400	1 hr.–1¾ hrs.	Cook to 175 in thigh
Turkey (10–25 lbs.)	325	10–12 minutes per lb. unstuffed; 12–15 minutes per lb. stuffed	Cook to 175–180 in thigh

The standard temperature for cooking roasts is 350°F, but the ideal temperature (or set point) can vary plus or minus 50°F, depending on the cut. Technically, the lower the heat of the oven, the better the final roasted product will be. At a lower temperature, the meat takes longer to cook but produces more flavor, retains more moisture, and shrinks less. In the process, the crispy outer character associated with the classic roast is somewhat diminished. When roasting meat at a temperature below 200°F, most professionals rely on Altra-Sham® cooking technology, a method that combines a constant, precise low temperature with relatively high humidity. At these same low temperatures, other wood-fired heat source methods of roasting—barbecuing, pit-roasting, and smoking—also produce desirable results.

Barbecuing is a roasting method of cooking. Food is covered and slowly cooked in an open pit or on a spit, using hot coals or hardwood as a heat source. The food is basted, usually with a highly seasoned sauce (with a vinegar or sweet tomato base) to keep it moist. North Carolina and Kansas City are two of the most famous U.S. spots for barbecue.



This roasting apparatus for chicken was devised in England in the early nineteenth century for use in hotels. This scene dates from about 1850. The rotisserie turns as the cook turns the crank. The reed screen on the left suggests that this was extremely hot work. ROUGHWOOD COLLECTION.

When meat is cooked slowly in a large hole in the ground, it is pit-roasted (more precisely, "pit-braised"). A hardwood fire is built in a pit and the wood is allowed to burn until the pit is partly filled with burning coals. The coals are then completely sealed with gravel and sand. Sometimes the meat is wrapped in fresh leaves, especially whole carcasses like pig, lamb, and goat. The wrapped meat is placed on the sand and then completely covered with earth, which holds in the heat and steam. Cooking times can vary from five to ten hours, depending on the size and thickness of the meat and how fast the coals are burning.

Smoke-roasting, also called hot smoke-roasting, is generally considered a restaurant application. Specialized ovens that apply constant heat and variable smoke intensity from a built-in smoker compartment are used to produce hot-smoked food. This application of heat and wood smoke are ideal for roasting meat, poultry, and fish because the food cooks at a low temperature under static conditions and there are no drying drafts of air moving through the smoker. The result is a tender, moist roast with consistent smoke flavor.

Once the internal temperature for a roast has been determined, the cook prepares the roast itself. The typical procedure for the roasting method is to place the prepared meat (trimmed, seasoned, and seared) into the oven in a roasting pan on a roasting rack. A roasting rack is required for a successful roast because it holds the roast above the pan in which it is roasting. This prevents the meat from cooking in its drippings and allows adequate air circulation for even cooking and browning.

Meat is roasted until a meat thermometer (inserted in the roast) indicates that its ideal internal temperature has been reached. The ideal temperature depends on the type of animal, the type of roast (bone-in or tied), and the cut of meat. There are many ways to tie a roast using either hand-trussing or butcher-wrapping. Roasts are tied for two reasons: to keep the roast in an aesthetically pleasing round shape or to hold stuffing inside of it. After the meat has rested, usually about fifteen minutes, the string can be removed from the exterior of the roast.

During the process of cooking, as meat achieves its ideal internal temperature, many chemical changes occur

HOW TO ROAST

Roast beef, pork, and poultry are among the most satisfying and impressive dishes the home cook can create, especially for family meals and festive occasions. Roasting is most successful when used with foods with some moisture or fat content. Drier cuts should have some fat added to keep them moist in cooking.

Essential to the appeal of roasting is the fact that it produces a tasty, crunchy crust on the surface of the food. Commonly known as browning, this phenomenon is known to food science as the Maillard reaction, after Louis Camille Maillard, the French chemist who first described the process in 1912. In a Maillard reaction, the heat of cooking causes protein components and natural sugars in the food to break down, combine in complex ways, and produce a brown pigment (technically called "melanoidin"), and the result is a crust that usually tastes rather sweet. The process can be magnified by the cook with the addition of more sugar, such as the glucose in corn syrup, or protein, such as butter.

Meat that is to be roasted should be allowed to sit at room temperature for an hour or two, depending on the size of the roast, in order to let the interior lose its refrigerator chill. (This step is not as important with poultry because the center of a chicken or turkey is hollow, whereas a meat roast is solid.) Allowing a meat roast to sit out for a time should not present a food safety hazard unless the kitchen is very warm; for added safety, the cook might sear the meat to kill any surface bacteria.

There are several ways the cook can be sure to produce a delicious, juicy roast. The roasting pan should not be covered. A covered pan traps the moisture escaping from the meat and surrounds the meat with steam, producing a mushy rather than crisp exterior and a flabby taste. In order to avoid losing the natural juices of the meat, the meat should not be pierced with a fork nor should it be salted before or during cooking. The one exception to the rule against piercing the meat is that a meat thermometer can be used to check for doneness. (See accompanying table for recommended temperatures.) Insert the thermometer before the roast goes into the oven and leave it in during cooking. Measure the temperature in the center of the roast, not touching bone (since bone conducts heat better than muscle and will give a higher reading). Be sure to remove the roast when it reaches a point ten to fifteen degrees below the target temperature since the temperature will continue to rise after the roast is removed from the oven. Allow the roast to "rest" for fifteen to twenty-five minutes (depending on size) after removing it from the oven because heat causes the proteins of the meat to coagulate and give up their juice; if the meat is carved as soon as it is out of the oven, the juice will rush out, leaving much of the meat rather dry. If the roast is allowed to rest, the meat relaxes and much of the moisture is reabsorbed, allowing for juicy sliced meat.

Meat classified as "Prime" by the U.S. Department of Agriculture has more flecks of fat in the muscle than the next-best grade, "Choice." Even leaner and tougher is "Select." Prime meat is hard to find in most supermarkets since it is more expensive and generally sold to the restaurant trade. Choice cuts will roast well, but Select cuts should be cooked with a moist-heat method.

Many different foods are suitable for roasting. Meat made from the rib, short loin, and sirloin cuts make the best beef roasts since they are the tenderest parts of the animal and do well in the dry heat of the oven. Beef cuts ideal for roasting include the tenderloin, standing rib, rolled (boneless) rib, rib-eye, strip loin, sirloin, beef round, and eye of round. Cuts that are both tender and relatively small, such as the tenderloin or rib-eye, can be cooked at high temperatures (400°F) to achieve a well-browned exterior and juicy, tender interior. Larger cuts, such as "prime rib" (standing rib roast) need a lower temperature (250°F to 350°F) to prevent the exterior from overcooking before the interior reaches the desired state of doneness.

Various cuts from pork loin are suitable for roasting, including the tenderloin, top loin roast, crown roast, and rib roast. The whole ham or portion (shank or butt) is a classic roasted dish.

Leg of lamb is considered by some connoisseurs to be the most magnificent cut of meat available for roasting. It can be roasted on the bone; if the leg is deboned, it can be rolled for roasting.

Whole chickens and turkeys are easily roasted, the only challenge being to keep the white meat of a large bird moist until the dark meat, which cooks more slowly, is done. Poultry parts, such as legs or breasts, that are cooked in the oven are said to be "baked," while the whole bird is "roasted." Duck and goose can also be roasted, although the fat content, especially with goose, is considerably higher than that of chicken or turkey and the cook will likely find a large amount of grease in the pan.

In the vegetable world, the most commonly roasted items are the potato and sweet potato. In a reversal of the terminology used for poultry, a whole potato is said to be "baked" while potatoes cut up and put in a dish are said to be "roasted."

Richard L. Lobb

that affect its appearance, taste, and texture, including shrinkage, browning, and flavor development. The first effect of roasting is that muscle proteins shrink and moisture is lost. As meat is heated, the muscle proteins coagulate and shrink, squeezing out water. The longer meat is cooked, the more water is forced out. This is why "dry" and "overcooked" have become synonymous. The loss of juices through drip, evaporation, and cooking time, along with the intramuscular fat or marbling content, determine the meat's juiciness, amount of shrinkage, and, thus, the final cooked weight or portion yield. An accurate internal meat thermometer is an essential piece of equipment for roasting because overcooking produces meat with so little remaining moisture that it is dry and tough.

Heat also affects the internal pigmentation of meat and changes its color. In beef, for example, the red color of uncooked beef changes to light pink, then to brownish-gray as the internal temperature increases from 125°F to 165°F. During long, slow cooking, most connective tissue softens, and collagen (fibrous protein) gelatinizes. Heat also causes fat to melt, and slightly browning fat develops flavor.

It is a myth that searing meat seals in the juices during roasting. Searing or browning the outer, lean surface of meat, usually at a fairly high temperature, does develop flavor and color as a result of Maillard reactions. It is an important step in several dry-cooking methods, including roasting, in order to produce a tasty outcome. When roasting meat, sear it to a good brown color to improve appearance and flavor, remembering that overcooked lean meat will be dry, and therefore not as good to eat as properly cooked lean meat, which is succulent and juicy. Two solutions are available to the cook. One is to bard meat with fat (cover it with strips of fat, usually pork fatback), an outdated practice but one still taught in cooking schools, or to add a fat cap or caul fat wrapping to lean meat. The rule of thumb is to use caul fat on fowl and bard lean roasts before roasting.

See also **Barbecue; Broasting; Broiling; Cattle; Cooking; Frying; Game; Goat; Grilling; Mammals; Meat; Meat, Smoked; Pig; Preparation of Food; Sauces.**

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Francis McFadden

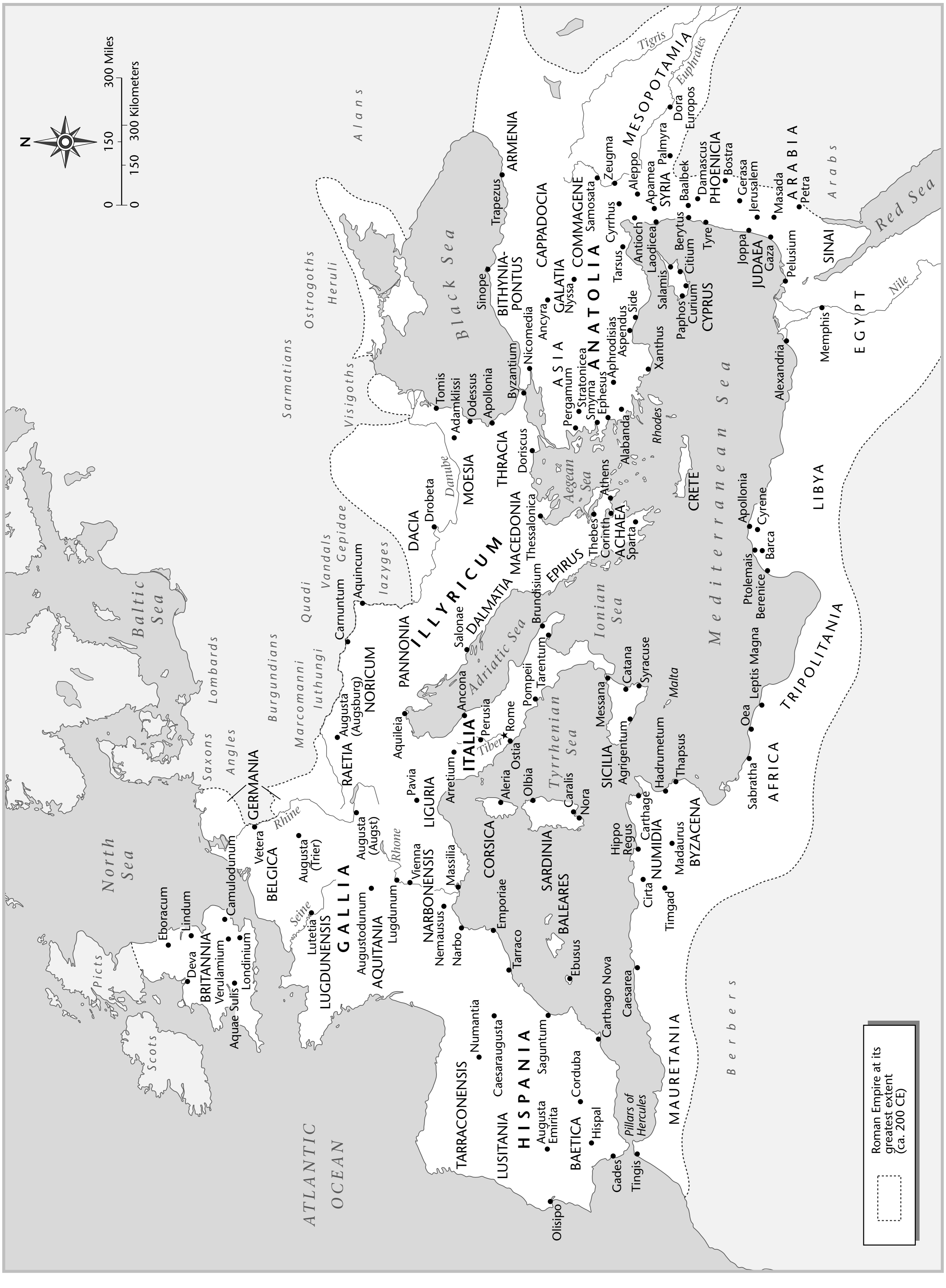
ROME AND THE ROMAN EMPIRE. Roman gastronomy, or gluttony, impresses all who read the Latin and Greek literature composed under the great Mediterranean empire of the first four centuries C.E. Feasting was a central feature of Roman society. The cuisine of Rome, much influenced by ancient Greece and the Near East, is the direct ancestor of the national cuisines of most of western Europe.

Ancient texts form one of the source materials for reconstructing Roman food behavior. These texts include scientific and technical writings (such as the earliest surviving recipe book, *Apicius*, probably compiled in the fourth century C.E.) as well as lively depictions of food, wine, and banquets in classical Latin prose and poetry. Archaeology is is an equally important source of information on this topic. Notable in this context are the finds at Pompeii, the Italian city buried in 79 C.E. by the disastrous eruption of Mount Vesuvius.

Historical Outline

Rome was said to have been founded by Romulus and Remus in 753 B.C.E. on the banks of the Tiber in central Italy. It was a country town whose power gradually grew until it was the center of a world empire. In the third and second centuries B.C.E., Rome fought and defeated the Carthaginians of north Africa, a victory that opened the way to Roman domination of the whole western Mediterranean; in the second and first centuries B.C.E., successive victories in Greece, Anatolia (Turkey), Syria, and Egypt extended Rome's power and wealth eastward.

The rule of the first Roman emperor, Augustus (27 B.C.E.–14 C.E.), marks the beginning of a four-hundred-year period, unique in history, during which a single political power governed the whole Mediterranean. Travel and trade were relatively free throughout the region and there was intensive cultural interaction. Travel was slow, however: it was a five-month voyage from the Pillars of Hercules (Straits of Gibraltar) to Antioch at the eastern end of the Mediterranean. Only foods that were dried, pickled, or salted, and only special wines (see below), would withstand the rigors of such a journey.


Roman Empire at its greatest extent (ca. 200 CE)
N
0 150 300 Miles
0 150 300 Kilometers
ATLANTIC OCEAN
North Sea
Baltic Sea
Black Sea
Mediterranean Sea
Aegean Sea
Adriatic Sea
Tyrrhenian Sea
Ionian Sea
Red Sea
Picts
Scots
Saxons
Angles
Lombards
Burgundians
Marcomanni
Iuthungi
Quadi
Vandals
Gepidae
Iazyges
Sarmatians
Visigoths
Ostrogoths
Heruli
Alans
Arabs
Berbers
BRITANNIA
Eboracum
Lindum
Deva
Verulamium
Camulodunum
Londinium
Aquae Sulis
GERMANIA
Vetera
BELGICA
Augusta (Trier)
GALLIA
LUGDUNENSIS
Lutetia
Augustodunum
AQUITANIA
Lugdunum
Augusta (Augst)
Vienna
NARBONENSIS
Nemausus
Narbo
Massilia
Rhine
Rhone
Seine
HISPANIA
TARRACONENSIS
LUSITANIA
BAETICA
Numantia
Caesaraugusta
Saguntum
Tarraco
Emporiae
Augusta Emerita
Corduba
Hispal
Gades
Olisipo
Carthago Nova
Pillars of Hercules
Tingis
BALEARES
Ebusus
CORSICA
Aleria
SARDINIA
Olbia
Caralis
Nora
RAETIA
Augusta (Augsburg)
NORICUM
PANNONIA
Carnuntum
Aquincum
Aquileia
LIGURIA
Pavia
ITALIA
Arretium
Perusia
Rome
Ostia
Tiber
Pompeii
Ancona
Tarentum
Brundisium
SICILIA
Messana
Catana
Syracuse
Agrigentum
Malta
ILLYRICUM
DALMATIA
Salonae
DACIA
Drobeta
Danube
MOESIA
THRACIA
MACEDONIA
Thessalonica
EPIRUS
ACHAEA
Thebes
Corinth
Athens
Sparta
Doriscus
Tomis
Adamklissi
Odessus
Apollonia
Byzantium
Nicomedia
BITHYNIA-PONTUS
Sinope
Trapezus
ARMENIA
CAPPADOCIA
GALATIA
Ancyra
Nyssa
COMMAGENE
Samosata
ASIA
ANATOLIA
Pergamum
Stratonicea
Smyrna
Ephesus
Aphrodisias
Alabanda
Aspendus
Side
Xanthus
Rhodes
Tarsus
Cyrrhus
Zeugma
CYPRUS
Salamis
Paphos
Curium
Citium
MESOPOTAMIA
Tigris
Euphrates
Dura Europos
Palmyra
Aleppo
Apamea
Antioch
Laodicea
SYRIA
Berytus
Baalbek
Damascus
PHOENICIA
Tyre
Bostra
Gerasa
Jerusalem
ARABIA
Masada
Petra
Joppa
JUDAEA
Gaza
Pelusium
SINAI
Nile
EGYPT
Memphis
Alexandria
CRETE
LIBYA
Apollonia
Cyrene
Barca
Ptolemais
Berenice
TRIPOLITANIA
Leptis Magna
Oea
Sabratha
AFRICA
Thapsus
Hadrumetum
BYZACENA
Carthage
Hippo Regus
Madaurus
NUMIDIA
Cirta
Timgad
Caesarea
MAURETANIA

Crises in the third and fourth centuries C.E. led to the division of the empire into two parts, which had quite different fates. The Eastern Roman Empire was directly continued in the Byzantine Empire. The Western Roman Empire collapsed, finally disappearing in 476 C.E. However, the "barbarian" kingdoms that took its place inherited Roman dietary ideas and developed a way of life that had many Roman features.

Even before those eastern conquests, Romans had become rich enough to spend their wealth enthusiastically on imported luxuries. Lavish banquets became fashionable, and the price of slave cooks rose steeply. Moralists inveighed against these developments, but they did so in vain. Meanwhile, other changes had affected the Roman diet. The acquisition of new territories provided the opportunity for experimentation in agriculture and food production. Romanization in the provinces encouraged people to demand that what was available in the capital should also be available more widely, especially to Roman legionaries and provincial administrators. The province of Britain, whose conquest began in 43 C.E., provides an example: vines, peaches, walnuts, celery, coriander (cilantro), carrots, and several other important foods were first transplanted to that province in Roman times. Wine, olive oil, olives, figs, lentils, chickpeas, and rice were among the commodities that Roman traders first exported to Britain in response to the popularity of Roman fashions in that region.

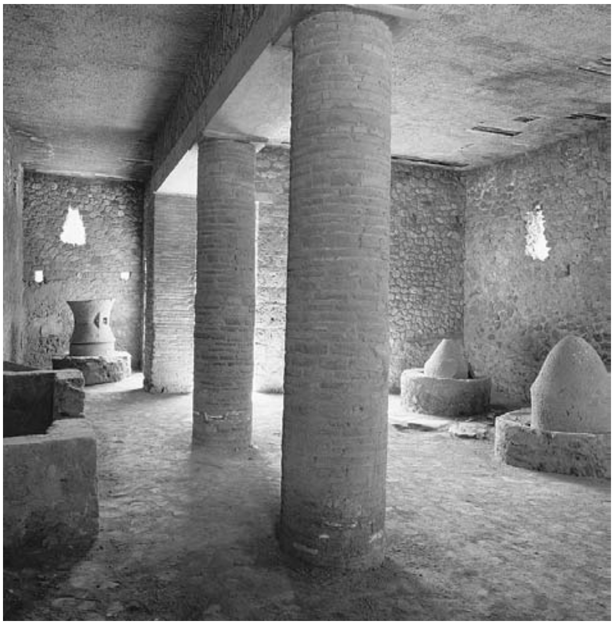
Many special features of Roman administrative and economic life left their marks on the food and cuisine of the vast region that was once the Roman Empire. Great frontier armies, whose zones of recruitment ensured movement and mixture of populations, required the delivery of reliable, standardized supplies on well-built roads. Inscriptions show that periodic markets existed: they were held every eight days in Italian towns, twice a month in North Africa, and three times a month in Asia Minor.

The Literature of Food

The oldest Latin prose text, written about 175 B.C.E., is *De Agri Cultura* (On farming) by the statesman Cato. This work focuses on the two great cash crops of Italy—wine and olive oil—and also includes recipes for cakes and flavored and medicinal wines suitable for farmhouse production. The tradition of Roman agricultural texts culminated in Columella's detailed manual *On Agriculture*, written about 50 C.E. Columella provides much information on food throughout the manual, as well as a long section (Book 12) full of recipes for household preserves and other food products. Written at about the same date, the Latin encyclopaedia *Historia Naturalis* (Natural history) by Pliny the Elder contains eight books (12–19) on plants and their uses, with special attention to fruits and vegetables. Book 14 is devoted entirely to grapes and wine. Although Latin was the native language of Rome, many medical and scientific texts of the Roman Empire were written in Greek: examples are a dietary manual, *On the Properties of Foods*, by the imperial physician Galen (129–199 C.E.), and a medical and dietary textbook by one of his successors, Oribasius (c. 325–400 C.E.). These dietary manuals list foods in great detail, which allowed the reader to work out suitable diets. The manuals also make allowances for seasonal factors and each individual's constitution, lifestyle, and current state of health, in accordance with ancient medical theories. (For English translations of all the texts named in this paragraph see the bibliography.)

Poetry and literary prose give a different perspective on food from that of the technical texts. The personal poetry from the period of Augustus is full of insights on food and dining among the elite, demonstrating the growth of gastronomy and the ways in which food articulated social relations. Authors of this period include Propertius, Horace, and Ovid. Written about one hundred years after the time of Augustus, the picaresque novel *Satyrica* by Petronius mocks the luxurious lifestyle of the new rich. The series of biographies of emperors by the imperial archivist Suetonius (*Lives of the Twelve Caesars*, written about 115 C.E.) provides a glimpse into palace lifestyles, in which feasts sometimes turned into Roman orgies. Lives of poorer people are depicted in the fictional *Metamorphoses* (often translated under the title *The Golden Ass*) by Apuleius (born 125 C.E.), and later in the biographies of Christian hermits and saints.

It was common in Roman writing to despise complicated dishes designed for show rather than for taste. Yet, in practice, Romans reveled in the spices and deli-



Interior of the bakery of Sotericus at Pompeii, Italy. © MIMMO JODICE/CORBIS.

cacies of the whole ancient world: the pepper of south India and even the cloves of the Spice Islands were prized luxuries. In the recipes of Apicius, the flavor of the main ingredient is often enhanced with ten or fifteen spices and herbs. Rich households must have spent much money and slave labor on the finding of rare ingredients and the elaboration of showpiece dishes. The parrot wrasse (a type of fish) and the dormouse fetched high prices not because of their flavor but because of the way they looked on the table. Peacocks, and peahens' eggs, were in demand among gourmets for their rarity more than their quality.

It was also a commonplace to boast of the freshness and simplicity of the farm produce that one was offering to one's guests. There is a tradition of poetic "invitations to dinner" that demonstrate changes in style as well as individual responses to food fashion, extending from about 50 B.C.E. to 110 C.E.: authors of this genre include Catullus (*Poems* 13), Horace (*Epistles* 1.5; *Odes* 3.29, 4.12), Martial (*Epigrams* 5.78, 10.48, 11.52), Juvenal (*Satires* 11), and Pliny the Younger (*Letters* 1.15).

Staple Foods and Major Flavorings

Rome's status as an overgrown city-state was signaled in one of the special privileges enjoyed by inhabitants of the city: the free bread ration. Interruptions in the wheat supply led to riots. Rome's annexation of Egypt, after Cleopatra's suicide in 30 B.C.E., ensured the continuity of the supply. Thereafter, huge grain ships left Alexandria regularly throughout the sailing season, bringing wheat to Ostia at the mouth of the Tiber. It was on such a ship that St. Paul reached Italy after having been shipwrecked on Malta. Roman bakers baked leavened bread, both white and wholemeal. Small-scale baking required a dome-shaped baking-crock (*testum* and *clibanus*). Archaeologists often find fragments of these. A commercial bakery, complete with fossilized loaves, has been excavated at Pompeii.

The traditional staple food of early Italy had been not wheat bread but *puls* (porridge made from emmer wheat). The staple diet of the Roman provinces varied considerably, depending on climate and local custom. Barley, although widely considered a respectable, even desirable, staple food in ancient Greece and Italy, was viewed by Roman soldiers as punishment rations. This increased the demand for wheat wherever Roman armies were stationed.

Always in use in the Roman kitchen were olive oil, fish sauce, and wine. All three were manufactured and distributed on a large scale. *Garum* was the major source of dietary salt: scarcely any *Apicius* recipes call for pure salt. Grape syrup was also much used in flavoring, as were honey and dates. Many recipes begin with the instruction, "Pound pepper and lovage," a reminder that both exotic spices and local herbs were appreciated (lovage, native to Liguria in northern Italy, is a bitter culinary herb resembling parsley). Other commonly used flavorings were onion, mustard, dill, fennel, rue, savory, thyme, mint, pine kernels, caraway, cumin, ginger, and *asafoetida*, the central Asian substitute for the *silphium* that the Greeks had appreciated so much.

Pliny the Elder and Galen—both of whom were wine enthusiasts, judging from their writings—provide full information on the wines that Romans drank with their meals. Italy had many fine wines to boast of. The famous Caecuban vineyards in Latium (modern Lazio) succumbed to urbanization, but Falernian wine, from hillsides in northern Campania, maintained its reputation throughout the empire. In the world's oldest recorded tradition of wine vintage years, fine wines were labelled with the name of one of the consuls elected for the year. The Opimian vintage (121 B.C.E.) was legendary: Opimian wines were served, already 160 years old, at a banquet given for the emperor Caligula in 39 C.E. Horace addressed an amusing poem to a jar of wine: "born, as I was, when Manlius was consul," (that year was 65 B.C.E.). It was in Roman times that the wine-growing regions of Spain and southern Gaul (France) first came to real economic importance. Long-distance transport of wines was less risky if they were "cooked" and sweetened with honey or grape syrup; it was in this form that Greek wines were enjoyed in Rome. Roman territory eventually extended northward far beyond the latitude at which grapes ripen to full sweetness. In these regions, including northern Gaul and Britain, Roman legionaries developed a taste for local beer, which was usually brewed from malted barley.

Food in Roman Society

City dwellers in imperial Rome, many of whom lived in apartment blocks, had little opportunity to cook: cooking required an open fire, often an unacceptable risk. However. street food was always available to the city dweller. Street stalls and cookshops sold cakes and sweets, mulled wine, hot sausages, hot chickpea soup, and porridge. "In the tavern all are equally free," wrote Juvenal (born 67 C.E.) with an undertone of disapproval. He continues, "all drink from a common cup, the couch is barred to no man, the table is no closer to one than it is to another," (*Satires* 8.177-8). The philosopher Seneca the Younger (died 65 C.E.) gives us the sounds of the busy street just outside his apartment window: "pancake-sellers and a sausage-vendor and a confectioner and all the proprietors of cookshops selling their wares, each in his distinctive accent" (*Letters to Lucilius*, 56).

Poor countryfolk had to depend largely on food from their own fields and gardens, supplemented by herbs and fruits gathered from the wild. Meat and fish were uncommon in their diets. For a sense of the flavors of a Roman peasant diet, see the poem "Moretum" (c. first century B.C.E.).

For the peasant population of the ancient countryside, food preparation was a shared task, but in general it was the special responsibility of women. Large households had kitchens staffed with slaves, the skilled cook himself often being an expensive and carefully-chosen acquisition.

Romans tended to eat little during the first part of the day: a breakfast (*ientaculum*) was a snack that many did not trouble to take at all, and only the greedy wanted a heavy lunch (*prandium*). There was no better preparation for a full evening meal, (*cena*) the one big meal of the day, than a couple of hours at the baths. These were fashionable meeting places, ideal locations for informal business discussions. One could easily spend a whole evening there, for food and wine were available at bars and restaurants.

Typical larger Roman houses had a special dining room, the *triclinium*. Three couches arranged in a U-shape, each large enough for three diners, surrounded a central table. A house with a big enough garden might have had a garden dining area, as well, which was shaded by vines and creepers, with three stone couches sloping gently upwards to the middle (cushions and pillows made these comfortable). The open side of the square was for waiters to come and go.

Servants took off guests' sandals as they reclined and brought water to wash their hands. A sequence of dishes began with the appetizer or hors d'oeuvre (*gustus*), followed by an aperitif such as honeyed wine (*mulsum*) or spiced wine (*conditum*). The appetizers were generally more varied and more costly than the main course, though not as bulky. At one religious dinner attended by Julius Caesar, sixteen hors d'oeuvres awaited the priestly celebrants. The appetizers ranged from sea urchin and clams to slices of venison and wild boar.

The main courses were accompanied by bread and wine. Diners ate with their hands, with the occasional help of a knife. Waiters were constantly coming and going, bringing new courses, clearing away dishes, and supplying perfumed water for finger-rinsing. Music and dance from hired performers, usually slaves, often accompanied the drinking, which tended to continue long after the meal itself was over. The emperor Augustus preferred to entertain his guests by employing traditional storytellers.

A napkin, which lay in front of the diners as they reclined, might serve as a knapsack to take home the little gifts (*apophoreta*) with which a host would regale his friends as they departed. Similar gifts were given to dependents not lucky enough to be invited to a real dinner. Martial (c. 100 C.E.) wrote a collection of short poems intended to accompany such gifts. They are the most obvious sign that hospitality helped to articulate the patron/client relations that permeated Roman society. The Greek satirist Lucian (second century C.E.) wrote a convincing sketch of daily life in a rich Roman household and addressed it to a friend who had been offered a post as private tutor. Placed at the lowest table, Lucian warned, the friend would be sneered at by slaves and would taste little of the fine cuisine except the mallow leaves that garnished the serving dishes (*On Salaried Posts in Great Houses*, 26).

Among upper-class Romans, unlike Greeks, the sexes were not segregated at meals. It was said that Roman women once sat demurely at the feet of their husbands' dining couches, but by imperial times the women also reclined. It was said, too, that in the old days women did not drink wine, and that the kiss a Roman husband gave his wife when returning home was a way of assuring himself that this rule had been kept.

See also **Ancient Kitchen, The**; **Ancient Mediterranean Religions**; **Apicius**; **Feasts, Festivals, and Fasts**; **Greece, Ancient**; **Greece and Crete**; **Italy**; **Luxury**; **Petronius**; **Wine in the Ancient World**.

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Andrew Dalby

RUSSIA. Russian food is typically hearty in taste, with mustard, horseradish, and dill among the predominant flavorings. The cuisine is distinguished by the many fermented and preserved foods that are necessitated by the short growing season of the Russian North. Cabbage (sauerkraut) and cucumbers (pickles) are enjoyed greatly, as are a wide range of salted fish, vegetables, and meats. Fish and produce are also frequently dried or brined for lengthy storage. Foraged foods, especially mushrooms, are important to both Russian diet and culture. Although the Russians have never excelled at making hard cheeses, they prepare an expert array of fresh dairy products, such as creamy curd cheese (*tvorog*) and various cultured yogurt-like preparations (*riazhenka*, *prostokvasha*), in addition to excellent sour cream (*smetana*). Honey is the traditional Russian sweetener and is used as the basis for drinks, fruit preserves, and desserts. Early condiments (known as *vzvar*, from the word "to boil") consisted of onions or beets cooked slowly in honey until rich and sweet.

Russian cuisine is known for its extensive repertoire of soups. The national soup (*shchi*) is made from cabbage, either salted (sauerkraut) or fresh, in which case it is known as "lazy" *shchi.* The beet soup (*borshch*) commonly associated with Russian cuisine is actually native to Ukraine, to the south of Russia; it became popular abroad following Jewish emigration from that region. Soup is traditionally served at the midday meal and is accompanied by an assortment of small pies, croutons, or dumplings. The Russian diet tends to be high in carbohydrates, with a vast array of breads, notably dark sour rye, and grains, especially buckwheat (*grechnevaya kasha*).

The national cuisine is further distinguished by wonderful pies filled with myriad combinations of meat, fish, or vegetables. Prepared in all shapes and sizes, pies are both festive and a practical way to use up leftovers. The most elegant pie is, perhaps, the *kulebyaka*, a multilayered fish pie with thin pancakes (*blinchiki*), kasha, and salmon (including the spinal marrow or *viziga*) that was adopted into French cuisine as *coulibiac*.

Diet of the Early Slavs

Early Slavic agriculture was largely grain based. Hearty crops like rye, oats, barley, buckwheat, spelt, and millet provided the mainstay of the diet, most often in the form of gruel or baked into cakes made of meal sweetened with honey and flavored with berry juice. Although wheat was cultivated in the South, it remained of secondary importance. From the Scythians, a Eurasian tribe that roamed the steppes of southern Russian from the eighth to the fourth centuries B.C.E., the early Slavs learned how to make leavened breads, using primarily sourdough. Grains were supplemented by legumes (*gorokh*), an important source of protein. Freshwater fish and wildfowl, both of which were abundant, provided additional sources of protein. Vegetable and nut oils (especially hempseed and linseed), foraged mushrooms and berries, and orchard fruits such as cherries, pears, plums, and apples supplemented the largely carbohydrate diet. Also critical were cultivated vegetables, including turnips, beets, radishes, onions, garlic, cabbage, and cucumbers. Turnips were an important staple until the widespread (and enforced) cultivation of the potato in the nineteenth century. Given the geographical limitations on agriculture, much of the population lived in a state between hunger and starvation, and up through the twentieth century Russia experienced frequent famines.

The earliest domestic livestock included cows, pigs, sheep, and goats; chicken, ducks, geese; turkey was introduced somewhat later. Butter was traditionally prepared from cow's milk by heating sour cream, rather than by churning it from sweet cream, a method the Russians learned only in the eighteenth century from the Finns.

By the twelfth century the Russians were already boiling down salt from water from the White Sea, but salt remained an expensive commodity that only the wealthy could afford. Even those who could afford salt used it sparingly. A seventeenth-century German visitor Adam Olearius, complained that "in Moscow, they use coarse salt fish, which sometimes stinks because they are thrifty with the salt. Nevertheless, they like to eat it." In general, the affluent had a plentiful assortment of fish, meat, fruits, vegetables, and grains, a diet that contrasted greatly with the meager rations of most of the population, who subsisted on little more than oatmeal gruel (*tolokno*) and rye bread. Although the soil around Moscow and in the south of Russia yielded excellent produce, the growing season was short, and most people did not have access to a variety of foods.

Cooking Methods

Apart from the methods used for preserving food, boiling and baking were the most common ways of preparing foods (frying and grilling were also practiced). By 1600 rich and poor alike were cooking food in the Russ-

N
0 250 500 Miles
0 250 500 Kilometers
ARCTIC OCEAN
Bering Strait
Chukchi Sea
U.S.A.
Wrangel Island
Franz Josef Land
East Siberian Sea
Bering Sea
New Siberian Islands
NORWAY
Barents Sea
Severnaya Zemlya
SWEDEN
Laptev Sea
Murmansk
Kara Sea
FINLAND
Kolsk (Kola) Pen.
White Sea
Novaya Zemlya
Baltic Sea
L. Ladoga
POLAND
LATVIA
EST.
LITH.
St. Petersburg
Arkhangel'sk (Archangel)
Kolyma
Kamchatka
Magadan
BELARUS
Vorkuta
Noril'sk
Siberia
Yakutsk
Yaroslavl'
Moscow
Tula
Ryazan'
Novgorod
UKRAINE
Voronezh
Kazan'
Perm'
RUSSIA
Ob'
Yenisey
Lena
Sea of Okhotsk
Kuril Islands
Sakhalin
Penza
Volga
Yekaterinburg
Rostov-na-Donu
Samara
Saratov
Ufa
Chelyabinsk
Komsomol'sk
Amur
Khabarovsk
Volgograd
Black Sea
Krasnodar
Orenburg
Omsk
Tomsk
Krasnoyarsk
Lake Baikal
Astrakhan
Novosibirsk
Kemerovo
Novokuznetsk
GEORGIA
Caucasus
Caspian Sea
Barnaul
Irkutsk
JAPAN
Sea of Japan
CHINA
Vladivostok
AZER.
KAZAKHSTAN
MONGOLIA
CHINA
NORTH KOREA

ian masonry stove (*pech'*), which was massive enough to take up nearly one-quarter of a peasant cottage. This stove defined the living space, demarcating the female and male spheres of the room into the cooking area (female) to the left of the hearth, and the icon-dominated "beautiful corner" (male) to the right. The earliest stoves had no flue, causing smoke to issue directly into the cottage; more prosperous families replaced these "black" stoves with more refined "white" stoves fitted with chimney pipes. Russian peasants generally believed that the stove held mystical powers, with a house spirit (*domovoi*) residing beneath or behind it.

Food could be prepared in many different ways on the stove—boiled, baked, steamed, roasted, and braised. Many of Russia's most typical dishes reflected the specific properties of the stove, which blazed and was very hot after firing and then gradually diminished in the intensity of its heat. Breads and pies were baked when the oven was still very hot, either right in the fire's ashes or immediately after they had been scraped out. Once the temperature began to fall, grain dishes could cook in the diminishing heat, which ensured that porridges were crusty on top and creamy within. As the oven's heat continued to subside, the stove was ideal for the braised vegetables and slow-cooked stews that represent the best of Russian cooking. Dairy products were cultured in any residual oven heat.

Whether the medieval Russian diet was varied or sparse, the cooking methods for rich and poor were nearly analogous. Although Tsar Peter the Great introduced the cooktop (*plita*) from Holland in the eighteenth century, and metal stoves became common in urban dwellings in the nineteenth century, the Russian stove remained in use in the countryside well into the twentieth century.

Influence of the Russian Orthodox Church

In 988 Grand Prince Vladimir of Kievan Russia adopted Christianity for his people. Many of the existing pagan celebrations, such as those marking the seasonal solstices, were transformed into religious holidays like Christmas and Easter. The Orthodox Church had a profound influence on the Russian diet, dividing the year into feast days (*skoromnyi*) and fast days (*postnyi*). The latter accounted for approximately 180 days of the year. The fast periods largely coincided with times in the agricultural year when food supplies were running low. Most Russians took fasting seriously, strictly following the proscriptions against meat and dairy products. In addition to meatless Wednesdays and Fridays, the Russians also observed extended fasts, the most important of which were the Great Lenten Fast (forty days, plus one week, Passion Week, which precedes Easter), the Christmas or Filippov Fast (the six weeks preceding Christmas), the Fast of Saints Peter and Paul (beginning in late May or June and lasting from one to six weeks, depending on when Easter fell); and the Fast of the Dormition (two weeks in August). On the most stringent fast days (Lent and the Dormition Fast), even fish and vegetable oil were forbidden. Generally, the poorer the household, the more devoutly it fasted, since meat and dairy products were at best scarce even on non–fast days. For the wealthy, fasting did not necessarily mean deprivation. A mid-seventeenth-century state dinner given on a fast day for the English ambassador Carlisle offered no fewer than five hundred dishes, not one of which was made with meat products. Throughout the nineteenth century, cookbooks offered suggestions for both feast day and fast day meals. In addition to recipes for fish and vegetarian dishes, the cookbooks provided information on substituting nut oils and almond milk for dairy products in cooking and baking.

Holidays and Ritual Foods

Numerous feast days compensated for the stringent fasts. Feasts were held in celebration of weddings, funerals, and the name days of saints, which the Russians observed instead of birthdays. Many religious holidays were also considered feast days. Just before the rigorous Lenten fast came Butter Week (*Maslenitsa*), similar to Mardi Gras, except that it lasted a full week. Although no meat was allowed, the Russians consumed excessive amounts of dairy products, most often in the form of blinies. These traditional yeast-raised pancakes, made with buckwheat or wheat flour, are porous enough to soak up plenty of melted butter. Topped with caviar, smoked fish, pickled herring, or sometimes jam, the bliny can be traced back to pagan times, when the early Slavs baked round pancakes in the image of the sun to welcome its return at winter's end.

Easter is the most important holiday in the Russian Orthodox year. Throughout Easter week a table is kept laden with food. The two most traditional foods are *kulich*, a tall loaf of bread enriched with eggs, butter, sugar, and candied fruits, glazed with confectioners' sugar, and often topped with a rose; and *paskha*, fresh farmer's cheese mixed with cream and butter and molded into a pyramid shape. Raisins or nuts are used to decorate it with the letters XB for "Christ is Risen."

Virtually every festive occasion calls for a special bread. Pies, such as an elaborate chicken pie layered with vegetables (*kurnik*), are served at weddings; a sweet, pretzel-shaped loaf (*krendel'*) is traditional for name days; and animal-shaped buns are distributed to Christmas revelers. These buns, as well as the lark-shaped breads baked to celebrate the return of the birds in spring, predate the Christian era. Other breads, such as one baked in the shape of a ladder for the holiday of the Ascension, have Christian roots. *Kut'ia*, which is a dish of wheat berries sweetened with honey and flavored with dried fruits or nuts, is traditionally served at funeral repasts.

The Tradition of Hospitality

The Russian word for hospitality (*khlebosol'stvo*) derives from the words for bread (*khleb*) and salt (*sol'*). Taken together, they mean a regalement with that which is most basic to life, and that which is a luxury. A large, round loaf milled from the finest flour (*karavai*) was traditionally presented as a symbol of hospitality or was offered to newlyweds as a housewarming gift. The loaf often had an indentation in the top crust to hold a small dish of salt. The act of honoring guests lies at the heart of the Russian national identity. As counseled by the *Domostroi*, a sixteenth-century manual that teaches household management and piety, guests are sacred; by receiving them well, you also serve God. One should offer guests are the very best food available. The Russians took this advice to heart: even the poorest households did not turn strangers away.

The sharing of bread was ritualized in the practice of "begging for crusts," which occurred whenever food shortages threatened the peasantry. Unlike simple begging, which was looked down upon, "begging for crusts" was accepted as part of the natural order: each peasant family knew that the situation could be reversed, and next time they might be the ones in need of food after a bad harvest.

In medieval Russia hospitality to foreigners was expressed through the institution of the *podacha*, a ritualized presentation of food. Privileged guests at the tsar's palace were given confectionery items to bring home at the end of each feast; the amount given was determined by the person's rank. Anyone unable to attend the festivities might have the *podacha* delivered to his residence by couriers, who would parade through the streets of Moscow in a display of the tsar's power and largesse.

Today, the hissing *samovar* or tea urn is the acknowledged symbol of Russian hospitality, ready to serve unexpected guests at a moment's notice. However, this tradition is relatively recent, as use of the samovar became widespread only in the second half of the nineteenth century.

Alcohol Consumption

The *Primary Chronicle*, Russia's earliest historical record, relates that Grand Prince Vladimir proclaimed "Drinking is the joy of Rus'" when he chose Christianity over Islam, which forbids the consumption of alcohol. From the earliest times the Russians enjoyed alcoholic beverages, especially mead, a fermented honey wine flavored with berries and herbs; *kvas*, a mildly alcoholic beverage made from fermented bread or grain; *berezovitsa*, lightly fermented birch juice; and beer. Distilled spirits, in the form of vodka, appeared only in the fifteenth century, introduced from Poland and the Baltic region. Vodka was originally used for medicinal purposes, but it gradually displaced the older beverages in popularity, and by the seventeenth century spirits were already causing social problems. Because the high taxes on vodka filled the state coffers, the government was not eager to curtail use of the substance (a few privileged noblemen were given the right to produce vodka, but the government basically had a monopoly on its production). In the late nineteenth century the famous chemist Dmitri Mendeleev set the optimal alcoholic content of vodka at 40 percent spirits diluted with distilled water. Commercial producers capitalized on Mendeleev's pronouncement, and Russia has been known ever since for its excellent vodka.

Tsar Ivan the Terrible established the first taverns (*kabaki*) in the sixteenth century by for the sole benefit of his elite guards. Since then the government has vacillated between strict and lax approaches to vodka consumption, at times encouraging it to build up the state treasury and ease public unrest, at other times curtailing access to the drink. Tsar Peter the Great was known to ply his guests with drink in order to find out what was really going on at court, and he himself engaged in drinking binges that lasted for days at a time. More recently, in the Soviet era, two Communist leaders, Yuri Andropov and Mikhail Gorbachev, attempted to control access to vodka. Their ill-fated attempts caused widespread discontent, as well as severe shortages of sugar, which people purchased in bulk to produce moonshine.

Eastern Influence on Russian Cuisine

In 945 Russia, though still not unified, initiated trade with Constantinople, the seat of the Byzantine Empire. In exchange for honey and furs, the Russians received rice, spices, and wines. In 1237 the Mongols invaded the Russian principalities, and for nearly two hundred years Russia had to pay tribute to the Golden Horde. The occupation was not without culinary benefits. The Mongols reopened the ancient trade routes between China and the West, which had become too dangerous due to frequent tribal wars. Foods introduced along these routes included noodles and cultured milk products such as *koumiss*, the fermented mare's milk drunk by Turkic nomads.

With Russia's conquest of the Volga region in the mid-sixteenth century, the Russians were able to trade for spices like pepper, saffron, cinnamon, and ginger, as well as rhubarb, which became an extremely lucrative export crop. Also from the Volga region came sweet watermelons from Astrakhan, at the mouth of the Volga, and increased access to sturgeon, sterlet, and caviar from the Caspian Sea.

Tsar Ivan IV (the Terrible; 1530–1584) led a series of Eastern campaigns to subjugate the khanates of Kazan, Astrakhan, and Tatar Bashkiria; in 1582 he also annexed Siberia. This eastward expansion introduced the Russians to *pel'meni*, wonton-like pockets of boiled dough filled with ground meat and onions. The Russians serve these dumplings either with vinegar and mustard or with butter and sour cream. Pel'meni are frequently made in large quantities at the beginning of winter and kept frozen outdoors in a bag, ready for boiling into a quick meal. Exotic fresh and dried fruits were also introduced from the East, and raisins and dried apricots have held a prominent place in Russian cuisine ever since.

Tea also arrived in Russia by way of Siberia. As early as 1567 emissaries from Ivan IV had spoken of this strange brew, but it wasn't until 1638 that tea found its way to the royal court. The signing of the Treaty of Nerchinsk in 1689 established regular trade between Russia and China. From then on tea became a valuable commodity, although until the nineteenth century tea drinking was largely confined to Moscow's urban population.

With the expansion of the Russian Empire into the Caucasus and central Asia, beginning in the late eighteenth century and continuing under Soviet rule, dishes from Eastern cuisines entered into the Russian repertoire. From Georgia came grilled meats (*shashlyki*), flattened chicken cooked under a brick (*tabaka*), and herbed kidney beans (*lobio*); from Armenia came flat bread (*lavash*); from Azerbaijan, ground lamb kebabs (*lyulya-kebab*); from Tatar Crimea, fried meat pies (*chebureki*); from Uzbekistan, rice pilaf (*plov*) and dumplings (*manty*); and from Kyrgyzstan, lamb and noodle stew (*lagman*).

The Era of Muscovy

During the era of Muscovy (from the fourteenth to early eighteenth centuries) the disparity between rich and poor became firmly established, resulting in two very different cuisines. The poor ate little more than bread, gruel, and soup made from vegetables and grains. The wealthy, on the other hand, ate so lavishly that foreign visitors like the French envoy Foy de la Neuville, on a 1689 visit, declared them gluttons. Foreigners generally considered the Russians uncivilized, not only due to their prodigious appetites, but also due to the pleasure they so openly expressed from their meals via belching and other bodily sounds.

The wealthy indulged in feasts that lasted for hours. Pickled or salted beef, ham, suckling pig, elk, boar, lamb, and rabbit all appeared on the table. Swan was considered the most luxurious of birds, although the wealthy also enjoyed crane, heron, black grouse, hazel hen, partridge, lark, goose, duck, and chicken. Veal was rarely consumed, and the Russian Orthodox Church forbade eating doves, since the birds symbolized the Holy Spirit. Hot and cold soups, noodle dishes, roasts, and sauces were seasoned with onion, garlic, pepper, saffron, and sometimes savory. The combination of sweet and sour so typical of medieval foods throughout Europe was especially compatible with Russian tastes. Rich, dark swan meat was often served with vinegar or a combination of sour milk, pickles, and prunes.

The tsar's table was furnished year-round with fish from distant waters, transported whole or in pieces, fresh or salted, or brined in barrels. Sturgeon and sterlet were brought live in tanks from the Caspian Sea to Moscow; whitefish came from Lake Ladoga; and several varieties of salmon were sent overland from the Kolsk Peninsula in the far North. Pike, bream, perch, pike-perch, and many other sorts of excellent fish were caught in the rivers and ponds around Moscow.

CAVIAR

The Russians were the first to develop a caviar industry based on the several varieties of sturgeon that they fished, and the world's best caviar still comes from the Caspian Sea. The thirteenth-century court of Grand Prince Yaroslav of Novgorod had a special sturgeon master to oversee the procurement, preparation, and serving of sturgeon. The roe was particularly relished. (Although Russians consider sturgeon roe the finest, they also enjoy the eggs from such fish as burbot, white salmon, pike, carp, and grayling, although technically this roe is not considered caviar.)

Making caviar is extremely labor-intensive, as the fish eggs are both fragile and perishable. The roe must be extracted by hand, then kept cold during processing (generally at 28°–32°F [−2°–0°C]) to keep it fresh. Salt is added to lower the temperature at which the eggs will freeze, as well as to help preserve them. The best fresh caviar, which contains roughly 4 percent salt, is known as *malosol* ("little salt" in Russian). Today, for exports to Europe, the Russians also add a small amount of borax to the roe, which works as a preservative and reduces the need for salt. Borax gives the eggs a slightly sweeter taste and makes them a bit oilier. Russia omits the borax for caviar imported into the United States, which prohibits the sale of borax-treated eggs.

The flavor and quality of caviar depend on the type of sturgeon it is taken from. The most common types, in decreasing order of size, are beluga, osetra, and sevruga. Beluga sturgeon can weigh over two thousand pounds; its roe is a pearly gray and has a very subtle flavor. Many Russians prefer the strong flavor of *payusnaya* or pressed caviar, made from eggs that have been broken in processing or from very mature eggs pressed into a concentrate the consistency of thick jam.

Caviar was standard fare for the wealthy on the numerous fast days dictated by the Russian Orthodox Church, when meat and dairy products were proscribed. Medieval Russians often left the roe in the egg sac. They seasoned it with salt and pepper, then dusted it with flour and fried it, serving an onion, cranberry, or saffron sauce on the side. Sometimes they offered the cooked caviar cold, cut into slices and flavored with an herb vinegar or mustard sauce. For the Muscovite dish *kal'ia*, pressed caviar was cut into thin rounds, then placed in an earthenware pot with chopped onion, pepper, pickles, pickle brine, and water. This mixture was steamed in the Russian stove, with additional pepper added upon serving. Nineteenth-century culinary fashion called for slicing pressed caviar and serving it in a napkin as "serviette caviar." Elena Molokhovets, Russia's Mrs. Beeton, suggested a more practical use for pressed caviar. In her classic cookbook, *A Gift to Young Housewives*, she explains how to clarify bouillon with pressed caviar, using one-quarter pound of the caviar in place of two egg whites.

By the mid-nineteenth century the finest sturgeon caviar had become rare enough that it was generally served unadorned. Astrakhan caviar, with its large, gray grains, was considered the ultimate roe. It was served on toast points or mounded in a pyramid and decorated with lemon wedges with croutons on the side. Late-nineteenth-century cookbooks sometimes cautioned against buying caviar with a greenish tinge, which was caused by treatment with a dye containing copper salts.

All varieties of sturgeon are endangered, due to environmental pollution and poaching (there is a thriving black market in caviar in southern Russia). The political and economic chaos that afflicted Russia after the collapse of the Soviet Union caused many foreign purveyors to turn to Iran for the highest quality caviar. Now, in order to keep up with world demand for the roe, scientists are experimenting with farm-raised sturgeon, particularly in the Caspian waters belonging to Kazakhstan.

Eighteenth-Century Reforms

The reforms carried out by Peter I (the Great; 1672–1725) affected virtually every aspect of Russian life. Upper-class women, who had previously lived in seclusion, were allowed into male company and could eat at the same table as men. Peter introduced napkins from Holland (until his reign, tables had been covered with short cloths, the edges of which were used to wipe the hands and mouth while eating). Since large joints of meat were carved and served in small pieces at table, several people would generally share forks and knives among them, but Peter encouraged the use of individual two-pronged forks.

In the kitchen, the most significant development for Russian cuisine was the introduction of the Dutch range, which, contrary to the traditional Russian stove, relied on a cooktop more than on oven chambers. This change necessitated more labor-intensive cooking methods as well as new utensils. Saucepans, for instance, replaced the customary earthenware pots.

Peter was eager to acquaint Russians with new foodstuffs and culinary methods that he had learned on his extensive travels. From Holland he imported not only hothouse vegetables and fruits (pineapples became a particular Russian passion), but also aged cheeses, which the

Russians did not know how to make. He sought grape varietals that could thrive in southern Russia and placed the two-centuries-old Astrakhan winery under the supervision of a French vintner to increase its quality and production.

In 1712 the imperial court moved from Moscow to Saint Petersburg. The design of the commercial center (*Gostinyi dvor*) incorporated a canal right in the building so that boats could unload their wares on site. Petersburg's significant foreign population influenced the city's eating habits, and foods such as waffles and artichokes found welcome reception. Furthermore, the young Russian men whom Peter had sent abroad to further their education returned with new tastes. Seeking more variety in their diet, they began to import exotic foods. When Peter hired a Saxon as his private chef, the nobility soon followed suit. Thus Russia's first foreign chefs came primarily from Saxony, Bavaria, and Austria.

Because the founding of Saint Petersburg had caused trade to decline at the far northern port of Archangel on the White Sea, in 1721 Peter issued an *ukaze* ordering his people to eat ocean fish. Previously the Russians had used only freshwater fish from rivers and lakes, and many were suspicious of such strange species as cod, whiting, and mackerel.

French Influence on Russian Cuisine

The culinary changes wrought during Peter's thirty-six-year reign were so great that by the time his daughter Elizabeth seized the throne in 1741, lemons and oranges were no longer a luxury, and English beer was in greater vogue than traditional Russian brews. As the century progressed, more and more European influences came to bear on traditional Russian methods. The vocabulary introduced into Russian over the course of the eighteenth century reveals influences from the Dutch, German, English, and ultimately French cuisines. By the close of the eighteenth century, food in the homes of the wealthy was unabashedly French, and Russia's most affluent families employed French chefs, whose style supplanted the Germanic influences of Peter's era.

With so much foreign influence, Russian cuisine lost its simple national character and became increasingly complex. By the end of century, meat was cut into small pieces that demanded complicated handling, as opposed to the large joints of meat that had been roasted or braised in the great Russian stove, or grilled on a spit. As the nineteenth century drew near, many French dining habits were firmly entrenched in Russia, although sometimes with a Russian twist. One practice that came into vogue among the aristocracy was the open table, at which any nobleman, invited or not, was welcome to dine. The conservative prince Mikhail Shcherbatov, in his treatise *On the Corruption of Morals in Russia*, complained that the nobility's excessive socializing at table led to moral deterioration. He was troubled that the nobility gave so little thought to the relationship between the food served and the religious obligations underlying it. Even so, Peter the Great's reforms and the subsequent refinements to the table broadened and polished Russian cuisine. Adapting western trends to their own needs and tastes, the Russians ultimately made their table quite sophisticated.

Table Service and Meal Times

The Russian peasantry ate their meager fare from a communal bowl, with each individual wielding his or her own spoon. The wealthy, however, sat down to a vastly different table, which was also distinct from its European counterparts. By the seventeenth century society meals throughout Europe were served in the style known as *service à la française*, which meant that for each course, all of the foods were set out on the table, ranked according to size and symmetrically arranged. The Russians ate in a manner that came to be known as *service à la russe* (it eventually replaced the French style of service in Europe in the late nineteenth century). Here the table was not previously laid with the foods for each course. Instead, each dish was brought individually to the table and presented with fanfare before being removed to the kitchen or sideboard for carving. Each diner received a portioned serving, which ensured that the food was still hot and at the peak of freshness. Furthermore, diners were not limited to the foods located within reach. The drawback of service *à la russe* was that it entailed a large and well-trained staff.

Under Peter the Great, the multicourse banquets typical of the Muscovite era began to evolve into the sequence of four courses that is familiar today. Peter's war with Sweden and his travels in Holland resulted in the introduction of the lavish *zakuska* (hors d'oeuvres) table that has become the hallmark of Russian cuisine. Adapted from the Swedish smorgasbord, an array of salted and smoked foods, including caviar, salmon, sturgeon, herring, pickles, and ham, is offered before the main course. Open-faced sandwiches with meat or cheese reflect a direct borrowing from Dutch practice. After the *zakuski*, soup is served, then a main course, followed by dessert.

Meal times were rather flexible. The wealthy, having no immediate tasks to attend to, often slept late and did not have breakfast until mid-morning. The main meal of the day (*obed*) took place at around 2:00 P.M., followed by a late-afternoon collation or tea, then supper between 8:00 and 10:00 P.M. Peasant families had more structured mealtimes. Breakfast (*zavtrak*) was typically eaten at 5:00 or 6:00 A.M., followed by the so-called second breakfast (*vtoroi zavtrak*) at around 10:00 A.M., providing a break from the day's labors. Dinner was eaten any time between 12:00 and 2:00 P.M., with a midday snack (*poldnik*) at 4:00 or 5:00 P.M. Supper (*uzhin*) was generally served at 8:00 P.M., and, after tea drinking became an established custom in the late nineteenth century, tea (*chai*) often followed. For those who could afford a variety of foods, the Russian breakfast was a hearty affair, complete with porridge (often buckwheat or semolina), smoked or pickled fish, and eggs or pancakes. The main meal of the day was still not considered complete without a soup course before the entrée.

Revolutionary Changes

The indulgent lifestyle of the aristocracy and gentry came to an abrupt end with the Revolution of 1917 and the subsequent establishment of the Soviet Union. The new Bolshevik government undertook a radical transformation of social life, promoting as one of their platforms the liberation of women from kitchen drudgery. To this end, vast communal dining facilities ("factory kitchens") were set up. However, because the food was bad, and most families did not like the impersonal cafeteria style of these facilities, the experiment ultimately failed. What did take hold, however, were communal kitchens in urban houses that had been requisitioned by the government. The great influx of people into the cities following the Revolution of 1917 caused a housing shortage that led to the creation of communal apartments, with sometimes as many as a dozen families sharing a kitchen. Communal kitchens, some of which still exist, contributed to the disintegration of family life and created social tensions.

The political and economic turmoil of the Civil War (1917–1922), coupled with drought in the Volga region, caused a severe famine between 1921 and 1922, in which nearly half a million people died. But this loss of life is small in comparison to the many millions who perished during Joseph Stalin's enforced collectivization of agriculture, which he carried out between 1929 and 1934, especially in Ukraine. Under this policy, private farms were destroyed and agriculture organized into state-run collective farms (*kolkhozy*). Collectivization proved disastrous for Soviet agriculture, as it was inefficient and discouraged personal initiative. The Soviet Union was forced to import much of its grain from the United States and Canada and frequently suffered from food deficits.

The Soviet Era

The Soviet Union was never a fully egalitarian society. Most of the populace subsisted on a monotonous diet of poor-quality food, but the government and cultural elite had access to special stores and goods, so they were able to eat well. Although the government ensured that no one went hungry (all factory workers, for instance, received a free lunch at state expense), the average diet was not especially nutritious, as it was low in fresh fruits and vegetables.

The Soviet period was marked by extraordinary hardship. Following collectivization and the political purges of the late 1930s, the Russians endured World War II, also known as the Great Patriotic War. During the Siege of Leningrad (1941–1944), which lasted for nearly nine hundred days, roughly one million people died of starvation. At the most critical point in the siege, the bread ration for factory workers was only 250 grams (8.8 ounces) a day, 125 grams (4.4 ounces) for all others, with no other food available. Leningraders resorted to eating whatever they could scavenge from the city or find in their apartments, including tooth powder, Vaseline, glycerine, cologne, wallpaper paste scraped from the walls, flour dust collected from cracks in the kitchen floorboards, and spattered grease that was licked from the kitchen walls.

Although life stabilized after the war, the Soviet era was generally characterized by a low standard of living. Shopping was especially difficult, with long lines even for basic foodstuffs. There was very little variety. When so-called deficit items did suddenly appear, shoppers had to stand in line for hours. The vocabulary reflected this reality: products were "obtained" (*dostat'*) rather than "bought" (*kupit'*). Because of the hierarchy of food distribution, country dwellers flooded daily into Moscow, increasing the crowds and further limiting availability.

The state food stores had very little to offer, but decent foodstuffs could be purchased at the farmers' markets, where entrepreneurs from Georgia, Armenia, and central Asia sold lemons, melons, and high-quality meat and produce, often at steep prices. To survive, most Soviet citizens became adept at working the unofficial barter economy, and they knew how to take advantage of the black market. Restaurants were few; those that existed frequently offered only one item from their menu and subjected diners to surly service. Therefore most Russians ate at home. The Soviet-era kitchen table became the site of the most important social interactions, where information was exchanged, poetry recited, politics argued, friendships expressed. Despite the food shortages, the difficulty of shopping, and the cramped living space, Russians still took pride in being generous toward their guests, and the tradition of hospitality endured.

Post-Soviet Russia

The Soviet Union was officially disbanded at the end of 1991. The following year saw the introduction of stringent market reforms, which brought economic hardship to the general population. With a safety net no longer in place, beggars appeared on the streets. The countryside, in particular, suffered from insufficient food. Russia's economic problems were exacerbated by the crash of 1998, when the ruble lost two-thirds of its value. Still, the Russians are a resourceful people, and in the early twenty-first century the economy was back on its feet.

The collapse of the Soviet state initially brought a rash of investors to Russia, and numerous fast-food chains, such as McDonald's, gained a foothold. In response to so many Western imports, a feeling of national pride gradually emerged, and domestic chains like Russkoye Bistro began to compete with the foreign establishments. Homegrown products again appeared on the market when the economic turmoil of the 1990s caused many foreign firms to leave. Once the economy stabilized, many restaurants opened that offered expensive and elegant pre-Revolutionary fare, nostalgic country-style cooking, and ethnic cuisine. After seventy years of isolation under Soviet rule, the populace was eager to experiment with new tastes.

With the appearance of self-service grocery stores, shopping was simplified, and it was no longer necessary to stand in line for food. However, one might question whether shrink-wrapped tomatoes imported from the Canary Islands represent progress when locally grown produce can be bought at the market or at curbside kiosks. The slick grocery stores with their aisles of imported goods and the expensive restaurants were status symbols for the wealthy class of New Russians who had money to spare: the majority could not afford them. These New Russians also bought food magazines (unheard of during the Soviet era) and cookbooks: both the French Cordon Bleu cooking course and the *Hare Krishna Book of Vegetarian Cooking* were translated into Russian. Young Russians became increasingly aware of diet and nutrition, the down side being that eating disorders began to appear.

Meanwhile, average Russians could only admire the glossy publications and the wide variety of foods, which were beyond their means. Police in a number of cities have had to put Operation Harvest into effect to protect the potato fields—which were now private property—from hungry poachers. Significantly, the consumerism of the moneyed class was balanced by a return to spiritual values, as many Russians once again expressed their identity through the foods they choose either to eat or forego.

See also **Asia, Central; Central Europe; Christianity: Eastern Orthodox Christianity; Food as a Weapon of War; France; Siberia**.

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RYE. *See* **Cereal Grains and Pseudo-Cereals.**

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SACRIFICE. Sacrifice is the ritualistic and reverential slaughter, cooking, and distribution of meat. Conventional accounts of sacrifice stress the colorful and religious aspects of slaying an animal for the benefit of the participants' relationships with the gods. This understanding leads to the generalized use of the word "sacrifice" to mean giving up something—including other foods—in anticipation of more valuable rewards.

From the viewpoint of a cultural outsider, sacrifice may seem a brutal or incomprehensible practice. Yet historically, sacrifice has been a common practice in many tribal and agrarian societies, as have food offerings, in a more general sense. Sacrifices serve various functions: the ancient Chinese text *Li chi* describes ceremonies that summon spirits from above to restore social harmony. Maintaining environmental balance is also a common sacrificial motive. Sacrifices are important in the doctrines of Hindus, Jews, Christians, and Muslims: they enable participants to share a table with their deity, give thanks, atone for sins, or appease angry forces. For example, Muslims believe that the animal slaughtered at the Id al-Adha (Festival of Sacrifice) at the conclusion of their pilgrimage to Mecca will carry them to Paradise.

Social scientists have explained that dramatic rituals encourage group solidarity. The act of coming together to present gifts helps to bind members of a group together as well as any blood oath can. According to Scottish anthropologist W. Robertson Smith in *The Religion of the Semites* (1889), sacrifice originated in a meal shared between people and their god. French sociologist Émile Durkheim and his associates asserted that sacrifice constantly renews group consciousness of the sacred and that the all-powerful god which society worships is itself.

Ceremony promotes social cohesion, but such theories are incomplete because they do not explain why cohesion important in the first place. As stated earlier, the underlying action of a sacrifice is the coming together for the slaughter and distribution of meat. This core social action is elaborated on cultural and religious levels. The animal is not lost but is allocated to the group according to precise rules. In groups that perform sacrifices, animals are valuable enough food to warrant special attention, typically at a festival, and often the animals are large enough to warrant wider dispersal than within an immediate household. This dispersal typically takes place at some central place such as a temple.

Early Jewish celebrations of Passover traditionally required the sacrifice of one lamb for each household or for distribution among several small households; the lamb was then eaten with unleavened bread and bitter herbs (Exodus 12:1–28). This ritual is a seasonal festival that, on one level, recalls the nomadic origins of the Hebrews, who would annually gather to celebrate increased flocks. On another level, however, Passover recalls the escape from Egypt after Moses had cursed the Egyptians to suffer the death of their first-born males. To avoid this curse, the Hebrews placed on their door posts a sign made from the blood of sacrificial lambs.

Gods have traditionally played key roles in food distribution. Each temple-state in ancient Mesopotamia had its own deities who lived in the ziggurat and who were fed offerings from the surrounding farms. This tribute not only supported the temple bureaucracy and artisans but also fed the poor of the region. In other places, this type of food redistribution also took place in kingdoms that were under the leadership of warrior rulers. For example, the ancient leader King Solomon oversaw the apportioning of 22,000 oxen and 120,000 sheep at the dedication of his temple. These sacrifices served as a vast round of public meals, which were shared by "all Israel . . . a great assembly" from distant places. These meals also lasted for quite some time, as Solomon dismissed the crowd on the eighth day (1 Kings 8:62–66).

The role of the *mageiros* in ancient Greece also illustrates the social centrality of sacrifice. This same word was used for priest, cook, and butcher (which might bewilder the modern mind). Nevertheless, the common link among these individuals was that each of them was responsible for the cutting up of meat, the priest wielding his cleaver (or *machaira*) ritualistically, the butcher commercially, and the cook artistically.

Aztec priests gained notoriety for sacrificing human victims. In *The Sacred Cow and Abominable Pig*, the anthropologist Marvin Harris argues that such "warfare cannibalism" occurs when captives have greater value as meat than as slaves (pp. 199—234). Yet many claims of human sacrifice are often suspect, as they can be misrepresentations of others as "less civilized." For example, some people in the ancient world mistook Christians for cannibals because they spoke of their savior as a sacrificial lamb and of their eucharistic bread and wine as his flesh and blood.

Because the acquisition and distribution of meat are so fundamental in society, they have been surrounded by many different relationships, rituals, and meanings. The allocation can become so formalized, the portion of food "lost" to the gods so large, and sacramental feelings so profound that the process may no longer resemble sharing. In addition, many accounts have overemphasized religious meanings at the expense of focusing on the sacrificial process of cooking offerings. However, a gastronomic interpretation of sacrifices need not diminish the importance of the ties among people, natural forces, and gods that sacrifices represent. On the contrary, taking the sharing of food under serious consideration arguably grounds the religious aspects of sacrifice and increases their relevance.

In much of the world, the act of slaughtering meat has been removed from plain view to the city outskirts. It has shifted from the butcher's shop to behind a supermarket wall. The final carving of joints now tends to be kept to the kitchen, and the image of cattle is separate from that of hamburgers. Greater sympathy with ceremonial sacrifice may help reconnect meat-eaters with their metabolic universe. A keener sense of the sacred when eating meat might help counterbalance tendencies toward instant gratification, conspicuous consumption, viewing animals as commodities, and the increasingly unbalanced distribution of the world's resources. If animal-devouring gourmets do not entirely embrace such religious impulses as atonement, propitiation, divine commensalism, and thanksgiving, they might nevertheless remember that to "immolate"—from the Latin for 'sacrifice'—is to sprinkle with a condiment.

Arguing for a more materialist reverence that brings the sacred back into the kitchen, Episcopal priest Robert Farrar Capon advises cooks to remember that they inhabit "bloody ground and holy ground at once." In his recipe book and "culinary reflection," *The Supper of the Lamb*, he confronts the dilemma of the "bloody, unobliging reciprocity in which life lives by death, but still insists that death is robbery" (pp. 45–52).

See also **Anthropology and Food; Aversion to Food; Christianity; Disgust; Fasting and Abstinence; Feasts, Festivals, and Fasts; Hinduism; Islam; Judaism; Meat; Pig; Religion and Food; Sheep; Sin and Food; Taboos.**

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SAFFRON. *See* **Herbs and Spices.**

SALAD. Although the ancient Greeks and Romans did not use the word "salad," they enjoyed a variety of dishes with raw vegetables dressed with vinegar, oil, and herbs. Pliny the Elder in *Natural History*, for instance, reported that salads *(acetaria)* were composed of those garden products that "needed no fire for cooking and saved fuel, and which were a resource to store and always ready" (*Natural History*, XIX, 58). They were easy to digest and were not calculated to overload the senses or stimulate the appetite.

The medical practitioners Hippocrates and Galen believed that raw vegetables easily slipped through the system and did not create obstructions for what followed, therefore they should be served first. Others reported that the vinegar in the dressing destroyed the taste of the wine, therefore they should be served last. This debate has continued ever since.

The cookery writer Marcus Apicius of the first century C.E. offered several salad recipes, some of which were unusual. His recipe for "bread salad" covers the bottom of a large salad bowl with bread, then adds layers of sliced chicken, more bread, sweetbreads, shredded cheese, pine nuts or almonds, cucumber slices, finely chopped onions, then finishes with another layer of bread. A dressing made of celery seed, pennyroyal, mint, ginger, coriander, raisins, honey, vinegar, olive oil, and white wine is poured over the salad. Another dressing Apicius used on lettuce was a cheese sauce that included pepper, lovage, dried mint, pine nuts, raisins, dates, sweet cheese, honey, vinegar, *garum* (fish sauce), oil, wine, and other ingredients. Other Roman salads were similar to present-day ones, such as lettuce and cucumbers or raw endive dressed with *garum*, olive oil, chopped onion, and vinegar or a dressing of honey, vinegar, and olive oil. Roman salad dressings eventually became more complex. Apicius gave a recipe for one containing ginger, rue, dates, pepper, honey, cumin, and vinegar. With the fall of Rome, salads were less important in western Europe, although raw vegetables and fruit were eaten on fast days and as medicinal correctives.

Many medical professionals did not approve of fresh fruits and uncooked vegetables. Both were considered "cold" in the humoral system of medicine. To counter this coldness, salads were seasoned with salt and olive oil, which were thought to be "hot," thus counteracting the coldness of the raw fruits and vegetables. However, this health concern continued into the nineteenth century.

The Emergence of *Salade*

The term *salade* derived from the Vulgar Roman *herba salata*, literally 'salted herb'. It remained a feature of Byzantine cookery and reentered the European menu via medieval Spain and Renaissance Italy. At first "salad" referred to various kinds of greens pickled in vinegar or salt. The word *salade* later referred to fresh-cooked greens or raw vegetables prepared in the Roman manner.

Under the category of herbs and vegetables, Platina's *De Honesta Voluptate et Valetudine* (1470) included salads, such as raw lettuce seasoned with a vinaigrette composed of olive oil, vinegar, and salt; boiled endive, borage, or bugloss with a vinaigrette seasoned with calamint and mint parsley; purslane with a vinaigrette seasoned with onions; boiled mallow placed in a dish like asparagus and seasoned with a vinaigrette; pimpernel seasoned with a vinaigrette; sorrel served as a first course with bread seasoned with a vinaigrette; and asparagus served in wine. Platina also offered a salad *(pantodapum)* composed of lettuce, borage, mint, calamint, fennel, parsley, wild thyme, marjoram, chervil, sow-thistle, and other herbs seasoned with a vinaigrette and served in a large dish. Common Italian salads of the twenty-first century include *insalata condita*, a green salad; *insalata caprese*, composed of sliced tomato and mozzarella with fresh basil dressed with olive oil; *insalata russa*, composed of cooked vegetables; and *insalata di mare*, a seafood salad.

French *Salade*

The French cookery manuscript *La Viandier* from the fourteenth century includes a recipe titled "*Poree de Cresson,*" a leek stew, which mutated into a vegetable stew of a soupy consistency. *La Viandier* recommends serving boiled watercress and chard with oil, cheese, meat broth, and salt. In the following century the French sprinkled raw vegetables with oil and vinegar in the Roman manner. François Rabelais (1490–1553) mentioned a long list of *salades*, including ones with cress, hops, wild cress, asparagus, and chervil. In the next century Louis XIV (1638–1715) had a weakness for salads. According to the French culinary historian Maguelonne Toussaint-Samat, in *History of Food* (1992), Louis XIV "ate a prodigious quantity of salad all the year round." Hygienic precepts of the time held that salads were "moistening and refreshing, liberate the stomach, promote sleep and appetite, temper the ardors of Venus and quench the thirst" (Toussaint-Samat, 1992, pp. 695–696).

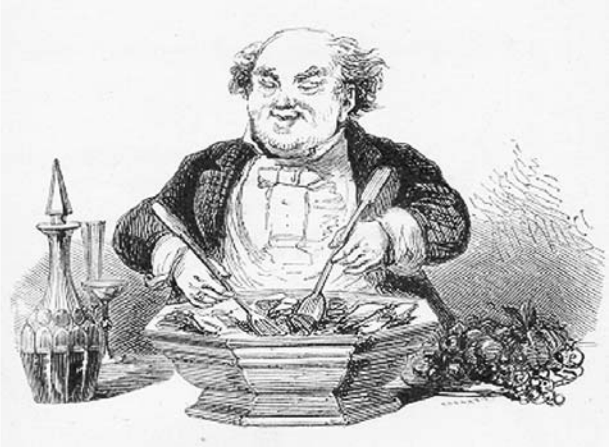
Prejudice against raw vegetables and fruit continued, and green salads were not commonly served on the tables of the upper class until the late eighteenth century. Jean-Anthelme Brillat-Savarin, in *The Physiology of Taste* (1986) felt obliged to recommend salads "to all who have confidence in me: salad refreshes without weakening, and comforts without irritating; and I have a habit of saying that it makes me younger."

Modern restaurant salads have evolved into studies in the deliberate arrangement of raw plants of different colors and textures. Since the food must be arranged by hand, some food critics have decried this as unnecessary and overly fussy, yet the eye appeal cannot be denied. © Aaron Rezney/CORBIS.

Common French salads include *salades simples*, plain salad composed of raw salads and cooked salads composed of vegetables; *salade andalouse*, cooked rice seasoned with vinegar, salt, and paprika; *salade de légumes*, a vegetable salad seasoned with oil, vinegar, salt, and pepper; *Rossini salade*, truffles dressed with vinegar, lemon juice, salt, and pepper; *salade parisienne*, vegetable salad with lobster or crayfish and truffles dressed with mayonnaise; and *salade Niçoise*, composed of diced potatoes, hard-boiled eggs, French beans, olives, capers, tomatoes, and anchovies dressed with olive oil, vinegar, salt, and pepper. French salads are frequently seasoned with a vinaigrette of oil, vinegar, mustard, salt, and pepper. Anchovies, cream, bacon fat, garlic, lemon juice, egg yolks, paprika, and tomato juice are sometimes added to the vinaigrette.

English *Salet* or Salad

In the late fourteenth century the English *salade* or *salet* (also *sallet*) was frequently composed of leafy vegetables served as an accompaniment to cooked meats or poultry. *The Forme of Cury* (c. 1390) includes a recipe that calls for parsley, sage, garlic, chives, onions, leeks, borage, mint, cress, fennel, rue, rosemary, and purslane. Other



The construction of the perfect salad was done with great flourish in the nineteenth century; aside from carving meat, it was one of the few food preparation activities allowed to men at table. This much-copied image first appeared in *Salad for the Social* (New York, 1856) by American essayist Frederick Saunders (1807–1902). Roughwood Collection.

salad recipes included flowers, and later fruits, such as oranges and lemons, were added at least in a decorative role. John Gerard's *Herball* (1597) offered many serving suggestions. As new vegetables, such as sweet potatoes from the Caribbean and red beets from Europe, entered England, they were added to the list of salad ingredients.At first salads were simple compositions, such as sliced lemons with sugar. But these became increasingly complex and could be assembled from many herbs, fruits, nuts, spices, and flowers. In the late seventeenth century the grand *sallet* had multiple ingredients, including borage, capers, carrots, cowslips, currants, marigold, primrose, purslane, violets, and sugar and were dressed with oil and vinegar.

John Evelyn's *Acetaria* (1699; 1982) was the first salad book published in the English language. Evelyn defined *sallet* as "a particular Composition of certain *Crude* and fresh herbs, such as usually are, or may safely be eaten with some *Acetous* Juice, Oyl, Salt, &c. to give them a grateful Gust and Vehicle." He included roots, stalks, leaves, and flower buds but excluded fruit, although the juice and the grated rind of oranges and lemons were listed among the herbs. Evelyn's salads have no meat. His recipe for salad dressing says, "Take of clear, and perfectly good *Oyl-Olive*, three Parts; of sharpest *Vinegar* . . . *Limon*, or Juice of *Orange*, one Part; and therein let steep some Slices of *Horse-Radish*, with a little *Salt*" (Evelyn, 1982, pp. 121–122). But Evelyn banned garlic, although he admitted that Spaniards and Italians used it "with almost everything."

By the early nineteenth century the art of salad making in the French style had been introduced to England by émigrés who fled to London during the French Revolution. By the mid-nineteenth century salads and their dressings were taken seriously in England. Mrs. Beeton's *Book of Household Management* (1859–1860) includes the first known recipe titled "fruit salad."

American Salad

Americans had little interest in green salads and most other salads before the Civil War. Some exceptions did exist. German immigrants brought with them hot potato salad, usually made with bacon, onion, and vinegar. The Shakers made fruit salads, which might not include any greens at all. The medical establishment considered raw fruits and vegetables unhealthy and the cause of illness. However, by the mid-nineteenth century the medical profession reversed its earlier opposition to eating raw fruits and vegetables and promoted salads as healthful. Poultry and cooked vegetable salads occasionally graced the American table.

During the 1880s salads joined the culinary experiences of all Americans. The first known American cookbook solely dedicated to salad making was Emma Ewing's *Salad and Salad Making* (1883). At that time molded salads, composed with gelatin or aspic and sugar or sweet fruits, were invented. Salads included such greens as watercress, dandelions, sorrel, chicory, escarole, chives, kohlrabi, and celeriac. Although tomatoes had been used as or in salads for decades, the ubiquitous lettuce and tomato salad first appeared in the United States in the late nineteenth century, when it became one of the more common salads in cookbooks. It was popularized by Fannie Merritt Farmer's *Boston Cooking School Cook Book* (1896). Another common dish was the perfection salad, which was composed of shredded cabbage, diced celery, minced onions, canned pimento, and chopped olives held together with gelatin, vinegar, lemon juice, sugar, and Worcestershire sauce.

European-style salads were served to the upper class in restaurants in large cities. In New York, for instance, Delmonico's Restaurant specialized in the then novel green salads dressed with vinegar and olive oil. Oscar Tschirky, initially a chef with Delmonico's, moved to the Waldorf Astoria, where he invented the Waldorf salad, a combination of lettuce, apple, and celery dressed with mayonnaise. Walnuts were added in the 1920s. The salads were popular, but the salad dressings were also. The New York restaurateur George Rector noted in *Á la Rectors* (1933) that a new salad dressing could become "the talk of the town" and could attract customers away from other restaurants. By the end of the century, salads had found a place in many middle-class homes and restaurants. In *The American Salad Book* (1899) Maximilian De Loup reported that Americans preferred them to "heavy bulky materials," and he believed green salads were the wave of the future.

Beginning in the late nineteenth century, salads were promoted by manufacturers of salad dressings and oils.

Until the passage of the Pure Food and Drug Act in 1906, vinegar and olive oil were frequently adulterated with acetic acid and cottonseed, peanut, rapeseed, and poppy seed oils. To promote their products in the twentieth century, companies composed booklets of recipes for salads dressed with commercial dressings. Early commercial manufacturers of salad dressings included Best Foods, E. R. Durkee & Company, R. T. French Company, H. J. Heinz Company, Richard Hellman, Jell-O Company, Kraft-Phoenix Cheese Corporation, and Tildesley & Company, and those manufacturing oil included Mazola and Wesson Oil. By the 1920s, bottled mayonnaise and salad dressings were commonly used in households across the United States.

Salads flourished where the raw ingredients were easily available, particularly in Florida and California. Francis Harris's *Florida Salads* (1914) was revised and reprinted several times during the early twentieth century. However, California was considered the "land of salads" and salad dressings. Green Goddess Dressing, introduced by the Palace Hotel in San Francisco in the early 1920s, was purportedly inspired by the British actor George Arliss, then performing in the play by that name. In 1926 Robert Cobb, owner of the Brown Derby restaurant in Los Angeles, introduced Cobb salad, which consists of avocado, tomato, watercress, lettuce, bacon, chicken, Roquefort cheese, and a hard-boiled egg arranged in a striped pattern in a flat bowl and topped with French dressing. So pervasive was the California influence on food that the chef's salad became a meal in itself throughout the United States.

Salads arrived in the United States from other countries, continents, and cultures. German potato salad, a cold or hot side dish made with potatoes, mayonnaise, and seasonings, became popular in mainstream America in the second half of the nineteenth century. In the twentieth century Caesar Cardini, an Italian immigrant who opened several restaurants in Tijuana, Mexico, created the Caesar salad with romaine lettuce, garlic, olive oil, croutons, Parmesan cheese, Worcestershire sauce, and often anchovies. The Caesar salad became popular with Hollywood movie people who frequented Tijuana, and it quickly spread to Los Angeles and other cities. Italian immigrants helped popularize the lettuce and tomato salad and introduced cold pasta salads of tortellini, mayonnaise, and dill.

In the late twentieth century, health food advocates championed salads, which were greatly advanced by the invention of the salad bar purportedly by the Chicago restaurateurs Rich Melman and Jerry Orzoff, whose R. J. Grunts featured a long counter of greens, seasonings, vegetables, and condiments. Many restaurants and delis throughout the United States quickly adopted and expanded this concept.

Salad dressings range from simple to elaborate. Three common dressings of the early twenty-first century are vinaigrette, commonly called Italian dressing in the United States, composed of three parts oil to one part vinegar; Thousand Island, a mayonnaise-based dressing flavored with chopped tomatoes, peppers, and other ingredients that is presumably named for the small islands in the St. Lawrence River between the United States and Canada; and Roquefort or, more accurately, blue cheese dressing.

See also **Apicius**; **Brillat-Savarin, Anthelme**; **Fruit**; **Lettuce**; **Oil**; **Vegetables**.

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SALMON. *See* **Fish: Sea Fish.**

SALT. Because salt is indispensable to life, acts as a food preservative, and uniquely flavors foods, humans have been preoccupied with it since the beginning of recorded history. The desire to obtain salt politically or militarily has influenced the histories of countries in Asia, Africa, Europe, South America, and the Middle East. Indeed, salt was used as a form of currency and had greater value than gold in some ancient societies. Even religious and magical significance has been attributed to this mineral.

In chemistry, the term "salt" generally refers to any compound that results from the interaction of an acid and a base. In the fields of geology and agriculture, the term "salt" is used as a synonym for the word "mineral." Although numerous salts are essential to human health (for example, potassium chloride, sodium hydroxide), in the following paragraphs the term "salt" will refer specifically to the inorganic, white crystalline substance that is known as sodium chloride (abbreviated NaCl), unless otherwise noted. It is also known as table salt, rock salt, sea salt, and saline. The reader should be aware that some paragraphs below refer to sodium chloride, whereas others refer to sodium, the mineral/ion/electrolyte.

When sodium chloride enters the body, it dissociates almost completely into its constituent particles, the ions sodium and chloride. Sodium chloride is soluble in water and glycerin. Sodium is the most plentiful ion in blood. As electrically charged particles, positively charged sodium (Na^+) and negatively charged chloride (Cl^-) are classified as electrolytes because they conduct electricity when dissolved in water.

Dietary Salt

Sodium exists in many foods that are commonly consumed in Western diets including processed sandwich meats, cheese, canned vegetables, pickled foods, salty snacks, and soft drinks. Other sources of sodium are not as well recognized: condiments, sauces, baking soda, baking powder, and bread. In restaurant foods, fast-food meals, and Chinese cuisine the sodium levels can be very high. Only about 10 percent of the sodium in Western diets is due to discretionary salt added at the table.

The sodium content of plants and vegetables depends on numerous factors. These include plant maturity, genetics, agricultural practices, soil salinity, soil fertility, soil pH, the rate at which water percolates through soil, as well as meteorological factors such as rainfall, cloud cover, and sunlight.

For most Americans today, eating preserved and processed foods has become a way of life. Sodium chloride is the most common food additive. Approximately 75 percent of sodium in Western diets originates from processed foods. Because salts of all kinds, including sodium chloride, are very stable, it is virtually impossible to remove sodium from foods that have been canned in glass or metal containers. In fact, the addition of sodium may occur during home meal preparation as well as commercial processes. For example, it is possible that a vegetable contains only 2 mg of sodium per 100 g on the vine but may contain 2 to 310 times that amount after canning. Processes such as adding a salt solution to prevent discoloration of vegetables (that is, brining), or the use of sodium salts as processing aids, also result in the addition of sodium to the final product.

Salt in Food Processing

In the late nineteenth and early twentieth centuries, before modern processing techniques existed, food preservation consisted primarily of heat sterilization used in combination with the addition of salts and spices. Salt was used to suppress the growth of unwanted bacteria. Today, sodium is added to processed foods in several forms. Sodium nitrate and sodium nitrite are added to meats as preservatives. Sodium citrate monobasic is added as a pH buffering agent. Both sodium fumarate and malic acid sodium salt are added to foods as buffering agents and flavor enhancers. These salts are used in concert with numerous other food additives in the United States (for example, antioxidants, stabilizers, colors, sweeteners, enzymes, and emulsifiers), under the direction of the U.S. Food and Drug Administration.

Fergus Clydesdale, a professor at the University of Massachusetts at Amherst, explained in 1988 that the loss of sodium during processing is solely due to leaching (that is, extraction, rinsing, or filtration). Canning, boiling, steaming, blanching, and cooking are the processes most likely to cause leaching of sodium and other salts. However, the extent to which these electrolytes are lost varies with the food product, type of processing, and properties of each ion. The amount of water used in a given commercial process also affects mineral losses. Steaming, for example, uses less water than boiling. Further, the total processing time may affect sodium losses from foods. Brief procedures will likely extract less salt than lengthy ones.

Various other salts (for example, potassium chloride, magnesium chloride, sodium nitrate, sodium benzoate, and sodium acetate) are added to foods during commercial processing. They serve to cure meats, provide or intensify the flavor of numerous products, decrease caking of dry products, stabilize pH (that is, when used with jams, gelatins, baked goods, pasteurized cheese), fortify nutrients, and enhance texture. Sodium nitrite, for example, reacts with meat pigments to develop a characteristic pink color. In bread and baked goods, salt serves a variety of functions including the control of the rate of fermentation in yeast-leavened products. Fermented vegetables such as sauerkraut require salt for flavor and to extract water and other nutrients from the plant tissue to form brine, in which desirable organisms flourish and undesirable ones are subdued. The firmness and color of fruits and vegetables are preserved by the calcium salt of lactic acid. In cheese products, salt is added to the curd or applied to the cheese surface to remove whey and to slow the production of acid. Sorbic acid and its salts are antimicrobial agents that work to suppress the growth of bacteria; molds in cheese, sausages, fruits, jellies, bread and cakes; and yeasts in salad dressings, tomato products, syrups, candies, and chocolate syrup.

Biological and Physiological Considerations

The various minerals in the human body serve to maintain acid-base balance, blood volume, and cell membrane permeability, and provide the constituents of bones and teeth. Sodium chloride is important in maintaining the proper concentration of body fluids (that is, osmolality), expediting fluid movement between cells, enhancing glucose absorption, and allowing proper conduction of impulses along nerve and muscle tissues.

Body fluids are distinguished as either intracellular (that is, existing inside muscle and organs) or extracellular (that is, circulating blood plus the interstitial fluid that lies between cells). To accomplish their functions, body tissues maintain intracellular and extracellular ions in different concentrations. This requires considerable energy, approximately one-third of all resting metabolism, and is accomplished by molecules that are embedded in cell membranes throughout the body; these large protein molecules are known as pumps because their action causes an unequal distribution of an ion on the inside and outside of a membrane. In blood, the concentrations for some ions (for example, potassium and calcium) are maintained within narrow limits. Table 1 illustrates these concepts for sodium, chloride, potassium (K^+), and magnesium (Mg^{2+}). Chloride is the most common negative ion that combines with sodium in the extracellular fluid. Sodium and chloride account for more than 80 percent of all particles in the extracellular fluid. Potassium, magnesium, and phosphate are the most abundant intracellular ions. Potassium speeds energy metabolism and is involved in the synthesis of proteins and a storage form of carbohydrate (that is, glycogen). Magnesium allows the body's chemical reactions and biochemical pathways to function efficiently. Approximately 60 percent of the body's magnesium exists in the skeleton, in combination with calcium and phosphorus; in fact, 99 percent of all calcium exists in bones and teeth. The remaining magnesium is present in red blood cells and muscle, supporting the transport and storage of oxygen.

The concentrations of ions in sweat and urine, which constitute the major avenues of loss, may vary markedly between individuals. This large range exists in sweat and urine because diet, acute exercise, chronic physical training, and heat acclimatization alter the loss of these ions—especially sodium and chloride—at the sweat glands and kidneys.

Sodium Metabolism

Sodium is so intimately related to other intracellular ions, extracellular ions, and water that it is difficult to consider the factors that regulate its metabolism independently. Nevertheless, the following text is limited to the regulation of sodium retention and excretion.

TABLE 1

Sodium, chloride, potassium, and magnesium ion concentrations (mmol/L) in intracellular fluid and in four extracellular fluids

Source	Sodium	Chloride	Potassium	Magnesium
Intracellular fluid	8	150	31	10
Extracellular fluids				
Sweat	15–53	4–8	2–5	15–70
Urine	32–224	43–60	8–10	39–218
Blood plasma	96–110	3–6	1–2	135–145
Saliva	11–45	11–23	0.1–0.4	10–75

At rest, the kidneys filter circulating blood at the rate of 1.0 to 1.5 L/min, causing the kidneys to generate approximately 180 L of fluid during a 24-hour period. Because the average urine volume of normal adults totals 1.3 L/day, almost all of the renal filtrate is reabsorbed and returned to the bloodstream. The amount of sodium excreted into the urine depends upon the body's need for sodium. If excess sodium is consumed without water, the kidney excretes urine with a high concentration of sodium. If dietary sodium is restricted, the kidneys are capable of producing a dilute urine that maintains the concentration of sodium in body fluids at a normal level.

Whole-body sodium balance is maintained over a wide range of dietary and environmental conditions, primarily due to the action of the hormone aldosterone on the kidneys. When dietary sodium is high, urinary sodium increases to excrete the excess. When dietary sodium is low, aldosterone reduces the loss of sodium in urine appropriately. Thus, a sodium deficiency is rare, even among individuals who consume very low-sodium diets (see below). The body may experience a sodium deficiency when sweat losses are large and persistent, or when illness (for example, chronic diarrhea, renal disease) results in inadequate sodium retention by the kidneys. Following major changes in dietary sodium levels, concentrations of the following hormones also adapt, suggesting that they minimize perturbations of extracellular fluid-ion balance: renin, angiotensin II, atrial natriuretic peptide, and nitric oxide. The latter compound plays a pivotal role in blood pressure maintenance by regulating sodium and water excretion at the kidneys. Despite our knowledge of these facts, scientists cannot explain the exact mechanism by which the brain assesses whole-body sodium status.

A predictable sequence of events occurs when a normal individual limits the intake of sodium (for example, 230 mg daily). During the initial days of salt restriction, urinary sodium levels progressively decrease until about the fifth day, when the 24-hour losses become small (for example, 115 mg or less). This individual ordinarily loses 1 or 2 kg of body weight, which is attributable to the loss of sodium and an appropriate volume of water. Initially, the reduced body water comes almost exclusively from the extracellular fluid; as time passes, the intracellular fluid compartment also shrinks. For the next few days, urinary sodium concentration remains low, and the body continues to maximize salt conservation until a reduced whole-body sodium equilibrium is established. Sweat sodium levels decrease in a manner similar to urine during dietary restriction; both are due to the action of the hormone aldosterone.

Toxicity

As is true for virtually all nutrients and compounds, salt can be detrimental or lethal in large quantities. Direct contact with sodium chloride can cause skin irritation, and heating it to high temperatures emits a vapor that irritates the eyes. When heated to the point of decomposition, it emits toxic chloride and disodium oxide (Na_2O) fumes. When consumed in large amounts, sodium chloride can cause stomach irritation. In addition, laboratory experiments have shown the following dose-response effects: 50 mg/24 hr, skin irritation in rabbits; 100 mg/24 hr, moderate eye irritation in rabbits; 125 ml/L, inhibition of DNA synthesis in isolated human cells; 27 mg/kg body weight, abortion of a human fetus; and 3,000 mg/kg body weight, lethal oral dose for 50 percent of the animals tested. Potassium chloride causes physiological responses at the following doses: 500 mg/24 hr, mild eye irritation in rabbits; 125 g/L, lung cell death in hamsters; 2,600 mg/kg body weight, lethal oral dose for 50 percent of the animals tested. Calcium chloride is lethal for 50 percent of the animals tested at a dose of 1,000 mg/kg body weight, when administered orally, and at an intraperitoneal dose of 264 mg/kg body weight. Studies have shown that magnesium chloride is lethal for 50 percent of rats tested at an oral dose of 2,800 mg/kg body weight.

The preservatives known as sulfites (see Sodium and Hypertension, below) can produce deleterious side effects, when consumed in large quantities. Investigations involving laboratory animals have shown that sulfites may inhibit some of the body's biochemical reactions and retard whole-body growth in infants; cause gastrointestinal distress; and induce reversible anemia, nutrient deficiency (for example, thiamine), and gene mutations. A lethal oral dose of sodium bisulfite (50 percent of the animals tested) was 498 mg/kg body weight in rats and 300 mg/kg body weight in mice.

Monosodium glutamate (MSG) is added to foods by chefs to potentiate various flavors. This effect is greatest in meat- and vegetable-based soups, sauces, gravies, and spice blends. The levels of MSG in foods range from approximately 0.3 percent in spinach and tomatoes to about 10 percent in parmesan cheese and 20 percent in dehydrated soup mixes. Some consumers also mix additional MSG into foods in the form of sauces. This may be strongly influenced by cultural food preferences. In Korea and Taiwan, for example, the average adult consumes six to ten times more MSG each day than the average person in the United States. Because sodium is a part of the molecular structure of MSG, it becomes available as free, metabolically active sodium. Therefore, individuals who consume restricted-sodium diets (see Sodium and Hypertension, below) should monitor both the natural levels of MSG in foods as well as the amount that is intentionally added. Monosodium glutamate also produces unwanted side effects in some individuals, including warmth, tingling, tightness, headache, swelling of the liver, and a feeling of pressure in the upper body or face. This phenomenon is often associated with consumption of Chinese food because of its high MSG content. The toxicity of MSG has been studied extensively and it is relatively low, compared to other salts. It has been estimated, for example, that an average adult, weighing 70 kilograms, would have to consume more than 3 pounds of MSG at one time to experience a toxic effect. This does not mean, however, that detrimental effects are nonexistent. A large quantity of MSG has been associated with convulsions, vomiting, and nerve cell damage in research animals, although there are great differences between species. Studies have shown that MSG is lethal, for 50 percent of rats tested, when consumed as an oral dose of 17,300 mg/kg body weight. Thus, when consumed in typical amounts, MSG does not appear to induce illness or toxicity. Because the scope of this article does not allow detailed considerations of the toxicities of other salts, the reader may refer to the book *Food Additive Toxicology* for further information.

Sodium and Hypertension

Because the kidneys regulate the volume of circulating blood, they are intimately involved in the genesis of high blood pressure (that is, hypertension). This disease often involves excessive retention of extracellular fluid, especially in the bloodstream. For unknown reasons, resistance to blood flow through the kidneys is increased two- to fourfold. And, unfortunately, even though blood pressure may be reduced by prescription medications, the kidneys do not excrete normal amounts of salt and water in urine. This scant urine output causes water and sodium retention until blood pressure rises again to an elevated level. Treatment for this fluid and electrolyte retention often involves diuretics, which increase hourly water and salt losses in urine markedly. Considering these facts, a multiple-stage scientific hypothesis has evolved. This concept proposes that a high dietary sodium intake (1) overloads the kidneys' capacity to excrete sodium and results in fluid retention, (2) increases endocrine gland secretion (that is, natriuretic hormone), (3) inhibits cell membrane function, (4) increases the sodium concentration inside cells and calcium levels in the smooth muscles that encircle blood vessels, which (5) subsequently increases the resistance to blood flow and blood pressure. Interestingly, some research indicates that hypertension may be dependent on the coexistence of sodium and chloride in the diet. Consumption of chloride salts (for example, potassium chloride and calcium chloride) is associated with hypertension, in a way similar to that of sodium.

Forty-three million Americans live with persistently high blood pressure, defined as readings of 140/90 mm Hg or above; this represents 24 percent of the adult population of the United States. This makes it one of today's most prevalent disease conditions. High blood pressure increases the risk of stroke, heart disease, and kidney failure. Individuals with a family history of hypertension, the elderly, middle-aged men, and middle-aged black women are at greatest risk. Yet, everyone is vulnerable because blood pressure typically rises with age.

It is important to acknowledge that heredity plays a critical role in hypertension and that this complex disease is affected by many different genes. Present wisdom states that, without these genes, a person will not develop high blood pressure. Such individuals, whose blood pressure increases with increasing sodium consumption, are salt-sensitive. This explains why there are great differences in human responses to sodium chloride.

Several factors play a role in reducing high blood pressure. In hypertensive adults, for example, a single aerobic exercise session (45 minutes) reduces blood pressure for 12 to 24 hours. A healthy diet (high in fruits, vegetables, low-fat dairy products; low in saturated and total fat) also reduces blood pressure. But salt has received the most attention. There is a large body of evidence, and consensus within the scientific community, that dietary sodium chloride is a risk factor for high blood pressure, independent of other risk factors such as alcohol and obesity. During the last 25 years, numerous professional organizations and advocacy groups have supported reductions of sodium in commercially processed foods, including the American Academy of Pediatrics, American College of Cardiology, Food Research Action Center, American College of Preventive Medicine, American Health Foundation, National Alliance of Senior Citizens, and National Urban Coalition.

In countries where dietary sodium is low, high blood pressure is rare. According to clinical investigations, when hypertensive adults reduce salt consumption their blood pressure usually decreases, although not always to a normal level. Additional evidence suggests that a high-salt diet aggravates other illnesses including asthma, gastric cancer, kidney stones, and osteoporosis. Therefore, consuming a low-salt diet will, for many people, reduce their risk of developing or aggravating a chronic illness such as cardiovascular stroke.

Individuals who are placed on sodium-restricted diets often consume other salts in place of sodium chloride. This increases the daily potassium intake because salt substitutes usually contain a high percentage of potassium chloride. This dietary strategy offers potential health benefits in the form of lowered blood pressure and reduced risk of stroke. For some individuals, however, the use of a potassium-containing salt substitute can cause illness or death. Individuals with a disease, those taking medications, and the elderly should be advised that these salt substitutes ought to be used only to enhance taste, and not for cooking purposes. Sulfites also should be considered. These compounds preserve food by retarding deterioration, rancidity, or discoloration and thus are categorized as antioxidants. At least three sulfites are commonly used as food additives: sodium sulfite (Na_2SO_3), sodium metabisulfite ($Na_2S_2O_5$), and sodium bisulfite ($NaHSO_3$). Because these preservatives contain sodium that becomes free and metabolically active in cells, each contributes to the diet's total sodium load.

TWO LOW-SODIUM RECIPES

The April 1985 issue of *FDA Consumer* magazine provided two recipes as examples of low-sodium meal items that are easy to prepare. The first describes baked dinner rolls and yields 100 servings: 3¼ ounces active dry yeast, 2 quarts water, 7¼ pounds all-purpose flour, 1⅓ cups sugar, 1 tablespoon salt. Normally, a recipe of this size would utilize 4 tablespoons of salt, resulting in a sodium content of 295 mg in each roll. By reducing the amount of salt by 25 percent, each roll contains only 73 mg of sodium.

The second recipe describes low-sodium sausage patties and yields 16 servings. Mix 1 pound ground beef with 1 tablespoon lemon juice, ¼ cup dry bread crumbs, ¼ teaspoon sage, ¼ teaspoon ginger, 1 teaspoon garlic powder, 1 teaspoon onion power, and ½ teaspoon liquid smoke. Dissolve 1 low-sodium bouillon cube in water and add this solution to the ground beef mixture. Mix thoroughly and let stand for 15 minutes. Form sixteen 1-ounce patties. Brush skillet with vegetable oil and cook the patties for seven to eight minutes on each side, or modify the time as desired. The use of low-sodium bouillon is the key to sodium reduction in this recipe.

Unfortunately, reducing the salt content of foods, to restrict sodium consumption, affects the quality and properties of foods. In the meatpacking industry, for example, reducing sodium chloride extremely results in inferior meat cohesion and water retention, and reduces shelf life. These and other unwanted effects explain why commercial food processors usually do not reduce the sodium chloride levels in their products voluntarily.

Managing Dietary Sodium

Compared to the average daily intake in the United States, ranging from 2,300 to 6,900 mg/day, the minimum physiological need for sodium (40 to 300 mg/day) and the intake necessary for good health (500 mg/day) are very small. In fact, the amount of sodium in fresh vegetables alone may be enough to meet an adult's basal requirement. Eight simple procedures make reducing salt intake effective. First, cook with only small amounts of added salt. Second, add little or no salt to food at the dinner table. Third, limit your intake of salty foods such as potato chips, salted nuts, pretzels, popcorn, soy sauce, steak sauce, garlic sauce, pickled foods, and cured meats. Fourth, request that the chef omit salt from your restaurant meal. Fifth, educate yourself about foods that contain large qualities of sodium and seek low-sodium brands when shopping for crackers, pasta sauce, canned vegetables, bread, and other commercial products. Sixth, develop a taste for the unsalted flavor of foods. The taste preference for salty foods can be altered with patience. Seventh, evaluate your diet by reading food labels carefully to determine the sodium content. This can be especially helpful in the aisles of a supermarket because you cannot eat what you do not purchase. Eighth, make a mental list of foods that you will avoid because they contain too much sodium. Here are a few examples, presented in units of milligrams per 100 g of food: fried crisp bacon, 2,400; baking soda, 9,000; beef bouillon cube, 24,000; bologna, 1,300; celery salt, 28,000; cured ham, 1,100; dill pickle, 1,400; frankfurters, 1,100; salt pork, 1,800; green pickled olives, 2,400; and processed cheese, 1,500.

Careful selection of low-sodium food items also will prove to be useful. Table 2 provides a comparison of the sodium content of several vegetables, in fresh and canned forms. Obviously, individuals who desire to reduce their total dietary sodium levels should substitute fresh vegetables for canned varieties, whenever possible. The exception to this recommendation lies in vegetables that lose sodium during processing, due to leaching. This provides the added benefit of ensuring that other dietary nutrients are not lost during commercial packaging (that is, leaching, boiling, blanching).

Another excellent way to lower sodium intake is to alter food preparation practices in the home. Many spices, herbs, and other flavorings do not contribute significant amounts of sodium but may be used to improve the flavor of low-sodium meals. These include allspice, basil, bay leaf, chives, cinnamon, cloves, curry, dill, garlic, ginger, leeks, lemon juice, mint, mustard, nutmeg, orange extract, oregano, paprika, parsley, pepper, peppermint, pimento, poppy seed, saccharin, saffron, sage, sesame, brown and white sugar, tarragon, vanilla extract, and wine.

In determining the amount of sodium that a person consumes, groundwater is often ignored. However, the sodium content of public and private aquifers in the United States varies greatly from one location to another. Although most sources of water include less than 20 mg of sodium per liter, a minor input to daily sodium, certain areas of Arizona, Texas, and Illinois report 325 to 432 mg of sodium per liter of groundwater. Considering the fact that the average adult consumes more than 2 L of fluid each day, this could mean that some Americans receive over 1 g of sodium per day from tap water alone. If a water softener is used to reduce hardness from a local water supply (for example, remove the mineral calcium carbonate), sodium content can be magnified.

TABLE 2

Sodium content (milligrams per cup) of vegetables: Fresh versus canned

	Fresh, raw	Canned
Asparagus	4	285
Beets	57	36
Carrots	31	280
Green beans	8	536
Green peas	2	236
Lima beans	1	310
Sweet potatoes	24	48
Tomatoes	2	18
Tomato juice	2	230

Individuals on low-salt diets also should be concerned about the adequacy of other nutrients. It has been estimated that 40 percent of all low-sodium diets lack other essential nutrients, especially protein, the B vitamins, riboflavin, and calcium. These deficiencies result from the removal of food items that contain sodium.

Salt Restriction and Sodium Deficiencies

As noted above, the basal physiologic need for sodium is 40 to 300 mg/day and the amount recommended for good health is 500 mg/day. Field studies, conducted between 1931 and 1962, confirmed that adults can eat low-sodium diets and remain healthy. Interestingly, some of these populations lived in tropical climates, where sweat losses were great, including the vigorous Masai warriors of Africa who consume less than 1,955 mg of sodium per day, the inhabitants of tropical Nigeria who ingest less than 2,760 mg of sodium per 24-hour period, and Galilean naturalists who ingest only 736 mg of sodium per day.

It is difficult to deplete the body of sodium. The action of the hormone aldosterone on the kidneys, and the relatively large per capita daily intake of sodium in Western diets relative to basal physiological needs, are quite adequate to maintain whole-body sodium levels. Thus, sodium deficiencies are rare, but may be experienced in three extraordinary situations. The first involves dietary salt restriction as therapy for disease (for example, hypertension or congestive heart failure). The possibility that sodium depletion may occur in these illnesses does not contraindicate the use of a low-sodium diet when suitable, but it is important that the patient be monitored carefully. Frequent measures of serum sodium concentration are desirable during the first few weeks of a salt-restricted diet. A decline in serum sodium level should prompt a reevaluation. The second circumstance involves diseases of the kidneys or endocrine glands that alter normal sodium balance, such as Addison's disease or diabetes insipidus. The third situation, involving hot environments, is considered in the following section.

Hot Environments Exaggerate Salt Losses

Exercise or labor in cool environments increases the sweat loss and water intake, but the psychological drive to drink and fluid-electrolyte hormones regulate total body water within +0.2 percent (+150 g) of the normal body weight each day. Blood plasma volume is regulated within + 0.7 percent (+ 25 g) on consecutive days.

During mild-to-moderate intensity exercise in a hot environment, voluntary water intake does not keep pace with water losses. Most humans produce 0.8 to 1.3 L of sweat per hour, but replace only one-third to three-fourths of this amount by drinking. Thus, if exercise in a hot environment is prolonged and strenuous, a 3 to 5 percent body weight loss can occur. This is significant because, at these levels, both endurance and strength decline.

Table 1 demonstrates that sweat contains sodium, chloride, and other minerals. In fact, sweat contains more than forty distinct organic compounds. Regarding the sodium chloride content, considerable interindividual differences exist among healthy adults. Physically fit athletes who are heat-acclimatized (that is, adapted to exercise in a hot environment) usually lose 400 to 800 mg of sodium chloride per liter of sweat. In contrast, the sweat of unfit, nonacclimatized adults contains from 1,000 to 3,000 mg of sodium chloride per liter. This difference occurs because physical training and heat acclimatization reduce the concentration of salt in sweat.

Salt Balance during Exercise and Labor

Table 3 provides estimates of the amount of fluid and salt lost in sweat, during different activities that are conducted in hot environments. Obviously, water and sodium chloride losses increase in proportion to the duration and the intensity of exercise. As a point of reference, Table 4 describes selected nutrients that are consumed by an adult in the United States. The intake of sodium chloride averages 4,600 to 12,700 mg, and water consumption averages 2.5 L/day. Comparing these two tables, it becomes obvious that 30 minutes of mild gardening produces a small fluid and sodium loss that can be replaced by a normal diet. An ultramarathon, requiring 20 to 30 hours to complete, involves extraordinary salt (14,400 to 70,000 mg NaCl) and water (18.0 to 35.0 L) losses that far exceed normal 24-hour food consumption. Clearly, constant fluid-electrolyte intake is required, during and after an ultramarathon, to replace lost nutrients.

TABLE 3

The amount of water and sodium chloride lost in sweat during labor or during exercise in hot environments

Event, Duration, Personal Characteristics	Total Water Loss (L)	Sodium Loss (mg)[a]
Mild gardening, 30 min, sedentary adult	0.3–0.5	240–2,000
Strenuous work, 60 min, experienced laborer	0.8–1.5	640–4,500
10-km run, 40 min, healthy adult	0.5–1.0	400–4,000
Leisure hike, 2 hr with rest, heat-acclimatized adult	2.0	1,600–6,000
Intense cycling, 2–4 hr, physically-fit cyclist	3.0–8.0	2,400–24,000
Ultramarathon, 20–30 hr, highly trained runner[b]	18.0–35.0	14,400–70,000

[a] Loss in sweat and urine; these calculations assume a range of 800–4,000 mg sodium chloride per liter of sweat; physical training and heat acclimatization increase a person's sweat rate but decrease the sodium content of sweat and urine.

[b] Running pace is slow and includes walking.

SOURCE: Average Consumption of Selected Minerals and Sodium Chloride in the United States (mg/day). National Research Council, 1989.

Three fluid-electrolyte disorders involve sodium (that is, heat exhaustion, heat cramps, and exercise-related hyponatremia) and have become the most common illnesses among athletes and laborers in hot environments. Heat exhaustion, an inability to continue exercise in the heat, is primarily a fluid depletion disorder in which either large sodium, water, or mixed sodium-water losses occur during exercise-heat exposure. Heat cramps occur most often in the abdominal wall and large muscles of the extremities and are due to whole-body sodium depletion. Treatment for these two heat illnesses involves replacing the sodium chloride and water that was lost in sweat and urine. Exertional hyponatremia involves a reduced serum sodium concentration (<130 mEq/L) and represents a marked dilution of the extracellular fluid. This disorder, unlike the previous two, involves overhydration. Athletes

TABLE 4

Consumption of selected nutrients in the United States (mg per day), as published by the National Research Council in 1989.

Mineral	Amount consumed (mg/day)[a]
Sodium chloride	4,600–12,700
Sodium	1,800–5,000
Potassium	2,500–3,400
Magnesium	207–329
Calcium	530–1,179

[a] The water intake of a 70-kg adult is approximately 2.5 L/day, in solid foods and fluid.

Salt jar made at the Schofield Pottery, Penrith, Cumberland, England, circa 1930. This traditional form, dating to at least the 1600s, was intended for use near the open hearth, where it hung from a hook. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

or laborers, who consume and retain a large volume of pure water (for example, 10 L in 5 hr), may experience a life-threatening series of physiological changes that signal water intoxication. The most serious effects are coma, fluid in the lungs (pulmonary edema), and brain swelling (cerebral edema).

Replacing Salt Losses due to Exercise

Individuals who exercise for more than two hours, and who are not hypertensive, should increase their salt intake slightly (see Table 3). Similarly, if a weight loss of 3 percent or more is due to fluid losses during work or exercise, a minor sodium deficit should be expected. The simplest means to replace these deficits after exercise involve adding salt to your meals and selecting saltier foods. Canned soup, for example, contains 1,950 to 2,450 mg of sodium chloride; canned tomato juice contains 1,525 mg. Fluid-electrolyte replacement beverages contain 150 to 300 mg, and 1 percent low-fat milk contains 300 mg sodium chloride It also is wise to eat more fruits, such as bananas and watermelon, to replace lost potassium.

See also **Assessment of Nutritional Status; Body Composition; Electrolytes; Fish, Salted; Meat, Salted; Microbiology; Minerals; Nutrition; Sodium; Thirst.**

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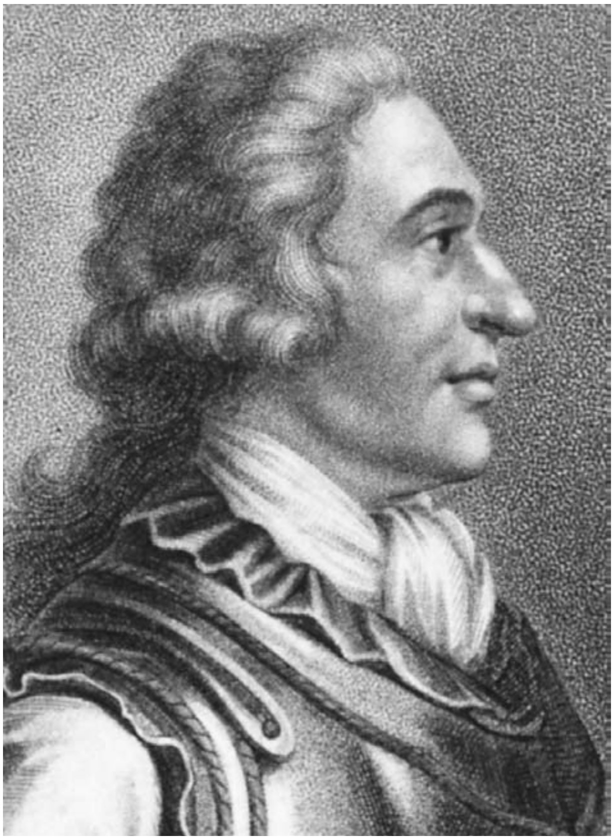
Lawrence E. Armstrong

SANDWICH. The bread-enclosed convenience food known as the "sandwich" is attributed to John Montagu, fourth earl of Sandwich (1718–1792), a British statesman and notorious profligate and gambler, who is said to be the inventor of this type of food so that he would not have to leave his gaming table to take supper. In fact, Montagu was not the inventor of the sandwich; rather, during his excursions in the Eastern Mediterranean, he saw filled pita breads and small canapés and sandwiches served by the Greeks and Turks during their mezes, and copied the concept for its obvious convenience. There is no doubt, however, that the Earl of Sandwich made this type of light repast popular among England's gentry, and in this way, his title has been associated with the sandwich ever since. The concept is supremely simple: delicate finger food is served between two slices of bread in a culinary practice of ancient origins among the Greeks and other Mediterranean peoples.

Literary references to sandwiches begin to appear in English during the 1760s, not only in connection with their presumed Englishness, but also under the assumption that they are a food consumed primarily by the masculine sex during late night drinking parties. This connotation does not change until the sandwich moves into general society as a supper food for late night balls and similar events toward the end of the eighteenth century.

That sandwich, the creation of caterers, is amply described by Louis Eustache Ude, an illustrious cook who finished his career as chef de cuisine of the Crockford Club in London, in his *French Cook* (1818). Ude took particular care to outline a proper supper and the critical execution of the superior sorts of English sandwich that originally gave the food its high status. He explained that bread for sandwiches filled with salads must be specially baked in molds so that the texture is dense, though the crust not dry, to avoid sogginess once the sandwiches are stacked on a silver tray, as they should not bend when held in the hand. Breads for other sandwiches should be baked long and round like a tube so that the slices are even and thus fit neatly together without lumpiness or air spaces between. Furthermore, all crusts on sandwich breads should be rasped so that they acquire the texture of chamois. His sandwiches for two or three hundred persons included fillet of guinea fowl with cold béchamel sauce ("make them towards nine o'clock to serve up at twelve"), fillet of pheasant poached in a fumet, fillet of sole à la Ravigotte, salad sandwiches made of small lettuces and cresses ("cut the salad off which protrudes . . . observe much neatness in the preparing of these sandwiches and do not confide them to any of the kitchen maids.") And finally, anchovy sandwiches: "the pieces of anchovy should not touch each other, as they might then be too salt, unless when eaten to assist wine drinking."



John Montague (1718–1792), the Earl of Sandwich, whose title is now the name of a popular food. From an eighteenth-century engraving. © CORBIS.

Charlotte Mason was one of the first English cookbook authors to provide a recipe for sandwiches, which she published quite appropriately along side other supper dishes like Welsh rarebit and salmagundi (an elaborate ornamental salad): "Put some very thin slices of beef between thin slices of bread and butter; cut the ends off neatly, lay them in a dish. Veal and ham cut thin may be served in the same manner." Her homey recipe is quite different from the sort of grand fare sent up by the likes of Ude, but far more typical of what happened to the sandwich in the hands of Victorian home cooks.

During the nineteenth century, as midday dinner moved later and later into the day, the need for a hot supper declined, only to be replaced with light dishes made of cold leftovers, ingredients for which the sandwich proved preeminently suitable. Thus the sandwich became a fixture of intimate evening suppers, teas, and picnics, and popular fare for taverns and inns. This latter genre of sandwich has given rise to multitudes of working class creations, such as the butty and sarny of Britain, and the bacon-lettuce-and-tomato sandwich of the American diner. In the home, however, for such meals as English high tea, or the late-night Quaker "tea" parties of nineteenth-century Philadelphia, sandwiches were not usually premade, but rather, sliced bread was provided, enabling diners to assemble a sandwich from the various tidbits laid out for the meal.

Cookbook author Eliza Leslie was one of the earliest American writers to publish sandwich recipes in the United States. Her *Directions for Cookery* (1837) contained a recipe for what has become a ubiquitous American institution: the ham sandwich. Her sandwich consisted of thinly sliced bread spread with butter and mustard (French mustard flavored with tarragon), and sliced or finely chopped ham, with no other embellishments. "You may either roll them up, or lay them flat on plates. They are used at supper, or at luncheon." The fact that they needed explanation at all may be taken as a sign of their uncommonness outside of urban centers, since the sandwich of the 1830s was still more or less a creature of upper-class cookery; Leslie's use of French mustard gives further evidence of that fact.

During the early years of the railroad, sandwiches proved an ideal form of fast food, especially since they could be sold at train stations when everyone got off to buy snacks. With the appearance of the dining car, the sandwich became a travel-related institution, and it remains so as the typical meal served as lunch on airplanes. During the late nineteenth and early twentieth centuries the sandwich came into its own, especially as a response to the Temperance Movement. Taverns and saloons offered free sandwiches with drinks in order to attract customers, which led to the development of many distinctive sandwiches that have endured. In the United States, these include the club sandwich, a multi-layered affair designed to combine two or three types of sandwich into one, a meal in itself, which earned its name through its popularity with businessmen in private dining clubs.

Among working-class men, the submarine loaf became a popular vehicle for hearty sandwiches made with various fillings. This long, narrow Viennese loaf first appeared in the early 1880s as a marketing gimmick in connection with the Gilbert and Sullivan operetta "H. M. S. Pinafore," which features a ditty with sexual innuendos about submarines. The sandwiches made with this type of bread bear different names in different parts of the country: subs, grinders, poor boys, torpedoes, and hoagies, all featuring very localized types of ingredients. For example, the Philadelphia hoagie (derived from "hokey-pokey man," the sandwich vendor), contains the essentials of a southern Italian antipasto, including cold cuts, Italian cheeses, peppers, olive oil, and oregano. New England gave birth to the lobster roll: cold, cooked lobster served with mayonnaise in a small toasted submarine loaf (which evolved into hot dog rolls). A hot counterpart to this, the so-called beefsteak sandwich, was first popular in the nineteenth century as fried chipped beef and onions served over toast. Once married to the submarine loaf, it further evolved with the addition of cheese and various hot pepper sauces.

Luncheonettes of the 1920s served grilled cheese sandwiches and the Cuban sandwich, which resembles a hoagie pressed between two hot irons so that it is slightly flattened and hot when eaten. In spite of its association with Havana, this sandwich was created in New York and New Jersey. The most famous of the American hot sandwiches, however, is the Reuben, which was introduced at Reuben's Restaurant in New York City (there was also a branch in Miami, Florida). The restaurant was essentially a Jewish-owned sandwich shop that offered a wide range of creations named after famous personalities of the 1930s and 1940s: Danny Kaye, Hedda Hopper, Judy Garland, Ozzie Nelson, to name just a few. The Reuben Special, the hot grilled sandwich of fame, contained turkey, Virginia ham, Swiss cheese, cole slaw, and Russian salad dressing. The substitution of pastrami and sauerkraut came later, as a courtesy to kosher Jewish customers, who could not eat ham or a mixture of meat and cheese. Reuben also sold steak sandwiches for $2.00 (the most expensive sandwich on the menu), a specialty called Chicken Reubenola, and hamburgers on a roll.

The hamburger, at one time simply a meat patty eaten with bread and gravy, has, in the hands of McDonalds and similar global food chains, become the ultimate industrialized food eaten throughout the world, as well as a dubious symbol of American culture in far-off places. While the Earl of Sandwich might not recognize his finger food thus transmogrified and chef Ude might be appalled by the sloppiness of its presentation, neither could find fault with the hamburger's convenience or its cross-gender, cross-cultural, cross-generational appeal.

See also **Bread; Fast Food; Hamburger; Leslie, Eliza; Lunch; Picnic; Take-out Food**.

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William Woys Weaver

SAUCES. Sauces are food preparations with a fluid consistency, often with nutritional richness and a relatively pronounced taste, that are used to complement other foods. Although they typically stand out as a special development of cookery, their social and historical importance tends to be underrecognized.

Sauces may be divided into two broad categories. First, they can be essentially nutritious partners to a staple, such as the sauces eaten with pasta, corn chips, rice, and so on. Historically, this group arrived with settled society, when communities relied on perhaps only one cereal (such as barley, wheat, rice, or maize) or tuber (potato, taro, yam, or cassava). These foods could be cultivated in bulk and stored from one crop to the next. However, they were starchy foods that were nutritionally incomplete, requiring the addition of vegetables, legumes, meat and other animal products, often cooked separately as a sauce.

A second category primarily imparts flavor and is often served separately on, or in addition to, meat and vegetables rather than the staple cereal or tuber. These sauces range from relishes, such as tomato ketchup, which are often preserved, to subtle compositions often based on stocks and egg emulsifications and slightly sticky to form a coating. Because they are so refined and velvety, sauces became the pride of French cooking. Just as the first category of sauces catered to the culinary needs of civilization, the second brought to dining a certain luxury and high standard of taste.

Sauces are not normally eaten by themselves, generally require some sort of preparation (a raw ingredient, such as poured cream, is not conventionally considered a sauce), often have a homogenous look and texture, and are usually soft or runny in consistency. However, the boundaries are blurred, variations are many, and language is imprecise.

Some sauces merge with soups and stews, which differ in that it is possible to eat either alone. On the other side of the spectrum, some sauces merge with relishes and condiments. A fluid state is normal, although many pounded compositions are considered sauces (e.g., Italian *pesto* consisting of basil, Parmesan, garlic, and olive oil), and chopped ingredients often act like sauces. For example, pizza toppings are virtually identical to pasta sauces. Although sauces are usually placed on top of other foods, they can also bind other ingredients or function as fillings, encased in buns, pastry packets, sheets of pasta, rice balls, and so on. While the range includes sweet toppings (such as chocolate sauce), soft, sweet pastry fillings are more likely to be called creams or crèmes. Runny custard (*crème anglaise*) can be a sauce, but usually not a set custard or ice cream. Nonetheless, one's definition of the "sauce" category should be flexible, especially for sauces that fill the two roles already described, namely, as a nutritional complement to a staple, or a taste complement to a nutritional complement.

Reasons for Sauces

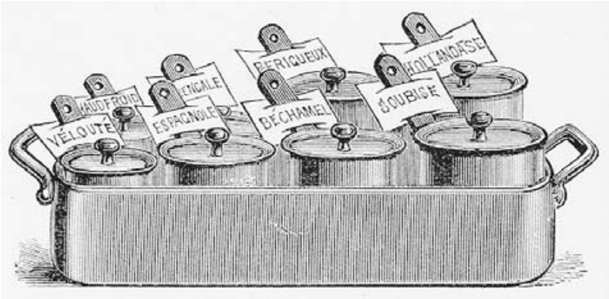
The role of sauces may be hedonistic; they are clearly designed to be pleasurable. A more disparaging view is that sauces simply exist to make people overeat, and such an assumption lies behind the familiar saying, "hunger is the best sauce" (perhaps first used by Cervantes in *Don Quixote*). Yet another line of argument suggests that certain sauces are used repeatedly within a cuisine to mark a food as familiar and generally "safe," so that cultural knowledge replaces the eaters' own instincts.

In a more specialized sense, sauces may put the salt back into cooked food from which it was leached. The modern words "sauce," "salsa," and so on derive from the Latin word *sal* for 'salt', which highlights the fact that many sauces have frequently been too salty, often as a result of added ingredients that have been preserved with salt.

Apart from any of this, sauces' historical origin was as a nutritional accompaniment to complex carbohydrates. The ancient Mesopotamian, Egyptian, and Chinese civilizations, and subsequent ones, were based on basic agricultural products, the progenitors of wheat and barley, and so on. In all cases, these staples were complemented by what might, broadly, be termed "sauces." Accordingly, the Chinese speak of supplementing *fan* with *ts'ai*, that is, supplementing cereal and starchy dishes (porridge, steamed rice, dumplings, pancakes, noodles) with vegetables, meat, or fish. The two have to be in balance, although more *fan* might be prepared for everyday meals and more *ts'ai* for feasts. Many of the *ts'ai* preparations are recognizable sauces, served in separate dishes or contained within the staple, such as pork buns.

An Indian meal is focused on a bowl of rice (in the south) or bread (in the north), surrounded by small bowls of vegetables, extra ingredients such as lentils, and possibly meats. These are typically cooked with a careful blend of spices and herbs to make what is called a *masala*, and the best known is *garam masala* from the north. Particularly in southern India, where a more liquid stew better accompanies a larger portion of rice, a wet *masala* is made by adding yogurt, coconut milk, and other liquids. English "curry"—which is based on *Tamil kari*, a sauce in which meat, fish, or vegetables are stewed —often results from the addition of a dry powder by the same name, but this is a mere caricature of the richer, more flavorful Indian curry sauces, which vary depending on the cook's social status, religion, and geographical location.

Foods to accompany staples have often been preserved. Among the various cheeses, dried fruits, pickles, and other relishes that fall in this category, many are readily classified as sauces. Fermented fish sauce, known as *garum* or *liquamen* to the ancient Romans, appears in Asian variants, such as Vietnamese *nuoc mam.* Soy sauce is a similar product (made from fermented soya beans), and Worcestershire sauce is a commercially successful English variant. Bottled sauces have become important, too, notably any kind of tomato sauce.



Bain-Marie or water bath for keeping prepared sauces hot. From a wood engraving, circa 1880. ROUGHWOOD COLLECTION.

Some of the sauces just mentioned are used more for their spicy or pungent flavor, rather than any nutritional value. Such flavorings can be considered a second category of sauces, often refined from the original more nutritious versions.

Kinds of Sauces

The primary sauces are pounded, stewed, stock-based, starch-thickened, emulsified, preserved, or sweet (which includes custards, syrups, and fruit purées).

Pounded. The mortar and pestle have been successfully used to produce an enormous variety of pastes across the globe, including the Italian *pesto* and Indian *masala* already mentioned. Purées, such as tomato sauce, are rubbed through a sieve or finely chopped in a food processor.

Stewed. Cooking meat, vegetables, legumes, and/or herbs in a pot with water or other liquid can produce soups, stews, and also sauces. An important example is the Italian accompaniment to *pastasciutta*, the meat *ragù* or *sugo*, known elsewhere as *bolognese* sauce. The *mole* sauces from Mexico are cooked mixtures of many ingredients, including chili and chocolate in the famous *mole poblano* used with turkey.

Stock-based. The roasting or baking pan may be deglazed (residues scraped up with liquid and then reduced) to provide gravy. Much more important, the *fonds* ("foundation") of French cooking is stock, which requires meat, bones, and vegetables to be simmered gently to extract flavor (often after browning the ingredients by baking or frying). Stock can be reduced and then reduced again. Jean-Anthelme Brillat-Savarin wrote in the *Physiology of Taste*, appearing in 1825, that Bertrand, the steward of the Prince of Soubise, used fifty hams for one supper, but only one ham appeared on the table, the rest being essential for his *sauce espagnole*, white sauces, and so forth (1949, p. 54). The secret is the large quantity of gelatin produced when collagen in animal connective tissue is heated in water. Gelatin is a wonderful thickening agent owing to its peculiar, long molecular structure.

Starch-thickened. Starch in wheat and corn flours is useful because of its behavior in hot water. Put starch into cold water and the granules slowly sink, but hot water disrupts the long starch molecules so that the granules become amorphous networks of starch and water intermingled. A little flour can thicken a great deal of liquid. Eighteenth-century England was accuse of having "sixty different religious sects, but only one sauce" (attributed to both Voltaire, 1694–1778, and Francesco Caraccioli, 1752–1799)—this was the ever-present "melted butter," which was butter and (usually) water, thickened with flour.

Emulsified. Some sauces acquire their velvety consistency as emulsions, which are suspensions of one liquid in another with which it does not ordinarily mix, notably oil in water. The simplest is a dressing of oil and vinegar (dilute acetic acid) called vinaigrette. In hollandaise, mayonnaise, and their variations, the heated butter and oil are suspended with the help of egg yolk as an emulsifier.

Preserved. Vegetables and fruits are cooked and then immersed in vinegar and spices to make pickles and chutneys. Fish sauces are fermented, and soy sauce comes from fermenting soya beans. Bottled sauces have become important, too, notably tomato.

Sweet. Custards are sweet, moist, tender gels of egg protein. A creamy rather than solid custard is made by stirring continuously during heating to prevent the proteins from bonding into a solid mass. Sugar syrup is sugar dissolved in water with heating to arrive at the desired coloring.

The French Triumph

One of the great French chefs of the twentieth century, Fernand Point, proclaimed the secret of his cuisine as follows: "Butter! Give me butter! Always more butter!" Much of it went into sauces, which, for him, were the mark of a good cook. Among the players in the kitchen, according to Point, "the saucier is a soloist." He also wrote in *Ma Gastronomie* (1969) that the making of béarnaise sauce is a virtuoso performance: "What is it? An egg yolk, some shallots, some tarragon. . . . Well, believe me, it takes years of practice for a perfect result. Lift the eyes for a moment, and your sauce is unusable."

Beginner, or even moderately experienced, cooks have difficulty not only preparing grand French sauces, but also differentiating the vast array of sauces, often with distinguished-sounding names, such as *périgueux*, *financière*, and *grandveneur*. Some chefs have attempted to identify the basic sauces (*sauces grandes* or *sauces mères*, meaning "great" or "mother" sauces), which, with various additions, become compound sauces (*sauces composées*). *Soubise* sauce has onions, Robert mustard, and *madeira*, the fortified wine of the same name. The "mother" sauces generate brown sauces (*sauces brunes*), derived from meat stock, and white sauces (*sauces blanches*), derived from *béchamel* sauce (milk thickened with flour). Nonetheless, both stock and flour have thickened many sauces, and the browning of their original ingredients helps determine color, as when roux (equal quantities of butter and flour) is browned to a required extent. For a third family tree, hollandaise is the primary egg and butter sauce; béarnaise is its popular offspring. Then, there are cold sauces based on mayonnaise (yolks and oil).

An often-cited delineation of sauces is that of the renowned chef Auguste Escoffier, who wrote in his *Guide Culinaire* (1903), of five leading sauces: *espagnole* (brown stock, brown roux, and tomatoes), *velouté* (white stock, yellow roux), *béchamel* (milk, white roux), *tomate* (tomato), and *hollandaise* (butter, eggs, vinegar or lemon juice).

The nouvelle cuisine of the 1970s gave new life to sauces: by favoring "lighter" (less thick and flour-enriched) renditions, by rediscovering more rustic versions such as *beurre blanc* (butter, vinegar, shallots), and by featuring colorful purées, using one of the few important twentieth-century contributions to good cooking, the food processor. Though nouvelle chefs were also more likely to place the sauces underneath the food rather than on top of it, the goals remained the same. The first aim is a slightly sticky consistency that will coat other foods even when they are picked up with a fork. Thickening is achieved by the gelatin in stock, starch in the roux, reduction (evaporation), cream, egg emulsification, sugar syrup, and so on. The second aim is an intriguing flavor. Third, the sauce should look glossy, which usually means a long and careful clarification.

Jean-François Revel recounts in *Culture and Cuisine* (1982) that French chefs took flavor to a new level in the eighteenth century. They replaced "old-style cuisine of superimposition and mixture" (i.e., crude additions of flavors) with the "new cuisine of permeation and essences" (subtle combinations). He bases this view on the foreword to François Marin's *Les Dons de Comus* [which means the Gifts of Comus, the Roman god of feasts], published in 1739. The author (thought to be two Jesuit priests) explained that the science of cooking was to mix and blend foods to make a harmonious whole, not dominated by any one ingredient.

English gastronomic writer Launcelot Sturgeon sought to relay his enthusiasm for the art that "binds the whole fabric of society" in two chapters, "On the Physical and Political Consequences of Sauces" and "On the Importance of Forming Good Connexions [Connections]," in his *Essays, Moral, Philosophical, and Stomachical*, originally published in 1822. He spoke of two primary indications of "the connexion [connection] of sauces," namely, the harmony of the sauces and the social harmony they produced. Sauces, which are ingredients combined in "exquisite concord," draw people together around a table, connecting them "by ties which no one ever wishes to dissolve."

Modern chemistry took Sturgeon's work one step further by showing how molecules tie sauces together. Culinary investigator Harold McGee details starch-thickening, emulsification, and other methods in *On Food and Cooking* (1984).

See also **Condiments; Cooking; Nouvelle Cuisine; Preparation of Food; Serving of Food**.

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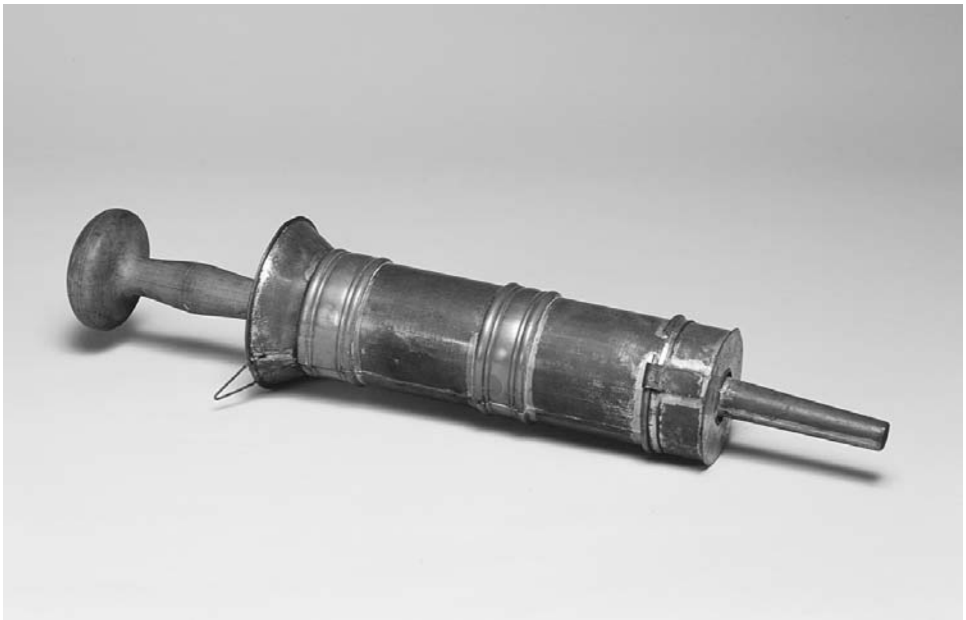
Michael Symons

SAUSAGE. Essentially, sausages are just seasoned forcemeat. In cuisines around the world, however, countless variations have been played on this simple theme. Sausages were probably first invented as a means of preserving blood, offal, and small scraps of meat in convenient edible containers—the stomachs and intestines of the slaughtered animal. The earliest known reference to sausage dates to Greece in the eighth or ninth century B.C.E. It appears in Homer's *Odyssey* (XX: 24-27), where Odysseus, lying in his bed, is seen

> rolling from side to side
> as a cook turns a sausage, big with blood
> and fat, at a scorching blaze, without a pause,
> to broil it quick

They are also found in Apicius's *De re coquinaria* (Rome, first century C.E.), a cookbook that was clearly intended for diners with discriminating palates. While sausages may have begun in frugality, they had already evolved into delicacies worthy of a gourmet's attentions.



Sausage stuffer. Berks County, Pennsylvania, circa 1860. Wood handle, tin and copper. Ground meat was pressed through the tube into a gut, which was then twisted to make sausages. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

In form, sausages may be patties of freshly chopped and seasoned meat or they may be stuffed in casings, dried, fermented, smoked, or produced using any combination of these techniques. The meats can be ground exceedingly fine (*weisswurst*) or simply cut into large chunks (headcheese). Some are eaten cooked, using any of the traditional methods for cooking meats, while some are so heavily cured and smoked that they can safely be eaten raw (*salame crudo*).

Pork is the meat most commonly used to produce sausages, although almost any sort of protein will do (sausages have even been made from gluten and soy proteins) providing they contain enough fat to maintain a juicy product. Beef, chicken, duck, lamb, seafood, and veal have all been used in sausages. Game, such as venison or rabbit, tends to be very lean, so pork fat or beef suet are usually added. Typically, a sausage forcemeat contains 20 to 30 percent—and sometimes as much as 50 percent—fat by weight. Fats chosen must be flavorful and not too soft, so that they don't melt out too quickly during cooking. Depending on cooking method, much of the fat may be removed before the sausage comes to the table.

All sausages contain salt (indeed, the word "sausage" is descended from the Latin *salsus*, meaning 'salted'). Salt serves three purposes. It acts to preserve perishable meats, killing some bacteria through osmotic pressure. In addition, salt dissolves some globular protein from the meats, which then acts as a binding matrix for the bits of meat when the sausage is cooked. The globular protein is released when the meats are ground or kneaded (the sausagemaker can see when this has occurred because the forcemeat becomes sticky). Salt, of course, also provides flavor, and it reinforces the flavors of other seasonings, especially in foods that are served cold.

Seasonings vary according to the cuisine producing the sausage. Black pepper is almost universal; in fact, the simplest fresh Italian sausages contain nothing but pork, salt, and pepper (Italian sausages made in the United States almost always add fennel seeds and red pepper). Garlic is a key ingredient in sausages of many countries, including Germany, Hungary, France, Poland, Portugal, Spain, and the United States. Chili pepper, in forms ranging from dried flakes to cayenne to paprika, appears in sausages around the world (although its use in sausages is limited in northern cuisines that typically avoid hot pepper). Fresh breakfast-type sausages usually contain sage, and often marjoram. Cloves, cinnamon, and nutmeg are sometimes used, especially in black (blood) sausages. Chinese sweet sausages (*lop cheong*) are flavored with sugar, soy sauce and five spice powder (a mixture usually consisting of ground cassia, cloves, fennel seeds, star anise, and Szechuan pepper).

Natural casings include sheep casings (breakfast links, chipolata), hog casings (Italian sausage, bratwurst), hog bungs (liverwurst), caul fat (*crépinettes*), beef middles (salami), and beef rounds (mortadella). Haggis, the Scottish national dish, is nothing more than a large sausage made of seasoned sheep organ meats and oats, stuffed in the sheep's stomach. Synthetic casings, made of cellulose, collagen, or plastic, can be made in any size, and are used for spreadable pâtélike preparations (braunschweiger), salamis and other cold cuts, and skinless frankfurters. Dolmas, grape leaves stuffed with a mixture of seasoned lamb and rice, can even be considered a form of sausage.

Sausages are often dried by hanging, in cool circulating air, to preserve them as well as enhance their flavor and texture. Once they are fully dried, they can be kept unrefrigerated for weeks. Before they are dry, however, they can spoil, so a curing salt—such as Prague powder, a mixture of salt and sodium nitrite—is used to prevent the development of the bacteria (*Clostridium botulinum*) that cause botulism. The nitrite has an additional advantage; it prevents the cooked meat from turning gray (the characteristic pink color of cured hams results from the nitrite in the cure). Nitrites, used in recommended quantities, do not cause the development of carcinogenic nitrosamines that were formerly found in cooked meats containing nitrates (saltpeter). Some dried sausages are also fermented, either with naturally occurring organisms or through the addition of a starter (lactobacillus) to the forcemeat. These bacteria produce lactic acid, which preserves the meat while providing a tangy flavor. *Sopressata* and some kinds of chorizo are fermented, but quick recipes for fresh chorizo substitute a little vinegar for the lactic acid that would have developed through fermentation.

Smoking adds flavor to sausages. It acts as a preservative, both by adding a number of phenolic compounds found in smoke, and by forming a tough coating on the outside of the sausage. This impervious layer is known as the pellicle.

Sausages continue to appear in recipes around the world, even after the development of other means of preserving meats. In many peasant cultures, the largely vegetarian diet is enhanced by small quantities of sausage. In modern diets sausages make up for their high fat and sodium content by contributing more flavor and variety than their size would suggest. Thus sausages satisfy sophisticated palates with lower quantities of food.

GELB WURST
GELB WURST

Window display of local sausages and radishes in the Liebold Butcher Shop, Bamberg, Germany. Germany is renowned for its large variety of sausages and meat products. © DAVE G. HOUSER/CORBIS.

See also **Apicius; Meat; Meat, Salted; Meat, Smoked; Pig; Preserving.**

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SCANDINAVIA. *See* Nordic Countries.

SCHOOL MEALS.

Operating primarily in industrialized countries, such as England, Japan, and the United States, school meals programs have become an integral part of the school day. If efforts by the United Nations and the United States are successful, up to 20 million children in developing countries will be able to participate in a similar program for the first time beginning in the early years of the twenty-first century.

Typically started on a local level, school feeding programs emerged as recognition grew of the link between malnourishment and academic performance. Numerous cities in Europe and the United States, including London, Milan, New York, Paris, and Zurich, established feeding programs by the early twentieth century. Over time, the local programs evolved into statewide and nationwide programs. In 1946 the United States established its National School Lunch Program (NSLP), after finding that many men were rejected for military service during World War II due to malnutrition. The lunch program has grown from serving daily 4.6 million children in 1947 to more than 26 million by the end of the twentieth century. In the 1960s the feeding program was expanded to include a school breakfast program and a summer feeding program primarily targeted to low-income children. In the United States school meals programs are required to offer free and reduced-price meals to children from low-income families. About half of the children participating in the NSLP receive free lunches.

Until 1996, U.S. school meals were required to comply with a meal pattern designed to meet, on average, one-third or one-fourth of the U.S. Recommended Dietary Allowances (RDA) for essential nutrients for the lunch or breakfast programs, respectively. The meal pattern for lunch consisted of one serving of meat or meat alternate, two or more servings of vegetables or fruits, a serving of bread or bread alternate, and a serving of fluid milk. Until 1974 lunches were also required to include a teaspoon of butter. Children's diets were found to be high in calories, fat, cholesterol, and sodium, and the number of children who were overweight had more than doubled between 1960 and 1990. In 1995 the United States Department of Agriculture updated its nutritional standards to reflect current scientific knowledge about disease prevention and health promotion. For instance, it is now standard to require that school meals contain no more than 30 percent calories from fat and 10 percent from saturated fat. Earlier in the decade a nationwide study of school meals had found that school lunch and breakfast programs met the RDA requirements, but were well above the nutritional guidelines for fat, saturated fat, cholesterol, and sodium. As a result, both school lunch and breakfast programs, for the first time, had to conform to the 1990 Dietary Guidelines for Americans. States are responsible for ensuring that schools are compliant. Since then most of the nation's 96,000 schools have substantially reduced their fat and saturated fat levels, and increased their levels of carbohydrates.

At times, the dual mission of providing nutritious school meals and encouraging the consumption of domestically grown commodities has created a tension between nutrition advocates and farm groups. The distribution of government commodities was often viewed by the nutrition and health communities as a barrier to providing healthy meals. This conflict has diminished with the new nutrition standards and policy changes in commodity purchases that include increased purchases of fresh produce and lower fat items. Unresolved issues seen by nutrition advocates include the presence of junk food vending machines in schools and the growing number of private food service companies replacing or competing with the government's school meals programs.

See also **Dietary Guidelines**; **Food Stamps; Government Agencies, U.S.; Malnutrition; Nutrition; Obesity; WIC (Women, Infants, and Children's) Program**.

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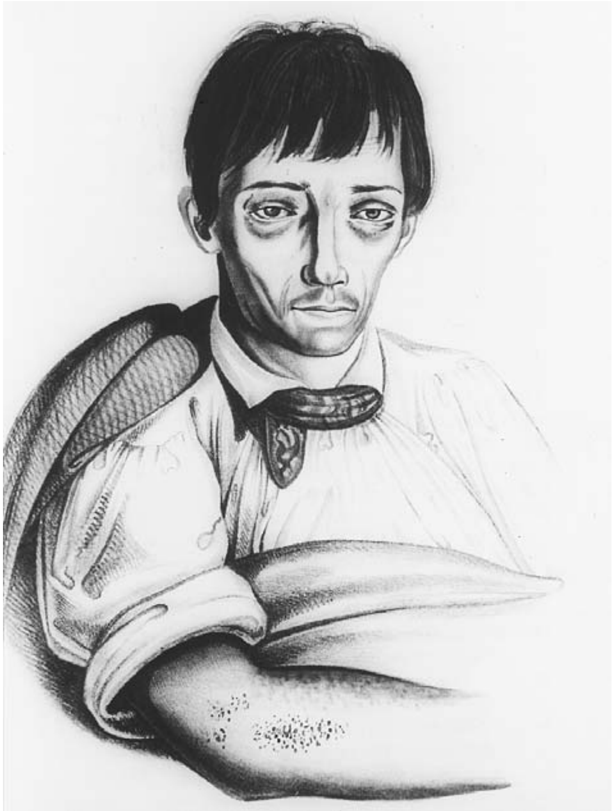
Patricia McGrath Morris

SCOTLAND. *See* **British Isles.**

SCURVY. A corruption of the earlier word "scorby," scurvy is the name given to the disease that is the consequence of a prolonged deprivation of vitamin C. The minimum daily requirement to prevent the disease is approximately 7 mg, but it takes several weeks of depletion of body reserves before the problem becomes evident. There are many descriptions of the disease as it appeared among sailors engaged in the long voyages that began to be undertaken from the end of the fifteenth century. After ten or more weeks at sea, men began to experience general pain and stiffness, while their lower body became covered with large purple spots. In addition their gums would swell and grow over their teeth, which became loose; and old wounds would reopen. Finally, sufferers would die suddenly, "in the middle of a sentence," to the astonishment of their mates. This is now explained as the consequence of impaired protein synthesis, with connective tissues weakening, so that the wall of a major artery would finally burst. It soon was discovered that the disease could be prevented, and even cured, by sailors consuming fresh fruit and vegetables. Long sea voyages were only indirectly responsible, by preventing crews from living on anything but foods that could be stored for long periods, like salt meat, dried peas, and flour that could be cooked into bread and puddings. The same disease appeared on land when fresh food was unavailable for long periods, as in the California gold rush, for example. The first "antiscorbutic" (i.e., antiscurvy) foods to be prized by sailors were oranges and lemons, but they would become moldy on long voyages, and juices preserved with brandy or rum were more stable alternatives that also proved to be more palatable. Sailors in the British navy were required, from early in the nineteenth century, to take a portion of lime juice in their daily ration of rum; men from other navies called them "limeys" as a term of abuse, implying that "real men" did not need to drink fruit juice. Another tradition among sailors on long whaling expeditions was to take a large store of potatoes. These are not very rich in the vitamin but contain enough to prevent the disease if one is eaten freshly cooked every day.

In the early twenty-first century the disease still appears occasionally in adults, typically as "widowers' scurvy," among men who have never learned to cook and,



This patient in an 1842 drawing shows all of the major signs of Vitamin C deficiency, including the sores on the arms. © VISUAL IMAGE PRESENTATIONS.

when left to fend for themselves, subsist on things like breakfast cereals and sandwiches made from bread and cheese or ham. It also has appeared in people living on very restricted "fad" diets, such as a Zen macrobiotic diet of brown rice sprinkled with sesame seeds.

With the recognition of the importance of bacteria in causing diseases, at the end of the nineteenth century, it became a practice in some cities to sterilize cows' milk by autoclaving it. Children's deaths from "summer diarrhea" were reduced greatly as a result of this practice. However, this processing also resulted in the destruction of most of the vitamin C in the milk and, when it was fed to infants with only a cereal supplement, scurvy became a common problem. The addition of orange juice to the infants' diets provided a simple solution. With modern technology, milk can be freed from pathogens and potatoes can be dried under milder conditions, so that vitamin C is preserved; alternatively, the synthetic vitamin can be added to restore vitamin C levels in foods.

See also **Beriberi; Niacin Deficiency (Pellagra); Nutrient Bioavailability; Nutrients; Nutrition; Vitamin C; Vitamins**.

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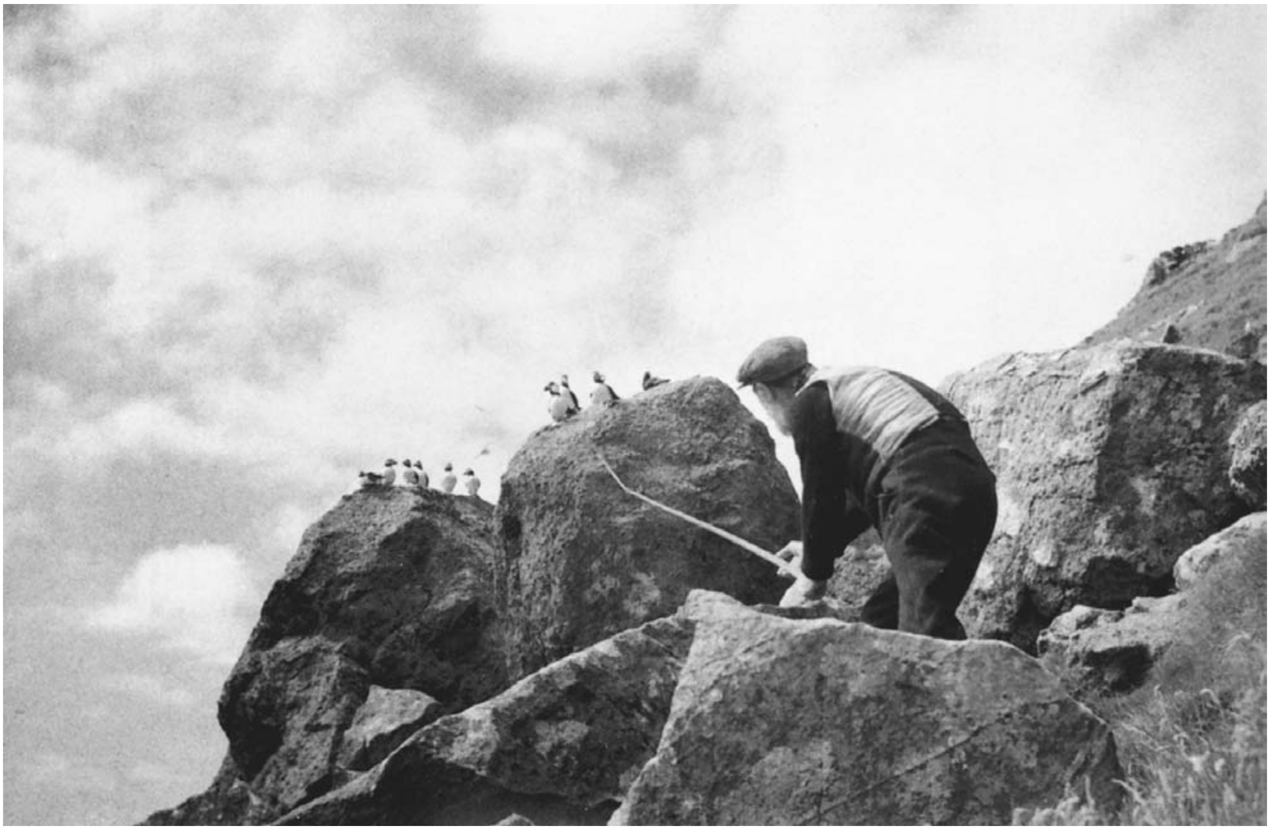
Kenneth John Carpenter

SEABIRDS AND THEIR EGGS. Seabirds and their eggs played an important part in the coastal economies and life patterns of many areas of the North Atlantic fringes of Europe into the twentieth century. In the struggle for survival in peripheral socioeconomic settings, the harvesting of seabirds and their eggs was a means of providing seasonal fresh foods and of augmenting the supply of preserved foodstuffs for winter and spring. The exploitation of these natural resources was an activity that required adaptation to the environment, ingenuity, courage, and a taste for foodstuffs often considered unpalatable by inland dwellers.

Seabird fowling and egg collection were undertaken by men while women were normally involved in the preparation and processing of the birds and eggs for household food or sale. Since seabirds exist primarily on the sea but come to rocks, cliffs or grassy sea-slopes, to breed and roost, they and their eggs were normally taken from these habitats by scaling up or down the rocks, cliffs or slopes. Bird-catching was a complex activity and a wide range of catching methods were employed depending on the roosting habits of the birds. Among the most common along the North Atlantic region were catching or seizing by hand, using snares consisting of a single noose or jaw attached to the end of a fowling rod, arranging multiple nooses on the ground, and using nets of various kinds, to trap the birds.

Seabird fowling and egg collecting varied in intensity along the north Atlantic region from Iceland in the north to Ireland in the south. The harvesting of seabirds on the Faroe Islands was described by Kenneth Williamson in 1948 and more recently by Arne Nørrevang (1977). John R. Baldwin has compared the fowling equipment, techniques and allied terminology of the Faroes with the centuries-old practice of seabird fowling on islands off the northwestern and northern coasts of Scotland, an activity that has attracted attention for several centuries. Sir Donald Munro mentions Sula Sgeir in that context in 1549, and Martin Martin in *A Description of the Western Islands of Scotland* (c. 1695), tells that the inhabitants of the isle of St. Kilda (abandoned since 1930) killed and preserved an enormous quantity of seabirds and preserved seabirds' eggs in peat ash, which gave then an astringent taste. St. Kilda was, in fact, unique in Scotland for its organized farming of the fowling cliffs. The year's cycle has been described as "killing of gannets and some shearwaters in April, collecting eggs of puffins and catching fulmars in May, snaring puffins in July, catching fulmars and



Finlay MacQueen snaring puffins on the isle of St. Kilda, west of the Outer Hebrides, Scotland. COURTESY OF R. L. ATKINSON, SCHOOL OF SCOTTISH STUDIES PHOTOGRAPHIC COLLECTION, EDINBURGH.

gannets in August and catching young gannets in September" (Fenton, 1987, p. 170).

These activities on St. Kilda were a response to an extreme environment. Elsewhere in Scotland wild birds and their eggs were welcome seasonal supplements to the diet, rather than being a major focus of economic activity. May was the time for harvesting the eggs of gulls, fulmars, puffins, razor-bills, guillemots and so on. Guillemot and gannet flesh was eaten. A limited cull of the young of the gannet (Gaelic: *guga*) still takes place on Suileisgeir (Gaelic: *Sula Sgeir*, "gannet reef"), a small barren island with craggy cliffs covered in guano, lying forty miles northwest of Lewis. This centuries-old tradition is carried on by the community of Ness, at the northernmost tip of the Island of Lewis, also in the Outer Hebrides. It is the only surviving gannet hunt in the British Isles.

Gannet hunting on Suileisgeir was regulated by the First Bird Protection Act of 1869, which gave the men of Ness a special dispensation to take gannet chicks. Nowadays, annual licences to take 2,000 such birds, starting only from the first week in September, when the birds are about three months old, are necessary. A crew of ten men spend two weeks on the rock catching and preparing the birds. All equipment, food supplies, including fresh water, and salt to dress the birds, must be ferried to the rock.

The method of catching has changed little over the centuries, and men still go down the steep cliff-faces on ropes to trap the birds. They are caught using a long fowling rod with an iron jaw fixed at the end, which is put around the bird's neck and pulled closed by a rope to trap the bird. The manner of processing has also changed little over time. They are plucked, and the down is removed by singeing over a peat flame, which apparently confers its unique flavor on the flesh. The ribcage and entrails are removed, and cuts made in the four pockets of meat at the wings and legs are packed with salt. The finished birds are then carefully laid in a wheel-like formation, lair upon lair, in order to retain the pickle drawn from the flesh by the salt so that it will not become hard and salty.

The birds are sold on the quay on return and are much in demand. They are scrubbed clean with washing soda, placed in a pot, covered with boiling water and boiled for twenty minutes. The water is then changed and the bird is boiled for a further twenty minutes. This procedure is repeated a third time. In this way the salt content in the bird is reduced. The flesh has the texture of meat with a salty and fishy flavour. It is, indeed, an acquired taste.

The role of the gannet chick as a food in the Ness community has changed greatly in the course of the twentieth century. No longer necessary as a welcome variation in diet, it has become somewhat of a delicacy which embodies a sense of identity for the people of Ness.

Seabird fowling and egg collecting were also seasonal activities along parts of the Atlantic coast of Ireland, from Rathlin island in the northeast where the cliffs and sea-slopes were apportioned in strips, and individual men in search of eggs and birds would lower themselves on ropes attached to iron spikes in the cliff edge, westwards to the great cliffs in southwest Donegal, northwest county Mayo, around the Conamara coast, in the Aran Islands in Galway Bay, and in county Clare on the towering Cliffs of Moher, in some cases into the twentieth century.

Further south on the islands and coastlands of county Kerry, seabirds, their eggs and feathers, were important in the food-provision strategies and local market economy of the Blasket Islands and contiguous mainland from at least the eighteenth century. The most westerly of the Blasket Island group, a towering rock appropriately named Tiarach "westerly isle" was the seabirds' haunt par excellence especially of the puffin population, whose eggs and chicks were exploited for food.

On the Great Blasket Island the eggs of the oyster catcher, guillemot, razor-bill, puffin and seagull were eaten. The flesh of guillemot, razor-bill and to some extent that of the Manx shearwater, cormorant and storm petrel were eaten, fresh, or preserved by salting for later use. Salted seabird were also sold on the mainland. The young of the puffin was considered the "chicken of the sea" and was much sought after. Because of its fat content it was roasted in a pot or grilled on a tongs laid over live cinders to allow some of the fat to escape. The storm petrel, a very small bird, was similarly cooked to discharge its fat. Regarded as a delicacy, and an acquired taste, it appears to have been swallowed whole rather than chewed.

By the early twentieth century seabird-fowling was no longer an organized, specific food-provision strategy on the Great Blasket Island due in some measure to the expansion and demands of the fishing industry during the summer months, but also to changing tastes, reflected, too, in the cessation of the hunting of seals for food.

Gannet hunting, for the flesh and feathers of the young chicks, was still practiced commercially on the Little Skellig, a great towering sea-crag lying in the Atlantic to the south of the Blasket Islands, and the second largest gannetry worldwide, in the course of the nineteenth century. By the end of that century, however, this activity was no longer viable, and the rock was too distant and the sea too rough for local light rowing-craft to reach. And the very strong and fishy taste of these birds was no longer desired.

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Patricia Lysaght

SEEDS, STORAGE OF. Seeds are by far the single most essential cultivated source of food, with wheat, rice, corn, soybean, barley, millet, and sorghum providing the vast majority of food for humans and their domesticated animals. While root and tuber crops, such as potatoes, yams, sweet potatoes, and cassava, are important sources of food in certain regions, they come in a distant second behind seeds. Besides serving as food, seeds also give rise to the next generation of crops. In general, annual crops are grown from seed (for example, grains, legumes, and vegetables), while perennial crops rely on vegetative propagation. Seeds are therefore stored not only to ensure a stable source of food, but also to provide the propagules from which additional crops can be grown.

Importance of Seeds

Modern agriculture is based on the establishment and growth of uniform stands of crops. Plant density should be uniform throughout a field, as should the plant age and stage of development. Uniform propagules and growing conditions are necessary to assure crop uniformity. Propagules are either produced sexually (as in seeds), or asexually (through cutting, graphing, budding, and division, etc.). Even vegetatively produced crops (such as tree fruits) use seed to produce rootstocks and in breeding programs. Seeds are composed of an embryo, stored food, and a protective covering. They fulfill a number of functions besides being the product of sexual reproduction. Seeds assist in the replication of individuals in a population, aid in dispersal of the species into new areas, and provide protection for the delicate embryo. The food sequestered in the seed to nourish the germinating embryo and growing seedling is the source of our food, while the embryo is the source of a new plant.

Seeds Stored for Food

By far the greatest bulk of stored seeds are used as food. Huge silos store wheat, corn rice, soybeans, and other grain, and legume crops prior to their being processed into flour, bread, corn meal, cornstarch, and the myriad other products we consume daily. Seed-derived vegetable protein can be mixed with colors and flavors and then extruded under moist heat and high pressure to produce various shaped and sized products that can be used in place of meat. Oils can be extracted from seeds, and sweeteners can be produced from the starch in seeds through enzyme digestion. Storage conditions for these seeds are designed to minimize loss of food value resulting from seed respiration and metabolism, and contamination or loss due to the growth of mold and insects, while at the same time retaining desired processing qualities. Low degrees of moisture and temperature are the two most important factors in storage of seeds for food. Both of these factors reduce seed respiration and the growth of pests.

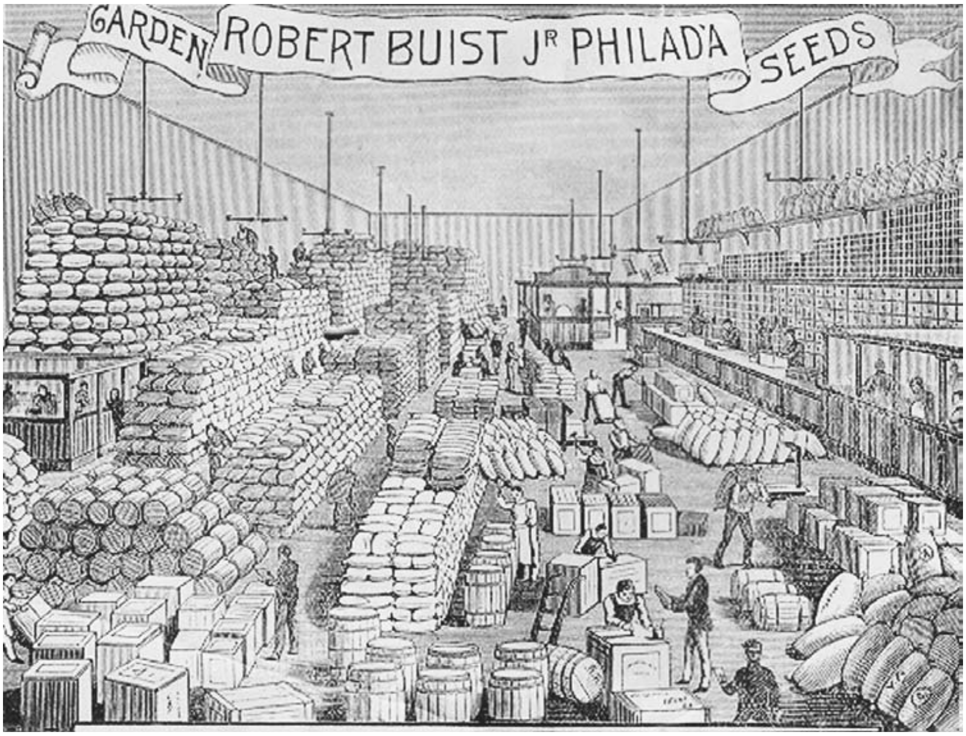
Seeds Stored for Propagation

If seeds are not stored in a manner that maintains their vigor and viability, there will be no food for the next season. Seed vigor and viability is primarily based on generic factors, so differences occur among species, and in varieties within a species. The conditions under which seeds were produced can also affect seed longevity. Temperature, rainfall, humidity, nutrition, and diseases during seed production all influence seed viability, as does seed maturity when harvested. Mature seeds remain viable longer than immature seeds. Seed vigor usually decreases with time in storage; exceptions are seeds in which the embryo must develop or mature before they are ready to germinate (as with elm).

There are three general categories of seeds based on their desiccation tolerance and the time they remain viable in storage. Most annual and biennial crops, and horticultural crops produce orthodox, or desiccant-tolerant, seeds that can easily be stored for many years in a dry, cool storage environment. These crops include grains, legumes, vegetables, floral crops, and temperate fruit trees. By contrast, recalcitrant, or desiccant-intolerant, seeds are difficult to store and usually remain viable for only a few weeks or months before they are killed by desiccation. Desiccant-intolerant seeds do not enter dormancy after maturing. Their continued respiration and physiological activity leads to rapid deterioration. They must be planted while still fresh, or stored moist at low temperatures. Even if properly stored, they can only be kept for short periods of time before they succumb to fungal or bacterial rots, or exhaust their food reserves. They include tropical perennials (such as avocado, mango, and coconut) and some temperate deciduous trees (such as chestnut, buckeye, maple, and oak). Between these two extremes are the intermediate seeds that can be stored for a few years if maintained under proper conditions of temperature and humidity. They include tropical and subtropical perennials (for example, coffee, citrus, macadamia, and papaya), and some tree nuts (such as hazelnut, hickory, pecan, and walnut).

In order to maintain seed quality in storage, the relative humidity of the air (in percentage relative humidity, or RH) and the temperature of the seeds (in degrees Fahrenheit) should total, as a general rule, less than 100. This means that the relative humidity around seeds stored at room temperature (about 72°F) should be less than 28 percent, while it should be less than 63 percent for seeds stored in a household refrigerator (about 37°F). Storage life of orthodox seeds is doubled for every 10°F drop in temperature, or every 1 percent drop in seed moisture content. Seeds are hydroscopic, meaning they will absorb or lose water from the atmosphere until they come into equilibrium. At the same relative humidity, seeds containing mainly carbohydrates will contain more water than do oil-containing seeds. At a relative humidity of between 20 and 70 percent, the seed-moisture content of a carbohydrate containing wheat seeds is around 30 percent more than that of oil-containing soybean seeds at the same relative humidity. So the relative humidity around stored seeds must be adjusted to produce the same level of moisture in seeds of different composition.

Whether plants were selected for domestication because they produced seeds that stored well, or whether plants were bred to produce seeds that stored well as they were domesticated, the seeds of most cultivated plants are orthodox and can be stored for a few years at near ambient conditions of moisture and temperature. The vigor and viability of most seeds of cultivated annuals can be maintained for two to five years under favorable storage conditions of 30 to 60 percent RH (8 to 14 percent seed-moisture content) and 40 to 60°F. Difficult-to-store seeds can be kept for extended periods at very low temperatures. This technique of cryopreservation can maintain



Seed storage warehouse of Philadelphia seedsman Robert Buist. From an 1891 wholesale seed catalog, ROUGHWOOD COLLECTION.

recalcitrant seed for decades at liquid nitrogen temperatures (−320°F; −196°C). However, the vigor of seeds stored at even these low temperatures declines over time. The continued maintenance of specific seed lines requires that they periodically be removed from storage and used to produce a new crop of seeds. Seed storage facilities, therefore, need not only modern storage equipment, but also the land, personnel, and expertise to periodically grow the stored seeds under conditions that maintain their genetic purity.

High vigor is characterized by the seed's ability to germinate and for the embryo to grow under stressful conditions that can include compacted soil, pathogens, salinity, and cold or hot temperatures. Seeds with higher vigor possess greater storage potential and can be stored for longer periods before the seed becomes nonviable. Both vigor and viability decline gradually during the early stages of seed storage; they parallel one another initially, with vigor ultimately declining in advance of viability. Later in storage, there is a sharp decline in both, until the seed only produces a weak seedling that quickly succumbs to environmental or pathogenic stresses.

Seeds that are planted in a field should have been sorted to produce a group of seeds that will germinate and grow at the same rate to produce uniform plants. Cracked, deformed, and small seeds should be eliminated in this winnowing process. In addition to selecting robust seeds, various preplanting treatments can increase seed viability and ensure uniform seedling establishment. Seeds' viability can be increased by partially germinating them under optimal conditions before planting. Holding seeds in an aerated aqueous solution for a week or so and then immediately planting them or drying and planting them later can also increase viability. The osmotic strength of the solution allows the seeds to take up water but not to germinate. Another method is to enclose each seed in a porous clay coating that contains fertilizers or fungicides to assist the seedling during early stages of growth.

Preparation of Seeds for Storage

Seeds should be harvested after maturing on the plant, separated from the fruit or protective plant parts in which they developed, and cleaned. Desiccant-tolerant seeds can be slowly air dried over a few days at low relative humidity and then sealed in moisture-tight containers before being placed in a refrigerator. If the seeds are sufficiently dry, they can be stored in the freezer section. Desiccant-intolerant seeds must be stored moist and need to be planted as soon as possible.

Stored Seeds Preserve Genetic Resources

Before the advent of scientific plant breeding, farmers would keep seed from the previous harvest to plant for the next season. From this process, numerous land races of the major crops developed that were specifically adapted to the conditions of their environment, such as climate, cultural practices, diseases, pests, soils, weeds. The availability of commercially produced seed with improved quality characteristics, pest resistance, and yields have supplanted many of these local varieties, and many have disappeared. Older crop and heirloom varieties of many horticultural and ornamental plants have also been lost because no one kept their seeds. Recognizing that such seeds may contain traits and genes (for example, pest resistance) whose introduction could improve modern varieties, private and governmental groups have developed seed banks and germplasm repositories to collect and preserve seeds and other propagules for long periods of time. These facilities include the National Seed Storage Laboratory in Fort Collins, Colorado; the Seed Savers Exchange in Decorah, Iowa; and the National Genetic Resources Program (NGRP), authorized in 1990 by the U.S. Congress. The Plant Sciences Institute (PSI), part of the National Germplasm Resources Laboratory (NGRL), is located at the Beltsville Agricultural Research Center, Agricultural Research Service, U.S. Department of Agriculture.

See also **Barley**; **Biodiversity**; **Crop Improvement**; **Maize**; **Rice**; **Soy**; **Storage of Food**; **Vegetables**; **Wheat**.

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SENSATION AND THE SENSES. Striving for variety and intensity in sensory experiences may be a fundamental human characteristic, likely reflecting our evolutionary history as both foragers of foods and omnivores. The enduring popularity of high-speed activities such as roller coaster rides or extreme sports, as well as films or computer games with impressive visual and sound effects, points to sensation seeking as still being an important aspect of many people's lives. Yet, in terms of the *range* of sensations they evoke, these experiences might be considered trivial by comparison with those delivered every day by foods and beverages. Particularly in the chemical senses (the collective term for smell, taste, and pungency), food consumption provides a continuous stream of sensory information to be processed and evaluated. Far from being mundane, even eating an apple provides an enormously varied set of sensations that begins even prior to the first bite.

Appearances and Expectations

When it comes to assigning priority to sensory information, humans are visual animals. Given uncertainty or conflict in the sensory information we receive, we tend to rely most on what we see. This is the basis of ventriloquism illusions. It is perhaps surprising, though, that a visual bias is so important with foods, where we might think that odors and tastes should predominate. Nevertheless, initial judgments of foods and beverages very often rely on appearances. In fact, our ability to identify even common flavors is typically very poor, so vision may sometimes be a more reliable source of information. Thus, foods that are miscolored—for example, a lime drink colored red—are often identified on the basis of the color rather than the flavor.

As well as being appreciated in their own right, visual aspects of foods provide important clues as to other sensory qualities, creating expectations about what we are soon to consume. We learn to associate the appearance of a food with its other sensory qualities, and the impact of these associations is perhaps most obvious in the effects of food colors. Whether an apple is red or green, for example, will lead us to expect a certain degree of ripeness and, often, quite specific levels of sweetness and acidity. Surface textures and color brightness can also provide clues to internal textural properties such as hardness. Because of such associations, colors can also influence *what* we perceive. Adding red coloring to a sweet solution increases the perceived sweetness, while the addition of any color to a solution containing an odor increases how intense we perceive that odor to be.

Expectations about a food's sensory properties can also be created in advance of consumption by information about a food, for example, on labels. These have the ability to influence a product's acceptability. Serious mismatches between what we expect a product to taste like and its actual sensory properties can be an important determinant of whether the food is ever consumed again. Like color, information can also be powerful enough to influence perceptions. For instance, labeling a product as high in fat has been shown to lead to higher ratings of "fattiness" and lower ratings of flavor intensity, relative to the same product with a low-fat label. The mechanism appears to be that, when mismatches between prior expectations and the reality of the product are relatively minor, "assimilation" takes place. That is, perceptions and preferences can be "brought into line" with product claims. These effects are an excellent reminder that, ultimately, perception is a cognitive process that receives information both from the sensory impact of food ingredients and from other sources of information about the food.

Odor Perception

While the odor of a food can also generate expectations for other sensory properties, its most valuable role is to help us to identify foods. Olfaction provides us with more information about what we consume than perhaps any other sense. Most important, whether as part of a flavor in the mouth or as an aroma that we sniff, odors reliably inform us whether we have experienced a food before. To a great extent, this assists us in making a decision to consume or not.

Olfaction has been called a dual sense. Both at a distance from the food, and when the food is in the mouth, our sense of smell acts as a detector of volatile (i.e., gaseous) chemical compounds. The mixture of compounds that we perceive as apple odor reach the olfactory receptors in the patch of tissue known as the olfactory epithelium, a mucus membrane at the top and back of the complex maze of passages found within the nose. The physiological processes that such odors initiate in the receptors are not completely understood. We do know, however, that the small odor molecules bind to receptor proteins present on the cilia, hair-like extensions of olfactory nerve cells that protrude from the epithelium. This binding initiates complex sequences of biochemical changes leading to depolarization, and firing, of the olfactory cell. This electrical signal travels via the olfactory nerve to the olfactory bulb in the brain.

How we recognize such neural signals as specific odors is perhaps *the* crucial question in the science of olfaction, particularly if we consider just how many odorants humans are capable of detecting. In stark contrast to the relatively small number of different taste qualities (see below), we can certainly perceive thousands, if not tens of thousands, of distinct odor qualities. Moreover, there does not seem to be any underlying organizing principle that we can use to classify these qualities. Historically, various schemes have been proposed for categorizing odors. Linnaeus, for example, classified odors as "aromatic," "fragrant," "musky," "garlicky," "goaty," "repulsive," and "nauseating." This and many other classification systems suffer from the use of categories that are either too general ("fragrant") or clearly related to the acceptability of the odor, rather than its sensory properties ("repulsive," "nauseating").

In practice, odors are often classified into categories that make sense to their users, whether they are winemakers, flavorists, or perfumers, as well as having practical applications. While they often have an internal logic and consistency—fruit odors may be grouped together, for instance—such classifications relate primarily to the object producing the odor, to a lesser extent to the odor chemistry, and not at all to how the brain codes the odor information. The molecular properties of the odorant must be responsible a priori for odor quality, but any laws that could allow us to reliably predict a particular quality from those properties are not as yet apparent. Instances of dissociations between structure and quality make this a challenging task. The compounds D-carvone and L-carvone have the same structure, differing only in that they are optical isomers (effectively, molecular mirror images) of one another, yet one smells of spearmint and the other of caraway.

A milestone in our understanding of the mechanism of odor perception came in 1991, when Linda Buck and Richard Axel of Columbia University identified a family of genes that encode olfactory receptor proteins. It is thought that this family, now believed to include more than 1,000 genes or around 3 percent of our total genome, is able to generate an equally large number of receptors. It is unlikely, though, that we have a unique receptor for each odorant since this would seem to be an inefficient way of coding. The most promising hypothesis regarding olfactory coding suggests that patterns of activity across different receptors, perhaps each expressed by a different member of the gene family, form the basis of odor qualities. Olfactory coding is thought to be also partly mediated by organization of the olfactory epithelium into four different zones, each zone containing receptors expressed by different genes. A given odor will likely activate receptors in more than one zone, creating a spatial, as well as a receptor-specific, code.

Any complete theory of odor perception must explain how what we perceive as apple odor is the product not just of a single apple-like compound, but of the mixture of the compounds 2-methylbutyl acetate, butanol, and hexyl acetate (amongst many others), none of which smells uniquely of apple. The odors of the majority of the foods and beverages that we consume consist of mixtures of the odors of many separate compounds. For example, hundreds of different compounds, each with their own distinct odor, combine to make coffee and chocolate odors. What we perceive, though, is a single unique quality. A major question in our attempts to understand how the brain processes odors is how this information is combined. There does seem to be some sort of limit to the number of individual odors that we can combine and still detect. Beyond a mixture of three or four different odor qualities, we are unable to say which of a set of individual odors the mixture contains, even if we are very familiar with those components. At the same time, however (and seemingly paradoxically), complex odors can contain "notes" in addition to having an overall quality, although these notes cannot be related to the odors of the specific chemical compounds in the mixture. One of the challenges for food scientists in industry is to be able to identify which of the multitude of chemical compounds within a food are essential for producing its characteristic odor and flavor.

How Many Tastes?

The conventional wisdom in both the scientific community and among the general public is that taste is composed of a set of discrete qualities, almost like separate senses. Sweet, sour, salty, and bitter have formed the core of our understanding of taste since Aristotle. While other tastes have been proposed from time to time—astringent, pungent, fatty, insipid, alkaline, to name some—these four qualities have almost always been recognized as fundamental.

Outside of the laboratory, however, we seldom experience so-called pure tastes. Fruits are often simultaneously sweet, bitter, and sour, and savory dishes may be salty, sweet, sour, and high in *umami*. Similarly, many chemicals that produce tastes are not "pure" examples. Potassium chloride is both bitter and salty. To what extent do we perceive these mixtures as sets of basic qualities, and to what extent as unique tastes themselves? Are such compounds steps along a continuum of tastes (as orange exists along a continuum of colors from yellow to red), rather than having discrete and separate qualities? These questions challenge the orthodoxy of a set of discrete basic tastes.

The recent evidence that the taste of glutamate appears to constitute a fifth basic taste, *umami*, is somewhat embarrassing for those who strongly argued for four primary qualities. If five, then why not six, or seven? In fact, there is evidence to support the notion of a taste associated with fatty acids and of the quality metallic as an independent taste. A case can be made for the survival value of such tastes: fats are important sources of energy, while the salts of metals such as iron, copper, and zinc are both metabolically necessary and toxic at high levels. Arguments have also been mounted for recognition of the tastes of other amino acids and starch as basic qualities.

Beyond such challenges to the concept of four (five) basic tastes, it has been argued that the whole notion of basic tastes is flawed. Robert Erickson and Susan Schiffman, both of Duke University, have proposed that the paradigm of a limited number of basic tastes has impeded our understanding of this sensory system. In the early part of the twentieth century, Hans Henning proposed that the four basic tastes could be represented at the points of a tetrahedron. Did Henning mean to convey that there were no intervening qualities on the tetrahedron's surface or were the basic tastes merely distinct points on continua? This influential attempt to classify tastes has been interpreted both ways, but Erickson and Schiffman argue that the evidence favors the latter interpretation. They point out that there are no strong physiological reasons to accept only four basic tastes. There appear to be more than four transduction (receptor) mechanisms for taste; not only are there not four distinct types of taste neurons in the brain, but taste cells are broadly sensitive to many qualities.

What do we really perceive?

Erickson and Schiffman have suggested that the acceptance of the idea of a limited number of basic qualities prejudices our understanding of taste. In other words, if you accept that sweet, sour, salty, and bitter are the only tastes we can detect, then all taste sensations will be *a priori* classified into one of these categories. In one study, they asked subjects to indicate which of a variety of taste compounds, some of them mixtures of basic tastes, were singular tastes or mixtures of tastes. Many of the mixtures were viewed as a single taste, sometimes one that was distinct from the four basic tastes. Spatial mapping of the quality of a selection of tastants, based on ratings of the similarity of each pair (more similar tastants are mapped closer together, and so on), also did not conform to a pattern that could be represented by four basic qualities.

Similarly, Michael O'Mahony and colleagues at the University of California, Davis, asked subjects to sort a number of tastants into groups based on taste quality, but without using the traditional category names. Their subjects not only came up with more than four categories, but also used more than four self-generated labels to describe the different qualities. When asked to use only the four traditional qualities, these subjects were forced to label different groups using the same word, suggesting that restricting labels to the four terms was inadequate to describe the range of taste experiences.

Despite all these potential problems with the doctrine of basic tastes, there is widespread acceptance of sweet, sour, salty, bitter and, increasingly, *umami* as fundamental taste qualities, although perhaps not the only qualities. Certainly, for the foreseeable future, the existence of distinct, basic tastes will continue to be the key assumption behind research aimed at elucidating the fundamental mechanisms of taste perception.

Flavor: Sensory Qualities in the Mouth

It is only after we have taken a bite that the characteristic apple flavor, consisting of odors and tastes, emerges. After entering the mouth, the same odor compounds that we detected previously, now released and concentrated by the combined actions of heating and chewing, reach the olfactory receptors via the nasopharyngeal passage at the back of the mouth, a process known as retronasal perception. The reason we commonly refer to characteristic food qualities as tastes—apple taste, coffee taste, and so on—is that we are not conscious of this alternate route for the sense of smell. In fact, these "tastes" are mainly odors.

Odor and taste perceptions are so well integrated in flavors that there are seldom any obvious signs as to where one sense ends and the other begins. This gives rise to the illusion that retronasal olfactory qualities are perceived in the mouth. Our language both reflects and encourages this confusion, in that we use the terms "taste" and "flavor" interchangeably. Simply holding the nose while a food or drink is in the mouth is sufficient, however, to demonstrate just how large a contribution the sense of smell makes to flavor. The complaint of loss of taste during a head cold is also a consequence of this misunderstanding. In fact, taste is largely unaffected, and it is the sense of smell that suffers.

At the same time as the odor volatiles in our apple are released during chewing, acids and sugars stimulate taste receptors in the mouth, producing perceptions of sourness and sweetness. For a sense that is so crucial to both our survival and our enjoyment of life, it is remarkable that taste is so poorly appreciated. Perhaps this is because, after subtracting odor qualities (and other sensations such as pungency and various aspects of "mouthfeel"—see below) from the overall flavor of a food or beverage, we are left with a rather small group of sensory qualities—traditionally, sweetness, saltiness, sourness, and bitterness. This limited set of qualities is clearly inadequate to describe much of the sensory complexity of any cuisine. Compared to the rich, perhaps limitless, inventory of odors that contribute to the flavors in even an average diet, the sense of taste initially seems remarkably unimpressive. Yet, in forming the essence of any flavor, taste supplies information that is crucial to our survival and well-being.

Basic Tastes

Taste is usually considered to be an *analytic* sense, composed of a key set of unique, indivisible qualities. In contrast to the *synthetic* sense of smell in which combinations of odors can produce a new quality entirely distinct from the components, tastes do not combine to form new qualities. Combining salt, sugar, and lemon juice may result in changes in the intensity of the tastes involved (different tastes typically suppress one another in mixtures), but it will only produce a mixture with the qualities of saltiness, sweetness, and sourness. As a result, these taste qualities, together with bitterness, are commonly talked about in terms of a set of *basic tastes*. It should be noted that this classification system is not without controversy but is adopted here, as it is the premise of most scientific literature on taste.

Taste Perception

To be perceived as a taste, a chemical compound or food ingredient has to be soluble (for example, in water or saliva) in order to reach the taste receptors. These are located within 3,000 or so taste buds, which are themselves located within structures on the tongue called *papillae* (although there are also small numbers of taste buds in other parts of the mouth). The most numerous of these structures, the *fungiform papillae*, are apparent as tiny bumps on the tongue's front upper surface. The *circumvallate papillae*, larger structures arranged in a chevron pattern, are located further back on the tongue, while the *foliate papillae* occupy the tongue's sides. Contrary to popular belief, taste buds are not specialized according to tongue location—we are capable of perceiving all tastes at any tongue location where taste buds are present (although our sensitivity to detecting different tastes does vary somewhat across different locations). The commonly seen tongue map, showing salty and sweet perception at the front of the tongue, sour at the side, and bitter at the back, results from a prolonged misinterpretation of the outcomes of studies published in 1901 by the German psychologist D. P. Hanig. In fact, lack of anatomical specialization for the different qualities is a characteristic of the taste system.

How a dissolved chemical compound becomes converted into a perception of, for example, sweetness or sourness, is increasingly understood. A large number of taste cells occupy every taste bud, extending their fingerlike microvilli towards the pore through which the tastant compound will enter. For each taste quality, the microvilli of a cell contain different receptor mechanisms, which are responsive to the chemical structure of the tastant. Sodium and some other ions (potassium, calcium, and lithium) interact directly with channels on the membrane of the microvilli, entering the cell and producing biochemical changes that result in a nerve response interpreted by the brain as saltiness; the hydrogen ion (H^+) in acids is similarly responsible for sourness. Bitterness and sweetness are thought to bind to specific receptor proteins on the surface of the microvillar membrane, and it is this binding that initiates the biochemical changes within the cell.

Unlike sourness and saltiness, sweetness and bitterness can be produced by substances belonging to a wide variety of chemical classes: not only sugars, but some proteins and amino acids are sweet. Other amino acids are bitter, as are alkaloids and some salts. This diversity appears to be reflected in multiple receptors for each of these qualities, although whether we perceive different types of sweetness and bitterness is currently under debate. Once the neural signals reach the brainstem, carried by the VIIth (chorda tympani), IXth (glossopharyngeal) and, to a lesser extent, the Xth (vagus) cranial nerves, there is still no direct relationship between quality and anatomy. Taste cells in the brain respond best to some qualities ("salt best" or "sweet best," for example) but will in general respond somewhat to each of the basic qualities. This has led to the view that taste is coded (identified) in the brain through a pattern of responses across many taste cells.

In addition to the four well-known qualities, there is now considerable evidence for the existence of another basic taste, known as *umami* (pronounced oo-ma-me). This Japanese word, translated approximately as "savory deliciousness," refers to the quality of foods containing significant amounts of naturally occurring glutamate (a derivative of glutamic acid, an amino acid), its sodium salt, monosodium glutamate (MSG), or 5′-ribonucleotides. *Umami* quality is perhaps most evident in the taste associated with rich sauce or soup bases made from stocks, mushrooms, or tomatoes. Adding Parmesan cheese to pasta provides another means of increasing the *umami* quality of the dish, as do many of the manufactured sauces throughout the world, for example, soy sauce. The status of *umami* as a unique taste derives not just from this quality being perceived as distinct from the other four basic tastes, but also from evidence for the existence of both glutamate receptors within the tongue's taste cells, and cells within the brain which respond preferentially to the *umami* taste. Very recent evidence has also pointed to the existence of taste receptors that respond broadly to many of the other amino acids (twenty in total) that make up proteins.

The Hedonic Properties of Tastes

A limited set of basic tastes suggests that each of the qualities must be significant in some way. Why have we evolved to be sensitive to these qualities specifically? The answer lies in our hedonic responses to tastes. If our imprecise use of the word "taste" reflects our confusion about the different qualities that make up flavors, then perhaps in compensation, our language also provides clues as to the role that taste plays. In addition to describing food qualities, we also talk about tastes as a way of indicating good or bad aesthetic judgment, and we say that someone is bitter, or sweet, or has a sour face. Our use of taste qualities to describe such positive or negative emotions or qualities unwittingly reflects the underlying structure of the taste experience itself. In providing a hedonic basis to food and beverage flavors, taste functions as a built-in arbiter of what is good and bad in those things that we consume. As Brillat-Savarin noted in his gastronomical meditations (*The Physiology of Taste*, 1825), taste can be reduced "in the last analysis, in the two expressions, agreeable or disagreeable."

In contrast to our preferences for odors, which are molded by exposure and reinforcement from an early age, hedonic responses to pure tastes are remarkably fixed. Distinct hedonic responses to sweetness and bitterness are present at birth, and are essentially the same as those we experience as adults. Both in terms of amounts ingested, and also in terms of their ability to elicit characteristic facial expressions, sweetness is highly liked and bitterness rejected in human neonates. Sourness also seems to be disliked. A preference for saltiness, on the other hand, develops in the first few post-natal months. While MSG in solution is not well accepted by neonates (or, indeed, adults), soups to which it is added are preferred. These hedonic responses to pure tastes also seem to be relatively independent of culture or diet. Comparisons across cultures whose diets are very different, for example, Japan, Taiwan, and Australia, have found highly similar patterns of likes and dislikes for pure tastes.

The significance of taste hedonics. Whether as a genetic predisposition, or as a result of *in utero* influences, the origin of relatively fixed hedonic responses to pure tastes appears to lie in an adaptive capacity to respond appropriately to the nutritional implications of these qualities. Taste palatability, and ultimately the palatability of foods, seems to reflect either provision of energy, an individual nutritional need, or a warning of the presence of a potential toxin.

Sweetness is thought to signal the presence of energy in the form of calories provided by sugars and other carbohydrates, which are crucial to survival. Sweetness is thus a positive quality, reflected in its universally high palatability. This palatability is mediated by opioid (morphine-like) biochemical receptor systems in the brain, which are thought to be the biochemical basis for reward. This explains why sweetness can sometimes act like an analgesic, reducing crying in infants, for example.

Saltiness acts as a survival cue, by signaling the presence of the sodium ion (Na), necessary for maintaining the body's fluid balance. A liking for salt, while present at all times, grows substantially if we are deprived of it below what is physiologically necessary. Although there are many claims that cravings for various foods and nutrients exist, that for salt is the only one that is well-documented in humans.

The strong dislike that we naturally have to bitterness is thought to be a protective mechanism. Many plants manufacture toxins as a defense against predators, and very many of these toxins are bitter. Not surprisingly, then, we tend to be extremely sensitive to bitterness. However, as a result, we often reject levels of bitterness that are not in fact toxic to humans—witness the common fate of the poor brussels sprout. The significance of our dislike for high levels of sourness is not as clear-cut. It may be a signal for unripeness/spoilage in foods, or the fact that concentrated, and thus extremely sour, acids can cause tissue damage.

Because glutamic acid is an amino acid present in proteins that we consume, it has been suggested that the *umami* taste of glutamate acts as a signal for the presence of protein, thus promoting consumption. However, preference for *umami* actually seems to be strongest when protein intake is within normal limits. Alternatively, since dietary glutamate is involved in crucial metabolic processes and may possibly be used as an energy source within the gut, it may be that our preference for additional glutamate in foods reflects the importance of these functions.

Taste and Smell Disorders

The loss of our ability to smell or taste is perhaps not as immediately debilitating as the loss of the senses of vision or hearing, but such disorders can nevertheless have a profound impact on people's lives. The enjoyment of foods, beverages, perfumes, and nature, and our ability to avoid spoiled foods and environmental toxins, depend upon the proper functioning of these systems. Chemosensory disorders are also relatively common. As a conservative estimate, up to one percent of the population have some degree of smell or taste loss or disturbance. Given that alterations in the flavor of foods are the most immediate consequence of smell loss, it is not surprising that problems with "taste" are the most common chemosensory complaint.

In fact, complete loss of the ability to taste is rare mainly because, as a sensing apparatus, taste is highly redundant. Unilateral damage to the cranial nerves carrying taste information can eliminate sensitivity to taste on half of the tongue, but appears to produce few noticeable changes in our ability to appreciate tastes. Likewise, taste is able to survive even severe trauma to the tongue. *Aguesia* (total inability to taste), when it does occur through illness or accident, is reported to have devastating consequences in terms of food acceptability, food intake, and, consequently, physical and mental health. *Dysguesias,* or distortions of taste sensations, are, however, not uncommon. These, and partial taste losses (*hypoguesias*), can result from disorders of oral health, dental procedures, and some commonly prescribed medications (including antibiotics, antidepressants, antihypertensives, psychiatric drugs, analgesics, and chemotherapy agents). Neurological disorders such as Alzheimer's disease, renal and liver disease, diabetes, and viral infections have all been reported to be associated with taste losses or distortions.

The list of diseases associated with partial (*hyposmia*) or complete (*anosmia*) smell loss, or smell distortion (*dysosmia*) is even more extensive. Significant losses are reported in renal and liver disease, HIV infections, thyroid illness, epilepsy, Alzheimer's, and Parkinson's diseases. Most commonly, though, smell losses are associated with both acute and chronic diseases of the upper respiratory tract (including colds and influenza), nasal sinus disease, and allergies. Five percent of victims of head trauma also have some degree of smell loss. In cases of severe head trauma, smell loss is often complete and irreversible, resulting from a shearing of the olfactory nerve fibers at the point where they enter the brain through the base of the skull.

Olfactory functioning is also susceptible to environmental toxins, making smell loss an occupational health issue. A variety of compounds used in manufacturing and other work environments, including metal dusts such as those of cadmium and nickel, solvents (acetone), and irritant gases (formaldehyde) have been implicated as causes of smell loss, particularly with long-term exposure. Cigarette smoking is known to produce chronic decreases in olfactory sensitivity, although this tends to recover once smoking is given up.

Diseases that affect smell and taste tend to be more prevalent as we age, as does the taking of medications that can produce deficits. Beyond these causes, however, we can also look forward to a "natural decline" in our ability to detect and identify smell and taste qualities, and a lessening of their impact. Using a 40-item "scratch and sniff" odor identification test, Richard Doty and colleagues at the University of Pennsylvania Medical Center showed that in both men and women, odor identification is reasonably stable until we reach our eighth decade. From this point on, the decline is fairly pronounced, corresponding to some extent to declines in vision and hearing during these years. Odors, and consequently flavors, are also less intense as we age, and our ability to detect subtle changes in intensity is reduced.

The sense of taste tends to survive aging somewhat better than our ability to smell. The threshold level at which tastes are detected increases, and taste intensity decreases, although not substantially, and not equally for all taste qualities—bitterness perception is particularly diminished. The ability to distinguish between different concentrations of tastants is also affected. Such losses, while not dramatic, can still have significant consequences. The levels of sweetness and saltiness that are considered by elderly people to be optimum in foods are generally higher, and food that is not adjusted accordingly may be considered bland.

One notable consequence of both smell and taste losses due to aging is that eating enjoyment is reduced. Particularly in institutionalized or hospitalized elderly people, this may exacerbate problems of anorexia and poor nutrition.

These seemingly distinct adaptive processes reflect an underlying principle on which the hedonic properties of tastes are based. Animal studies have suggested that the palatability of any taste compound, and the responsiveness of taste cells in the brainstem, is strongly related to its toxicity. At one end of the spectrum are highly toxic

MEASURING THE SENSORY QUALITIES OF FOODS

To produce foods that meet consumer needs, food manufacturers need to know the relative contributions of the various sensory qualities—tastes, odors, and textures—to the flavor of foods. Arguably, until this is known, it is difficult if not impossible to understand the consumer's responses to the product. Such information can be used to guide product development and ensure a quality product by allowing measurement of the effects of different production methods, changes in ingredients, and storage.

The process of describing and measuring the sensory qualities of foods and beverages is known as descriptive analysis (DA). To perform DA, small panels of typically ten or twelve individuals receive extensive training, often over a period of many months. During this time, the panelists learn to be consistent in their use of specific labels to describe sensory qualities. Such intensive training is necessary because of our generally poor ability to identify odors and flavors. Even with common food flavors, correct identification can be as low as 50 percent. Despite being able to say that an odor or flavor is highly familiar, we are often at a loss to identify the correct name. This has been labeled the "tip of the nose" phenomenon. In addition, to describe texture qualities, an entire vocabulary must be learned and applied appropriately. Fortunately, our ability to attach names to sensory qualities improves with feedback and practice. Importantly, too, training allows "concept alignment"—essentially an agreement as to the meaning of sensory descriptors and what constitutes examples of the concept. For example, the panel might need to agree that the term "lemon odor" refers to the odor of fresh lemon juice but not that of lemonade.

Providing labels for sensory qualities actually improves our ability to "see" those qualities in the midst of a complex food or beverage. To a novice wine drinker, a glass of sauvignon blanc tastes like white wine; with experience, however, we learn that this wine variety often has odor "notes" reminiscent of asparagus or cut grass. Providing examples of these notes allows panelists to perceive these qualities within the wine. As a result, they are increasingly better able to detect that note each time they encounter this wine variety—in effect, panelists end up perceiving a collection of sensory qualities, whereas before they could only identify the taste as that of white wine.

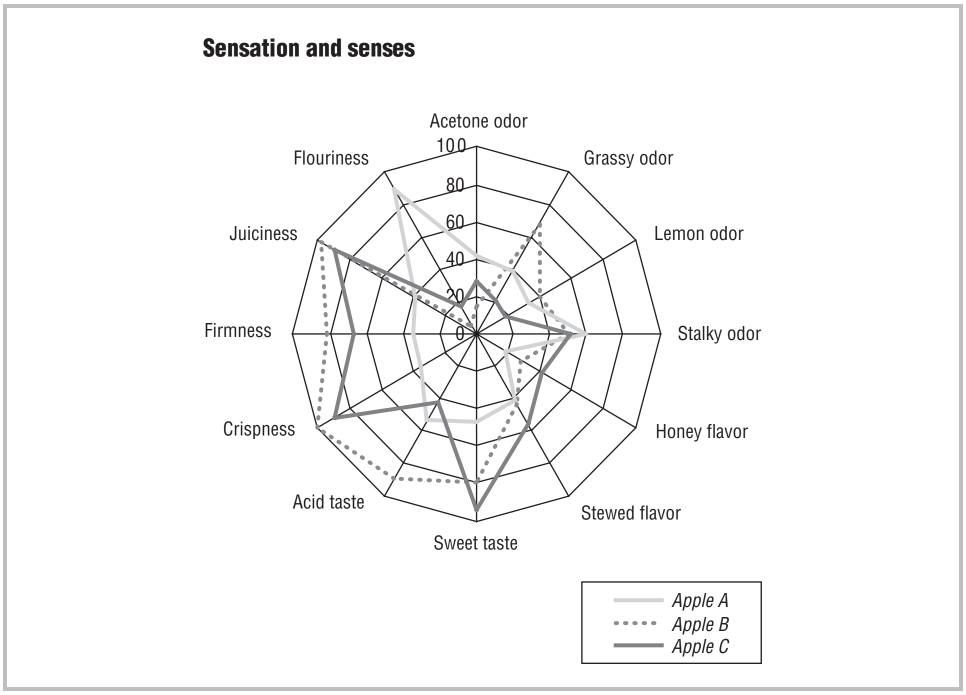
Quantifying the intensity of those qualities that are identified is a key aspect of DA, allowing us to measure differences between products in a scientific manner. Training improves our ability to measure sensory qualities using rating scales. Measurements made with rating scales are always relative—they do not quantify an absolute quantity unlike, for example, measuring the concentration of a chemical compound. But they can nevertheless be used reliably with training. Moreover, there are no alternatives. No instrument yet devised can reflect the complexity of human perception.

When developing these skills, trained panelists become less and less like consumers of the product. In fact, the aim is to have them approach the product in an entirely analytical way, which means ignoring any likes and dislikes and responding as though they were an instrument.

Once a panel is trained for a specific food, they are able to produce a flavor profile for a selection, or sometimes all, of the product's sensory qualities. In effect, this becomes the "sensory recipe" for that product. While flavor profiles say nothing about whether or not a product is liked, knowing the flavor profile of foods that are highly preferred can provide valuable information to guide future product development and predict the effects of variations in the sensory qualities.

compounds, which are rejected as unpalatable by both humans and many animals primarily due to bitterness; at the other end are highly nutritive substances with low toxicity that are well accepted, mainly because they are sweet. This neural and behavioral organization has led to the hypothesis that preferences for tastes are the method by which our bodies maintain their own physiological well-being. This makes considerable sense if our gustatory system is viewed as being at the interface between the external and internal environments. In this regard, we can view taste as being a "gatekeeper" whose function is to ensure that ingested substances maximize our survival. At least in this functional way, it is appropriate to talk about tastes as a continuum and to view sweetness and bitterness as opposites.

Consistent with the "gatekeeper" idea, regions of the brain responsible for processing information about tastes also receive neural information from the gut, and there is ample evidence of mutual interactions between taste perceptions and internal metabolic processes. Thus, metabolic states can modulate the palatability of tastes. The craving for salt when deprived of it has already been mentioned—but how does the body let us know it wants



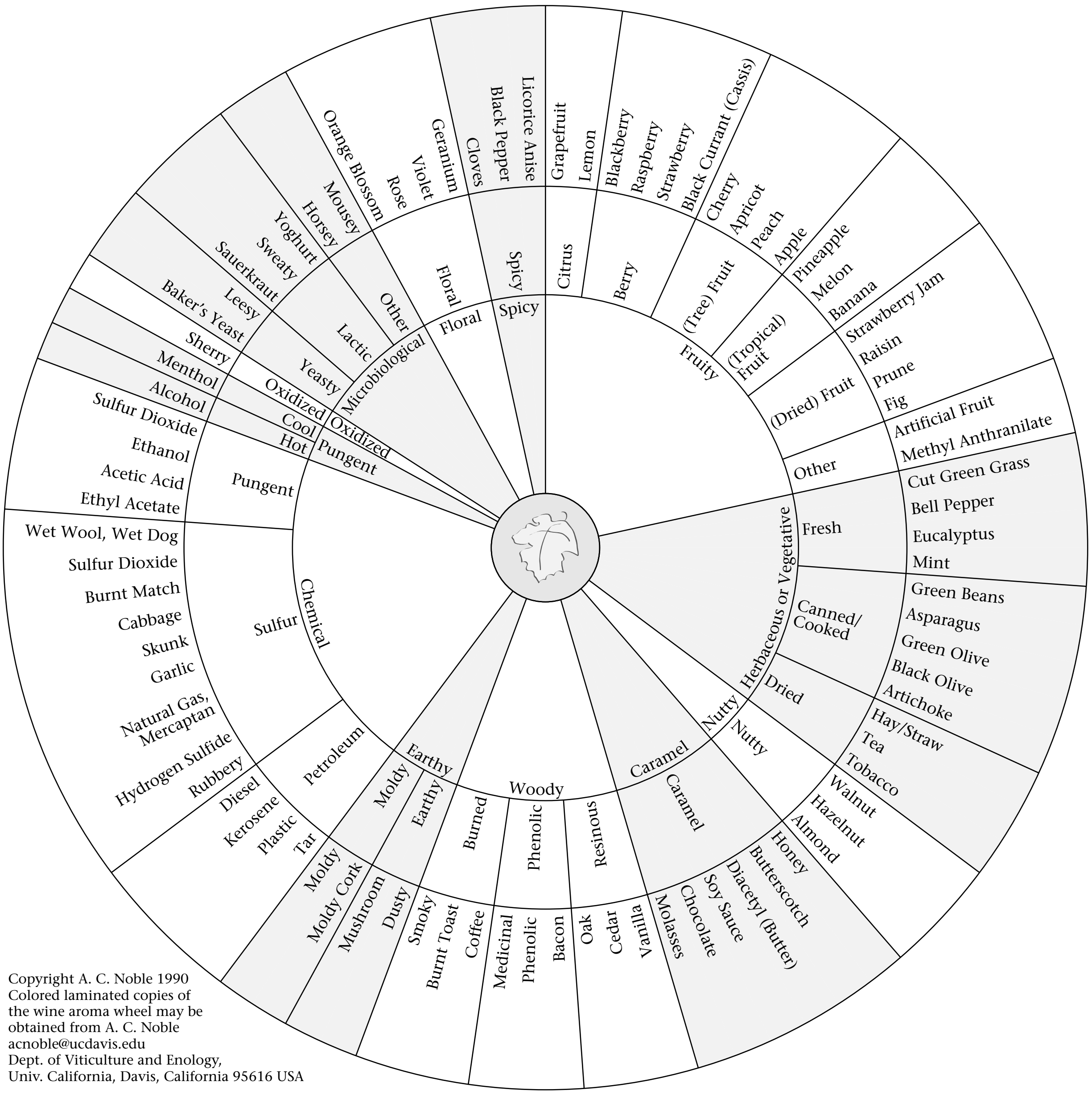
A "spider-web" graph used to show the mean ratings given by a descriptive analysis panel for a variety of odor, taste, and texture attributes in three apple varieties. This provides a sensory profile of these apples, allowing study of their similarities and differences. Distance from the center of the web represents increasing intensity of each sensory attribute, so that Apple B has the strongest *grassy* odor, followed by Apple A, with Apple C being the least intense for this quality. GRAPH COURTESY OF SHANE WALKER AND HORT RESEARCH, NEW ZEALAND

more salt? Studies in rodents have shown that "salt-best" taste cells in the brain actually decrease their responsiveness to salt following salt deprivation. Interestingly, however, this is accompanied by increases in the responsiveness of "sweet-best" cells to salt. This suggests that salt has become more pleasant, which would act to promote salt consumption to restore normal salt levels. In humans, too, the preferred level of salt in foods increases following salt depletion, and the rated desirability of salty foods goes up. This effect has also been shown for amino acids in cases of malnourished children and the elderly, in studies in which the addition of an otherwise unpalatable amino acid mixture increased the consumption of a soup. Similarly, animals fed a diet deficient in just one essential amino acid such as lysine will recognize its presence in foods, consuming them preferentially. Just the reverse seems to happen as a response to repletion. Sweetness becomes less pleasant following consumption of glucose, a phenomenon that is accompanied by decreased activity in "sweet-best" taste cells in the brain. Conversely, tastes are also able to influence metabolic processes, even prior to the nutrients' absorption by the gut. These so-called cephalic phase responses include increases in salivation and secretion of gastric enzymes and insulin, changes that prepare one for receiving the nutrients and energy provided by foods.

Chemesthesis: The Perception of Pungency

If the acidity in our apple is high enough, we might also perceive a degree of "bite" or "sharpness" due to activation of the free nerve endings of the Vth (trigeminal) cranial nerve. This nerve, which sends branches into the eyes, the nose, the mouth, and especially the tongue, transmits information regarding a wide range of tactile sensations, plus warmth, cooling, and even pain (think *very* hot curry). These sensations, often called pungency in the context of foods, are important to our appreciation of flavor in many foods and beverages. A cola drink without the fizz; the glass of wine without its sharpness; and onion, mustard, and horseradish without their bite or ability to induce tears have lost much of their defining quality. Whenever we talk about tactile sensations—stinging, biting, burning, numbing, tingling, or cooling—we are referring to pungent or chemesthetic qualities.

Trigeminally mediated sensations also very often contribute to the odors that we perceive in our environment. The eye-opening qualities of ammonia and many solvents derive from their ability to stimulate the trigeminal nerve as well as olfactory receptors. Not all such sensations are unpleasant. The cooling effects of peppermint, producing the pleasant illusion that our nasal passages have suddenly opened, are similarly mediated.


Fruity
Citrus
Grapefruit
Lemon
Berry
Blackberry
Raspberry
Strawberry
Black Currant (Cassis)
(Tree) Fruit
Cherry
Apricot
Peach
Apple
(Tropical) Fruit
Pineapple
Melon
Banana
(Dried) Fruit
Strawberry Jam
Raisin
Prune
Fig
Other
Artificial Fruit
Methyl Anthranilate
Herbaceous or Vegetative
Fresh
Cut Green Grass
Bell Pepper
Eucalyptus
Mint
Canned/Cooked
Green Beans
Asparagus
Green Olive
Black Olive
Artichoke
Dried
Hay/Straw
Tea
Tobacco
Nutty
Nutty
Walnut
Hazelnut
Almond
Caramel
Caramel
Honey
Butterscotch
Diacetyl (Butter)
Soy Sauce
Chocolate
Molasses
Woody
Resinous
Oak
Cedar
Vanilla
Phenolic
Medicinal
Phenolic
Bacon
Burned
Smoky
Burnt Toast
Coffee
Earthy
Earthy
Dusty
Mushroom
Moldy
Moldy
Moldy Cork
Chemical
Petroleum
Diesel
Kerosene
Plastic
Tar
Sulfur
Wet Wool, Wet Dog
Sulfur Dioxide
Burnt Match
Cabbage
Skunk
Garlic
Natural Gas, Mercaptan
Hydrogen Sulfide
Rubbery
Pungent
Ethyl Acetate
Acetic Acid
Ethanol
Sulfur Dioxide
Pungent
Hot
Alcohol
Cool
Menthol
Oxidized
Oxidized
Sherry
Microbiological
Yeasty
Baker's Yeast
Leesy
Lactic
Sauerkraut
Sweaty
Yoghurt
Other
Horsey
Mousey
Floral
Floral
Orange Blossom
Rose
Violet
Geranium
Spicy
Spicy
Cloves
Black Pepper
Licorice Anise

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the wine aroma wheel may be
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Dept. of Viticulture and Enology,
Univ. California, Davis, California 95616 USA

This wine aroma wheel shows how taste, sensation, and the senses are affected by various smells, flavors, and such taste components as saltiness, bitterness, and sweetness. For example, start from the center with fruity. Taste a wine and then narrow the fruitiness to berry or citrus (or both), then taste again to judge what flavor sensations are appropriate in the outer wheel. Courtesy A. C. Noble.

The trigeminal nerve also transmits information about temperature. It is not surprising then that chemically mediated chemesthetic qualities are modified by heating and cooling. The most obvious example of this is the ability of cool water to instantly eliminate chili-induced burning; conversely, this same burning is greater if the food is also (temperature) hot.

While pungent qualities are important sensory components of foods throughout the world, pungency is often associated primarily with cultures such as those of Korea, Vietnam, Thailand, and Mexico, whose cuisines use a lot of chili. These cuisines provide much greater flavor impact than typical Western diets, and their recent popularity in Western countries may reflect not just increased availability, but a striving for new, intense culinary sensations. Even so, many people have reservations about hot (spicy) food. This is not surprising given that pain, oral or otherwise, is a clear signal to warn that damage has occurred or is imminent. The main heat-producing compound in chilies is capsaicin, a powerful irritant. However, despite common anxieties, there is no evidence that it damages otherwise healthy stomach linings or kills taste buds.

Even regular hot-food eaters complain, though, that if a food is *too* hot, appreciation of other aspects of flavor are spoiled or overwhelmed. On the face of it, it seems evident that such a strong sensation should overwhelm a weaker one. We are used to suppression of flavor and taste qualities by other flavors and tastes—for example, reducing the sourness of lemon juice by adding sweetness. Yet, the research evidence for this occurring with "heat" is fairly weak. When capsaicin (even at levels equivalent to a very spicy meal) is combined with tastes or odors in mixtures, only sweetness is reliably reduced.

The failure to find stronger effects of burning sensations is certainly contrary to popular belief and, perhaps, experience. Wine commentators, grappling with the question of what to drink with spicy food, commonly invoke the idea that hot foods overwhelm "subtle" wine flavors. However, it may be that burning sensations are simply a more prominent or memorable sensory experience since they persist long after the tastes and flavors have disappeared. Evaluating the intensity of something, we typically make comparisons ("sweet compared to what?"). Especially if the level of pungency is higher than an individual finds pleasant, this phenomenon might simply reflect the fact that the burn is intense and the flavor is not a "real" reduction of flavor intensity.

Texture and Mouthfeel

Problems with texture are a common reason for rejecting foods. It is unlikely that we will finish an apple if it is either mushy or rock-hard. Our perception of many texture qualities relies on information from mechanoreceptors in the tongue, gums, and palate (also part of the trigeminal nerve) that detect the shape of food particles, together with pressure sensors in the jaw and gums. These sensors give feedback on how much force to exert in chewing, information that forms the basis for hardness perception. Compared to some other senses, hearing is perhaps of lesser importance in food appreciation. Nevertheless, the sound of the crunch when we bite into an apple allows us to fully appreciate its freshness and ripeness, and forms an integral part of our perception of its texture.

Sometimes in the past considered a taste, the property of astringency is now generally accepted as a set of *mouthfeel* sensations. Characteristic of foods and beverages containing tannins, including some fruits, nuts, tea, and cranberry juice, astringency consists of sensations of drying, puckering, and roughness felt on the mucous lining of the mouth. These sensations result when the tannins cause the lubricating proteins in saliva to precipitate out. Although it sounds largely unpleasant, astringency is a good example of how responses to sensory qualities are often highly dependent on context. While one of the reasons that we might not eat a green banana is that it tends to leave the mouth feeling like a sandpit, drinkers of red wine value these sensations, at least to some extent. When a wine is described as "dry," the sensation is due to a significant extent to astringency.

Other textural sensations are produced by the water (for example, juiciness) or fat content of foods. Fat, in particular, is a key component of many of those foods that are highly liked, including red meat, desserts, cakes, chocolate, and dairy foods. Fat not only produces a sought-after texture, it is also an important carrier for flavor. Fat-reduced foods have often failed to be accepted because they were generally low in both flavor and textural properties such as creaminess. In addition to the desirable properties that fats create, liking for fat may actually be innate, because of its ability to provide energy (in a similar way to sweetness). This possibility is supported by recent evidence to suggest that fatty acids may have their own receptor—in other words, our bodies adapt to be able to detect fat. Given these considerations, it is not surprising that many people report that it is the sensory properties of low-fat foods that are responsible for poor compliance to dietary advice.

Sensory Integration: What Are We *Really* Perceiving?

Despite the contribution from all of these senses, what we ultimately perceive—as opposed to the sensations we've experienced—is *an apple*. In his seminal *The Senses Considered as Perceptual Systems* (1966), the psychologist J. J. Gibson proposed that the purpose of perception was to seek out objects in our environment, particularly those objects that are biologically important. Nowhere is this more evident than in our perception of food qualities. Although we know implicitly that, while eating, a variety of signals are impinging on our gustatory, olfactory, tactile, visual, and auditory systems, this type of analysis does not come naturally. Thankfully, what we perceive when we sit down to dinner are "objects"—a steak and a glass of red wine—rather than a collection of distinct sensory signals. Moreover, likes and dislikes naturally spring from this synthetic mode of perception since we are responding to objects that we have learned to recognize as foods and that are therefore important to survival. Initial, "gut" responses to foods are almost always hedonic, and this naturally precedes accepting or rejecting the food.

The perception of food qualities reflects the integration of information from multiple sources. This is seen in the convergence of inputs from different sensory modalities in the brain. Edmund Rolls of Oxford University has described convergence of taste and odor information in what may be the physiological basis of flavor

Taste Perception: Are We All the Same?

"Now, anatomy teaches that all tongues are not equally provided with these papillae, and that one tongue may possess three times as many as another . . . the empire of taste also has its blind and deaf subjects." —Brillat-Savarin, *The Physiology of Taste* (1825)

Black coffee and beer are not only amongst the most commonly consumed beverages in many countries, they are also amongst the most commonly rejected by first-time users—primarily due to their bitterness. Clearly, preferences for initially disliked foods and beverages can develop. Repeated consumption itself tends to lead to increased liking. But why do some people more easily develop a liking for beer than others, and why, for some, does it remain unpalatable because of the bitterness? Research has begun to focus on individual differences in taste sensitivity as an explanation. While there have been some previous attempts to classify responses to tastes—for example, into those whose liking for sweetness tends to increase (sweet likers), versus those whose degree of liking flattens out or decreases (non-likers), with increasing concentrations of sweeteners—such classifications are poor predictors of food likes and dislikes. Recently, however, there has been a growing body of research that has investigated individual differences in taste sensitivity, the results of which have raised the possibility that these variations may be important influences on food preferences.

In 1931, A. L. Fox, an industrial chemist with the DuPont Company, reported the discovery that some people appeared to be "blind" to the bitterness of a compound, phenylthiocarbamide, or PTC. Subsequent research confirmed that this difference between individuals had a genetic basis, and it was initially thought that non-tasters might lack a receptor for PTC and other thiourea compounds. For several decades following Fox's discovery, the main focus of research was on this genetic basis, and how this might vary across different population groups.

In the 1970s, however, this phenomenon began to interest taste scientists, in particular, Linda Bartoshuk from Yale University. Since then, our understanding of such genetic variations in taste sensitivity has grown considerably. Using a compound chemically related to PTC, 6-n-propylthiouracil (PROP), Bartoshuk and colleagues have demonstrated that each of us belongs to one of three groups—non-tasters, medium-tasters, or super-tasters—each varying in their response to PROP. Non-tasters, around 20–25 percent of the population (at least in Western cultures), find PROP tasteless, or very weakly bitter. Medium-tasters (approximately 50 percent) find PROP mildly to moderately bitter, while super-tasters (20–25 percent) find this compound almost traumatically bitter.

perception. He identified neurons in the olfactory area of the monkey cortex that responded specifically to qualities that occur together in flavors, for example, the sweetness of glucose and fruit odors. However, these neurons did not respond to incongruous combinations, such as saltiness and these same odors. Such neurons may actually start off responding only to odors and learn to respond to sensory combinations during repeated pairing of particular tastes and odors when they occur together as a flavor. Multimodal neurons in other sensory systems are thought to enhance the detection of, and reduce ambiguity associated with, external stimuli. In the case of odors and tastes, these neurons could help to resolve any ambiguity regarding the wisdom of consuming particular foods. Perceiving whole flavors, rather than distinct sensory signals, can be seen, therefore, as a survival strategy.

Interactions within Flavors

The brain's integration of food qualities makes it difficult to discuss the different sensory systems in isolation from one another since these systems tend to interact. The way in which sensory properties like color can influence odors and tastes was mentioned earlier. Because sensory properties are perceived as aspects of the same "object," we repeatedly associate the occurrence of one property with that of another.

In addition to setting up expectations for other sensory qualities to follow, learned associations between different qualities in foods can actually determine the qualities that we perceive. One of the most interesting examples is the ability of odors to rapidly form associations with other sensory qualities, especially tastes. In what appears to be the perceptual equivalent of the neurons described by Rolls, novel odors that are repeatedly experienced combined with a sour taste start to smell "sour"; those combined with sweetness start to smell "sweet." These effects are borne out in everyday experience. When asked to describe the odor of vanilla or caramel or raspberry, we will commonly use the word "sweet." This seems to be more than simply the fact that the odor recalls a food that was sweet since such odors can influence the intensity of that taste. Strawberry odor when placed together with tastes in solution can both enhance the sweetness of sucrose and reduce the sourness of citric acid, just as the addition of "real" sugar would.

Thus, our final perceptions receive input not just from a variety of sensory systems, but also from our mem-

Such findings would merely be of academic interest if it were not for the fact that, as observed so long ago by Brillat-Savarin, there is also considerable variation between individuals in the number of fungiform papillae on the tongue. In fact, different degrees of sensitivity to PROP are highly correlated with such variations in the density of fungiform papillae. Since individual papillae are not specialized for specific tastes, it is not surprising that those sensitive to PROP also tend to be sensitive to other bitter compounds, including caffeine and quinine, and also to the sweetness of sucrose, the sourness of citric acid, and the saltiness of common salt. The artificial sweetener, saccharin, is perceived as both sweeter and more bitter by PROP tasters than by non-tasters. Bartoshuk has suggested that, effectively, the different taster groups inhabit different taste worlds.

Although these are not taste qualities, PROP taster groups also vary in their perception of the texture of fats and the pungency of alcohol and chili. This is because fibers of the trigeminal nerve in the mouth, responsible for transmitting information on the majority of tactile and irritant qualities that we perceive in foods, tend to be anatomically associated with taste cells. So, the more taste cells that an individual has, the more trigeminal fibers they also possess.

These differences in taste *perception* influence how much tastes are liked, which ultimately produces different patterns of food preferences. For example, coffee, spicy, and sharp-tasting foods such as some cheeses are liked more by non-tasters than tasters. Liking for cruciferous vegetables such as broccoli, cabbage, and brussels sprouts also appears to be related to variations in perception of their bitterness, and hence they are less likely to be consumed by PROP medium- and super-tasters than by non-tasters.

These relationships, apparent in both young children and adults, may turn out to be crucial in our understanding of food choice as it relates to disease risk. Increased consumption of cruciferous vegetables and reduced consumption of fats have both been linked to reduced risks for certain cancers. While the links between diet and diseases such as cancers and cardiovascular disease are increasingly being demonstrated, the notion that taste sensitivity could also predict risk has only recently been suggested, and may represent an important step in our understanding of susceptibility to dietary-related diseases. Sensory factors have frequently been implicated in the difficulties that we face in switching to healthier foods, e.g., lower-fat foods. These recent findings suggest that how successfully we are able to switch from a food containing a high level of sugar, salt, or fat to a version that is more consistent with health requirements may also be partly determined by genetic variations in taste sensitivity.

ory of past associations. In practical terms, it means that our perception of a quality like sweetness within foods will often include a contribution from a sweet odor and a sweet taste. Such phenomena also help us to appreciate that the sensory properties that foods possess derive not just from perception of their chemical constituents, but also from complex cognitive processes. Understanding these processes—even for the humble apple—requires inputs from a variety of scientific disciplines, most notably psychology, food science, neurophysiology, and molecular biology.

See also **Brillat-Savarin, Anthelme**; **Eating: Anatomy and Physiology of Eating; Wine**.

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John Prescott

SERVING OF FOOD. The step between cooking and eating is far from insignificant. With sophisticated production and preparation, the serving of food involves important role divisions, etiquette, and cultural forms.

Such are the intricate social and cultural pressures that being served at an unfamiliar table or even just the arrival of an unfamiliar food can make diners uncomfortable. Families can fight over shares—the social struggle for resources in microcosm. But the serving of food is also a site of courtesy and generosity. Domestic hospitality depends on serving graciously, taking care of guests first, and offering second helpings. Professional waiters commit complicated orders to memory, return smoothly without mix-ups, perhaps conduct elaborate serving rituals, and note before anyone else any missing components.

Types of Service

One logistical variable is the proximity of the cooking. This can be immediately in front of the diners so that the cook, host, or diners serve, at an adjacent kitchen as in restaurant waiter service, or at a distant factory when packaged snack foods are trucked to coin-activated machines. Serving can be done from staging posts, whether the immediate table, sideboard, dumb-waiter, trolley (as in the Hong Kong *yum cha*) or picnic basket. Diners sitting regally along only one side of a table enable service from the front; served from behind, dishes are conventionally offered from the left and taken from the right.

The number of diners changes the picture: from a handful of people around a campfire to thousands in dining halls, to vast street banquets, which have sometimes been served using bicycles.

Another key variable is the ratio of servers to diners. A ratio of one-to-one or even higher has enabled magnificent displays, vast tableaux, from which attendants could retrieve helpings on command. One waiter for ten diners or more can readily take orders and carry individual plates already made up in the kitchen. Even lower labor levels are needed for a cafeteria or hotel buffet, where diners help themselves and face the indignities of queuing.

The food itself is the most important variable. Dishes might require dressing, lifting, pouring, spooning, slicing or, most impressively, carving. In agrarian societies, eaters have helped themselves, or been served, from a common bowl or pot, but many meals involve two or more containers. The boxed Japanese meal called a *bentō* should display at least ten pretty items ready for the choosing. Sometimes diners have no choice, which is the case with table d'hôte (sharing the "host's table" typical of an inn), but a selection is often served. Chinese diners select food from the table and perhaps from a lazy Susan (central revolving stand). This can magnify into whole tables or "services" of food, which might even be changed through the meal as in the grand French style, service *à la française*.

Styles of Serving

à la carte: 'by the card'. The diner orders the progression of dishes beforehand from a menu or bill of fare typically showing the price of each item.
service à la française: 'service in the French manner'. Each course magnificently arrayed like a buffet, from which the diner or servant selects.
service à la russe: 'service in the Russian manner'. One dish at a time, either served at the table or already plated in the kitchen.
table d'hôte: 'host's table'. A common meal served at a fixed price, typical of an inn.

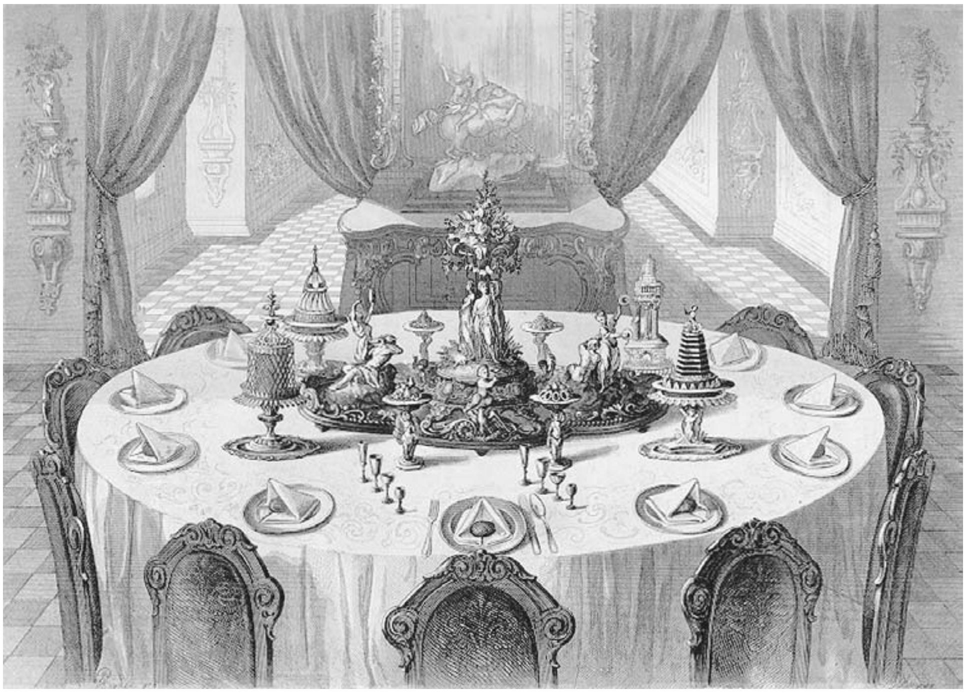
The alternative, service *à la russe*, brings a series of dishes through the meal, perhaps carved in the dining room but often plated in the kitchen for each person, and is particularly associated with French-style restaurants. The food tends to be hotter and the meal to last longer. Individual choice is restored in restaurants with à la carte, that is, selections made previously from a menu or bill of fare.

The nineteenth-century debate about service *à la française* and service *à la russe* is not arcane, but reflects the broad historical trend from simultaneous serving to successive presentation, and from mass displays to individualized plates. The distinction is blurred, though, since many meals have been served sequentially, and the grand French spread (*le grand couvert*) already had several courses. Each plate in the modern Western style will probably carry several items.

Server and Served

The sharing of food in meals gives serving its social significance. Meals also enable the sharing of roles, or division of labor, each person contributing what they can. Herein lies a paradox, for the very act of sharing food introduces a split between server and served.

Servers can take pride: Italian waiting can be highly skilled and as entertaining as any opera, French service so suave as to be hardly noticed, and the proverbially "resting" New York actors can demonstrate people skills.



There were several methods of serving food in the nineteenth century, the newest style being service *à la russe* (Russian style) shown here. This is the serving style employed by most modern restaurants, whereby the food is cut up into serving portions in the kitchen rather than at the table. Wood engraving from Alphonse Gouffé's *Royal Cookery Book* (London, 1868), copy of Charles Delmonico. ROUGHWOOD COLLECTION.

In a civilized society, people might take turns being served and serving. Jesus said he came "not to be served but to serve" (Mark 10:45 and Matthew 20:28). The Greek *diakonia* could mean "service" in a general sense, but Jesus meant the specific serving at table, his mission centered on table-fellowship.

However, serving has generally retained low status. "Beulah, peel me a grape," ordered American actor-writer Mae West in her movie *I'm No Angel* (1933). The words "serve," "service," and "servant" derive from the Latin *servus* for 'slave'.

When people began keeping livestock and other stored wealth, they introduced the concept of private property. Given that men made themselves the owners of the new sources of foodstuffs, this phase marked the "world-historic defeat of the female sex,"continues German social philosopher Friedrich Engels in the *Origin of the Family, Private Property and the State* (chapter 2, "The Family") in 1884. The "woman was degraded, enthralled, the slave of the man's lust, a mere instrument for breeding children." She also cooked and served.

Women have often served men first—and larger shares than warranted by different body sizes and energy requirements—even at the expense of their own health. In *Cooking, Cuisine, and Class* (1982), British anthropologist Jack Goody notes that women of the Gonja of Ghana distributed larger portions of cooked meat to men's bowls. Even when the meat went into a common soup, he found that educated women held back, though the men "jokingly claim that if women do not help themselves beforehand, they are fools" (p. 68). The differential distribution of food between sexes shows up in modern societies, as Nickie Charles and Marion Kerr illustrate in *Women, Food and Families* (1988).

Friedrich Engels also argued (chapter 9, "Barbarism and Civilization") that the increase in production with agrarian civilizations increased the demand for labor, which was furnished by captives of war made into slaves. The Roman propertied classes numbered their household slaves in dozens, sometimes hundreds, and they ran the meals. A crowd, typically male and properly attired, carried in the meal's three to six courses. A contemporary observed that "all night long they have to stand around, hungry and dumb." Real prestige belonged to the wine waiters—who were expected to be "young, smooth-shaven (but long-haired), and sexually attractive," writes John H. D'Arms in "Slaves at Roman *convivia*" (1991).

To believe the satire of a nouveau riche banquet at the height of Nero's Rome, described in the *Satyricon* of Petronius, the "boys" might make dozens of entrances, pouring out snow-cooled water, sprinkling the room with colored sawdust, carrying round bread, towels and hot water, anointing the diners' feet, singing, clapping, and dancing. Elaborate carving was already well established, and Petronius describes a man slashing at a great platter of plump fowls, sows' udders, a hare and fish, with his hands moving in time to the orchestra, "like a charioteer battling to the sound of organ music." At the same feast, a whole boiled calf is demolished by a carver playing the warrior Ajax in a scene from Homer, sharing the pieces on the point of his sword among the surprised guests.

Slaves routinely had access to leftovers, but any concessions to conviviality have to be set against the fundamental powerlessness. Suetonius, a biographer of the Caesars, relates how Emperor Tiberius once publicly reprimanded the lecherous old spendthrift Cestius Gallus, while privately accepting his dinner invitation as long as the waitresses were naked. Humiliation and punishment (including murder) contrasted with the convivial setting. Again according to Suetonius, a slave stole a strip of silver from a couch at a public dinner, so Emperor Caligula had the executioners lop off the slave's hands, hang them around his neck, and take him on a tour of the tables.

Being a house rather than field slave could bring privileges in the American South. As Eugene D. Genovese notes in *Roll, Jordan, Roll* (1975), "servants trained and polished for elegant performance as butlers, cooks, and dining-room attendants were hard to obtain and not easily spared" (p. 329). But the household staff could also have less free time, have to snatch meals when they found a moment, miss out on plantation singing and feasting, and were continually reminded of their deprivation.

Courtly Service

The recipes in the courtly English book dated around 1390, *The Forme of Cury* [Cookery], begin "Take . . ." and usually conclude "serve it forth" or "*messe* it forth." The word *mess* has referred to a portion of food, a liquid food, a made dish, and a course of foods, all of which had been "messed" forth—from the Latin *mittere*, 'to send'. Those sitting together at a banquet and sharing from the same dish were called a *mess*.

The officers in grand medieval households, where regular diners numbered in the hundreds and even thousands, included the ewerer who carried washing water and towel, the cupbearer who fetched wine, the butler who supervised butts of wine and ale, and the surveyor who controlled the surveying board to which the cook directed the platters. The carver's was still an exalted domestic station, with intricate rules to "break" that deer, "display" that crane, *alay* that pheasant, *tranche* (slice) that sturgeon, and so forth. Madeleine Pelner Cosman writes in *Fabulous Feasts* (1976) that the titles, responsibilities, and implements of food service could be carried by noblemen and sons of gentlemen. Serving could prove a means for political and professional advancement; Cardinal Morton predicted that the young Sir Thomas More, who was waiting on him, would prove a marvelous man (p. 26).

The disappearance of public carving in stylish European culture was accompanied towards the end of the nineteenth century by the switch from service *à la française* (each course or "service" arrayed like a buffet) to service *à la russe* (one dish at a time). With the cook often "plating up" behind the kitchen door, the mealtime distribution of food was moving to the back room and from the hierarchical to the individualistic. This reflected the shift in power from the aristocracy to the business class, and their more private meals.

This rationalization of food serving was supported by Thomas Walker, the London essayist of "aristology" (the art of dining). Devoting much of his 1835 weekly newspaper, *The Original*, to what he calls "attendance," Walker protested against the "cumbrous" ceremony of service *à la française*. Servants would take each dish on a circuit, and the wines move "languidly round two or three times." He favored service *à la russe*. "I like the familiar and satisfactory style both of cooking and of eating, with the dish actually before me on *mensa firma*, the solid table—not a kickshaw poked from behind, and dancing in the air between me and my lady neighbour's most inconvenient sleeve, without time to think whether I like what is offered." A small party of eight should assemble, and every dish be "served in succession, with its proper accompaniments, and between each dish there should be a short interval, to be filled up with conversation and wine, so as to prolong the repast as much as possible, . . . time would be given to the cook, and to the attendants."

Self-Service

If not enforced by marriage or slavery, household servants have been tied through affective, material and financial dependence. The smaller households late in the nineteenth century had just one or perhaps two live-in domestics, a cook and a maid. However, the employers confronted a "servant problem," because many young women preferred more public work as shopgirls. This helped stimulate the feminist dream of "kitchen-less" homes reliant on central facilities.

If the keynote of the nineteenth century was the reduction in servants, that of the twentieth was the effort to displace serving entirely. The "service industries" took over more roles of a servant with less labor. The factory took over more finished food preparation. Costs might also be reduced by "self-service." In the cafeteria, a line of customers might choose items, place them on a tray, and carry them to the cashier. Oddly, this was like a return to service *à la française*, without assistance.

McDonald's has become emblematic of casual, deskilled, and formulaic service. In 1948, at the drive-in restaurant of the McDonald brothers, Dick and Mac, at San Bernardino, about fifty miles east of Los Angeles, twenty young women waiters called "carhops" served up to 125 cars from the twenty-five item menu, featuring beef and ribs cooked in a barbecue pit fuelled with hickory chips. But the brothers faced increasing competition and labor and advertising costs, so they sacked their carhops, slashed the menu, halved the price of a hamburger to an unheard-of 15 cents, abandoned china and flatware in favor of paper bags, wrappers and cups, organized industrial kitchen equipment, and adopted rigid operating procedures to "eliminate the principal obstacle to fast-food service—the human element," corporate historian John F. Love observes in *McDonald's: Behind the Arches* (1986, pp. 11–18). The brothers put an "industry that prided itself on extremely personalized procedures" on the assembly line. Under subsequent owners, McDonald's introduced the world to the inane-sounding, "Have a nice day."

Having meals in company requires the serving of food, but this can become exploitative and inequitable. One answer is a "help yourself" culture of individualized service, but generosity is maintained when people take turns as server and served.

See also **Class, Social; Kitchens, Restaurant; Places of Consumption; Restaurants; Waiters and Waitresses.**

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Michael Symons

SEX AND FOOD. Food and sex are inextricably linked. Feeding insures survival of the individual while sexual activity insures survival of the species. Beyond biology, making love and eating share psychological attributes as two of life's greatest pleasures, both capable of providing a sense of nurturing, comfort, and being loved as well as instant gratification. Paradoxically, the two drives can also be the source of much psychological conflict, guilt, and shame. They generate anxiety in many cultures, partly because these are traits we share in common with animals.

Speaking of Food and Sex

The language we use to describe sex and food is very similar. In *The Rituals of Dinner* (p. 18), food anthropologist Margaret Visser describes a meal as a ritual in which "desires are aroused and fulfilled." We speak of fat, in particular, with sexual connotation—words like "juicy," "tender," "satisfying," "greasy," "soft," "great mouthfeel." In popular culture, the semantic commonality and double entendres are even more pronounced. A T-shirt sold in New Orleans, for example, displays a picture of a Louisiana oyster with the words "Eat me raw" (Schell, p. 203). The pages of women's magazines are largely filled with articles on food or sex with a typical headline reading "The Next Best Thing to Sex is . . . Chocolate." Advertising plays on sensuality in promoting acquisition of food products. Häagen-Dazs premier ice cream, for example, has run a campaign based on the tagline "Too much pleasure?" Best-sellers using food as a theme, including such sensual novels as *Chocolat* by Joanne Harris and *The Mistress of Spices* by Chitra Banergee Divakaruni, as well as memoirs with erotic elements such as *Aphrodite: A Memoir of the Senses* by Isabel Allende and *Comfort Me with Apples* by Ruth Reichl vie with self-help books about sex for top billing. In 1972, physician and sex expert Alex Comfort published his classic sex manual *The Joy of Sex*, a play on the title of the classic cookbook *The Joy of Cooking*. His approach of prescribing "recipes" for good sex was criticized.

Life's Greatest Pleasures or Pain?

Sigmund Freud blamed sexuality and the need to master and socialize sexual impulses as the root cause of psychological angst. These feelings, he reported, began at birth. He described sexual response in nursing infants, tracing the arc of sexual arousal and fulfillment, flushing of the skin, and sleep following the satisfaction of feeding. More recently, food psychologist Paul Rozin of the

University of Pennsylvania theorized in *Social Research* (p. 9) that Freud would have had a stronger case making eating the culprit in the clash between biology and society. The feeding drive, he argued, is more frequent, urgent, and crucial to everyday life and human evolution than sexuality.

A love affair that ends can provoke great pain. Similarly, in some cultures, eating too much and gaining weight can undermine self-worth and compromise chances of finding a sexual partner. Much overeating is conducted in secret, just as sex often takes place behind closed doors. It is interesting that some people, not necessarily overeaters, suffer from a social phobia in which there is a fear of being watched or humiliated while eating a meal. This phobia provokes such overwhelming anxiety that it is impossible to enjoy the pleasure of going to a restaurant. Both sex and food are associated with physical as well as psychological danger—namely the morbidity and mortality consequences of obesity, foodborne illnesses and bioterrorism as well as the risk of contracting sexually transmitted diseases (STDs) and autoimmune deficiency syndrome (AIDS).

Sexual and Feeding Appetite

To some extent, appetite for both sex and food increases with variety. Some fad diets succeed temporarily because they reduce the number of permitted foods, a restriction that presumably suppresses appetite. It is interesting to note that as variety and availability of foods, particularly imports, has increased in the United States over the past one hundred years, so has obesity. Among males, at least, a new or novel sexual partner can stimulate a sexually spent male to copulate again. This novelty effect, also known as the Coolidge effect, is not true for females, according to the newsletter of the Human Behavior and Evolution Society. Sexual appetite may be suppressed in a long-term monogamous relationship with a familiar partner.

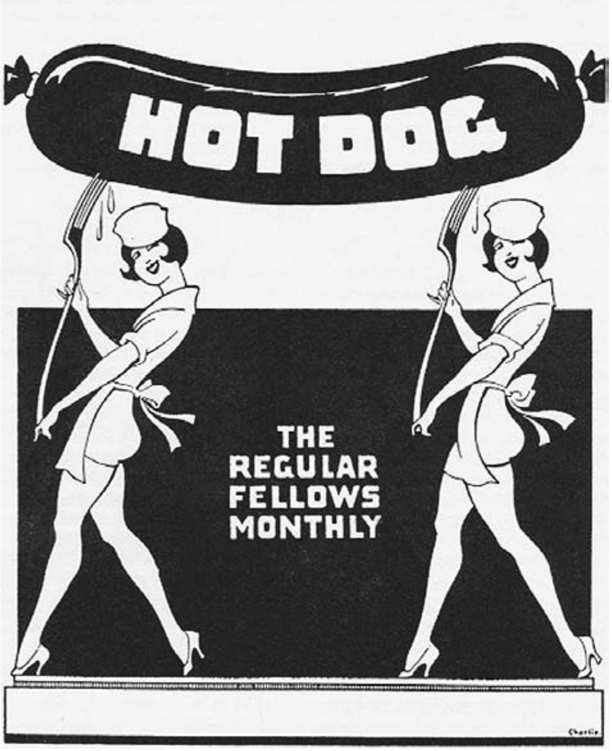
Across Cultures

Anthropologists have long studied how sex and food intersect in less developed cultures. Among the Langkawai, a Malay island culture, kinship is defined by "incorporation," the process of neutralizing differences between people by taking in ("incorporating") some of their "foreign" substance, food or sexual fluids, through the rituals of feasting and marriage. Both acts serve to convert the Other, someone unrelated in this case, into kin, and therefore nonthreatening. In the Hua society of New Guinea, there is an implicit association between feeding and sexual intercourse in which one partner "feeds" the other. Both acts are believed to achieve the transfer of *nu*, the vital essence.

Food Sharing: Key to Intimacy

Sharing food is a way of establishing closeness. There are profound differences among cultures in this practice. Research has focused on heterosexuals, but there is no reason to think that the same principles would not apply to homosexual couples. In France, sharing of restaurant food between a man and a woman takes on a sexualized characteristic. It is a common flirtatious practice to eat out of each other's plates. In this playful exchange, each partner may be testing how far the other is willing to go toward greater sexual intimacy.

Research conducted by Miller, Rozin, and Fiske has found that, in the United States, at least, college students perceive variations in food sharing as revealing the level of intimacy. The students viewed videotapes of opposite-sex couples sharing food in one of three ways: (1) simple sharing, such as passing a dish; (2) feeding the partner from his or her plate by hand or utensil; or (3) offering food from which one has already taken a bite or lick. The observers were asked to assess which couples, were involved in a sexual relationship. Those who practiced "simple sharing" were perceived as nonsexual friends; the couples who either fed each other or exchanged already sampled food were perceived as sexually involved. Across cultures, offering and accepting food that has already been eaten or licked (like an ice cream cone), meaning that it is potentially "contaminated" by saliva and germs, is often perceived as limited to people who are intimately related. There is a survival rationale—the saliva



Cover logo for a men's magazine called *Hot Dog* (Cleveland, Ohio, 1925). The hot dog, a food icon, is transformed into a metaphor of sexual innuendo. ROUGHWOOD COLLECTION.

of someone one does not know is more likely to contain dangerous foreign germs.

Courtship feeding among couples is common, ranging from the proverbial Valentine's Day gift of a box of chocolates, to the dinner date as a prelude to sexual activity, to preparation of dinner or food gifts for a potential lover. Food here serves as foreplay. A sensual experience in the eating sphere is expected to lead to one in the sexual sphere.

Gender Differences

In most cultures men and women generally occupy prescribed gender roles in the arenas of both food and sex. The women's movement aside, females are still most often expected to be the "cooks," the presenters of enticing tidbits which may be themselves, while men are the consumers. In homosexual relationships, one partner may self-select to assume the more traditional female role. Beginning in the early twentieth century and well into the 1960s, many U.S. cookbooks offered women culinary and sexual/marital advice side by side. In 1962, food writer Mimi Sheraton suggested in *The Seducer's Cookbook* that a woman use her culinary wiles to lure a man into the bedroom. In 2001, British television cook Nigella Lawson was still perpetuating gender stereotypes in her book *How to Be a Domestic Goddess*. At the same time, the media have discovered the macho sex appeal of many male chefs such as Ming Tsai, Marcus Samuelsson, and Anthony Bourdain, who may well be alluring to both sexes.

Women in many cultures are still encouraged to deny their hunger and desire both for food and sex. In various cultures at different points in time, slender bodies have been idealized in an apparent attempt to restrain women's sexual desire. Historian Carol Groneman notes that in eighteenth-century France, nymphomania was thought to be caused by, among other things, eating rich food and/or too much chocolate. Paradoxically, while being told to restrain their desires, women are at the same time expected by most cultures to provide food and sexual pleasure for others. This contradiction has been blamed by some feminists for the preponderance of low sexual desire and eating disorders among women.

That women at least are judged both morally and sexually on the basis of what they eat was demonstrated in a unique experiment at Arizona State University in 1995. Subjects were asked their opinions of the morals of two fictional twenty-one-year-old women of the same height and weight, based on their diets. The first "Jennifer" ate fruit, salad, homemade whole wheat bread, chicken, and potatoes. The second favored steak, hamburgers, French fries, doughnuts, and double-fudge ice cream sundaes. The Jennifer who ate the lean, healthy diet was perceived as moral, feminine, attractive and sexually monogamous. The second was labeled immoral, inconsiderate, unconcerned, and sexually promiscuous.

Sexy Foods

Particular foods—often high in fat and sugar, like chocolate—have come to be specifically associated with sexuality. In nineteenth-century Glasgow, Scotland, when ice cream was introduced by Italian entrepreneurs, it was blamed for loosening the sexual mores of the young. The fact that this rich treat was served in a new kind of public eating establishment, a café, patronized by unchaperoned adolescents, was part of the threat. However, Francis McKee in his paper "Ice Cream and Immorality" designated the ice cream itself, with its overtones of the forbidden and of sexuality, as at the root of the fear. Other foods are considered erotic because of their physical resemblance to sexual organs. Shellfish such as mussels and clams are said to look like female genitalia. Sausages, hotdogs, and corn on the cob are often the subject of jokes based on their phallic appearance.

Rules for Sex and Food

The lure of unrestrained enjoyment of food and sexuality for their own sakes has evoked a long history of cultural tension. Societies that fail to limit the expression of these biological drives are often considered doomed. The fall of Rome is typically depicted as a consequence of excess—too much sex, food, and wine consumed at the nightly orgies of the wealthy. Few cultures tolerate such freedom of expression. Consequently, taboos, moralizing, and laws are imposed to control and "civilize" the drives. Christianity has identified gluttony and lust as two of the classic "seven deadly sins." The number-one food proscription, across cultures, is the taboo against cannibalism. The equivalent in the sexual sphere is the incest taboo. It has been noted that the first has been more successful than the second.

Urging people to strive for slimness for health and aesthetic reasons has the effect of curbing the sensual pleasure of eating. So does the frequent emphasis on the health risks of certain foods. Attitudes vary widely from one culture to another. In a study of the attitudes toward food in four cultures—Japan, Flemish Belgium, France, and the United States—Rozin found that the French had the least concern about health consequences of high-fat food and placed the greatest premium on food's ability to enhance the quality of life. The moralization of food and lack of interest in its pleasure-enhancing effects is more typical of Western cultures, specifically Great Britain and the United States. Rozin has also noted that it is ironic that in America, where food is plentiful, the major maladaptive response is overconcern about health risks, with no thought given to the benefits lost in terms of quality of life.

See also **Anorexia, Bulimia; Appetite; Gender and Food; Metaphor, Food as; Obesity; Pleasure and Food; Women and Food**.

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Linda Murray Berzok

SHEEP. If the dog is humankind's best friend, then sheep are its most ancient provider. Sheep may be the first domesticated ruminant, tamed by nomadic people in the Middle East and Asia 11,000 years ago, perhaps even before agriculture gave rise to civilization. Thousands of years before sheep appear in the writings of Abrahamic faiths, they were slaughtered for religious rituals. Neolithic farmers, who raised them for meat, herded them into Europe. Wool breeds appeared at least 8,000 years ago, in plenty of time to supply the looms of ancient Egypt and Babylon. Vikings carried sheep to Iceland. The Spanish brought them to the Americas. Today, sheep are found from the Arctic region to Australia and in the tropics from Africa to the Caribbean. Yet the world's billion sheep are a modest source of meat. Humans eat ten times as much pork as lamb and mutton. Sheep is not a forbidden food, though. It is eaten readily by Hindus, Muslims, Jews, and Christians. And thanks to its global acceptance, lamb can be a gourmand's delight. Its earthy flavors blend well with the spicy seasonings of Spanish *asadar*, Chinese red-cooked lamb, or just the smoke of an open-pit barbecue.

Origins

Sheep, the species *Ovis aries*, are descended from the mouflon, an endangered wild sheep native to Asia Minor and Cyprus. The mouflon has a reddish-brown hair coat with an undercoat that is shed seasonally. Europe also has a mouflon that prefers rocky slopes of mountains and may have escaped from flocks of primitive domesticated sheep. Wild and domestic sheep and goats belong to the subfamily Caprini, which evolved ten to twenty million years ago in the mountains of Central Asia. They are in the order of mammals Artiodactyla, which means even-toed, hoofed. That order includes ruminant livestock such as cattle. Bacteria in the rumen help these animals digest cellulose in grasses. With more than two hundred domestic breeds, sheep may have the largest number of breeds that are in active commercial production.

In the United States, most sheep are eaten as lamb, animals that are less than a year old. Worldwide, much lamb, especially "spring lamb" slaughtered at three to seven months of age, is not grain fed. (In the United States, most lamb is grain fed, which gives it a milder flavor.) Lambs sold for meat usually weigh between 70 and 100 pounds, accounting for the relatively low rate of world lamb consumption as compared with other livestock. A mature market hog, for instance, is more than twice as heavy, and pigs are much more prolific. Adult female sheep, or ewes, weigh about 150 to 200 pounds while mature males, or rams, weigh about 250 to 350 pounds. Mutton, the meat of mature sheep, is more popular in Britain and Europe than in the United States.

Methods of Consumption

In the developed world, sheep are processed and slaughtered in much the same way as cattle and hogs, in assembly-line, refrigerated packing plants. But in the tropics and deserts where they are still herded by nomadic people, they offer the advantage of being small enough to be consumed in a day, eliminating the need for refrigeration.

As with other meats, lamb's fat content varies with cooking methods and the cut of lamb chosen. Lamb loin chops, which correspond to pork loin chops and New York Strip steak in beef, are slightly leaner than either the beef or pork cuts, with 9.73 grams of fat in a 100-gram cooked serving trimmed to 1/4 inch fat and broiled, according to U.S. Department of Agriculture nutritional data. With 2 milligrams of iron, lamb has twice as much iron as pork, and nearly as much as the 2.47 milligrams in beef. Lamb is also a good source of phosphorus and zinc.

A comparison by the American Sheep Industry Association, a trade group, shows a 3-ounce portion of lean cooked lamb leg has 7 grams of fat, equal to that in beef round, less than fresh pork ham or chicken dark meat (both with 8 grams of fat), but more than the 4 grams of fat in chicken light meat.

The consumer group, the Center for Science in the Public Interest in Washington, D.C., lists lamb souvlaki at Greek restaurants as a relatively healthy food that compares favorably with other forms of red meat, at 310 calories and 11 grams of fat.

In a few less developed areas of the world, sheep are kept mainly for milk, or blood. A well-known vestige of sheep milking in the developed world is Roquefort cheese, made in France. Sheep's milk has almost twice as much fat as cow's milk (6.7 percent), but is denser in other nutrients as well, including calcium.

The main nonnutritional product of sheep is wool. Wool is one of the few fibers that will maintain body heat when wet. Wool also makes durable, fire-resistant rugs and carpets. Other widely used sheep products include skins and pelts for coats and rugs. Sheep lanolin, the purified grease that is washed from wool, is found in many cosmetics, salves, and ointments.

Nomadic Livestock with a Rich History

Archeologists have found evidence of sheep domestication from about 11,000 years ago, in northeastern Iran. Sheep bones nearly as old have been found in Palestine. A small statue of a woolly sheep from about 6,000 B.C.E. that was found in Iraq shows that the development of wool breeds is also ancient. By 6,000 years ago, Egyptians and Babylonians were weaving spun wool into fabric.

Sheep appear in early religious and mythological writing and history. In Ancient Egypt, the ram was the symbol of several gods. In Greek mythology Jason pursued the Golden Fleece. The Abraham of the Bible and Torah sacrificed a ram instead of his son. Long before agriculture gave rise to civilization, human hunting cultures seemed to have worshiped animals. The 30,000-year-old paintings of animals at the Chauvet Cave in France include the ibex, a wild relative of goats. Perhaps because sheep were domesticated early, their slaughter became ritualized in religious ceremonies.

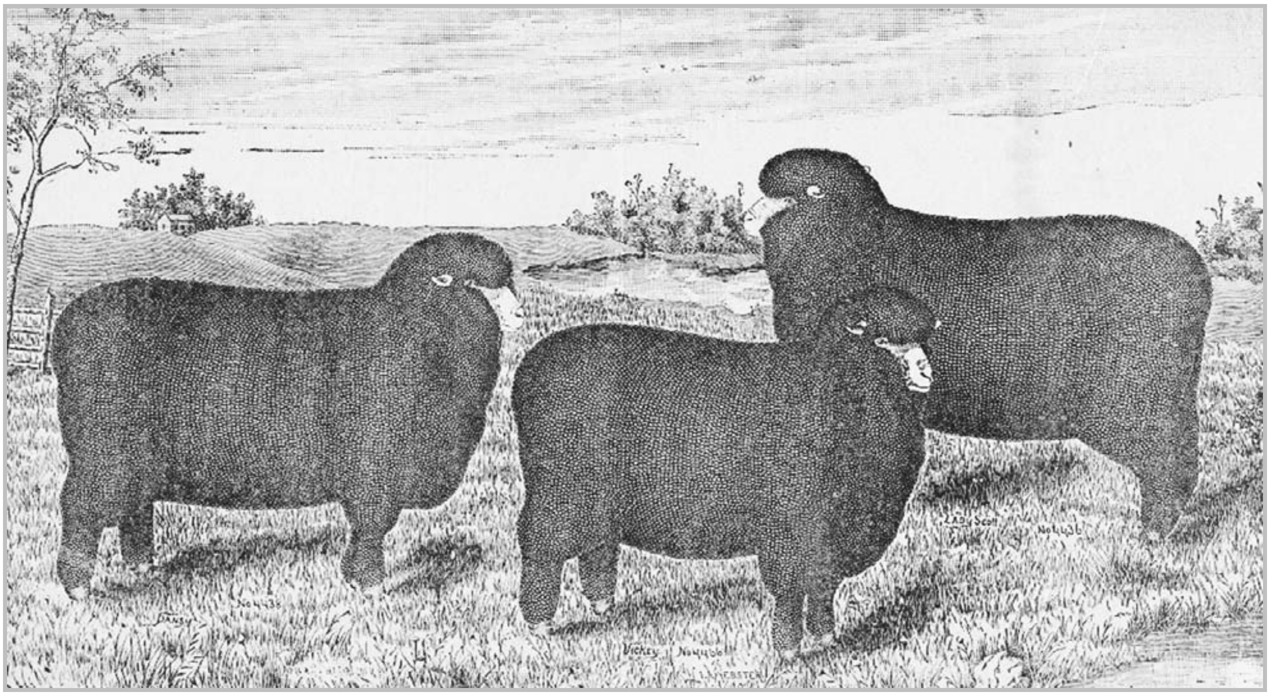
Sheep breeds have outlasted civilizations. The Merino, which has come to dominate high-quality wool production today in Australia, the world's top wool exporter, may date to the reign of the Roman Emperor Claudius in the first century C.E. Many in the sheep industry believe that the breed was developed then in what is now Spain when breeders crossed the Roman Tarentine breed with the Laodician sheep of Asia Minor. When the Romans reached Britain, other sheep breeds were already there. The Romans built Britain's first woolen mill in Winchester in about 50 C.E. In the centuries that followed the fall of the Roman Empire, both Britain and Spain dominated wool production. In Spain, selling Merino sheep without the permission of the king was a crime punishable by death.

Spanish monarchs did allow explorers to bring Merinos to the New World. The Navajo sheep in the United States and the Criollo of Latin America are their descendants. When slaves were brought to the Americas, African sheep breeds adapted to hot climates came with them. These breeds have a coat of shorter hair and do not produce wool. The West African Dwarf type of sheep gave rise to several tropical American breeds, including the Barbados Blackbelly. The Tunis breed of North Africa was two thousand years old when George Washington imported some to rebuild his own sheep flock after his presidency.

Sheep have long been herded by nomads in Central Asia. The portable dwellings, or yurts, of Mongolia are made of wool felt. In the fourth century B.C.E., the Chinese called the hinterlands of central Asia "the land of felt."

In contrast to tropical sheep, primitive sheep breeds from northern Europe have long outer wool coats of up to 15 inches in length as well as a soft inner coat. The Icelandic sheep, brought to Iceland by the Vikings in 874 C.E., are the purest breed of this type.

Modern sheep production began in the eighteenth and nineteenth centuries with two important developments. One is that the Spanish monopoly ended when Napoléon invaded Spain, making Merino sheep widely accessible. The other was the development of meatier breeds of wooled sheep in Britain in the eighteenth century by Robert Bakewell, an English agriculturalist who revolutionized the breeding of sheep and cattle through selection and inbreeding. At a time when wool prices were depressed, Bakewell began to select Leicester sheep that were heavier and stockier. This helped feed Britain's Industrial Revolution. Sheep were not herded long distances in Britain as they were in Spain, so the British Isles developed many more local breeds. Other breeders followed Bakewell's example of choosing breeds that have a dual purpose. In the United States, dual purpose and wooled breeds that excel in meat production are preferred in the eastern half of the country. The finer wool breeds are preferred for the western range because they are easier to herd.



Pansy, Vicky, and Lady Scott, prize black-top Spanish merino ewes bred in 1887. From the *National Stockman and Farmer* (February 7, 1889). Roughwood Collection.

Though adaptable and hardy, sheep are more difficult to raise in the humid tropics. They are scarce in Southeast Asia and the islands of the South Pacific and even northern tropical Australia.

Effects of Domestication

Domestication has changed sheep so much that they are almost helpless in the wild, according to animal scientists M. E. Ensminger and R. O. Parker, who in *Sheep and Goat Science* note that "domesticated sheep of all breeds are universally timid and defenseless and the least intelligent and least teachable of all the domestic four-footed animal. . . . Unlike other farm animals, they are unable to return to a wild life" (p. 4).

The Merino are among the most easily herded sheep. For centuries in Spain they were driven to northern pastures in the spring and back south in the fall. This resulted in selection for ease of herding. More primitive breeds remain more independent. Sheep farmers in Iceland often lose a few of their Icelandic sheep when driving them from summer mountain pastures to lowlands. One unusual type of sheep in Hawaii, the Feral Hawaiian, mostly of Merino stock, has confounded the experts by actually going wild. It was introduced in 1791 when Captain George Vancouver visited the islands.

Trends in Sheep Production

Britain and Spain once dominated sheep production and trade. In the early twenty-first century, dominance has shifted to former British colonies of the Southern Hemisphere. Australia ranks first in wool exports. Second-ranked New Zealand is a big exporter of carpet wool, mainly from its Romney breed, a native of English lowlands. Both nations are also top exporters of lamb. At the end of the twentieth century, Australia had 115.8 million head of sheep, slightly behind the world's largest flock, 131 million head in China (where they are mainly for domestic use). New Zealand was third with 45 million sheep, followed by South Africa and Turkey. China is a leading importer of wool for its mills.

By contrast, the United States produced only about 7 million sheep and lambs in 2001, a sharp decline from the beginning of the twentieth century, when the United States had nearly ten times as many sheep—61 million head. U.S. wool production has fallen from 260 million pounds to 49 million in a century.

American agricultural practices and the rise of industrial fibers—plastic—contributed to this decline. The industry survived in Great Britain, partly due to European Union subsidies. In the United States, government subsidies rewarded eastern U.S. crop farmers who grew corn and soybeans instead of those raising small marginal flocks. Corn and soybeans then flowed to large, mechanized complexes for hog and poultry, which convert grain to protein faster than can sheep. In the western range land, the federal government dropped wool subsidies in 1996 only to reinstate them in 2002 in an attempt to help a struggling industry. Only about 1 percent of the meat

The French prepare a number of dishes using parts of sheep not commonly eaten in the United States. This salad of lamb brains was prepared at the Restaurant Guy Savoy in Paris. © Owen Franken/CORBIS.

consumed by Americans was lamb. By 2000 per capita lamb consumption in the United States was less than 1 pound per year, compared to an estimated 221 pounds per year of all red meats and poultry. Growing popularity of ethnic foods, along with immigration from Mediterranean nations that relish lamb, ensured a remaining niche market for this meat. But outside of large cities, many consumers had to hunt in grocery store meat cases for a package or two of lamb chops or perhaps a single leg of lamb.

Reasons for the decline in U.S. sheep production seem to be both economic and cultural. Competition from plastic fibers, including polyester fleece, which has some of the desirable properties of wool, has hurt demand for a key product from sheep. A booming economy in the late twentieth century contributed to the already tough task of finding workers willing to take on the solitary task of herding sheep on the western range.

American taste for lamb may have been hurt by bad experiences of American servicemen and women during World War II, who sometimes ate old mutton from Australia and New Zealand and mistook it for lamb. But the main factor is undoubtedly economic. With a small market for U.S. wool, and therefore lamb, the meat has become an exotic, more expensive specialty food. A similar decline has taken place in Canada.

North America has also faced stiff competition from New Zealand and from the Australians, who rival the Spaniards as finicky producers of fine wool, developing several strains of Merino breeds best adapted to their climate. Both Australia and New Zealand offer longer grazing seasons than the northern United States and Canada, giving those nations another advantage. New Zealand farmers can graze their sheep from eight to twelve months of the year and are world leaders in developing microchip-controlled electric fences to allow the most efficient use of pastures. A flock is moved into a small paddock where the sheep graze all of the available forage before moving into another small field. New Zealanders can raise twenty-five sheep on a hectare of land (2.47 acres) with this method.

Unlike American and European farmers, Australia's and New Zealand's sheep producers receive no large government subsidies, which keeps their farm economies lean, preventing artificial inflation of land prices that boost costs. As the twenty-first century began, both nations had an exporting advantage of lower-valued currencies compared to the American dollar.

Even so, the returns in 2002 on sheep production in Australia lagged behind those enjoyed by U.S. grain farmers, and in New Zealand, where there are a dozen sheep for every person, the sheep population has declined from a peak of 70.3 million in 1982 to about 45 million, "due to declining profits compared to other types of farming," explains a wool products website, Sheep World.

The biggest challenge to sheep may still be plastic. Australian researchers are looking for new ways to turn wool into a fabric without weaving—a response to a 10 percent annual growth in "nonwovens," synthetic fabrics used in car seats, home draperies, and disposable wipes. Ironically, felt, the original nonwoven material, was made from sheep's fleece before spinning and weaving were invented. If the wool industry can compete successfully with the plastics industry, the availability of lamb as a food might increase.

A Case for Saving Sheep

From a gastronomic perspective alone, it would be a shame if sheep became extinct. Chefs Bruce Aidells and Denis Kelly argue in *The Complete Meat Cookbook* that lamb's flavor "makes this animal a favorite in cuisines all over the world. . . . No meat marries better with the pungent flavors of garlic, mustard, rosemary, thyme, oregano, savory and fennel, to name just a few" (p. 427). Among the world's most notable lamb dishes are Moroccan lemon *tagine*; kabobs (called souvlaki in Greece; *sis kebabi* in Turkey); and baked leg of lamb *asadar* from Spain (in Spain a whole lamb is roasted in a wood-fired brick oven).

Do-it-yourself gourmands should be aware of pitfalls. To avoid lamb's hard fat, which some people find disagreeable when it becomes cold, trim as much fat as is possible from lamb before cooking and be sure to keep lamb dishes hot at the table.

Other practical reasons for saving sheep include environmental ones. Although sheep were associated with some of the first human environmental degradation—soil erosion associated with overgrazing—properly managed, sheep can improve grasslands and range land. They will eat weedy plants that cattle ignore, including sagebrush, leafy spurge, and tansy ragwort. Some ranchers and wheat farmers consider them more effective at controlling plant pests than herbicides.

One serious problem that could instantly make sheep an unwanted food source is bovine spongiform encephalopathy, or BSE. Sheep may have been the indirect source of this dreaded affliction, known as mad cow disease. The incurable disease literally turns a cow's brain spongy, causing a progressive dementia that kills the animal. In Britain, rendered sheep, goat, and cattle not fit for human use were added to cattle feed to boost the protein content. Some scientists believe that a related disease in sheep, scrapie, somehow crossed the "species barrier" when the rendered sheep were fed to cattle in the 1980s. Scrapie, a rare but very old disease of sheep, has never been known to infect humans, but BSE apparently has killed Britons who ate infected beef. This family of diseases, which also includes chronic wasting disease in deer and elk, is poorly understood. The infectious agent is a prion, a type of protein that has no genetic material, like a virus or bacteria. Prions are extremely resistant to heat and antiseptics and can survive in soil for years. Yet certain types of sheep seem to have a greater genetic disposition to scrapie than others.

European and British health officials are concerned that sheep in that part of the world may also have been infected with BSE, rather than normal scrapie. If so, it would have the potential to make European lamb unsafe to eat. Even though scrapie itself is not deadly to humans, the possible confusion of BSE in sheep with scrapie has led the United States to start a scrapie eradication program in domestic sheep. New Zealand and Australia are believed to be free of the scrapie as well as BSE.

Finally, the loss of sheep and lambs to competition from plastic fabrics and more industrialized meats would be a blow to the collective memory of human history and tradition. The Bible has more references to lambs and sheep than to any other animal. The blood of the lamb protected Jews during the first Passover. Muslims break the month-long fast of Ramadan with a meal of lamb and rice. And to Christians, the lamb is the symbol of Christ sacrificed on the cross.

As a result of the efforts of rare breed preservationists, hobbyists, and home wool spinners, it is unlikely that sheep will ever become completely extinct, even if their long-term commercial success faces challenges.

See also **Australia and New Zealand**; **Christianity**; **Dairy Products**; **Food Safety**; **Greece and Crete**; **Herding**; **Islam**; **Judaism**; **Lamb Stew**; **Livestock Production**; **Mammals**; **Meat**; **Religion and Food**.

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Dan Looker

SHELLFISH. *See* **Crustaceans and Shellfish.**

SHERBET AND SORBET. Sherbet and sorbet are both frozen desserts. Sorbet is flavored syrup with a slushy texture; it is sometimes called a water ice, and contains no dairy ingredients. Sherbet describes a similar product, but contains milk. One definition, by the International Dairy Foods Association, states that sherbet should contain 1–2 percent of milk fat in the final product. Despite this, the word sherbet is sometimes colloquially applied to sorbets. Related recipes, such as ice milk, frappés, and granita (a grainy water ice of Italian origin) lead to further confusion.

In other countries, the definition of sorbet remains consistent, but that of sherbet varies considerably. In British English it means a class of children's candies, powders which give a fizzy sensation on the tongue, sweetened and flavored with lemon or other fruit. In the Middle East, sherbet is a chilled soft drink. The constants in these different foods are sugar, a sweet-sour flavor combination, and the idea (if not the actuality) of cool refreshment.

A complicated history of linguistic and culinary borrowing lies behind these definitions. Modern writers have despaired of untangling the subject. Liddel and Weir comment that it is almost impossible to define the word sherbet, because of a shifting background of common usage, local customs, and legislation.

Sorbets and sherbets in North America both start with sugar syrup. This may be specially made, but sugar and water are also naturally present in ingredients such as fruit juice, wine or milk and individual recipes allow for this. Flavors other than fruit are provided by infusing flowers, herbs, or spices in the base syrup. If too much sugar is present, the sorbet will not freeze properly. Large-scale producers, and those seriously interested in making sorbets by craft methods, measure the syrup concentration. The optimum is between 17–20° on the Baumé scale. Sorbets containing alcohol use a lower density of 14–17° Baumé. Although excellent sorbets are made using only sugar, water, and flavoring, some recipes require egg whites or gelatin. These act as stabilizers, especially in sorbets which melt quickly, or when fruits with a high pectin content (which affects texture) are used. Occasionally, egg whites are added as meringue, for instance in champagne sorbets.

Freezing by churning produces the smoothest texture, although at home a still-freezing method can be used. As the temperature gets lower, ice crystals begin to form, kept small and evenly distributed by churning or periodic beating. The ice consists of pure water, so in the liquid fraction of the sorbet, the sugar content becomes increasingly concentrated. Sugar lowers the freezing point of water, and prevents the mixture becoming completely solid. Alcohol also freezes at a lower temperature than water, which is why sorbets containing wine need a less dense syrup to achieve the same slushy texture.

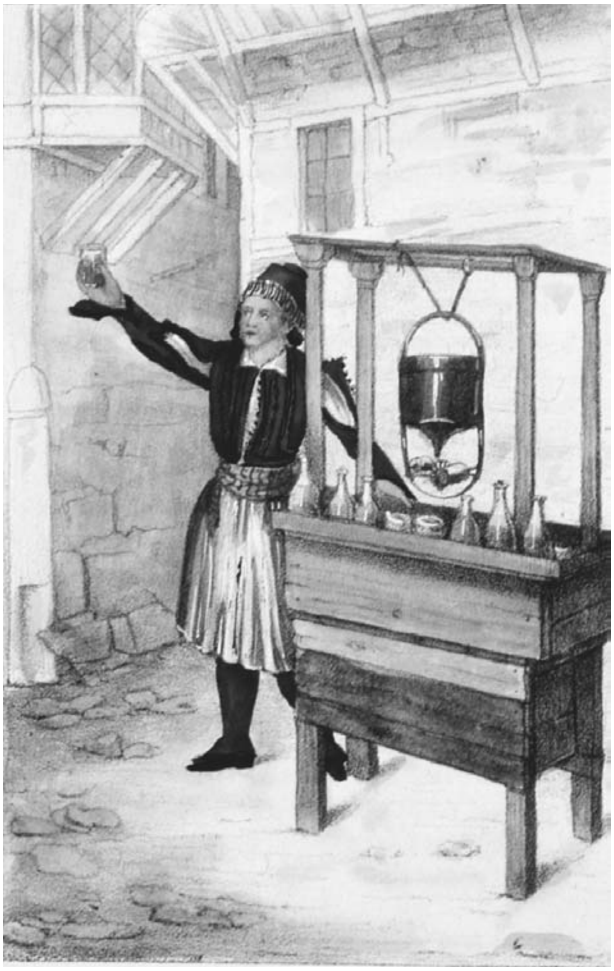
In sherbet recipes, milk provides some water for the basic mixture. It also adds small amounts of lactose, protein, and fat, giving a slightly different texture and a creamier flavor. However, sherbet is usually a very low-fat product. Sherbets and sorbets feel colder in the mouth than ordinary ice cream. This is partly because of the lack of fat (which helps to make ordinary ice creams smoother on the tongue), and partly because of their high sugar content, which makes the mixture both freeze and melt at lower temperatures.

A granita has an even lower syrup density (9–10° Baumé), and is always still-frozen, allowing relatively large ice crystals to form in the mixture. Minimal stirring keeps these evenly distributed and of a regular size, giving a characteristic grainy texture.

How do the iced desserts of North America relate to the sherbet candies and drinks to the east of the Atlantic? A clue lies in the derivation of the words sherbet and sorbet. Ultimately they can be traced back to a medieval Arabic root *sharâb*. This originally meant a sweetened drink (the word syrup shares a similar derivation), but was later applied to beverages containing alcohol. It gave eighteenth-century English the term *shrub* for an alcoholic punch. A slightly altered Arabic form, *shabât*, emerged to denote sweetened, nonalcoholic drinks. This passed into Turkish as *sherbet*, a word which diffused into European languages. However, the Turkish pronunciation only seems to have survived in English. Southern European languages dropped the *h*, following the Italian form which emerged as *sorbetto* (Spanish, *sorbete*; French, *sorbet*).

The sherbet mixtures of Arabia, Turkey, and Persia have always been flavored syrups that are diluted with water and served chilled, a welcome refreshment in hot weather. In the past, ice or snow was stored in winter for summer use with these drinks. Sometimes the syrup was boiled to the point at which it formed a solid candy. A version of this is still to be found in Turkey under the name *gul sekeri* (literally "rose sugar," although it is actually flavored with cinnamon). Popular flavors include lemon, pomegranate, flowers such as rose or violet, and herbs such as liquorice or mint. The importance of sherbet in the Middle East is apparent from evocative descriptions given by Roden (1970) and Shaida (1992).

In seventeenth-century Italy, *sorbetto* came to mean a flavored syrup frozen to a point at which the texture was obviously iced but not hard. In the past, these cooling ices were considered medicinal. In Italy, *sorbetti* were given to people suffering from fevers and malaria, a custom also recorded in Persia. It was the iced aspect of these drinks that became important for sorbets. Although they seem to have remained liquid throughout the eighteenth century, in nineteenth-century in France, sorbets became chilled confections with a texture somewhere between a drink and a modern water ice, sometimes with added alcohol. As the century progressed, sorbets were served colder and colder, and at some point they became solid enough to be eaten with a spoon. The culinary ascendancy of the French during the nineteenth century must have led to the adoption of sorbet as a standard term in restaurant cookery, giving it a relatively fixed definition.



Turkish sorbet vendor as depicted in Friedrich Unger's *Conditorei des Orients* (Confectionery of the Orient), published in 1838. Unger was royal confectioner to King Otto of Greece. COURTESY OF THE BAYERISCHE STAATSBIBLIOTHEK, MUNICH.

In English, the word "sherbet" retained the sense of a sweet drink throughout the centuries. It was made from fresh lemons, or perhaps mixed from chunks of flavored sugar candy which were already being imported in the seventeenth century. The drink aspect continued to be important throughout the eighteenth century. In London in the 1820s, a street seller of sherbet and soft drinks devised a powder of sugar, bicarbonate of soda, tartaric acid, and lemon flavoring. When mixed with water, this made a sweetened lemon flavored "sherbet" which effervesced as the soda and acid reacted to give off bubbles of carbon dioxide. By the early twentieth century, sherbet and lemonade powder had become synonymous, and candy manufacturers began to incorporate it into their products. Sherbet in Britain is now seen purely as this particular type of candy—cheap, usually lemon flavored, and always effervescent. Sorbet has retained the sense of a water ice.

In North America, sherbet developed down the iced dessert route. The sultry summer climate of the eastern United States, together with the commercial exploitation of lake ice stored for summer use, must have stimulated demand for such refreshments. During the mid-nineteenth century, sherbet and sorbet seem to have been synonymous, both words indicating frozen syrup, often served with wine or another alcoholic drink poured over. The habit for serving them between courses at dinner is also recorded. How sherbet came to acquire the meaning of an iced dessert which included milk is obscure. Recipes past and present do not make matters any clearer. Household recipes from the early twentieth century use the word to describe anything from a coarse crystal water ice (similar to a granita) through a standard sorbet, to mixtures containing milk. Later sherbet recipes sometimes contain buttermilk or milk and cream.

By the mid-twentieth century, ice-cream companies were producing sherbets flavored with lemon, lime, orange, or raspberry. Orange sherbet seems to be the one which stands out in childhood memories. In the 1980s and 1990s, there was a renewed interest in sorbets. The idea of serving them between courses in restaurants enjoyed a revival, but most compelling was the fact that they offer a dessert with no fat or dairy produce involved. Flavors have gone beyond the traditional lemon, lime or champagne into vanilla or chocolate, perhaps so that the products compete more overtly with conventional ice-creams. Sherbet, on the other hand, seems to have slipped into a slightly old-fashioned, declassé niche. Neither product offers a serious challenge to premium quality ice creams in the affections of the American public.

Nutritionally, sherbets and sorbets do offer low-fat alternatives to ice creams. Their principal contribution to the diet is energy, and their syrup bases give them a relatively high sugar content and higher calorie count than dieters might suspect. The milk in sherbet makes a small, but not a significant contribution of protein, fat, vitamins, and minerals. Fruit-based sorbets and sherbets, provided the fruit has not been heated or processed for a long time, contain a little ascorbic acid (vitamin C), but large quantities would have to be consumed to make them a significant source. The role of these items in the diet is principally one of a pleasant refreshment and light dessert.

See also **Candy and Confections**; **Dairy Products**; **Ice Cream**; **Syrups.**

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Laura Mason

SHROVE TUESDAY. The day immediately preceding Ash Wednesday, the beginning of Lent in the Christian churches of the West, is known in English as Shrove Tuesday. It occurs between 2 February and 9 March, depending on the date of Easter. The day takes its name from "shriving"—the pre-Lenten confession and absolution of the faithful as a preparation for Lent that was common in the European Middle Ages. Feasting on foods initially prohibited during Lent, such as meat, eggs, and milk products, was integral to Shrove Tuesday observance. The German term *Fastnacht* and the Dutch *Vastenavond* (eve of the fast) refer to the Lenten fast about to begin, while the French *mardi gras*, the Italian *martedì grasso*, and the Portuguese *terça-feira gorda*, all meaning "Fat Tuesday," refer to the feasting on foods rich in fat prior to the austerity of Lent. The Spanish term *martes de carnaval* (Carnival Tuesday) possibly reflects the formerly rigorous Lenten abstinence from meat commencing on Ash Wednesday and lasting through the forty days of Lent. The word "carnival" is thought to derive from Medieval Latin *carnem levare*, which means 'to take away or remove meat'.

The historical origin of carnival celebrations is obscure. The word "Lent" derived from Anglo-Saxon *lencten*, denoting the spring season. It may be, therefore, that carnival had its roots in an ancient spring festival or pagan agricultural rite marking the transition between winter and summer. Aspects of such ancient festivals are thought to be reflected in modern carnival celebrations connecting the change in nature with social and biological renewal. Thus, temporary social transformation, masking, processions, erotic dances, eating, and drinking still characterize carnival celebrations in much of Europe. The ludic element—the public, communal revelry—remains in the fore in carnival celebrations in the United States, especially in the New Orleans Mardi Gras, and in Brazil in the famous Rio de Janeiro Carnival.

In Britain this three-day period of ludic license was called Shrovetide. Various sports were common, especially games of football. One form of cruel sport prevalent at Shrovetide was pelting cocks and wagering, and this was still practiced in areas of English settlement in Ireland in the late eighteenth and early nineteenth centuries.

Carnival

As a point of closure for Christmas and Twelfth Night abundance, and a ritual sending off of the old year, Carnival evolved into a late-winter feast day of special importance to the Roman Catholic world.

The underlying theme to Mardi Gras or Carnival is that the days immediately preceding Lent were traditionally set aside for conspicuous feasting. In a medieval context, conspicuous consumption was a show of wealth, since it signaled that the lean days of winter to come were not an inconvenience imposed by financial or by religious considerations.

Since animal flesh was forbidden during the strict fast days of Lent, Shrovetide also became a period when weddings were once popular. This interesting fact is substantiated by medieval wedding records and makes economic sense, if we consider that June (a popular wedding month today) fell in the middle of harvest or planting according to the old calendar. This calendrical sensitivity placed the birth of the child in November, when there was nothing left to do in the fields. Thus Carnival also had an important influence on very basic human lifecycles far and beyond the actual month of celebration. It was also a time of general revelry in village and city alike, with processions of elaborately costumed and masked figures, dancers, and noise makers. It was in essence, a "feast of fools," a time when the usual rules of everyday behavior could be relaxed, even to the extent that such tabooed behavior as cross-dressing could make its appearance in parades with general approval.

European scholarship has meticulously analyzed the masking and de-masking of participants in the traditional Mardi Gras Carnival. On the one side there is a definite affinity to masks representing demons and animals, totemism disguising the living from the spirits of the dead, who were thought to be abroad on this eve of Lenten austerities. On the other hand, the serving of nourishing, satisfying fat foods at Shrovetide expresses the basic idea in European folk culture that one should, in Harvey Cox's words in *The Feast of Fools,* indulge in conscious excess. In some European regions it was customary to eat seven or even nine different kinds of food on Shrove Tuesday. These included butter and milk, roast pork, fish, peas, and millet. Feasting was sometimes interrupted by "wise" individuals, as evidence of aiding fertility. Fish were folkloric prognosticators of wealth to come—so many scales or eggs, so much the profit. The same benefit was claimed for millet—the more tiny millet grains eaten on Shrove Tuesday, the more coins one could hope for in the future.

The pre-Lenten feasting was thought to betoken an abundant harvest in the coming summer. Because Shrovetide cakes were products of a church festival, they acquired virtues beyond the nutritional. Crumbs were fed to the chicken on Shrove Tuesday so that they would produce more eggs and be protected from predators. Leftovers were also scattered for the angels, foxes, hawks, and martens, undoubtedly with mixed messages to the recipients to ward off danger. Even the Shrovetide lard was used in folk medicine as a wound salve, and ploughshares and wagons were symbolically greased with it before they were first used in the spring farm work.

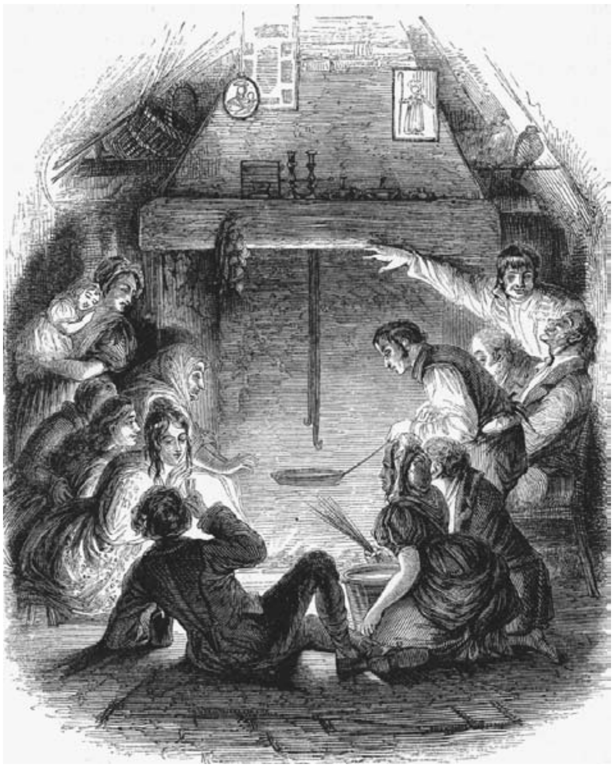
However, one of the greatest legacies of Shrove Tuesday is the urban carnival which took place in large cities like Rome, Paris, Cologne, Munich, and Basel. They assumed the form of huge processions, with rites of crowning a prince and princess (or king and queen). Similar feast day parades are found throughout the Americas, but especially in Mexico and South America. The most famous of these is the great Carnival parade in Rio de Janeiro, Brazil, an event for which the city prepares throughout the entire year. Much older Carnival traditions can be found in the mountain villages of the Black Forest and in the Austrian Tyrol, where carvers of wooden masks are still working a traditional art form that predates Christianity.

At the time of the Reformation, Protestant countries for the most part gave up traditional Carnival rites connected with the official ecclesiastical celebration. Mumming and masking were in particular dropped, or shifted to Christmas, New Year's Day, and Twelfth Night (Epiphany). This residual mumming was once popular in colonial North America, and survives today as the New Year's Day Mummers Parade in Philadelphia.

Don Yoder

Shrovetide was also a period of dietary license, and foods forbidden in Lent were consumed in abundance. Eggs and milk were at one time forbidden in Lent and therefore any supplies had to be used up before Ash Wednesday. On Shrove Monday, in parts of England, meat and eggs were eaten, or gifts of pancakes, flour, eggs, or money to provide Shrove Tuesday fare were collected by children or adults, who often recited a "shroving" verse. Refusal to contribute could result in shard- or stone-throwing, or loud knocking with clubs on doors.

Shrove Tuesday was also known as "Pancake Day" in England. After the Reformation, the Shriving Bell, which had hitherto called parishioners to be shriven, signaled the



Tossing the pancake. An engraving from Mr. and Mrs. Samuel Carter Hall's *Ireland: Its Scenery, Character &c.* (London, 1841). PUBLISHED WITH PERMISSION OF THE FOLKLORE SOCIETY, LONDON.

commencement of revelry and pancake-making. In parts of Wales children formerly collected pancake ingredients, while in the Isle of Man, pancake-making has apparently replaced the older custom of serving oatmeal and gravy for midday dinner and meat and pancakes in the evening.

In Scotland, beef was eaten on Shrove Tuesday (also called "Fastern's E'en") to ensure household prosperity. Oatmeal bannocks enriched with eggs and milk were baked, and, together with the beef broth, were used in marriage divination by the inclusion of a ring to betoken marriage, or other items to indicate the rank or occupation of the future marriage partner. The identity of the beloved might be revealed in dreams induced by placing a bannock under the pillow.

In Ireland, Shrove Tuesday (i.e., pre-Lenten) weddings were formerly popular, a custom seemingly connected to the canonical prohibition on the solemn celebration of the sacrament of matrimony during Lent, and pranks might be played on those still unwed at that time. Shrove Tuesday was especially a household festival, when "nobody should be without meat" (Danaher, p. 42). Pancakes—often including a ring to signify early marriage—were eaten, and pancake-tossing as a form of marriage divination was still practiced in the nineteenth century in areas of strong English settlement in Ireland from late medieval times.

Relaxation of the austere Lenten regulations meant that it was unnecessary to use up supplies of milk, eggs, and butter on the eve of Lent. Yet pancakes retain their festive connection to Shrove Tuesday. Homemade or commercially produced pancakes remain popular on Shrove or "Pancake" Tuesday in Great Britain. The traditional pancake greaze at Westminster School in London still takes place on Shrove Tuesday: the cook tries to toss a pancake over the pancake bar, and the boy who succeeds in getting the most cake in the ensuing "greaze" or scrimmage is declared the winner.

In Ireland also, pancakes sprinkled with castor sugar and served with a slice of lemon are much enjoyed as a Shrove Tuesday treat and are also a treat, though increasingly with multicultural dimensions, in British and Irish communities in North America, Australia, and New Zealand.

In many parts of Europe, a variety of pastries rich in milk, butter, and eggs and cooked in hot fat are eaten during carnival celebrations. In Slovenian and Croatian Istria, for example, they are termed *fritoli* and *kroötule*, while in Sardinia, these doughnut-like pastries are called *zeppole*. They are similar in texture to the small rectangular pastry called *Funkenküchle*, popular during carnival festivities in western Austria, parts of South Tyrol, several areas in Switzerland, and certain regions of southern and western Germany. This latter pastry is made of flour, salt, sugar, and cream, cooked in hot fat, and sprinkled with cinnamon and sugar. It is eaten around a large fire lit on the first Sunday of Lent (*alte Fastnacht*, old eve of fast) since the introduction of the Gregorian calendar in 1582. *Fastnachtkuchen* are still popular among the Pennsylvania Dutch. These were originally rectangular or diamond-shaped, but today many are made round like doughnuts.

See also **Fasting and Abstinence: Christianity; Feasts, Festivals, and Fasts; Holidays; Religion and Food.**

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Patricia Lysaght

SIBERIA. Siberia occupies a huge territory with a wide variety of climatic conditions and geographic landscapes. Apart from the Russian-speaking Siberians, about one-twentieth of the population consists of aboriginal groups. To better understand the food and meal traditions of the Siberian people, it is necessary to review the geography, climate, and the history of this region.

Geography and Climate

Siberia occupies about 5.2 million square miles, which roughly corresponds to about 9 percent of Earth's dry land mass. It is bounded by the Ural Mountains in the west and by the Pacific Ocean in the east. To the south lies central Asia, Mongolia, and China, and to the north the Arctic Ocean. For many people Siberia is synonymous with an intensely cold climate, but this image is only partially correct. The climate of most of Siberia is continental, which means there are large temperature differences between summer and winter. The Siberian winter is indeed long and cold, yet summers are fairly warm—warm enough to allow for the cultivation of watermelons in western and southern Siberia. Although there is relatively little precipitation in eastern Siberia, and the winter frost penetrates quite deep, the climate becomes milder and warmer towards the west and south. Due to heavy rainfall, the region is drained by numerous rivers and dotted with lakes filled with a variety of fish.

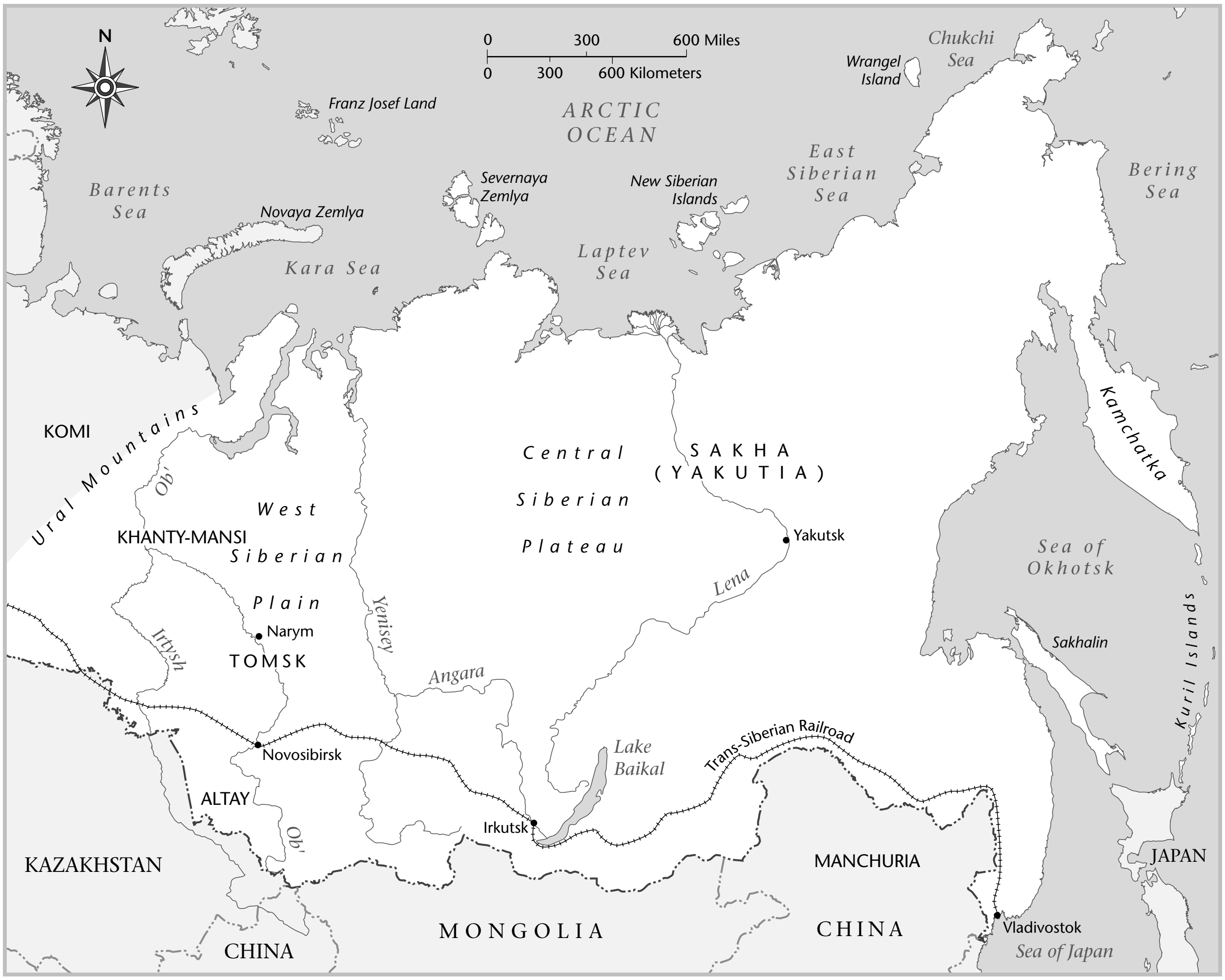
Detail of *pel'meni* showing the dumplings and various spices added to the broth in which they are boiled. On the right, *smetana* (sour cream), traditionally served with Siberian *pel'meni.* PHOTO BY ILYA VIKTOROVICH LOYSHA COURTESY OF STOLICHNAYA RUSSIAN VODKA.

The Siberian northern coastal region along the Arctic Ocean is occupied by a wide strip of arctic tundra, which is inhabited by an enormous population of reindeer. South of this is a vast area of evergreen pine forest, which gradually changes to fertile *chernozem* (black earth) steppes. The far southeastern part of Siberia, near Manchuria and the Pacific Ocean, consists of subtropical forests.

Siberian People and History

Much of Siberia (excluding the far north) was united for the first time under the rule of the Mongolian leader Genghis Khan in the beginning of the thirteenth century. Since the Mongolian Empire included China, Persia, and central Asia and stretched as far as Europe, many new culinary ideas from far-off places were introduced. *Pelmeni* and *chaj* (tea) are perhaps the most long-lasting remnants of that period.

Siberian history of the past four centuries has many parallels with the colonization of the Americas. Colonization of Siberia by tsarist Russia began in the 1580s and ended in 1860 with the founding of Vladivostok on the coast of the Sea of Japan. Most of the population of present-day Siberia consists of a mixture of different immigrant ethnicities and people of various aboriginal backgrounds. Siberians of mixed race and ethnic background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Chukchi Sea
Wrangel Island
Franz Josef Land
ARCTIC OCEAN
East Siberian Sea
Bering Sea
Barents Sea
Novaya Zemlya
Severnaya Zemlya
New Siberian Islands
Laptev Sea
Kara Sea
Kamchatka
KOMI
Ural Mountains
Ob'
Central Siberian Plateau
SAKHA (YAKUTIA)
West Siberian Plain
KHANTY-MANSI
Yakutsk
Sea of Okhotsk
Lena
Kuril Islands
Sakhalin
Narym
Yenisey
Irtysh
TOMSK
Angara
Trans-Siberian Railroad
Lake Baikal
Novosibirsk
ALTAY
Ob'
Irkutsk
KAZAKHSTAN
MANCHURIA
JAPAN
MONGOLIA
CHINA
CHINA
Vladivostok
Sea of Japan

refer to themselves as Chaldons and view themselves as an ethnic identity separate from Russian.

Siberia was colonized and settled by a variety of European ethnic groups rather than just by the Russians. During the seventeenth century, settlers included Russians, Komi peoples, Lithuanians, Ukrainians, and Byelorussians, and small numbers of Germans, Greeks, and even a few baptized Tartars and Turks. Later on, there were waves of other immigrants, some of whom were exiled forcibly. These included Swedish prisoners of war, German and other European technical specialists, Polish, Lithuanian, Byelorussian, Ukrainian, and Jewish exiles from rebellious Polish territories, as well as settlers who came from the central regions of Russia, Ukraine, and Byelorussia after the abolishment of serfdom in 1861. Colonization was especially intensive during the construction of the Trans-Siberian railway (1891–1905). The population of Siberia reached almost ten million people by 1914.

Since the political exiles who came to Siberia in the nineteenth century were generally well educated, many of them became involved in the improvement of truck farming, grain growing, the cultivation of oil-yielding crops (such as hemp), and the introduction of new vegetables and modern methods of cultivation. Each of the immigrant groups brought something of their own cookery to the big Siberian stewpot, thus enriching what is now called Siberian cuisine. For example, Korean spicy carrot salads, stuffed fish baked in the oven, and stewed sour cabbage and pork became Siberian national dishes.

Prior to Russian colonization of Siberia, local ethnic groups of various origins populated the region, including Turkic, Finnic, Mongolic, and other tribes. Some of these peoples intermarried with Europeans and some ethnic groups remained discrete, but in any case, colonists adopted many local food traditions through mixed marriages or through daily contact.

Cookery of the Chaldony

Due to the huge size of the country, almost limitless natural resources, a surplus of free land, and the absence of serfdom, life in the wilderness of Siberia was always more free, happier, and more prosperous than life in European Russia. It was easy to protect one's freedom in Siberia—

when faced with bureaucratic oppression, one could simply leave and settle in remote places or deeper forests. Because of this freedom and abundant local and foreign food products, Chaldon cuisine originated as a rich mixture of European and aboriginal traditions.

Before the Bolshevik Revolution, the Chaldon people produced basic food products on their own farms. These foods included dairy products, meat, vegetables, eggs, breads and other cereal products, vegetable oils, as well as mushrooms, wild berries, pine nuts, fish, and game. Although every family possessed hunting guns and traps, game was not central to the Siberian diet. Food was stewed, boiled, or baked in a Russian oven or fried in oil or drawn butter.

Breads and other cereal and legume products. Chaldon farmers grew rye, barley, oats, buckwheat, millet, peas, and beans. Wheat was raised in the southern regions, such as Altay. Wheat flour of very high quality, which was used for cookies and cakes, was usually bought at market fairs in large cities.

Every village family and many city households made their own rye, barley, and wheat breads in a round or *kalatch* (padlock-shaped) form; some families had wooden bread molds. Bread flour was mixed with milk and homemade hop yeast and was left standing over night. In the morning, when the bread dough was finished, eggs, *postnoya maslo* (Lenten oil), and milk were often added to the bread. Wealthy families might have used pine-nut oil instead—such bread had a unique flavor and could be kept longer than usual. During times of food shortages, some people baked a green emergency bread made from flour and a large proportion of ground dried nettle leaves.

Kasha. Kasha is the Russian word for gruel or porridge. It is used to describe any kind of boiled cereals, peas, beans, other seeds, or even potatoes and vegetables. Kasha can be made sweet or salty, and it can contain almost any kind of additions, like meat, milk, nuts, fresh or dry fruits, and even pumpkin. Kasha can be made from a mixture of different seeds and/or other components that are boiled or baked in an oven. It is eaten hot or cold, as a main dish or as a garnish, plain or with the addition of fruit jams, or diluted with fresh milk if buckwheat is used.

During the first part of the twentieth century, Siberians made many different kashas from barley, millet, or oats. Peas, string beans, and fava beans were also used. Rice was uncommon and used only on special occasions—unlike all other Orthodox Christians who use wheat for *kut'ya* (a funeral dish), the Chaldons make *kut'ya* from rice and raisins.

Pirogi, pirozhki, and bliny. Leavened dough was widely used for *pirogi* (large pies) and *pirozhki* (small pies). Pirozhki could be fried or baked and stuffed with potatoes, carrots, green onion and eggs, liver, minced meat, fish, or fresh or dried berries (black currant, raspberry, bird cherry, haws) mixed with malt. The Siberian analogue of pizza was a round, flat pie called *shangi*, which was topped with cottage cheese and sour cream and then baked. Another round pie, called *beliash*, was stuffed with meat, closed up, and fried. *Beliash* can be traced to a Tartar heritage, since in Kazan tartar cookery there was a meat pie called *belish*. The traditional large holiday pie of Chaldons, often called *kurnik*, was made with fish or chicken.

There are also sweet holiday open-faced berry-pies (usually made with black currant).

Many different recipes exist for *bliny* (large thin pancakes) and *oladyi* (smaller pancakes of thicker dough usually oval in shape). These could be made of wheat or rye, leaven or unleavened, and some buckwheat flour, milk, and eggs. Oil and honey could also be added. Once they were made, *bliny* could be stuffed with caviar and eaten cold, or filled with cottage cheese or meat and then baked in the oven or fried. Usually people had a separate frying pan or two for pancakes, and only a pigeon wing was used to grease the pan.

Other types of baked pastries included *pechen'ya* (cookies), *prianik* (a type of honey-cake), *sooshka* (ring-shaped pretzels, small *kalatch* dipped into boiling water before baking); *smetannyya kalatchiki* (baked pies of unleavened dough based on sour cream), and *kulich* (Easter cake with raisins or other dry fruits).

Oils and fats. Unlike that of European Russia, Siberian cookery involved many fried dishes. The reason for this is simple: Chaldons had a lot of vegetable oil. The most common oils were hemp-seed and linseed oils; rarer were sunflower and poppy-seed oils. The most expensive oil was pine-nut oil, produced only in forest areas. Since Siberians had many cows, they produced large quantities of butter, which was even exported to Europe. The Chaldony, however, preferred drawn butter for frying foods. The use of fish oil was adopted from local fishermen tribes. It was very rarely used in European Russia, but in the north of Siberia it served as a substitute for vegetable oils. For example, in northern Siberia, pies were fried in tench oil.

Meat. At the beginning of the twentieth century, meat was one of the main features of the Siberian menu. It was always on the table, excluding, of course, fasting days preceding the big Christian holidays, as well as Wednesday and Friday of every week.

The most important meats were beef, lamb, chicken, and goose. Meat-and-cabbage soup, called *shchi*, was usually cooked on a daily basis. Borscht, the red-beet meat soup, was popular among settlers from southern Russia. Due to the convenience of Russian ovens, boiling or stewing was the most common way of cooking meat.

According to the old custom only three-year-old bulls, "that had enough time to put on weight," were slaughtered for meat. *Kolbasa* (sausages) were traditionally made of beef; only at the end of the nineteenth century did Chaldon cooks learn recipes for pork *kolbasa* from newly arrived European immigrants. Horse meat was also used for sausages and was cooked in a variety of ways in the areas where Russian Siberians were in close contact with horse-breeding aboriginals. The Chaldony applied the same logic to reindeer venison in the areas of reindeer-raising tribes and to *maral* (Siberian deer) venison in the Altay Mountains of southern Siberia.

One of the most popular traditional foods in Siberia was aspic or meat jelly, called *kholodets*. It came from the legs and ears of cows and pigs that are boiled for a long time over a low heat. The meat was then cut off the bones, chopped into very fine pieces, and covered with its broth. Usually onion, garlic, and black pepper were added, as well as carrots and other root vegetables. Especially delicate was the *kholodets* made of duck, goose, or chicken feet, which required the most laborious preparation. *Kholodets* was usually served with very hot Russian mustard or horseradish sauce, often as a cold meal accompanied by vodka.

Kotlety, an oval-shaped rissole made from a mixture of minced beef and pork (with additions of onion, garlic, and white bread soaked in milk), was adopted from German settlers, as were *rybny* and *kurinny kotlety*, made from minced fish or chicken.

Pel'meni. *Pel'meni* was a very distinctive Siberian stuffed pasta dish traditionally cooked during winter. In form, *pel'meni* was a thin round (about 2–3 inches in diameter) of soft pasta dough folded over a minced meat filling to make a semicircle, with the two arms (the corners) twisted around and stuck together. One could find hundreds of *pel'meni* filling recipes involving chicken, game birds, elk, fish, reindeer, mushrooms, and many vegetarian variations; some restaurants even used meat from a brown bear as a local delicacy. However, the filling was made traditionally of two (beef and pork) or three (with the addition of lamb) types of meat, along with onion, salt, and ground black pepper.

In some villages, Chaldony made thousands of *pel'meni* during the first cold winter weeks, freezing them in the *seni* (unheated hallway) and storing them in sacks for consumption as fast-cooking food throughout the winter. *Pel'meni* were not cooked over steam, as many similar central Asian dishes were; rather they were boiled in water. In the past, *pel'meni* was the food normally given to travellers, especially to the *yamschik* (winter coachmen) who conveyed goods and passengers by *sani* (sleds) over huge distances of Siberia. The name *pel'meni* originates from the Komi language: *pel'*, meaning 'ear', and *nian'*, meaning 'bread'. In turn, the origin of Komi's *pel'nian* recipe can be traced to thirteenth-century China. When the Russian colonization of Siberia began at the end of the sixteenth century, Perm', the land of Komi, was used as the base for expansion. Not only did all Russian expeditions to Siberia go through Perm', where Russians learned about *pel'meni*, but also about 30 percent of the colonists were recruited from the Komi people. As a result, *pel'meni* spread throughout the huge colony and became a Siberian national dish.

Fish. Fish is a plentiful and favorite food of native Siberians. It is used for *ouha* (fish soup), pies, frying, and for pickling. Siberians love baked stuffed fish (usually pike); some scholars consider that it was adopted from Jewish cuisine, but differences in the recipe show that it is an indigenous local dish. *Eekra* (caviar) in Siberian cookery is not just a delicacy but also an everyday food. Siberians also make flat round caviar cakes—usually these cakes are just pure fried caviar, sometimes with the addition of chopped onion, black pepper, and a little flour. Fresh sterlet, sturgeon, salmon, or pike caviar is served slightly salted and mixed with fresh chopped onions.

From Siberian aborigines the Chaldony adopted such simple but extremely tasty food as fish *stroganina* or *chush*—thin chips cut from a large boneless piece of fresh frozen fish. *Chush* is a kind of simple but delicious accompaniment for vodka, usually eaten straight or with salt and black pepper, sometimes with chopped onion and vinegar.

Milk and egg dishes. Households of Siberian old-timers usually had many milk cows. *Tvorog* (cottage cheese) and *smetana* (sour cream) were mixed together to make a popular breakfast dish (a kind of thick yogurt) that was often eaten with honey or berry jams. In the areas near Turkic tribes, dried cottage cheese cakes were popular, and in Altay, cottage cheese cakes were smoked. *Tvorog* is the base for the dough of the popular Siberian *syrniki* (thick flat cottage cheese pancakes); it is made by combining *tvorog*, flour, milk, and eggs. *Paskha* (literally Easter, or in this case, traditional Russian Easter cake) is also based on cottage cheese mixed with eggs, raisins, honey, and candied fruits. Sour cream is used as a base for sauces and almost always as a soup dressing for *shchi*, borsch, mushroom soup, *okroshka*, and other soups, as well as a base for sweet cake creams.

Mushrooms and other wild plants. Mushrooms are an important source of proteins and are an essential raw material in Siberian cuisine: they are used in Siberian cooking much more often than in Europe. Many a Siberian family can collect up to 700–1,100 pounds of various wild mushrooms over a typical season (June to the end of September) just for the family's use. Agaric mushrooms are used for pickling with such ingredients as brine, dill, horseradish, and garlic, and, sometimes, oriental spices like black pepper, bay leaf, and cloves are added. Only saffron milk cap, chanterelle, and sometimes Armillaria (honey mushrooms) are fried on their own or stewed with potatoes. Armillaria can also be dried together with all spongy mushrooms: cep, brown cap boletus, orange-cap boletus, mossiness mushroom, *Boletus luteus*. In addition to drying for later use for winter mushroom soup or frying, spongy mushrooms are fried or stewed with pota-

Pel'meni are generally served with a variety of other foods, including special homemade bread, fish roe, sour cream, and of course, vodka. PHOTO BY ILYA VIKTOROVICH LOYSHA COURTESY OF STOLICHNAYA RUSSIAN VODKA.

toes, added to kashas, baked with eggs, and used in various mushroom soups.

Festive food. Patron saints' days, the so-called *guliaschi den'* (idle day) when nobody works, were planned well in advance. People made vodka and beer days ahead of time. Lots of guests from the neighborhood were invited into homes, and groups of people went from place to place visiting different houses. Every house had to prepare ample food, as in every house people were eating, drinking, singing, and dancing. Such holidays were only meant for married couples; young people were not entitled to take part in the feast.

For such feasts people always made pancakes, honeycakes, cookies, and various pastries. Meat- and fish-jelly and fish pie were some standards among a great number of other dishes. Before the guests approached the table, they would offer their good wishes to the hosts: "Bread on the table and salt on the table. Let it always be this way for you." After the meal and the merriment, parting guests would say: "Our Lord, save the hosts; give them good health, concord and ransom."

A Chaldon funeral repast consisted of a minimum of twelve dishes. The first items on the menu were the *kut'ya* (boiled-rice funereal dish), then *bliny*, boiled eggs sliced in half, and *okroshka* (cold soup) with meat. Chicken and meat soups, mushrooms, corned beef, aspic, meat and chicken, boiled meatballs, and kashas followed. The last dish was fruit compote or berry kissel along with small pies or a big sweet pie. Strong drinks were not served.

For the funeral repast usually all people who knew the deceased were invited. Then ninth day, fortieth day, and one year funeral repasts followed. For the ninth day repast, just relatives and those who were helping at the funeral and funeral party were in attendance; for the forty days meal, all who came for the ninth day and those who dug the grave attended. All who came to the funeral were invited to the one year repast.

The table at a wedding celebration was especially rich: the party was three days long and cost a lot of money. A tale from the Tomsk province tells of a wedding party where everything was ready and in place, but the bride's previous boyfriend stole her away. As much money and effort had been spent in preparation for the party; the empty-handed bridegroom decided to marry another girl, saying: "Since everything is ready why should I throw out so much food?"

Maslenitsa (Shrovetide) was the last week before Lent. Traditional foods for this time included *bliny*, fish, and caviar. The best food, including lots of meat, was prepared for *Paskha* (Easter). Traditionally painted eggs, *kulich*, and *Paskha* (the Easter cake) were also served. Christmas merrymaking took place over the course of three to four days. Pork gammons, chickens, and turkeys were cooked, as well as lots of pies with various fillings.

General Changes and Foreign Foods

In spite of political changes and the pressure of permanent shortages during the eighty years of Soviet rule, Siberians have preserved a large portion of their traditional culinary identity. A new, entrepreneurial approach is underway to market the foods of the region both for local consumption and for export. In the beginning of the twentieth century, European, especially French, influence was evident only in the cuisine of the upper classes and in restaurant cooking. It has now extended to the food customs of ordinary people, and some other influences have appeared as well. In cities, central Asian foods such as *shurpa* (meat and vegetable soup), *bishbarmak* (noodle and meat soup), *shahslyk* (small pieces of marinated meat grilled on sticks), *manty* (pasta stuffed with meat and onion, then steamed), and *plov* (rice pilaf and meat) are now quite popular. Many markets sell Korean prepared salads, and the basic Korean hot carrot salad is so popular that many Siberian families now own a special grater to cut carrots to make their own version of this salad at home. Young fern shoots that are salted, dried, or fresh became popular in the Altay region after locals started stocking it in the 1980s for orders from Japan. Perhaps of all the foreign influences now affecting the cuisine of Siberia, the foods of Japan and Korea are becoming the most widely accepted.

Siberia's Aboriginal Peoples

Historically all of the territory in Siberia can be divided into two large cultural (and economic) parts: the South—a region of ancient stockbreeding and agriculture, and the North—territories that have been populated by hunting, fishing, and reindeer-raising tribes. An overview of the cooking of the two major Siberian aboriginal ethnic groups, the Yakout (Saha) in eastern Siberia and the Khant of Finnic origin in western Siberia, may provide some idea of aboriginal Siberian cooking.

Yakout (Saha) People

Yakouts are of Turkish origin and number about 380,000 people. They follow the Christian Orthodox religion, but with some remnants of shamanism. Their country, Saha (Yakoutia), has one of the most severe climates in Siberia; it lies in the far northeastern part of Siberia and occupies an area of about 1.1 million square miles (which is about twelve times the size of Great Britain).

Between the tenth and fifteenth centuries C.E., the Mongols forced Yakout tribes out of their homeland in the steppes of south Siberia. There is clear linguistic proof of the Yakouts' southern origin: their language has such words as *khoy* (ram) and *khakhay* (tiger), even though in their country both do not exist. The environment of Yakoutia is forest, steppes on the sandy frozen meadows, and thermokarst lakes (arctic lakes formed when water holds heat that thaws the permafrost below). People live mainly in the areas of river meadows.

Yakouts are surrounded by various fishing, hunting, and reindeer-raising tribes. While the Yakout people have lived in this inclement climate over the centuries, they have not changed their traditional lifestyle of southern horse- and cattle-breeding nomads. Yakout horse, an extremely hearty breed, is the base of the traditional Yakout economy and their traditional cuisine. Yakout food is very rich in fats, including many milk, cream, and sour-milk products, and meat. Yakout people do not eat mushrooms.

Milk products. The traditional Yakout breakfast is *kuerchah*—a kind of sweet Western-style yogurt that is made of fresh cream and red whortleberries (very sour fruit) whipped into a homogeneous paste. *Kuerchah* is also frozen to make little round cakes, which in some cases include sugar. Another Yakout breakfast dish is a cake of dried cottage cheese.

Meat. The main meat for Yakouts is horseflesh, or more specifically, the meat of one-year-old colts. The horses graze all year on open pasture, in winter digging the food from under the snow, but the ones that are raised for meat are given extra food.

Thus for a year, a Yakout family of six people eats one and a half carcasses of horseflesh, a half carcass of beef, and three to four pigs. Reindeer venison is not eaten as it is considered unfit for consumption. Soviet collective farms bred reindeer, sheep, and even camels; but these meats were never popular.

The best *khan* (blood and milk pudding or sausage) is made from cow's milk and horseflesh (beef can be used but it is not as good). For spices, wild onion, garlic, and black pepper are added. These sausages are kept fresh-frozen, and boiled just before consumption.

Soups and bread. The most characteristic and popular is the beef intestines and flour soup. A fish soup is made with crucian (a kind of carp). From the beginning of Russian colonization in the seventeenth century, wheat and rye were introduced to Yakoutia and have been grown successfully ever since. Traditional Yakout bread is an unleavened flat cake. Modern Yakouts eat also "Russian" yeast-raised bread and make thick pancakes rather than the wide variety of pies known to the other Siberians. As a dainty treat, traditional bread is cut into squares and mixed with cream made of milk and butter, then it is frozen.

Vegetables. In modern times, Yakouts plant vegetables in greenhouses, but traditionally the Yakout people collected and preserved wild vegetables. Every spring they collected a lot of wild green onions that grew along the river Lena; these fresh onions were added to all dishes and were kept salted for year-round use. Wild garlic and some other plants were also collected. In springtime children eat the soft cones of larch trees, as these cones have a pleasant tart taste and contain a high quantity of vitamin C.

Beverages. The Yakouts drink *Chay* (tea) with cream or milk all day long. *Mors*, a fruit drink made of red whortleberries, is consumed instead of water. There are also many sour-milk drinks, like milk whey and herbs (tansy, thyme, wormwood), which is drunk on hot summer days as a cooling and tonic drink. For an alcoholic drink, fermented mare's milk is preferred: it provides the basis of such drinks as *koumiss* (which includes herbs such as wormwood) and *araghy*.

Festive food. *Salamat*, a ritual dish, is a type of rich buttery flour porridge. *Salamat* is served at weddings, housewarmings, funerals, and at many other important events. Since Yakouts are Russian Orthodox, funerals and funeral repasts are performed according to Russian Orthodox traditions. However, there is one important difference: all the personal possessions of the deceased have to be burned, only the most intimate belongings are put on top of the coffin, and what can not be burned is disposed of in the garbage.

Khant People

Until the 1930s, the Khant people were called Ostiak. Their dietary laws are very much influenced by their religion and taboos, and mystery and legend govern many of the Khant people's actions, including eating habits. For example, people of the beaver clan cannot eat beaver, and people of the elk clan cannot eat elk. Elk meat cannot be cut with a knife or even salted.

The bear is a relative to all Khants and is considered the guardian of world order, arbitrator, and the judge. Especially sacred is the front part of the bear: no woman is allowed to touch it. Dogs must not have any access to a bear's bones, and bear bones are not cut or broken. The Khant people believe that if they follow all of these rules, then a consumed bear will regain his flesh and walk again in the forest. Boiling crucian in the same cauldron as other fish is also prohibited, because crucian is fish for the dead who live in the underworld. All things white are holy and belong to their god, and therefore cannot be eaten, such as swans, ermine, and albino deer.

The cooking custom involving the burbot (a freshwater fish of the cod family) is also illustrative of the Khant people's reliance on tradition and mystery. Once burbot is caught, a Khant fisherman takes the fish's liver out through its mouth. If he succeeds in getting out all the liver, the rest of the flesh is eaten as well. But if the liver is cut and only a part of it is removed, the fish has to be released to the two sides of the world: the lower side (North) and upper side (South). The extracted liver is grilled on wooden sticks at the side of a bonfire. But the wood of the bonfire must be of the kind that is pleasing to the god. Willow wood is used for burbot liver cooking.

The whole cuisine of the Khant people is based on the products of fishing and hunting. Fish are so important that even the bread of the Khants is made with the addition of fish powder, and the main source of fat in their cooking is fish oil. Khants drink *chai* (tea) and eat dry wild berries for sweets.

See also **Asia, Central; Central Europe; China; Horse; Japan; Russia.**

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SILVERWARE. "Silverware" often refers generically to any flatware used for eating by most people in the Western world, and some parts of Asia and Africa—knives, forks, and spoons—whether it is made of silver, stainless steel, or a silver-plated base metal. Flatware, especially that used by most people when they eat informally, is usually made of stainless steel, not silver. "Silverware" also refers to dishes used for serving food and some decorative objects such as candlesticks.

In its narrowest sense, "silverware," which includes eating utensils, serving dishes, and decorative items, is made either of sterling silver—925 parts silver to 75 parts another metal, perhaps copper—or has layers of silver plated over another metal, often nickel silver. The more layers, the better the quality, and buyers are cautioned that flatware will be more durable and worth having if it is at least triple plate. Some manufacturers put extra silver on pieces at the point of most wear, for example, on the back of the bowl of a spoon, where it rests on the table.

Of the three pieces of cutlery used by most often by Westerners for eating, the knife was the first utensil. Because early humans were hunters and scavengers and ate meat when they could get it, knives—made of flint or obsidian—were necessary both for cutting meat away from the bone of a kill and for cutting it into manageable pieces for carrying it back to the campsite and for eating. Gradually, as metallurgy developed, knives were made of bronze, iron, and, finally, steel.

From the earliest times until well into the Middle Ages, knives were used for hunting and personal protection, and men always carried them. Because no utensils were provided with meals at the inns and taverns at that time, travelers used their own knives, which they also kept on the table in case they were attacked. Later, inns began to supply knives with the food they served.

Early spoons, used for eating liquids, were made of wood. Shells with attached wooden handles were also used fashioned as spoons. Metal spoons, when they began to be used, were made from the same metal used to make knives of the era. Forks were used in Roman kitchens, with smaller versions being used to carve meat at the side of the table. It is said that a Byzantine princess introduced table forks into Venice in the eleventh century, and their use as eating utensils spread across Italy. Eating with forks did not become fashionable, however, until the seventeenth century. The fact that forks had only two tines at first may account for the delay in adopting them as eating utensils because they were awkward to use. Thomas Coryate, an English traveler, is credited with introducing forks to England in 1608 after a visit to Italy. He wrote that forks were usually made of steel or iron, but that the nobility ate with silver forks. As the use of forks became popular, people began to carry their own forks in special cases when they dined at friends' homes.

Christening Spoons

Wealthy Romans customarily presented a silver spoon to a newborn child. To be "born with a silver spoon in its mouth" meant that the child had many advantages from birth. When the Roman Empire adopted Christianity in 312 C.E., Romans continued to give silver spoons to newborns. To indicate that the child had been baptized, the Chi-Rho, or XP, the Greek symbol for Christ, was engraved on the bowl of the spoon. The Corinium spoon was found in Roman ruins in England, near what is now Cirencester, called Corinium during the Roman occupation of Britain. Sterling silver replicas of the christening spoon were sold in the 1970s by Leonard Jones Ltd. of Cirencester.

Since the Romans, silver has been used to make utensils, but only royalty or the very wealthy could afford it until the end of the nineteenth century. Indeed, the ability to own and control precious metals has always been the prerogative of nobility and the wealthy merchant classes. During the Ottoman Empire, for example, only the Sultans ate from gold dishes, while the women of the harem had silver dishes for dining.

In the eighteenth century, silver eating utensils and serving pieces were popular in Europe and America for those who could afford them. Gorham Manufacturing Company began making table silver in the United States in 1831. Each piece was hand-forged, and two men could produce two dozen pieces a day. In eighteenth-century American society, silverware was identified with women of the moneyed classes. At that time, women could not legally own land or other property, so the scope of their lives was limited to home and family. For this reason, silverware was significant as a woman's contribution to the financial part of a marriage, and it was often purchased for her one piece at a time and kept in what was called a "hope chest," along with other household goods such as linens and quilts. Because it was bought with a woman's taste in mind, most silverware was designed for women. Silver flatware, along with other household goods, has traditionally been monogrammed with the bride's initials.

During the latter part of the nineteenth and early part of the twentieth centuries, wealthy families had servants who prepared and served elaborate dinners that required the use of many different pieces of silverware. There was a great amount of flatware and hollowware made from silver, and some of those servants were responsible for keeping all of it polished. It was a task that kept them busy. Complete sets of silver flatware came with specialized versions of the standard utensils: luncheon knives and forks, smaller than those used for dinner; place spoons (later called "soup spoons" in the United States and "dessert spoons" in Europe, but still listed as place spoons by manufacturers), which are larger than teaspoons; and salad forks and dessert forks, often the same fork used interchangeably. Specialty items of flatware included: iced drink spoons and fish cocktail forks, both long-handled and still available in flatware sets; butter spreaders, short knives that fit on bread plates in individual place settings (also still available); chocolate spoons for hot chocolate; ramekin forks (smaller than salad forks, to fit into small dishes—called ramekins—used to bake individual servings of food); tea forks and knives, about the size of luncheon silverware; sifting spoons with pierced bowls, to be used in sifting sugar over food; fruit knives; and demitasse, or coffee, spoons.

There was even special flatware made for children: pap spoons, which were small spoons with slightly elongated handles for feeding infants; small versions of forks and spoons for children old enough to feed themselves; and pushers, each piece with a plough-like blade attached at a right angle to the handle, used to push food onto a fork or spoon.

People in European countries also enjoyed silver flatware, but used different pieces specialized to accommodate Continental eating habits, for example, marrow spoons. These are long, narrow scoops, suitable for digging flavorful marrow out of meat bones. Special fish knives and forks are also used extensively. The fish knife has a broad flat blade, which makes lifting the flesh from the bones easy, and the fork tines are usually not as sharp as those of other forks. The flatware made to serve fish is similar, but larger. Fish sets are still used in European homes and restaurants, especially in Germany, Scandinavia, and Britain.

Serving pieces used in Europe, the United States, and Canada include tomato servers (or slices), which are flat, circular, slotted pieces; tongs, ranging from large ones for serving salad or asparagus to very small ones for sugar cubes; cheese scoops, used to serve from large chunks of cheeses; dressing or stuffing spoons (called "hash spoons" in Ireland and Scotland), large, long-handled spoons suitable for digging stuffing from the insides of turkeys; ladles; and strainer spoons (like sifter spoons), used secularly to strain seeds from fruit punch bowls and ecclesiastically to strain impurities from the communion wine. Potato forks, wide, with six tines, were made in Liverpool, London, and Dublin. There were spoons for serving candy, nuts, and ice cream. Specialty forks were made to serve sardines, macaroni, and poached eggs. There were grape shears, cracker scoops, butter picks, nut picks, and lobster picks. Pie and cake servers and serrated cake knives are still being made. (A cake knife can be engraved with the names of a bride and groom and given to them for a wedding gift.) Berry serving spoons have broad, deep bowls, and lemon forks are short, with three tines, wide apart. The most common serving pieces are tablespoons, some with holes for straining vegetables served in their cooking liquid, and meat forks.

Flatware has also been made of silver combined with various other materials such as gold, porcelain, wood, or enameled metals other than silver. Inspiration from other cultures influenced styles of silver produced in the United States. Textile designs and other forms of art from Russia, Persia, India, China, Japan, and England were imitated to develop designs for silver pieces. Mokume, a wood-grained metal from Japan, was also copied in silver.

Like flatware, silver hollowware has been used for centuries and made for many purposes. There are containers for every conceivable food. Bowls of all sizes and shapes have been made of silver, along with water pitchers, tea and coffee serving sets, sauce boats, cups, goblets, tankards, salt dishes, salt-and-pepper shakers, bread trays and baskets. Containers for cooking or keeping foods hot have been made of silver: chafing dishes, coffee serving sets, and samovars, the Russian urns in which tea is made. Silver vases, candlesticks, and other decorative objects have all been used on dining tables to enhance the place settings and make the meal a special occasion for families and guests.

By the end of the nineteenth century, the United States led the world in manufacturing silverware and purchasing it as well. In the 1890s, as the price of silver bullion kept decreasing and competition among manufacturers increased, silver became sufficiently inexpensive that lower-middle-class consumers could afford to own it.

Like other Continental nations, Scandinavians used silver for fine dining and held it in high regard. Georg Jensen Solvsmedie, a firm in Copenhagen, Denmark, began manufacturing tableware in 1904. Jensen's modern, clean designs were a change from the rococo and neoclassic designs of the nineteenth century, and, by 1938, the United States was the largest market for Danish sterling silverware. At the beginning of the twenty-first century, there was still a Georg Jensen showroom in New York City.

Silver Service

In Britain, a formal type of restaurant service is called "silver service." Foods are brought to the table in silver-plated serving dishes and platters and are placed on the diners' plates by the serving staff.

Silver and gold ice cream spoons in the Burgundian style, Germany, circa 1880. The large spoon in the center was meant for serving. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

The purchase and use of silverware, however, have been steadily declining since World War II, perhaps because families are unwilling to spend money on it and have neither the time nor the servants to care for it. Furthermore, many European families lost their silverware during wars and so had none to pass on to the next generation. It is also true that meals have become less formal, and stainless steel flatware and hollowware better-looking and more acceptable, not to mention less expensive, than silver as the twentieth century ended. However, sterling silver is still for sale and is still being collected and enjoyed by those who can afford it.

See also **Cutlery; Etiquette and Eating Habits; Kitchen Gadgets**.

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Mary Kelsey

SIN AND FOOD. "Rich as Sin," "My Sin," "Sin Pie"—all are recipe names found in community (and church!) cookbooks in the United States today. Initially these may entice the prospective cook or eater with the implied promise of an exceptionally delicious indulgence, so delicious in fact, that it ought to be too good for humans. Behind these sweet temptations, however, is a somber history. Because these foods are too sweet, too rich, too good, humans who eat them go too far. People have long associated food with sin. Although a complex concept that varies throughout human cultures, sin is at its most basic a violation of the boundary between the sacred and the profane. In most religious traditions, food, literally and symbolically, is a vehicle for transgressing limits. As an ancient Babylonian psalmist confessed, "The food that belongs to god, I have eaten." This is one side of a powerful paradox. Food has divine origins as other recipes for "Heavenly Hash," "Angel Food," and quite literally, "Ambrosia" (food of the gods) attest. It is the means by which life is sustained and through which mortals may commune with the divine and each other. To take food in ways that violate divine intentions, however, can have grave consequences.

In early religions, sin is usually an offense against the cosmic order of things rather than personal disobedience of a god's command. It is the violation of a prohibition, or taboo, that leads to defilement. To be in right relationship with the cosmos is to be pure or in one's appropriate state vis-à-vis the cosmos. Religions often have rules about food consumption and preparation that symbolize order on many levels. The Hua of Papua New Guinea, for example, have a complex system of food-related taboos. One should not eat the food of another with whom conflict may exist, as the vital essence transferred in eating may have negative affects. Pregnant women should not eat hard yams lest they induce a hard labor. Young men must avoid foods prepared in certain ways by menstruating women lest they be weakened by them. In each case, the idea of ordered relationships that perpetuate life is reinforced.

The major Eastern traditions, Hinduism and Buddhism, also conceptualize transgression as a violation of order or karma. In the Hindu caste system, offenses are relative to one's assigned station in life. A Brahman of the highest caste can be rendered impure by eating food touched by a lower caste Hindu. Even Brahman women render food impure if they touch it during menstruation, a time of ritual impurity. Among the major offenses in Hinduism are two general food-related ones. Killing or eating a cow, which is sacred, is forbidden. Drinking intoxicants is also forbidden because it arouses human sensibilities to levels for which they are not intended. Violating either of these proscriptions will lead to a lower state of existence in the next life. In Buddhism, one of the three roots of evil is *lobha*, which has a range of meanings including "craving." Craving foods, being attached to this existence through them, affects one's karma negatively. Eating must be done dispassionately lest it lead one out of the bounds of discipline. Conversely, the disciplined consumption of rice and tea have become means to enlightenment in some Buddhist traditions. Some gurus have advanced to such a high spiritual state that they are able to go without eating for long periods, having lost the need for feeding. In their perfectly balanced existence, they are self-replenishing.

Western religious traditions have defined sin primarily as willful disobedience of God's commandments and the resulting immoral actions. The sense of disorder and taboo remain, however. In Judaism and Islam, dietary codes help to define proper relationship to God. Jews must not eat foods that are *terefah* (unfit). Many foods are unfit because they are hybrids that defy order themselves. Shellfish are *terefah* because they do not have fins like other fish. To eat such foods is to become impure, separate from God and God's people. Muslims must avoid *haram* (unlawful) foods. Jewish and Muslim dietary laws overlap somewhat, most notably in the prohibition against consuming pork. Disciplined eating and periods of abstaining from food aid Muslims in their quest to submit themselves to Allah's will.

The connection between cosmic defilement and offending God also remains in Christianity. Some early Christians, as evidenced most clearly in the epistles of St. Paul, followed classical notions of food as healthy for the body and a licit pleasure to be enjoyed in moderation. For St. Paul, eating meat had nothing to do with one's spiritual state. Others maintained the Jewish dietary laws or other forms of dietary restriction such as vegetarianism. While the Pauline position won out in normative Christianity, and Christian sects that advocated special diets were often suspected of heresy, the notion that food had nothing to do with one's relationship to God did not pass into Christianity unchallenged. Gradually, eating became associated with desire that cannot be curbed and seen as an illicit pleasure that distracted from godly matters. And it became connected to that other unruly human urge, sexuality. Some church leaders advocated fasting, especially for women, as a means of curbing sexual desire. Thus celibacy and abstaining from food became hallmarks of Christian purity. Original sin, as St. Augustine came to define it, further connected food, sexuality, disobedience, and disorderliness. Because the first parents, Adam and Eve, ate fruit God had forbidden, every human inherits their lack of control through lust. For St. Augustine, it was the uncontrollable desire for the pleasure of eating, even more than sex, that was most difficult for him to control. So although the paradigm for communion with God in Christianity is a sacred feast, eating has become suspect in the Christian tradition as something mired in the profane and attached to human weakness. This takes many forms. Somewhat like the Eastern gurus, medieval Christian mystics gave up earthly food and fed only on Christ's body.

Though the "sinful" recipes in church cookbooks are taken lightly by the communities that enjoy them in fellowship meals, a growing movement among evangelical women in the United States encourages them to abandon their sinful cravings for food and strive to be, in the words of Christian dieter Patricia Kreml, "Slim for Him."

Food is often the central focus of another side of sinning, the failure to consider the needs of others as well as one's own. Greed, closely associated with gluttony and lust, is railed against in all of the world's major religious traditions. *Lobha* means 'greed' as well as 'craving', implying the close connection between transgression against the divine and the community. *Taqwa* (piety), a chief Muslim value, involves the proper fear of Allah and purity of intention, mind, and body. But charity and hospitality toward others are also necessary to *taqwa*. During

Ramadan, a fasting period in which Muslims strive with particular rigor to submit to God, giving food to the poor is also required. Attitudes toward another's feeding reflect one's relationship with the divine. St. Augustine illustrated the human condition in a story about an infant wailing loudly while his brother fed at their mother's breast: "But it can hardly be innocence, when the source of milk is flowing . . . abundantly, not to endure a share going to one's blood-brother, who is in profound need, dependent for life . . . on that food." (*Confessions*, I, vi).

The association between food and sin runs deeply through human cultures, perhaps because eating so clearly involves penetration of boundaries. It is the gift of God that comes from the earth, the sustainer of life through slaughter and harvest, substance that becomes self; and binder of one to another, child to mother, human to divine. Such transformation is mysterious business, not without risks. As anyone who has overindulged at a fellowship meal well knows, too much of a good thing can make food of the gods into devil's food.

See also **Buddhism**; **Christianity**; **Cookbooks, Community**; **Fasting and Abstinence**; **Feasts, Festivals and Fasts**; **Hinduism**; **Islam**; **Religion and Food**; **Women and Food**.

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Corrie E. Norman

SLOW FOOD. Slow Food Arcigola, founded in 1989 by Carlo Petrini and known simply as Slow Food, is an international movement headquartered in Bra, Piedmont, Italy, and organized around small, local chapters. Formed in 1986 in opposition to an attempt by McDonald's to place its golden arches in the Piazza di Spagna area of Rome, Slow Food's mission is to cultivate public appreciation for locally produced foods, wines, and authentic tastes. Pleasure and conviviality at the table are brought into harmony with humane, wholesome conditions of production. The movement encourages opposition to fast food and the fast life to improve the quality of life. While aiming to educate the public's palate, it advocates biodiversity in foods; local food and artisanal production; conservation of traditional foods and foodways and the environments that produce them; and measures to make traditional foods economically viable.

At the beginning of the twenty-first century the Slow Food movement counted sixty-five thousand members in forty-five countries on five continents. Chapters, called *convivia* internationally, numbered 560 worldwide, 340 of which were in Italy, where they are called *condotte.* The group's activities include public education forums, such as guided taste workshops, school programs, and conventions; and publications, such as guides to wines, cheeses, restaurants, food and wine cultures and their histories, and tourism. Slow Food is committed to philanthropy, including *Le Tavole Fraterne* or Friendship Tables; financing solidarity projects; and international charity programs, including sponsoring a soup kitchen in an Amazonian indigenous hospital and a school cafeteria in Sarajevo and rebuilding a cooperative cheese factory in Umbria, Italy, that was damaged in the 1997 earthquake. Through the Ark of Taste projects, begun in 1996, the movement advocates identifying and safeguarding endangered food "treasures," for example, charcuterie, cheeses, grains, vegetables, and local breeds; small, quality food products, such as *lardo di Colonnata*—lard packed in salt and herbs, served in thin slices on bread—and Protected Designation of Origin (DOP) cheeses; and agricultural and food heritage sites, such as, cafés, pastry shops, inns, and restaurants. The Slow Food presidia have focused on these areas to guarantee their economic and commercial futures, to protect the land from degradation, and to create new job opportunities. Small, quality food producers need protection against the industrial food complexes that control ever larger market shares and large-scale distribution. The industrial complexes often influence laws that threaten the very existence of traditional producers.

In the tradition of avant-garde manifestos, *The Slow Food Manifesto* (Paris, 1989) states, "We work towards the rediscovery of the richness and aromas of local cuisines by opposing the leveling effect of the Fast Life . . . which has changed our lives and threatens the environment and landscape." The movement's apt symbol therefore is the snail—small, cosmopolitan, prudent, and slow. The manifesto warns against being "too impatient to smell and taste" and "too greedy to remember what [we] have just devoured." Opposing fast cheap food and the values and systems of globalized food production, Slow Food can be firmly placed in the biocultural ecology movement. The mission statement of Slow Food USA reads:

> Recognizing that the enjoyment of wholesome food is essential to the pursuit of happiness, Slow Food USA is an educational organization dedicated to the stewardship of the land and ecologically sound food production; to the revival of the kitchen and the table as centers of pleasure, culture and community; to the invigoration and proliferation of regional, seasonal culinary traditions; and to living a slower and more harmonious rhythm of life.

The success of its agenda and the growth of its membership—attributable to the rise of an ecological consciousness among educated, affluent consumers, that fosters a concern with the quality of foods and their sources—have encouraged Slow Food to expand its publications, such as the *Slow* journal, published in Italian, French, English, and German; and to open offices in Switzerland (1995), Germany, (1998), New York (2000), and to make plans for an office in Paris. The group's highly successful international taste fair, *Il Salone del Gusto*, first held in Turin, Italy, in 1996, is a review of quality food and wine. With the theme of biodiversity, the fair between 5 and 9 November 1998 attracted 126,000 visitors and featured 300 stalls displaying Italian and foreign artisanal food in three halls devoted to charcuterie and cheeses; gastronomy; and pastry, cakes, chocolate, and coffee. Participants experienced tastings, conferences, seminars, and cooking and tasting courses.

The biennial Slow Food cheese fair was first held in September 1997 in Bra, Italy. The 1998 cheese fair was organized as a market devoted to the 127 European DOP cheeses. The Slow Food movement has also organized *Excellentia* for people to experience various wines; *La Settimana del Gusto*, a week of low-cost menus in restaurants throughout Italy to encourage those under age twenty-six to participate in quality food experiences; and *Il Gioco del Piacere*, biennial blind wine tastings attended by over fifteen thousand people.

See also **Artificial Foods**; **Fast Food**; **Natural Foods**.

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Slow Food Editore, established in 1989, has produced about sixty publications, largely in Italian, devoted to the pleasures of wine, food, and conviviality. Among its best-known publications are the quarterlies *Slow* and *Slowine; Osterie d'Italia* [Taverns of Italy], a guide to traditional eating establishments; *Vini d'Italia* [Wines of Italy], a comprehensive guide to Italian wines with Gambero Rosso; and *L'arca*, the review of the Slow Food presidia project. Slow Food also publishes monographs on cheeses, beers, wines, and oils. Among them are *Formaggi d'Europa* [Cheeses of Europe], which includes the 127 European DOP cheeses; the taste manuals *Dire, fare e gustare* [Saying, doing, and tasting]; and Giacomo Leopardi, *Il piacere del vino* [The pleasure of wine]; Italian regional recipe books, such as Anna Gosetti della Salda, *Le ricette regionali Italiane* [Regional Italian recipes]; books on food history, such as *Il gusto dell'agro* [Savoring the sour], a history of vinegar; tourism books, such as *Venezia: Draghi, santi e capesante* [Venice: Dragons, saints, and scallops]; and reprints of classics, such as Silvano Serventi, *Il cuoco Piemontese* [The Piedmontese cook] (Bra, Italy: Slow Food, 1995), an eighteenth-century text on Piedmontese cuisine. The Slow Food Web site is available at http://www.slowfood.com.

Luisa Del Giudice

SNACKS. Throughout human history, the frequency and content of meals has varied. From ancient times, light foods or leftovers were consumed between meals. These tended to be natural, sweet foods that required little or no preparation, such as grapes, figs, or apples. In nineteenth-century America, interest in snack foods shifted from natural foods to prepared commercial foods, with a high salt and sugar content. It is these processed foods that are considered snack foods in the early twenty-first century.

Salty Snacks

America's first commercial snack foods were peanuts and popcorn, which were cheap, tasty, filling, and eminently portable. Peanut and popcorn vendors sold their products on the streets, circuses, and fairs, and later at sporting events. One successful peanut vendor was Amedeo Obici, an Italian-born immigrant living in Wilkes-Barre, Pennsylvania. In 1906, he, along with another Italian immigrant, formed the Planters' Peanut Company. They constantly improved their products and packaging. To promote their products, the company adopted "Mr. Peanut" in 1917—a logo has appeared subsequently on almost every Planters package. Both popcorn and peanuts were marketed to children and were connected with children's holidays. These characteristics have become standard for snack foods.

Homemade pretzels were probably sold for centuries before they were first commercially produced in 1861. Pretzels did not become an important national snack until the 1930s, when a machine was invented to automate production. Recipes for potato chips appeared in the early nineteenth century. Under the name "Saratoga chips," they were popularized by George Crum, the chef of the Moon's Lake Lodge in Saratoga, New York. First manufactured by John E. Marshall of Boston in the 1890s, potato chips were sold in barrels but quickly became stale after a barrel was opened. Potato chips did not become popular until the 1920s, when Laura Scudder asked employees to iron two pieces of wax paper to form a bag. This set off a packaging revolution that permitted chips to be sold airtight bags. Corn chips were originally a Mexican snack—cut-up, fried, or dried tortillas. The first-known commercial corn chips were the *friotes*, which were made from fried *masa* (corn flour) in San Antonio. Elmer Doolin purportedly bought a bag of *friotes* and then bought the recipe for one hundred dollars. In 1932, Doolin began manufacturing them under the name Fritos. His renamed product was a success, and his sales expanded as far as St. Louis, Missouri. In 1945, Doolin met potato chip manufacturer, Herman W. Lay, who agreed to distribute Fritos, which became popular

SOME POPULAR SNACKS

Animal Crackers: Invented in 1871 by Pennsylvanian David F. Stauffer.

Baby Ruth: Introduced in 1920 by the Curtiss Candy Company of Chicago, this candy is filled with peanuts covered with nougat and a chocolate covering.

Butterfinger: Introduced by the Curtiss Candy Company in 1923.

Candy canes: Developed in Europe and arrived in the United States via German immigrants. Produced commercially in the 1920s, they became popular in the 1950s.

Cheetos: Invented by the Frito-Lay company in 1948.

Chocolat Delicieux à Manger: Produced by J. S. Fry around 1847, it is thought to be the first handmade chocolate candy bar.

Cotton candy or floss: Made by spinning colored sugar causing it to puff into cotton-like strands, became popular at circuses and fairs before 1900.

Eskimo Pie: Originally called the I-scream bar, it was created by Chris Nelson in Onawa, Iowa, in 1920.

Fig Newton: Invented by Charles M. Roser of Ohio, who sold recipe to what became NABISCO, which first sold them commercially in 1891.

Fortune cookies: An American invention started during the early 20th century, probably in San Francisco. They were first commercially manufactured about 1920.

Hershey Chocolate Bar: Introduced by Milton S. Hershey about 1900. It is the world's first manufactured chocolate candy bar.

Jelly beans: Probable descendent of Turkish Delight. French confectioners developed the process of "panning" necessary to make jelly beans. In America, jelly beans were a penny candy sold by weight. They were not associated with Easter until the 1930s.

Junior Mints: Originally produced by James O. Welch Company, the chocolate covered peppermint now a part of NABISCO Confections, Inc.

Life Savers: Developed in 1912 by Clarence A. Crane of Cleveland, Ohio. These round, white peppermints have holes in the middle that resemble life preservers on a boat, hence their name.

Kit Kat: A chocolate-covered wafer produced by the Rowntree and Company's Chocolate Crisp, it was renamed the Kit Kat in 1937.

Lollipops and Suckers: Unclear origin; a machine for making lollipops was developed by Russian immigrant Samuel Born in 1916 in San Francisco, but Wisconsin's Racine Confectioners Machinery Co. claims to have done so in 1908.

M & M's: Introduced in 1940. The company's goal was to create a candy that did not melt, and the idea was said to have originated during the Spanish Civil War, when soldiers ate chocolates covered with a thin layer of sugar candy that prevented the chocolate from melting in the heat. M&M's quickly became the best-selling confection in the world, but the original version did not contain peanuts. Mars introduced M&M Peanut Chocolate Candies in 1954, and they have been a good seller ever since.

Milky Way: Introduced by Mars, Inc., in 1923.

Mounds: Coconut and chocolate confection was released in 1922 by Peter Paul Halajia of Naugatuck, Connecticut.

Mr. Goodbar: Introduced by Hershey, it was a chocolate-peanut based confection released in 1925.

NECCO wafers: Hard cylinder-shaped candies released by NECCO (an acronym for the New England Confection Company), first appearing in 1912.

Nestlé's Crunch: Released in 1938 by Nestlé, it is a combination of milk chocolate and crisped rice.

Oh, Henry!: Introduced by George H. Williamson of Chicago in 1920, it was originally a log-shaped bar with a fudge center surrounded by a caramel and peanut layer and coated in pure milk chocolate.

Payday: Manufactured by the Pratt and Langhoff Candy Company in 1932.

Pez: Invented in 1927 by Eduard Haas III, of Vienna, Austria, the hard candy is named after the German word for "peppermint." Pez dispensers were invented in 1948.

Potato chips: Recipes were published early in the nineteenth century, and were first manufactured in 1890s by John E. Marshall of Boston. Potato chips did not become popular until the 1930s, after a packaging revolution permitted the chips to remain fresh.

Reese's Peanut Butter Cup: Introduced by the H. B. Reese Candy Company, the chocolate-covered peanut butter candy was first manufactured in 1928.

Snickers Bar: Created by Mars, Inc., in 1930, the candy bar, composed of a combination of peanut butter nougat, peanuts, and caramel encased in milk chocolate, was first marketed in 1930.

3 Musketeers: Created by Mars, Inc., in 1932, the candy bar consisted of three levels of chocolate coating and was named after the novel by Alexander Dumas.

Toblerone: Invented by the Swiss Theodor Tobler and Emil Baumann, the chocolate-covered almond nougat candy bar was first manufactured in 1908.

Tootsie Roll: Introduced in 1896 by New Yorker Leo Hirschfield, this round, chewy candy was named after his daughter who was nicknamed "Tootsie."

Twinkies: Invented by a Chicago bakery manager named Jimmy Dewar, the cream-filled sponge cake was first marketed in 1930.

nationwide, and the two companies merged. The Frito-Lay Company introduced Cheetos in 1948, and continued to grow by introducing new snacks and acquire other snack food companies. Owned by PepsiCo. today, Frito-Lay is the largest snack food conglomerate in the world. Many other chip-based snacks have been developed. Some more famous ones include nachos (1943), a snack purportedly developed in Eagle Pass, Texas, and Doritos, first marketed by Frito-Lay (1966).

Sweet Snacks

Peanuts and popcorn combined to create America's first successful commercial sweet confection. Frederick W. Rueckheim, an immigrant from Germany, combined peanuts, popcorn, and molasses to create Cracker Jack. By 1923 the Cracker Jack Company sold more than 138 million boxes annually. However, sweet snacks had been sold well before Cracker Jack. They fall into four major categories: hard candy, baked goods, chocolate candy, and frozen sweets

Candies have been produced in Asia for thousands of years. Homemade candies, such as lemon drops, jujubes, and peppermints, were produced in Europe by the late eighteenth century. Penny candies were frequently sold in grocery stores. During the nineteenth and twentieth centuries, thousands of candies have been manufactured, including saltwater taffy (1883), first manufactured commercially in Atlantic City, New Jersey, and Life Savers (1912), manufactured by Clarence Crane of Cleveland, Ohio.

The second broad category of sweet snacks are baked goods. Small baked cakes and pastries with sugar had been produced since the late Middle Ages in Europe and likely originated in Arab lands, particularly Baghdad. "Cookies," an American word derived from Dutch, initially referred to sugar cookies flavored with spices. The word was subsequently extended to include other kinds, such as wafers, snaps, and macaroons. Initially, cookies were handmade and were sold in grocery stores. They were first manufactured in the United States in the late nineteenth century. Animal Crackers (1871) and Fig Newtons (1892) were among the first commercially manufactured cookies. Numerous commercial varieties have been manufactured since, such as OREO's, a chocolate sandwich cookie, and gingersnaps. Several chains that bake fresh cookies have emerged in the last quarter of the twentieth century, including Famous Amos' in 1976 and Mrs. Field's Cookies in 1977. Many other baked goods were also converted into commercial snacks. Hostess Cup Cakes were first manufactured in 1919. Twinkies were invented by a Chicago bakery manager named Jimmy Dewar in 1930, and were later acquired by Hostess.

Chocolate Candy

The third broad category is chocolate-based candy. In 1847 Joseph Storrs Fry, a British Quaker, invented a process of combining cocoa powder, sugar, and melted cocoa butter that produced a thin paste which could be shaped in a mold. The handmade Chocolat Delicieux à Manger is considered to be the first chocolate bar. J. S. Fry and Company became the largest manufacturer of chocolate in the world. In Switzerland, Henri Nestlé developed the process of making milk chocolate in 1867. Another Swiss chocolate manufacturer, Daniel Peter, used Nestlé's chocolate to make a milk chocolate bar in 1879. A third Swiss, Theodor Tobler, marketed in 1908 his Toblerone, consisting of a triangular chocolate bar with almond-and-honey nougat. Other chocolate-making companies emerged, such as Lindt of Switzerland (1845) and Belgium's Godiva Chocolates (1926).

Hot dogs make a perfect urban snack food since they are sold on the street, easy to handle, and easy to eat. © PATRICK GIARDINO/CORBIS.

In the United States, chocolate candy and caramels became important by the 1870s. These were expensive in part because they were all handmade. Boxed chocolates were manufactured by the 1840s. Early chocolate confection makers included the Walter Baker Chocolate Company and Walter M. Lowney Company, both headquartered in Boston. The Whitman Sampler became a national boxed chocolate by 1907. Retail candy stores have developed, including See's Candy (1921) and Fanny Farmer (1919).

The first American to manufacture chocolate bars was Milton Hershey, who in 1903, began to build what would become the world's largest chocolate manufacturing plant in Derry Church (later renamed Hershey), Pennsylvania. Hershey's Chocolate Bars were the first of thousands of chocolate bars to roll off the assembly line, followed by Hershey's Chocolate Kisses in 1907. Hershey produced many new products including Mr. Goodbar, composed of chocolate and peanuts, and the Krackel, composed of chocolate and rice.

Hershey's success encouraged others to produce chocolate bars. Otto Y. Schnering of Chicago founded the Curtiss Candy Company, which released the Baby Ruth candy bar in 1920. Curtiss later introduced the

Butterfinger. George H. Williamson, a salesman for a candy broker in Chicago, opened a candy store and launched the Oh Henry! candy bar in 1920. In the same year, Frank and Ethel Mars of Minneapolis started up Mars, Inc. Three years later they produced the Milky Way candy bar, followed in 1930 by the Snickers Bar, which quickly became America's most popular candy bar—an honor it still holds today. This was followed by M&M's in 1940.

Frozen Sweets

Ices and ice cream have been produced for centuries. Ice cream parlors probably originated in Italy and France and have sold their goods since at least the late eighteenth century. The three major snack products have all been American inventions: the ice cream cone, ice cream bar, and popsicle. The ice cream cone was invented during the late nineteenth century and was popularized at the St. Louis World's Fair. The cone made it possible to consume ice cream without the need of a spoon and cup. Ice cream parlors have continued to thrive and major chains, such as Carvel's (1934), which serves soft-serve ice cream, and Baskin-Robbins (1948), have become very well known.

Handheld ice cream bars quickly became an important snack food in America. The Eskimo Pie originated in Iowa in 1920. In the same year Harry Burt invented the chocolate-covered vanilla ice cream bar on a stick in Youngstown, Ohio. Ice cream bars became popular during the following decades. The popsicle, frozen flavored water, was first commercially manufactured in the United States during the 1920s.

Snack Food in the Early Twenty-First Century

Many snacks are heavy on calories, fat, and salt. The term "junk food" was popularized in 1972 by Michael Jacobson of the Center for Science in the Public Interest. The concern with empty calories has continued, and of particular concern has been the targeting of youth by snack food companies. As a response to junk food charges, a natural snack food industry developed during the 1970s. This included such snacks as gorp, composed of various combinations of raisins, peanuts and other natural foods, used by hikers and now available commercially in most grocery stores.

The commercial snack food industry is a major component of America's economy. When the total statistics of commercial candy, baked snacks, chocolates, and frozen snacks are combined, the industry sells annually in excess of $75 billion of products in the United States alone.

See also **Candy and Confections**; **Chocolate**; **Ice Cream**; **Marketing of Food**; **Popcorn**.

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SNAILS. *See* **Mollusks.**

SOCIOLOGY. Sociology involves the study of how people relate to each other, as well as how the institutions of society affect behavior and attitudes. For most of the past hundred and fifty years, sociologists have focused mainly on social institutions and structures. It was only around the middle of the twentieth century that they turned their attention to the important roles that technologies (including food production and processing) play in society. Other disciplines (particularly anthropology) have a much longer history of research into food and culture.

Food and food habits have been only implicitly assumed in sociological literature until just recently. Food studies have been an integral part of both rural sociology and medical sociology. For rural sociologists, food has been central in studies of agricultural and technological change. Food has also been a main focus in the studies of farms, community living, social change, and consumer issues. In fact, rural sociologists began to study food production in the 1930s through research on the adoption and diffusion of innovations (new technologies).

For medical sociologists, food and nutrition are now recognized as an important factor in the study of health and wellness. Sociologists examine how our nutritional habits are based on cultural identity, gender, race and ethnicity, and social class. Although food is a fundamental concern for human life, sociologists are now just establishing a sociology of food by identifying how lifestyles, social class, gender, and ethnicity influence food selection and consumption. In fact, much of the market research that food companies conduct is in fact a form of sociological research (e.g., focus groups, surveys, and interviews).

The sociological study of food is important in understanding social change, the state, and consumer society. For example, positive social change has come about as a result of epidemiological and sociological studies of the importance of sanitation. Sociological studies based on food exportation, importation, and food agricultures have examined how states develop. In addition, research into the inequality of distribution and access to food comprises another way that sociologists can expose to explain class, race, and gender differences, as well as forms of political domination. Food is also important in explaining consumerism, cultural assimilation, modernization, and how beliefs and rituals change.

Sociologists have always been interested in social inequality and stratification (i.e., through analysis of gender, ethnic, and class differences.) For example, some foods are associated with women and some with men. Women eat less food overall, and they are usually light foods or foods that can be nibbled, such as salad or fish. Men tend to eat more food, and prefer foods associated with strength, such as red meat. Food habits also vary significantly with age. For example, soft or strained foods are appropriate for very young children who have no teeth, as well as for the elderly (for the same reason). As people age, they also become more concerned about the role of diet in their overall health.

Food also represents distinctive cultures; for example, pasta is associated with Italian culture, or curry with Indian culture. Cultures evolve to suit the local environment. For instance, spicy foods are more popular in the warmer climates. Class distinctions in foods abound. In the early 1900s in Great Britain, people in the upper classes ate more meat than those of the middle or lower classes. However, by the middle of the century, all people ate about the same amount of meat, as advances in food technology put meat in the range of everyone. Economically disadvantaged groups are sometimes forced to eat what is cheap, and these foods may not be as nutritious as higher-priced foods. Disadvantaged groups then are more vulnerable to health problems, such as heart disease or obesity.

It has been said that “We are what we eat.” Food becomes part of our self-identity. From a very young age, an individual is socialized into his or her adult eating habits. A person eats what his family eats when he is young—these habits do not tend to change that much with age. In Western cultures, young children are taught that the insects they find are not to be eaten. In other cultures, however, young children are taught that certain insects are edible and they become part of the diet. Foods are part of the rituals we use to accept new members into our group, to celebrate milestones, and to express religious or political beliefs. For example, a new neighbor might be presented with a basket of food or a homemade pie as a welcome gift.

Celebrations, such as birthdays and anniversaries, usually involve some kind of cake or other sweet food. National holidays usually include foods associated with the country. For example, Americans celebrate Independence Day with backyard barbecues (including hamburgers and hot dogs, potato chips and watermelon). Thanksgiving is closely associated with turkey. Religious holidays also use symbolic foods, such as ham at Christmas for Christians. Some religions have specific taboos on food. For instance, Jewish people do not eat pork, while Hindus do not eat beef, and Seventh-Day Adventists do not eat meat at all. Many religions also endorse fasting as part of their rituals.

Sociologists have shown how the level of development within a country influences food habits and preferences. Industrialized countries consume and waste more food than developing countries. Americans may waste up to 25 percent of their food. Waste results from poor storage and processing, as well as from unused leftovers and spoiled foodstuffs that are never used. There is less consumer waste in developing countries. However, this practice is increasing as more countries adopt Western ideas and values concerning food.

Almost every culture has some form of food taboo. In fact, there is only one taboo that is universal, and that is the restriction on eating human flesh. This was not always the case, however. Early people, such as the South American Indians, would grind up the bones of their ancestors into a communal pot, to share their strength and wisdom with all tribal members. Some taboos restrict certain kinds of foods to certain meals. For example, Americans eat cereal for breakfast, but not for dinner. Food taboos may be based on cleanliness standards, but taboos may also be used to change entire food systems. Sometimes it is easier to restrict foods on religious beliefs, than to convince people rationally to change their eating habits. Emotions also play a major role in decisions about what people eat and why. Sociological research and theory are therefore important for understanding how to increase human health through better diet and nutrition.

See also **Anthropology and Food; Feasts, Festivals, and Fasts; Food Politics: United States; Icon Foods; Political Economy; Population and Demographics; Religion and Food; Taboos; United States: Ethnic Cuisines**.

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SODIUM. Sodium is normally present in food and in the body in its ionic (charged) form rather than as metallic sodium. Sodium is a positively charged ion or cation (Na^+), and it forms salts with a variety of negatively charged ions (anions). Table salt or sodium chloride (NaCl) is an example of a sodium salt. In solution, NaCl dissociates into its ions, Na^+ and Cl^-. Other sodium salts include those of both inorganic (e.g., nitrite or bicarbonate) and organic anions (e.g., citrate or glutamate) in aqueous solution, these salts also dissociate into Na^+ and the respective anion.

Types and Amounts of Common Foods that Contain the Recommended Levels of Sodium

Only small amounts of salt or sodium occur naturally in foods, but sodium salts are added to foods during food processing or during preparation as well as at the table. Most sodium is added to foods as sodium chloride (ordinary table salt), but small amounts of other salts such as sodium bicarbonate (baking soda and baking powder), monosodium glutamate, sodium sulfide, sodium nitrate, and sodium citrate are also added. Studies in a British population found that 75 percent of sodium intake came from salts added during manufacturing and processing, 15 percent from table salt added during cooking and at the table, and only 10 percent from natural foods (Sanchez-Castillo et al., 1987). Most sources of drinking water are low in sodium. However, the use of home water softening systems may greatly increase the sodium content of water; the system should be installed so that water for cooking and drinking bypasses the water softening system.

The estimated minimum safe daily intake of sodium for an adult (0.5 grams) can be obtained from ¼ teaspoon of salt, ¼ of a large dill pickle, ⅓ can of condensed tomato soup, one frankfurter, or fifteen potato chips. The effect of salt added in processing is noted by the calculation that, whereas one would need to consume 333 cups of fresh green peas (with no salt added during cooking or at the table) in order to consume 0.5 grams of sodium, the estimated minimum safe daily intake of sodium is provided by only 1.4 cups of canned or 2.9 cups of frozen green peas.

Whereas the estimated minimum safe intake for an adult is 0.5 g/day of sodium (1.3 g/day of sodium chloride), average Americans consume between 2 and 5 g/day of sodium (between 5 and 13 g/day of sodium chloride) (National Research Council, 1989). Sodium chloride, or salt, intake varies widely among cultures and among individuals. In Japan, where consumption of salt-preserved fish and the use of salt for seasoning are customary, salt intake is high, ranging from 14 to 20 g/day (Kono et al., 1983). On the other hand, the unacculturated Yanomamo Indians, who inhabit the tropical rain forest of northern Brazil and southern Venezuela, do not use salt in their diet and have an estimated sodium chloride intake of less than 0.3 g/day (Oliver et al., 1975). In the United States, individuals who consume diets high in processed foods tend to have high sodium chloride intakes, whereas vegetarians consuming unprocessed food may ingest less than 1 g/day of salt. Individuals with salt intakes less than 0.5 g/day do not normally exhibit chronic deficiencies, but appear to be able to regulate sodium chloride retention adequately.

BRIEF OUTLINE OF THE HISTORY OF SALT

Common salt is the chemical compound NaCl. Salt makes up nearly 80 percent of the dissolved material in seawater and is also widely distributed in solid deposits. It is found in many evaporative deposits, where it crystallizes out of evaporating brine lakes, and in ancient bedrock, where large extinct salt lakes and seas evaporated millions of years ago. Salt was in general use long before history began to be recorded. Salt has been used widely for the curing, seasoning, and preserving of foods.

Recommended Intake of Sodium

The daily minimum requirement of sodium for an adult is the amount needed to replace the obligatory loss of sodium. The minimum obligatory loss of sodium by an adult in the absence of profuse sweating or gastrointestinal or renal disease has been estimated to be approximately 115 mg/day, which is due to loss of about 23 mg/day in the urine and feces and of 46 to 92 mg/day through the skin (National Research Council, 1989). Because of large variations in the degrees of physical activity and in environmental conditions, the estimated level of safe minimum intake for a 70-kg adult was set at 500 mg/day of sodium (equivalent to 1,300 mg/day of sodium chloride) by the National Research Council (1989). Although there is no established optimal range of intake of sodium chloride, it is recommended that daily salt intake should not exceed 6 grams because of the association of high intake with hypertension (National Research Council, 1989). The *Dietary Guidelines for Americans*, published in 2000, include a recommendation to choose and prepare foods with less salt.

Individuals who wish to lower their sodium or salt intakes should use less salt at the table and during cooking, avoid salty foods such as potato chips, soy sauce, pickled foods, and cured meat, and avoid processed foods such as canned pasta sauces, canned vegetables, canned soups, crackers, bologna, and sausages. Individuals should also become aware of and avoid "hidden" sources of sodium such as softened water, products made with baking soda, and foods containing additives in the form of sodium salts.

The need for sodium chloride is increased during pregnancy and lactation, with the estimated safe minimum intake being increased by 69 mg/day and 135 mg/day, respectively, for women during pregnancy and lactation. The estimated minimum requirement for sodium is 120 mg/day for infants between birth and 5 months of age and 200 mg/day for infants 6 to 11 months of age (National Research Council, 1989); these intakes are easily met by human milk or infant formulas. The estimated minimum requirements of sodium for children range from 225 mg/day at one year of age to 500 mg/day at 10 to 18 years of age.

General Overview of Role of Sodium in Normal Physiology

Total body sodium has been estimated at 100 grams (4.3 moles) for a 70-kg adult. In general, the cytoplasm of cells is relatively rich in potassium (K+) and poor in sodium (Na+) and chloride (Cl−) ions. The concentrations of sodium (and potassium and chloride) ions in cells and the circulating fluids are held remarkably constant, and small deviations from normal levels in humans are associated with malfunction or disease. Na^+, K^+, and Cl^- are referred to as electrolytes because of their role in the generation of gradients and electrical potential differences across cell membranes. Sodium and sodium gradients across cell membranes play several important roles in the body. First, sodium gradients are important in many transport processes. Sodium tends to enter cells down its electrochemical gradient (toward the intracellular compartment that has a lower Na^+ concentration and a more negative charge compared to the extracellular fluid compartment). This provides a secondary driving force for absorption of Cl^- in the same direction as Na^+ movement or for the secretion of K^+ or hydrogen ions (H^+) in the opposite direction in exchange for Na^+. The sodium gradient is also used to drive the coupled transport of Na^+ and glucose, galactose, and amino acids by certain carrier proteins in cell membranes; because as Na^+ enters down its electrochemical gradient, uptake of glucose/galactose or amino acids can occur against their concentration gradient. Second, sodium ions, along with potassium ions, play important roles in generating resting membrane potentials and in generating action potentials in nerve and muscle cells. Nerve and muscle cell membranes contain gated channels through which Na^+ or K^+ can flow. In the resting state, these cell membranes are highly impermeable to Na^+ and permeable to K^+ (i.e., Na^+ channels are closed and K^+ channels are open). These gated channels open or close in response to chemical messengers or to the traveling current (applied voltage). Action potentials are generated in nerve and muscle due to opening of Na^+ channels followed by their closing and the re-opening of K^+ channels.

A third important function of sodium is its osmotic role as a major determinant of extracellular fluid volume. The volume of the extracellular fluid compartment is determined primarily by the total amount of osmotic particles present. Because Na^+, along with Cl^-, is the major determinant of osmolarity of extracellular fluid, disturbances in Na^+ balance will change the volume of the extracellular fluid compartment. Finally, because Na^+ is a fixed cation, it also plays a role in acid-base balance in the body. An excess of fixed cations (versus fixed anions) requires an increase in the concentration of bicarbonate ions.

Consequences of Deficiency or Excessive Intake Levels

Sodium balance in the body is well controlled via regulation of Na^+ excretion by the kidneys. The kidneys respond to a deficiency of Na^+ in the diet by decreasing its excretion, and they respond to an excess of Na^+ by increasing its excretion in the urine. Physiological regulatory mechanisms for conservation of Na^+ seem to be better developed in humans than mechanisms for excretion of Na^+, and pathological states characterized by inappropriate retention of Na^+ are more common than those characterized by Na^+ deficiency.

Retention of Na^+ occurs when Na^+ intake exceeds the renal excretory capacity. This can occur with rapid ingestion of large amounts of salt (for example, ingestion of seawater) or with too-rapid intravenous infusion of saline. Hypernatremia (abnormally high plasma concentration of Na^+) and hypervolemia (abnormally increased volume of blood), resulting in acute hypertension, usually occur in these situations, and the Na^+ regulatory mechanisms will cause natriuresis (urinary excretion of Na^+) and water retention.

The body may be depleted of Na^+ under extreme conditions of heavy and persistent sweating or when conditions such as trauma, chronic vomiting or diarrhea, or renal disease produce an inability to retain Na^+. Sodium depletion produces hyponatremia (abnormally low plasma concentration of Na^+) and hypovolemia (abnormally decreased volume of blood) which place the individual at risk of shock. Medical treatment includes replacement of Na^+ and water to restore the circulatory volume. If the loss of Na^+ is not due to renal disease, mechanisms to conserve Na^+ and water are activated. Loss of Na^+ can also be caused by the administration of diuretics, which inhibit Na^+ and Cl^- reabsorption, or by untreated diabetes mellitus, which causes diuresis.

Regulatory Processes that Govern the Uptake and Excretion of Sodium

The kidneys are the main site of regulation of Na^+ balance. The intestines play a relatively minor role. Under normal circumstances, about 99 percent of dietary Na^+ and Cl^- are absorbed, and the remainder is excreted in the feces. Absorption of Na^+ and Cl^- occurs along the entire length of the intestines; 90 to 95 percent is absorbed in the small intestine and the rest in the colon. Intestinal absorption of Na^+ and Cl^- is subject to regulation by the nervous system, hormones, and paracrine agonists released from neurons in the enteric nervous system in the wall of the intestines. The most important of these factors is aldosterone, a steroid hormone produced and secreted by the zona glomerulosa cells of the adrenal cortex. Aldosterone stimulates absorption of Na^+ and secretion of K^+, mainly by the colon and, to a lesser extent, by the ileum.

The kidneys respond to a deficiency of Na^+ in the diet by decreasing its excretion, and they respond to an excess by increasing its excretion in the urine. Urinary loss of Na^+ is controlled by varying the rate of Na^+ reabsorption from the filtrate by renal tubular cells. Individuals consuming diets that are low in Na^+ efficiently reabsorb Na^+ from the renal filtrate and have low rates of excretion of Na^+. When there is an excess of Na^+ from high dietary intake, little Na^+ is reabsorbed by renal tubular cells, resulting in the excretion of the excess Na^+ in the urine. As much as 13 g/day of Na^+ can be excreted in the urine.

The most important regulator of renal excretion of Na^+ and Cl^- is the renin-angiotensin-aldosterone system (Laragh, 1985). Sensors in the nephrons of the kidney respond to changes in Na^+ load by influencing the synthesis and secretion of renin (Levens et al., 1981). A decrease in renal perfusion or Na^+ load will increase the release of renin. In the circulation, renin acts to initiate the formation of active angiotensin II from angiotensinogen, a protein produced by the liver. Angiotensin II conserves body Na^+ by stimulating Na^+ reabsorption by the renal tubules and indirectly via stimulating secretion of aldosterone. Secretion of aldosterone by the adrenal cortex is stimulated by a low plasma Na^+ concentration and by angiotensin II. Aldosterone stimulates cells of the renal tubules to reabsorb Na^+.

Because of the close association of Na^+ and Cl^- concentrations with effective circulating volume, Na^+ (and Cl^-) retention results in proportionate water retention, and Na^+ (and Cl^-) loss results in proportionate water loss. Expansion or contraction of the extracellular volume affects the activation of vascular pressure receptors, as well as the release of natriuretic peptides by certain tissues, and result in changes, mediated largely by antidiuretic hormone (ADH), in renal excretion of Na^+, Cl^-, and water. A deficiency of sodium chloride and hypovolemia have also been shown to produce an increase in appetite for salt, which will increase sodium chloride intake.

Evidence that Sodium Intake May Be Related to Risk of Hypertension

Both epidemiological and experimental studies implicate habitual high dietary salt intake in the development of hypertension (Weinberger, 1996). Primary hypertension, or abnormally high blood pressure, is a significant risk factor for cardiovascular disease, stroke, and renal failure in industrialized societies. Diets that are high in fat, high in sodium, low in potassium, low in calcium, and low in magnesium may contribute to the development of hypertension (Reusser and McCarron, 1994).

Although epidemiological and experimental evidence suggest a positive correlation between habitual high-salt consumption and hypertension, controversy remains regarding the importance of sodium salts in the regulation of blood pressure and the mechanisms by which salt influences blood pressure. This is not surprising, because the response of blood pressure depends on an interplay of various factors, such as genetic susceptibility, body mass, cardiovascular factors, regulatory mechanisms mediated through the neural and hormonal systems, and renal function.

A large comprehensive study on the role of sodium in hypertension was carried out in fifty-two geographically separate centers in thirty-two countries by the INTERSALT Cooperative Research Group (Stamler, 1997). Four centers included in the study had median values for Na^+ excretion that were under 1.3 g/day. Subjects in these four unacculturated centers had low blood pressure, rare or absent hypertension, and no age-related rise in blood pressure as occurred in populations in the other forty-eight centers in which mean values for Na^+ excretion were between 2.4 and 5.6 grams Na^+ per day. Although blood pressure and sodium intake appeared to be associated when all fifty-two centers were included, the correlation between systolic blood pressure and excretion of sodium was not significant when the four centers with the lowest median values of sodium excretion were excluded from the analysis.

Intervention studies of dietary salt restriction to lower blood pressure have produced mixed results. This may be explained by the facts that not all hypertensive patients are salt-sensitive and that many cases of hypertension are due to other causes. Nevertheless, various clinical trials indicate some beneficial effects of dietary restriction of sodium on blood pressure (Cutler et al., 1997; Reusser and McCarron, 1994) with response being greater in older patients, patients with the highest degree of restriction, and in nonoverweight, mildly hypertensive patients.

Researchers are currently attempting to identify the genetic basis of salt-sensitive hypertension and to identify polymorphisms associated with salt-sensitive hypertensive individuals. More than thirty different gene variations could be responsible for essential hypertension, and hypertension is considered to have a complex genetic basis. Further insight into the basis of hypertension may help to determine individuals for whom lowering salt intake would be beneficial and to facilitate the prescription of appropriate drugs.

See also **Dietary Guidelines**; **Fast Food; Fish, Salted**; **Health and Disease**; **Meat, Salted**; **Preserving**; **Salt**.

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Martha H. Stipanuk

SORBET. *See* **Sherbet and Sorbet.**

SOUL FOOD. *See* **United States: African American Foodways.**

SOUP. A soup is a broth that is infused with flavor. It may be thin and crystal clear like a consommé, voluptuously smooth and creamy like a creamed soup, or so chunky with meat, fish, grains, and/or vegetables that it is just this side of a stew. A soup may be the first of several courses, intended just to whet the appetite; it may be one of many dishes served at the same time; or it may be a hearty meal in a bowl. The bottom line is that in order to be a soup, it must be enough of a liquid preparation that eventually one gets around to sipping it, or eating it with a spoon.

Soups play an important role in traditional cookeries all over the world, especially in medical dietetics. Shown here is garlic soup from Nepal. While such preparations may soothe and comfort, the act of heating garlic destroys its antimicrobial properties. © Macduff Everton/CORBIS.

Soup is an important mainstay in the everyday diet of most cultures. It was probably one of the earliest cooked preparations because it could be made with just about anything (including leftovers from the day before) and could be extended greatly simply by adding more liquid. Where food is scarce, soup is a staple: The moral of the "Stone Soup" fable is that soup can be made from nothing at all but stones, water, and generosity.

Although classic French cuisine developed as a result of the availability of many types of food and involves many courses, it has also given soup a place of singular

ORIGINS OF SOUP

While soup is firmly imbedded in most cookeries of the world, the historical situation was somewhat different. Light soups were more generally viewed as adjuncts to medicine, easily digestible preparations employed in feeding the sick, the elderly, or small children. In Africa the stock from boiled greens served this purpose. In ancient China turtle stock was viewed as a potent restorative for the feeble or sick. During the Middle Ages the *iusculum consummatum* was administered in the same manner. Its modern descendant is beef consommé, but in the eighteenth century a concoction of this general class of clear soups was known as a "restaurant" and became fashionable in Paris as a health food. Soon the health food itself lent its name to the place where it was eaten: thus the soup house became the restaurant. During the late 1700s the restaurant quickly evolved from a soup house to an establishment where full meals could be purchased.

English includes several words that provide clues regarding the older meanings of this largely liquid form of food: "soup," "supper," "sip," and "sops," to name four. The Middle English word *soupen* meant to drink in sips, which is how most soups were consumed by the sick and the elderly. The Old French word *souper,* obviously a parallel term, meant to take an evening meal. In this context the evening meal was presumed to be light, and soup was in fact one way to create a *rechouffé* from the remains of midday dinner. However, the *soupe* itself was the piece of bread placed in the bowl into which broth was poured. In English this piece of bread was once referred to as the sops, and it was universal practice down to the nineteenth century for country people to put bread in soup before eating it. More fashionable recipes called for toast or even chopped bread fried in butter (croutons), but the essential concept was the same: the moist bread thickened the soup. This custom lingers on in only the most traditional types of recipes, such as French onion soup, where toast or croutons help keep the melted cheese from sinking before the soup reaches the table.

The addition of bread to soup was viewed as inelegant by the end of the eighteenth century—”farmish," to use the term of the nineteenth-century American cookbook writer Eliza Leslie. Other types of thickeners, especially roux (flour fried in lard or butter) grew in popularity, but so did purees. Puréed cooked vegetables, such as parsnips, turnips, or potatoes (or all three), often appear in Victorian recipes as more healthful substitutes for roux. Roux is largely banned from haute cuisine, and soups are thickened with a wide array of ingredients. Plastic squeeze bottles with tiny nozzles allow cooks to ornament soups with colorful swirls of coulis or intense-tasting herbal sauces. In spite of the emphasis on garnish and appearance, the universal appeal of soup is not its appearance but how it comforts the body.

William Woys Weaver

importance. According to the eighteenth-century French gastronome Grimod de la Reynière (1758–1838), "It [soup] is to dinner what a portico or a peristyle is to a building; that is to say, it is not only the first part of it, but it must be devised in such a manner as to set the tone of the whole banquet, in the same way as the overture of an opera announces the subject of the work." In other words, soup should inspire, set the stage, for the rest of the meal.

Classic French cuisine divides soups into two broad categories: clear soups and thick soups. These classifications are made on the basis of a Western, and specifically French, way of thinking about food that is essentially one of theme and variation. All soups in the "clear" category are prepared using a fundamental technique; variations on and additions to this technique create derivative soups. Once the cook has mastered the basic technique, he or she can make all derivations. One should not assume that other cultures think about food in the same way—in fact, the opposite can be assumed. But since soups from non-Western cultures fall well within this kind of classification system, it nonetheless seems a reasonable way to approach the topic. Such a system can also be adjusted to embrace ethnic as well as Western cuisines by redefining the categories this way: broth-based soups and thick soups.

Broth-Based Soups

Broth-based soups are soups made by simmering flavorful ingredients (meats, poultry, seafood, legumes, vegetables, herbs and/or spices) in water or stock to make a thin broth. The broth may then be garnished and seasoned in a variety of ways at the whim of the cook (e.g., with fresh meats and vegetables, herbs, grains or pastas), so that although the broth of such a soup is thin, the soup itself may also be hearty. Stocks are a kind of soup as well: water is simmered with bones, vegetables, and other flavoring agents such as herbs, to infuse the water with their flavor. (In the case of the Japanese stock, *dashi*, the vegetable is seaweed and the flavoring agent dried tuna.)

Unlike soups, stocks are not intended to be eaten on their own. They are a base or ingredient from which to build something more complex—a sauce, a stew, or a soup.

The most famous broth-based soup in the world must be chicken soup, made by cooking chicken in stock or water. Once the chicken is cooked, it may be boned and returned to the soup or eaten separately; then vegetables, rice, noodles, or matzoh balls are added to the soup, depending on the preference of the cook. If the chicken is cooked whole in stock with vegetables, and the resulting broth is served as a first-course soup, followed by the chicken and vegetables, it is called a *poule au pot* —which means "chicken in a pot" and is a meal in itself. If egg and lemon are whisked into the simmering broth until the egg "strings," and then rice is stirred in, it is the Greek *avgolemono.* Wonton soup (a soup traditionally served at the end of a Chinese meal although a formal dinner may include more than one soup) is made by poaching wontons in a ginger-scented chicken broth; when the broth is seasoned with fragrant lemongrass, kaffir lime leaves (the mildly lemon-tasting and highly fragrant leaves of the kaffir lime), and galangal (a root that tastes something like lavender) and enriched with coconut milk, it becomes the Thai soup *tome kha gai.* An Indonesian chicken soup may be flavored with lemongrass too, saffron or turmeric, and a cooked paste of shallots, garlic, kemiri nuts (a local nut that resembles a macadamia nut), shrimp paste, ginger, and coriander seeds. And if the broth is flavored with a purée of onion, garlic, and tomato, then garnished with crisp, fried strips of fresh tortilla and grated cheese, it becomes the Mexican *sopa de tortilla.*

There are just as many soups based on a beef broth, which may be made from the bones alone, or from an inexpensive cut of beef such as short ribs (which are usually served with the soup) or shin (usually discarded after cooking). French onion soup is one such soup, in which the broth is simmered with well-browned onions until it is sweetened and enriched with their flavor, then poured over thick slices of bread, and covered with a layer of broiled cheese. Onion soup belongs to a genre of bread soups—also broth-based soups—in which broth is poured over bread; the starch from the bread thickens the soup and makes a meal out of it. Bread soups are typically poor man's food and are likely to be made with water rather than stock. In *Catalan Cuisine*, Colman Andrews mentions a vegetable bread soup made with onions, garlic, sweet pepper, and tomato cooked in a liberal amount of olive oil, and poured over bread. *Ribollita* is another traditional bread soup, from Tuscany, chunky with cabbage and vegetables.

Vietnamese *pho bac* is a noodle soup based on a rich beef broth, spiced with ginger, anise, cinnamon, and chilies and seasoned with fish sauce (a pungent, salty liquid made from fermented anchovy) that is poured over thin slices of raw beef, rice noodles, sliced onion, bean sprouts, and fresh chilies, and garnished with fresh mint and cilantro. According to Nicole Routhier, *pho* is a traditional breakfast soup. (Throughout much of Southeast Asia, soup may be eaten at any meal and is served along with all main-course dishes.) Korean cooks make a beef soup with browned short ribs, flavored with toasted sesame seeds, soy sauce, garlic, ginger, and scallion; the ribs are then eaten with the soup. Russian borscht and goulash from Hungary are two Eastern European vegetable and meat soups made with beef broth (or probably with water and vegetables alone during lean times). For Japanese *shabu-shabu*, thin slices of beef, onion, cabbage, daikon, and mushrooms are dropped into a pot of simmering water flavored with a piece of kelp, then eaten with a variety of condiments; the flavorful broth—sometimes extended with noodles—is drunk at the end of the meal.

Thin vegetarian soups, like French pistou, are made the same way, by poaching vegetables in simmering water. Then the flavor of the broth is augmented by a purée of basil, garlic, Parmesan cheese, olive oil, and sometimes tomato. South Indian vegetarian cuisine includes a genre of fiery hot soups called *rasams* in which the flavor of the

Soup is also an icon food in some cultures. American alphabet soup assumes a patriotic shape in this clever serving of tomato soup. © TECMAP CORPORATION; ERIC CURRY/CORBIS.

FRANCO AMERICAN FOOD COMPANY'S
FRENCH SOUPS
TOMATO
Alphonse BIARDOT
NEW YORK — PARIS
FRANCO AMERICAN FOOD CO'S
FRENCH SOUPS
A. BIARDOT
Mock Turtle

Aside from military rations, canned soup was expensive for most people during the nineteenth century. Shown here is an 1893 advertisement for French-style tomato and mock turtle soups illustrating both the fancy labeling and the tissue wrapping (on the right) which went around the cans to preserve the labels from damage. ROUGHWOOD COLLECTION.

broth is derived largely from spices and then balanced with tomato, lemon, lime, and/or tamarind to add a sour taste. Although *rasams* may be served during the meal, they are also traditionally offered to guests as they enter the house, as a beverage, like tea, in anticipation of the meal to follow.

Seafood soups are almost a category unto themselves because they encompass such a tremendous variety of tastes, textures, and techniques. A simple Western-style seafood soup is made by simmering aromatic vegetables and herbs (and perhaps a bit of cured and/or smoked pork) with water or fish stock, and poaching fish and/or shellfish in the resultant broth. In *Japanese Cooking*, Shizuo Tsuji lists a soup made by poaching shrimp and seaweed in *dashi* seasoned with soy sauce. (Tsuji notes that such "clear" soups are traditionally served at the Japanese table at the beginning of the meal, after the appetizer; more luxurious banquets may include a second soup midway through the meal.) Some thin shellfish soups are made by opening the shellfish in simmering wine, water, or broth, perhaps flavored with aromatic herbs and vegetables. Broth-based seafood soups also include hearty concoctions made with a variety of different types of fish and shellfish poached in a broth. The seafood may be served in the broth, or separately, as in a bouillabaisse.

If chicken soup is the most famous broth-based soup, then one of the most elegant (at least in Western culture) must be the consommé. A consommé is made with a stock that is "clarified," which means that the stock is returned to the stove, several egg whites are whisked in, and the whole concoction is brought slowly to a simmer. As the mixture heats, the egg white coagulates into a gray-colored "raft" on top of the stock that traps and filters out the impurities that make the stock cloudy. When the raft is skimmed off, the stock has, almost magically, become perfectly transparent. Finely chopped fresh meat and vegetables are usually added during the clarification process since the egg white seems to rob the stock of flavor along with the impurities. Consommés may be served as is, or embellished with any number of garnishes including, at the simplest level, tiny chopped vegetables or herbs, or more complex preparations such as tiny quenelles—tender, oval-shaped dumplings of chopped fish, poultry, or meat, bound with egg—or royales, tiny, delicate cut-up shapes from a baked egg custard. A consommé may be served hot, chilled, or as an aspic.

Thick Soups

Thick soups are soups in which the liquid is thickened—what cooks call "bound"—in one of a variety of ways: by the addition of flour, cream, and/or egg, or by the action of puréeing. Classic French cuisine of the nineteenth and early twentieth centuries was particularly rich in this type of soup, although puréed soups were certainly common in France much earlier than that: The medieval cookbooks *Le Viandier and Le Menagier de Paris* include several recipes for puréed soups. An example of a very simple thick soup, achieved by puréeing alone, is a potato-leek soup made by simmering sliced potato and leek in water or chicken broth and then puréeing the mixture—the starch in the potato causes the soup to thicken. Any vegetable soup can be made this way; alternatively, rice, tapioca, pasta, and legumes will also provide thickening when cooked and puréed with the soup.

During the French Revolution, chefs who had made their living cooking for the aristocracy and royalty fled their homeland to other parts of Europe (particularly England) and America, bringing classical French cooking with them. By the late nineteenth century, French chefs were running the kitchens of fine American restaurants, particularly in New York City and Philadelphia, and wealthy Americans were dining in lavish French style. Creamed soups, characterized by a silky smooth texture, made of purées bound with flour and often further enriched with cream and/or egg, belong to this era of luxurious eating. (In 1917 Louis Diat, the French-born chef at the Ritz Carlton hotel in New York City, turned his mother's home-style, puréed leek and potato soup into a new soup, vichyssoise, by puréeing it very finely, enriching it with cream and milk, and then chilling it.) Bisques are a type of intensely flavored creamed soup, typically made with crustaceans such as lobster or crayfish, but also with vegetables, as in tomato bisque. The ingredients are cooked in a broth, then puréed (shell and all, for the seafood, to extract the considerable flavor of the shells), carefully strained, and next creamed. Traditional recipes used bread or rice to thicken the bisque, but that technique is no longer commonly employed.

Finally, chowders and gumbos are another variety of thick, distinctly American, soups. Chowders are soups made with milk or cream; they theoretically contain a starchy vegetable such as corn or potato. Gumbos are regional American soups from Louisiana, thickened either with a very dark roux—a mixture of flour and fat that is cooked to a deep brown color—okra, or file powder (made from dried sassafras leaves).

See also **Chicken Soup**; **Cuisine, Evolution of**; **France**; **Grimod de la Reynière**; **Stew**; **Taillevent**; **United States,** *subentries on* **Cajun Cooking** *and* **New England**; **Vegetables**.

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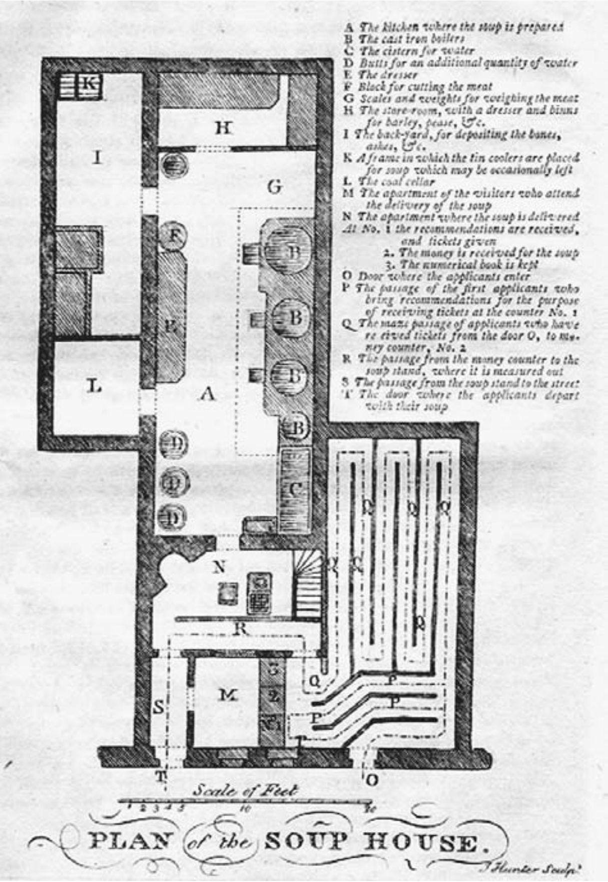
Stephanie Lyness

SOUP KITCHENS. Soup kitchens have been providing nourishment to the poor and hungry since at least the eighteenth century. Though no longer serving solely a fare of soup and bread, they remain an important component of private food relief three centuries later. Patterned after soup societies in Europe, soup kitchens had their genesis in the work of Count Rumford who sought to create a low-cost, nutritionally sound diet for the Bavarian military. He found that the cheapest, most savory, and nourishing food was a soup composed of pearl barley, peas, potatoes, cuttings of fine wheaten bread, vinegar, salt, and water in certain proportions. (He also made a culinary discovery: the crouton.)


A The kitchen where the soup is prepared
B The cast iron boilers
C The cistern for water
D Butts for an additional quantity of water
E The dresser
F Block for cutting the meat
G Scales and weights for weighing the meat
H The store-room, with a dresser and binns for barley, pease, &c.
I The back-yard, for depositing the bones, ashes, &c.
K A frame in which the tin coolers are placed for soup which may be occasionally left
L The coal cellar
M The apartment of the visitors who attend the delivery of the soup
N The apartment where the soup is delivered
At No. 1 the recommendations are received, and tickets given
2. The money is received for the soup
3. The numerical book is kept
O Door where the applicants enter
P The passage of the first applicants who bring recommendations for the purpose of receiving tickets at the counter No. 1
Q The maze passage of applicants who have received tickets from the door O, to money counter, No. 2
R The passage from the money counter to the soup stand, where it is measured out
S The passage from the soup stand to the street
T The door where the applicants depart with their soup
A
B
C
D
E
F
G
H
I
K
L
M
N
O
P
Q
R
S
T
Scale of Feet
PLAN of the SOUP HOUSE.
J. Hunter Sculp.

The Duke of Portland's plan for relieving the stress of the poor, published at Chester, England, in 1799. This is one of the earliest designs for a soup house, or soup kitchen as it is now called. Applicants for food enter at "O" on the plan and stand in line until they reach the money counter at "R." They exit the kitchen at "T." ROUGHWOOD COLLECTION.

Rumford's soups became famous throughout Europe. Originally they were used to feed the military but soon soup houses were established throughout Europe, England and the United States to feed the poor. In London, as many as sixty thousand people were fed daily from Rumford's soup kitchens. The Humane Society of New York City founded one of the earliest soup kitchens in the United States in 1802. Typical of soup kitchens in its day, the Society printed soup tickets that both public and private organizations purchased and distributed to the poor.

I'm spending my nights at the flop-house,
I'm spending my days on the street,
I'm looking for work, and I find none,
I wish I had something to eat.
Soup, soup, they give me a bowl
of soup, soup, soup. They give
me a bowl of soup.

Depression-era song (1930s)

Soup kitchens lost their popularity by the 1820s as civic leaders and charity reformers began to believe that indiscriminate handouts encouraged pauperism by destroying self-reliance. New emphasis was placed on reforming the moral character of the poor rather than on feeding them or providing other material needs. As a result only a small number of soup kitchens continued, often only on a temporary basis during unusually harsh economic times. One notable exception to this trend was the Salvation Army's food depots or soup kitchens, which remained in continuous operation after the organization was established in England in the late 1800s.

It was not until the Great Depression that there was resurgence in soup kitchens. Along with breadlines, soup kitchens became a daily part of the life of millions during the 1930s. They were immortalized in numerous poems, songs, and stories. Their heyday, however, waned as government income support and food assistance programs were established. In the early 1980s, when numerous reports of increased hunger surfaced, soup kitchens once again opened in large numbers.

Soup kitchens have become an integral part of a larger, ongoing, emergency food and hunger network. Known as emergency food relief (EFR) programs, soup kitchens and food pantries dominate the private sectors effort to feed the hungry. Soup kitchens usually prepare and serve meals on-site to individuals and families, while food pantries provide a package of several days worth of food for home preparation. It is estimated that between twelve and twenty-one million people each year rely on soup kitchens and food pantries. Second Harvest, the largest private food distribution program, is a national network of two hundred regional food banks providing food to more than 94,000 local soup kitchens, food pantries, and other food programs throughout the United States.

The modern soup kitchen meals are typically free and unlike public food assistance programs often do not have income or other eligibility requirements. The majority of soup kitchens are affiliated with larger nonprofit organizations, most often that of churches, which usually supply the facility and equipment, financial resources, food and volunteers to staff the operation. Additional resources, most often in the form of food, are obtained from the local food bank, government commodity distribution programs, community retail outlets, and community food drives. Many soup kitchens extend their assistance beyond feeding to include such services as information and referral to other social assistance programs.

Soup kitchens are usually opened on weekdays, typically serving lunch or dinner, but rarely both. They serve a diverse group of people, including homeless, unemployed, working poor, public assistance recipients, elderly, and people with health problems and disabilities. People often rely on these programs as a daily source of nourishment for many months, even sometimes several years. The limited information concerning the nutritional status of people relying of soup kitchens indicates that many frequently experience hunger despite their use of soup kitchens. Often the soup kitchen meal is their only daily meal.

Unlike in the past, soup kitchens serve a variety of meals often consisting of sandwiches or such casserole dishes as stews, tuna noodle casserole, macaroni and cheese and pasta with tomato sauce. Beverages most often served are coffee, tea and fruit drinks. If fruit or vegetables are offered, they are most often canned and rarely is fresh produce served. Desserts are often served and typically comprise cakes, cookies, donuts and pies. The scarce research on the nutritional quality of soup kitchens

PROFILE OF COUNT RUMFORD

Count Rumford, who was responsible for popularizing soup kitchens, is also credited with the invention of the cooking range, double boiler, and drip coffee pot, among other items now commonplace in the kitchen. Born Benjamin Thompson in Woburn, Massachusetts in 1753, he was a loyalist during the American Revolution and immigrated to Europe after independence. Leopold of Bavaria commissioned him to build an efficient and disciplined Bavarian Army. As part of his effort, Thompson discovered that by enclosing a cook fireplace it could cook food faster and more evenly. This invention became known as the kitchen range. He also invented cooking pots and pans to prepare large quantity meals. Prior to these inventions, each soldier was allotted a certain amount of food that he had to cook over a small fire for himself. For his work, the Bavarian government gave Thompson the title Count Rumford.

meals indicates that the vitamin and mineral content of meals varies widely among kitchens and that several nutrients may be consistently below recommended guidelines. The nutrients most often found lacking are calcium, vitamin D, vitamin B_6 and vitamin B_{12}. In addition, riboflavin and iron may be inadequate for women of childbearing age. Foods from the dairy group and in particular milk, all excellent sources of vitamin D, calcium, and riboflavin, are rarely served in soup kitchens. Dark green leafy vegetables, such as spinach or kale, rich in folate and vitamin B_6, are rarely served. And a full portion of meat, an excellent source of iron and vitamin B_{12}, is rarely served. Meats are most often served in small portions in casseroles. Meals may also be high in fat and sodium as they serve highly processed and canned foods.

SALVATION ARMY'S SOUP KETTLE

The soup kettle tended by a volunteer ringing a bell is a well-known symbol of the Salvation Army visible at Christmas time. Legend credits the origin of this practice to an incident in December 1894. Survivors of a shipwreck near San Francisco had been taken to a nearby Salvation Army post. Seeing that the soup was almost gone, a volunteer took the huge black soup kettle from the kitchen and affixed a sign to it that read: "Keep this kettle boiling." She then placed the kettle and sign on a street corner and stood by it ringing a bell to attract people. Within a short time passers-by tossed in enough money to buy plenty of food for the victims of the shipwreck. Ever since, Army volunteers have rung bells and stood by kettles.

Throughout their history soup kitchens and other emergency feeding programs have frequently been met with opposition. In the early years, critics claimed that soup kitchens encouraged pauperism and contributed to the moral decay of individuals. Contemporary critics claim that, at best, soup kitchens provide a short-term band-aid remedy to hunger but do not get at the root causes of hunger such as poverty, low wages, and affordable housing. Many soup kitchen supporters concede that their approach may offer only a short-term response to hunger, but they argue it plays a vital role in trying to meet immediate food needs of the poor.

See also **Class, Social**; **Food Stamps**; **Poverty**; **School Meals**; **Soup**; **WIC (Women, Infants, and Children's) Program**.

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Patricia McGrath Morris

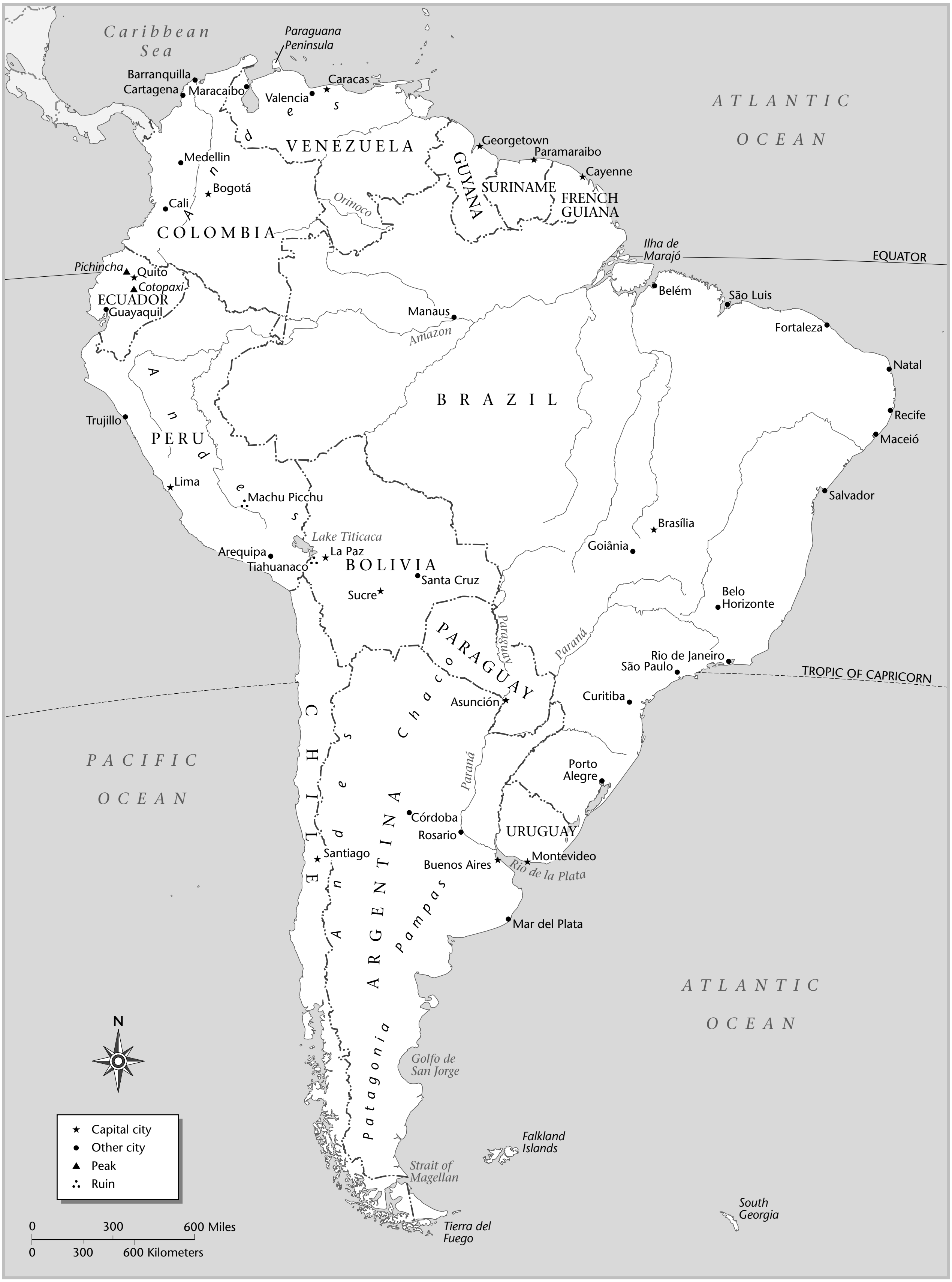
SOUTH, THE (UNITED STATES). *See* **United States.**

SOUTH AMERICA. South America is a continent composed of twelve countries and one French colony. The Spanish-speaking countries are: Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, and Venezuela. (Portuguese-speaking Brazil is treated separately in this encyclopedia.) The former colonies of Guyana and Suriname use English and Dutch, respectively, as their official languages, although many in their populations speak indigenous languages. The same can be said for the French colony of Guiana, the home of the cayenne pepper, where French is the official language. The geography of South America is even more varied than that of North America, with long coastlines, lowlands, highlands and mountains, and tropical rain forests. The climate varies from tropical, lying as the continent does across the Equator, to alpine in the high Andes, the backbone of the continent.

The cookery of South America reflects this rich diversity of culture and geography. The indigenous cookeries of pre-Columbian South America have gradually merged with imported cuisines from Europe and Asia. While the Spanish and Portuguese conquistadors introduced their own culinary traditions to the native peoples of South America, indigenous ingredients changed the cuisines of the Old World. The South American contributions included chocolate, vanilla, maize (corn), hot peppers (called *ají* in South America), guavas, sweet potatoes, manioc (cassava), tomatoes, potatoes, avocados, beans, squash (particularly the ancestor of zucchini), peanuts, quinine, and papayas, as well as turkeys.

Maize plays a key role in the cuisine of South America, and it is genetically different from the maize now grown in the Old World, manifested most obviously in its characteristically large kernels. The potato is another vegetable indigenous to South America that has played an important role in cooking worldwide. There are also many vegetables in South America largely unknown beyond the continent, including *ahipa*, *arracacha*, *maca*, *yacon*, *olluco*, and *oca*.

The demographics of South America are critical for understanding the diversity of its cuisines. In countries


Caribbean Sea
Paraguana Peninsula
Barranquilla
Cartagena
Maracaibo
Caracas
Valencia
ATLANTIC OCEAN
VENEZUELA
Georgetown
Paramaraibo
Cayenne
GUYANA
SURINAME
FRENCH GUIANA
Medellin
Bogotá
Cali
Orinoco
COLOMBIA
Andes
Ilha de Marajó
EQUATOR
Pichincha
Quito
Cotopaxi
ECUADOR
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Belém
São Luis
Manaus
Amazon
Fortaleza
Natal
BRAZIL
Trujillo
Recife
Maceió
PERU
Lima
Machu Picchu
Salvador
Brasília
Lake Titicaca
Arequipa
La Paz
Tiahuanaco
BOLIVIA
Goiânia
Santa Cruz
Sucre
Belo Horizonte
PARAGUAY
Paraguay
Paraná
Rio de Janeiro
São Paulo
TROPIC OF CAPRICORN
Chaco
Asunción
Curitiba
PACIFIC OCEAN
CHILE
Porto Alegre
Córdoba
ARGENTINA
Rosario
URUGUAY
Santiago
Montevideo
Buenos Aires
Río de la Plata
Pampas
Mar del Plata
ATLANTIC OCEAN
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0
300
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Tierra del Fuego

like Bolivia, Ecuador, and Peru, the indigenous populations predominate, and their foods and foodways are the most important cuisines. In contrast, Argentina's cookery was heavily influenced by a large European immigration dominated by Spaniards and Italians. Throughout South America, there is also an African influence due to the slave trade, which has added to the culinary mix.

Venezuela

Venezuela was discovered in 1498 by Columbus when he found the mouth of the Orinoco River. In 1499 the Venezuelan coast was explored by Alonzo de Ojeda and Amerigo Vespucci. Vespucci, coming upon an island in the Gulf of Maracaibo, called it Venezuela because, according to legend, the native villages were built above the water on stilts. Venezuela rises from lowlands to highlands with coffee plantations ascending to the white-capped Andean peaks. It has a mild climate due to its proximity to the Caribbean. Caracas, Venezuela's capital, is the cultural, commercial, and industrial hub.

Local dishes. Venezuelan cuisine relies heavily on maize. The two most important preparations are *hallacas* and *arepas*. *Hallacas*—traditionally eaten during holidays, especially Christmas—are boiled dumplings wrapped in banana leaves, but there are innumerable variations, depending on region and family tradition. *Hallacas* are made with a dough made of maize flour mixed with water, which is then filled with meat, vegetables, and spices. *Arepas* are versatile flatbreads, also made of maize flour, that can be baked, grilled, fried, or steamed and served either sweet or savory.

Black beans, called *caviar criollo*, are a Venezuelan favorite. They are served with *arepas* and are also part of the national dish, *pabellón caraqueño*. A hearty dish, it is said to resemble the national flag (*pabellón*), because of the colors of the beef, beans, rice, and plantains in it.

The most popular fish in Venezuela is *pargo*, a red snapper found in semitropical waters, which is a member of the family Lutjanidae. Imported salt cod, brought to the region by the conquistadors, is also important in the cuisine. A favorite dish throughout South America is chicken with rice, but in Venezuela cooks add olives, raisins, and capers to the rice.

Arequipe, milk pudding (milk cooked with sugar until very thick), is a favorite dessert in Venezuela, as it is throughout South America. It has different names in different places, but is perhaps best known in the United States as *dulce de leche*.

The traditional beverages of Venezuela are *chicha*, made of fermented maize, and *masato*.

Colombia

Colombia has two coastlines, one on the Pacific and the other on the Caribbean, that provide the country with a large choice of seafood. Colombia rises from the Pacific coast through a series of plateaus to the capital, Bogotá. Colombian cooks have a wide range of foods to choose from, including bananas and plantains, papayas, sugarcane, avocados, potatoes (especially in the Andes), and such tropical root vegetables as the sweet potato, taro, cassava (manioc), and *arracacha*. Apricots, pears, grapes, apples, and peaches all grow in Colombia as well.

Local dishes. In Colombia, coconut milk is used with great imagination in cooking fish, for example, herring simmered in coconut milk. One very popular soup is *sancocho de pescado*, a fish stew consisting of a variety of ingredients such as plantains, manioc (cassava), herbs, and coconut milk. Stews, usually served with rice, are the preferred way to cook meat, usually beef, especially with vegetables and fruits. Another traditional dish is *gallineta en barro*, an unplucked guinea fowl marinated in spices and lime juice and wrapped in an envelope of clay. It is then buried in hot coals and baked for approximately two hours. When the clay shell is broken, the skin is clean and golden brown and the meat is tender and flavorful.

During colonial times, sugarcane was introduced in Cartagena, one of the most important port cities in the Spanish empire. Due to its wealth as a mercantile city, Cartagena became a center of luxury cookery in which sugar figured as the main ingredient. Modern Colombia has inherited this rich confectionery tradition.

Ecuador

Ecuador, as the name implies, straddles the equator, which can be reached from the capital, Quito, in about half an hour. Home to two ranges of the Andes, Ecuador is quite mountainous, although the hot and humid Pacific coast lies to the west of the Andes and the rain forest falls largely to the east. Quito (elevation ten thousand feet) is known all over the world for its architectural beauty and cultural refinement. Unfortunately, for outsiders the elevation can cause discomfort. The city lies within a short distance of the extinct volcano, Pichincha. On clear days, a ring of eight volcanoes can be seen from Quito, among them the fabled Chimborazo and Cotopaxi.

Local dishes. Ecuador has two cuisines: a highland cuisine of the Andes and a lowland cuisine of the coast. Potatoes, indigenous to the Andes, play a central role in Ecuadorian highland cooking, and its magnificent vegetables and fruits are used liberally in recipes. *Locro*, a thick potato and cheese soup, is sometimes served with avocado slices. Another popular soup, s*opa de maní*, is made from peanuts. Peanuts also figure in *salsa de maní*, a dip consisting of unsweetened peanut butter, hot peppers (*ají*), achiote (annatto), tomatoes, lime juice, garlic, and onions. The paste is also used to flavor meats and vegetables.

Fish is plentiful and most commonly prepared as seviche. One popular seviche from the coastal city of Guayaquil consists of shrimp, *ají*, and vegetables marinated in lime juice. Once the shrimp are ready to serve, they are garnished with toasted corn kernels (*cancha*), which add an interesting texture and flavor. Stews are popular in the highlands. The spicy and flavorful pork stew, *seco de chanco*, is colored with achiote oil and cooked with beer.

Although the people of Ecuador mainly eat fruit as dessert, a richly flavored pumpkin (or winter squash) cake is very popular.

Bolivia

Bolivia, a high landlocked country in central South America, is bordered by Argentina, Brazil, and Peru. The famous Lake Titicaca, between Bolivia and Peru, lies at 12,500 feet. Legend has it that an island in the lake is the ancestral home of the Incas. Near the lake's southeastern end are the ruins of Tiahuanaco, a pre-Incan city. After the conquest, Bolivia became part of Peru and was known as El Alto Peru, highland Peru. With independence, the name was changed to Bolivia to honor the liberator, Simón Bolívar.

Local dishes. Bolivians like their food hot, and *ajíes* (hot peppers) are widely used. In addition to familiar grains like wheat and corn, quinoa, an indigenous grain that the Incas called "sacred mother grain," is still commonly consumed. The Spanish prohibited the cultivation of quinoa, but it never entirely lost its appeal to the native population. It is hardy and well suited to poor conditions, such as cold weather and high altitudes. Beef and pork, introduced by the Spaniards, are important foods, as are farm-raised guinea pigs (*cuys*), a native dish popular in Bolivia and Peru. In the native culture of Bolivia, the potato played such a significant role that it was used for predicting the future, among other things. In fact, Bolivians categorized potatoes as male or female, depending on their shape, and were used accordingly in their cuisine.

In Bolivia, many food traditions remain from pre-Columbian times. One of the relics of the Inca empire is *chicha*, a popular alcoholic drink made from fermented maize.

Argentina

The second largest nation in South America, Argentina extends from the subtropics to Tierra del Fuego. Although now a separate country, Argentina was once part of the Viceroyalty of the Río de la Plata (River Plate) with Uruguay. The pampas are primarily cattle country and famous for ranching and farming, but this fertile land also produces good crops and fine wine.

Local dishes. Finger foods are very popular and are served in cafés, called *whiskerias*, that evolved from tea shops. Empanadas, stuffed pies, are popular throughout South America, and in Argentina they come in various sizes and are eaten as hors d'oeuvres, for light lunches, or with cocktails. One popular filling combines meat and fruit.

Meat is grilled or prepared in stews (*carbonadas*). The Argentines are fond of combining meat and fruit in their stews, but the most famous meat dish is *churrasco* (barbecue), beef, with large salt crystals embedded in it for flavor, is marinated in spices and lime juice and grilled on spits over an open fire. *Viscacha*, a large wild rabbit or hare, is also appreciated on the pampas. Although the focus is on meat in Argentina, excellent fish are harvested from the waters off the coast and prepared in all the usual ways, including seviche and *escabeche* (pickled fish).

Dulce de leche (milk pudding) is particularly popular in Argentina and throughout neighboring Chile and Uruguay.

Maté, also called *yerba maté*, a popular tea in Argentina, is made from the dried leaves of the evergreen, *Ilex paraguariensis*, which is indigenous to South America. The name comes from the Inca word for the calabash that was used as a container. *Maté* can be served either hot or cold.

Chile

A long, narrow country stretching down between the Andes and the Pacific Ocean, Chile is noted for its copper mines as well as for its wines. The cold Humboldt Current gives Chile the most unusual seafood in the world, including the *erizo de mar* (sea urchin) and *locos* (abalone). The middle third of the country, where table and wine grapes and other fruits and vegetables are raised, enjoys a temperate climate and is very fertile. Seafood and vegetables and fruits are more important in the diet than meat because of the relative lack of land for grazing. Because the seasons in the Southern Hemisphere are the reverse of those in the Northern Hemisphere, so-called winter fruits—apples, pears, and grapes—are exported to North America.

Local dishes. Empanadas, often served with the local wine, are popular. Chileans like soups, and, since their fruits and vegetables are plentiful and particularly good, and are enjoyed raw or cooked, many are used for soup—cabbage, for example, and tomatoes. Fish and shellfish are plentiful along the coast and are cooked every conceivable way. One of the finest fish is *congrio*, the conger eel, unique to Chilean waters. Chicken and guinea pig, both raised at home, are family fare. Meat is not so popular, though Chilean meatballs, made with veal rather than beef, are very special.

The fertile soil produces beautiful fruits, which make admirable desserts. *Pisco*, a powerful brandy made from grapes, is served both as an aperitif and as an after-dinner drink.

Uruguay

A wedge of a nation tucked between Brazil and Argentina on the Atlantic coast, Uruguay is one of the smallest countries in South America and, after Ecuador, the most densely populated. The climate is generally warm, with

Roasting meat on an open fire in the province of Buenos Aires, Argentina. This is the classic Argentine beef *churrasco* in its most rustic form. © HUBERT STADLER/CORBIS.

an even distribution of rainfall throughout the seasons. Rolling grasslands of black, potash-rich soil make raising cattle and sheep the lifeblood of the nation's economy, and roads are edged with fenced driveways for livestock. The capital, Montevideo, is home to a large percentage of Uruguay's population. Much of its industry is centered on processing wool, meat, and hides.

Local dishes. Like other South Americans, Uruguayans favor soups and stews. The Atlantic supplies some seafood, and the River Plate (Río de la Plata) is a source of freshwater fish and large frogs, both often used for soup. Meat remains paramount, however. Beef and lamb are grilled as well as braised. *Albóndigas*, fishballs or meatballs, are very popular, particularly when served with a barbecue sauce enriched with wine. *Humitas*, a seasoned corn puree, is sometimes steamed in corn husks, like tamales.

Fresh fruit is abundant and popular for dessert, especially *feijoa* (also called "pineapple guava"), an egg-shaped fruit with a wonderful perfume.

Gin Fizz (pronounced "jeen feez"), as made in Montevideo, has been described as the great glory of Uruguayan drinks. The secret probably lies in the delicate flavor of the local lemons and limes.

Paraguay

A small landlocked country, bordered by Bolivia, Brazil, and Argentina, Paraguay is known as much for its arts and culture as for its food. Asunción, the capital and by far the largest city in Paraguay, is also the cultural center of the country. The landscape is quite diverse, with lush grasslands, rolling hills, and dense forests, as well as the Chaco prairie in the west. Cattle raising and the industries associated with it are economically significant. Guaraní, the local Indian language, and Spanish are the primary languages of the country, although most Paraguayans learn Guaraní before Spanish.

Local dishes. In Paraguay, manioc (cassava), the staple food, is consumed at least twice a day, but maize is also important in the diet. Soups and stews, whether vegetable-, beef-, or fish-based, are quite popular. *So'o-yosopy* (*sopa de carne* or beef soup) is more of a stew than a soup; it is so robust that little more is needed than a light dessert to make a complete meal. It is usually accompanied with *sopa paraguaya*, which is not a soup at all but a cheese cornbread that is also served with grilled meats. Very good fish are harvested from the Paraguay River, particularly *dorado*, a firm-fleshed white fish.

Bananas are widely used in Paraguay, fresh and cooked in desserts. *Tereré* is a refreshing tea mixed with cold water and aromatic herbs such as mint, traditionally drunk during the midmorning or early afternoon break for relief from the heat. *Maté* (also *yerba maté*), which has a great deal of caffeine, is pleasantly stimulating and traditionally drunk in the morning.

Peru

The Andes, which rise from sea level on the Pacific coast to 22,500 feet, dominate this country. Peru was once the center of the Inca Empire, which extended more than

Vendors selling potatoes in the market at Saquisilí, Ecuador. Ecuador is home to some of the oldest potato varieties in the New World. © CARL & ANN PURCELL/CORBIS.

2,500 miles along the Pacific coast of South America. The capital, Lima, is on the coast. Most of the people of the empire were Quechuas. Although the term "Inca" is commonly used to describe the people of the empire, "Inca" originally referred only to the emperor. The Incas terraced and irrigated a difficult terrain, and built roads to link the parts of the empire, enabling farmers to come to town with their produce. The architecture of the Incas is known for its great size and skillful construction. Machu Picchu, one of their most famous cities, stands on a heavily forested mountaintop in the Andes. The Incas were also well known for their administrative skills.

The Incas cultivated thousands of varieties of potatoes many thousands of years ago, and figured out ways to preserve them at high altitudes, either by drying or freeze-drying. The Quechuas also raised quinoa, a hardy plant that thrives where corn cannot grow. The Quechuas had few animals except for the cameloids (the llama and the alpaca) and the *cuy* (guinea pig). The *cuy* is an excellent food animal, and the llama provides wool, leather, fat, and dung for fertilizer, fuel, and building material, as well as meat. Llama meat is made into ham, and c*harqui*, or dried llama meat, has remained popular among the native population.

Local dishes. Peru has a real food culture. Peruvians like to eat at home and on the street. For example, in Lima the best place to buy *anticuchos* (skewered beef heart) is from stalls outside the *plaza de toros*, built in the 1700s. At home, they make an excellent hors d'oeuvre. Fish and shellfish are enormously popular on the coast and are prepared in myriad ways, including seviche. Along the shore, *cebicherias* serve fresh seviche night and day. Fowl have been known since pre-Columbian days, and the Quechuas knew how to freeze-dry duck. Turkey is very popular, especially for special occasions. The Europeans brought their domestic animals with them, and these have had enormous impact in Peru and elsewhere in South America. Besides grilled meats, Peruvian city folk are fond of *chicharrones*, pork rinds fried in lard, sold by street vendors.

In addition to potatoes and the local large-kernel maize, Peruvians cultivate many other vegetables, including a number of special hot peppers (*ajíes*), which they use in soups and stews, often serving them alone as well. Although Peruvians like sweets—homemade puddings and cakes, store-bought pastries, and convent sweets (although that tradition is dying out in Peru)—they are generally prepared and eaten outside the home, as they are in Europe. Dessert at the end of a meal is more likely to be fresh fruit. *Pisco*, the potent Peruvian brandy, is enjoyed straight or in a *pisco* sour.

See also **American Indians: Prehistoric Indians and Historical Overview**; **Brazil**; **Caribbean**; **Central America**; **Coffee**; **Columbian Exchange**; **Fruit**; **Iberian Peninsula**; **Inca Empire**; **Maize**; **Mexico**; **Mexico and Central America, Pre-Columbian**; **Vegetables**.

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Elisabeth Lambert Ortiz
With contributions by Enrique Balladares-Castellón

SOUTHEAST ASIA.

This entry includes three subentries:
Indonesia, Malaysia, and the Philippines
Thailand
Vietnam

INDONESIA, MALAYSIA, AND THE PHILIPPINES

Since cuisines are born on the land and grow within its climate, contours, topography, and geography, Indonesia, Malaysia, and the Philippines have bred sister cuisines that find similarities as well in Thailand, Vietnam, Laos, Cambodia, and Brunei Darussalam. It is thus possible to speak of Southeast Asian cuisine even while acknowledging the regional differences that come from history, society, and culture.

Indonesia, for example, with its fifteen thousand islands, covers a large portion of Southeast Asia, and in the early twenty-first century its population (209.4 million) ranked fourth among the world's most populous nations. Although the islands vary greatly in size, climate, and soil and thus in cuisine, it is possible to speak of pan-Indonesian culinary traditions, to set them in their regional contexts, and to invite comparisons with their neighbors.

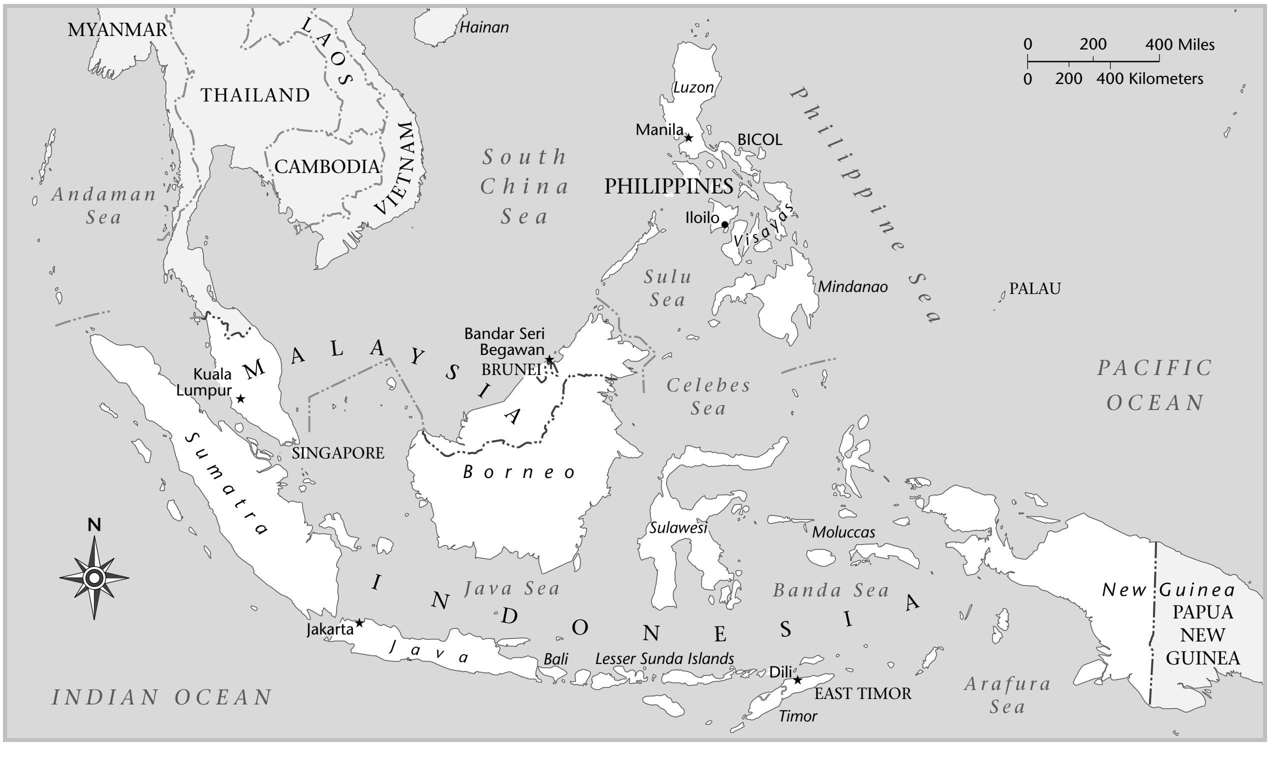
Malaysia is contiguous to Singapore on one side and to Brunei on the other. Its land, weather, and geographical features are similar to those of the rest of Southeast Asia. However, its population (23 million) is composed of Malay Muslims, Peranakan or Straits Chinese with roots in South China, and Indians, mainly from South India, so it developed three principal cuisines, Malay, Indian, and Chinese. The country's leaders emphasize its multicultural nature and consider all three cuisines equally national.

The Philippines (population 75.8 million), with seven thousand islands, many of them small, has the longest discontinuous coastline in the world. With its tropical weather, plains and mountains, and wealth of water sources, it developed a culinary pattern similar to those of Indonesia and Malaysia. History and the colonial experience, Spanish for almost four hundred years and American for forty years, mediated and transformed its basic Asian cuisine.

Indonesia, Malaysia, and the Philippines therefore demonstrate cuisines that grew on virtually the same soil and in analogous weather conditions but which developed individual, regional characteristics through the actions of history and society on the countries' cultures. Certain similarities and commonalities stand out, however, even before the differences.

Rice

Meals in all three countries assume the presence of rice, without which the repast is not a meal but a snack,


MYANMAR
LAOS
Hainan
THAILAND
CAMBODIA
VIETNAM
Andaman Sea
South China Sea
0 200 400 Miles
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Luzon
Manila
BICOL
PHILIPPINES
Philippine Sea
Iloilo
Visayas
Sulu Sea
Mindanao
PALAU
Bandar Seri Begawan
BRUNEI
Kuala Lumpur
MALAYSIA
Celebes Sea
PACIFIC OCEAN
SINGAPORE
Borneo
Sumatra
N
Sulawesi
Moluccas
Java Sea
Banda Sea
INDONESIA
New Guinea
PAPUA NEW GUINEA
Jakarta
Java
Bali
Lesser Sunda Islands
Dili
EAST TIMOR
Timor
Arafura Sea
INDIAN OCEAN

pangtawid gutom, just to bridge hungers, Filipinos say. To the native varieties modern research, for example, that conducted by the International Rice Research Institute (IRRI) in the Philippines, has added high-yield, pest-resistant strains. But Asians treasure traditional strains for their fragrance, particular characteristics, and lore.

Deep from mythic history come the rice stories. The Bagobo people of Mindanao talk of the hero Lumabat, who wished to explore the sky with his sister Mebuyan. She refused, sitting firmly in a rice mortar, which sank into the earth with her as she scattered handfuls of rice. She has stayed underground since then. In a Javanese story Tisnawati, daughter of the supreme god Batara Guru, falls in love with a mortal, Jakasudana, of whom her father disapproves. The father punishes her disobedience by turning her into a rice stalk, but then, in pity, he transforms Jakasudana as well. Their marriage is reenacted by the Javanese harvest ritual in Malaysia.

The cooking of rice proceeds in similar ways. It is washed, cooked in water (steamed, boiled, or parboiled), and made the background and taste-shaper of Southeast Asian meals. Because of its mildness, rice invites contrasting tastes, the hot curries of Malaysia, for example, the chili-hot *sambals* of Indonesia, or the salty preserved fish *(tuyo, daing)* of the Philippines. It can be fried, as in Indonesian *nasi goreng* and the morning-after garlic-flavored Philippine breakfast rice *(sinangag)*. Malaysians cook rice in coconut milk for the favorite breakfast dish *laksa* and cook thick coconut milk with fragrant herbs until it becomes oil to make *nasi ulam*, which the writer Sri Owen calls a Malaysian version of the British-Indian kedgeree.

All throughout the region, of course, rice is the basis of cakes and other snacks. Glutinous rice cooked in coconut milk with sugar or salt, sparked by ginger, appears everywhere, bare in bamboo baskets; layered, varishaped, or colored; wrapped ingeniously in coconut fronds, banana leaves, or other leaves; and in fresh and artful native packaging designs. *Kue bugis* are Indonesian steamed-rice cakes filled with sweetened grated coconut and cooked in banana leaves. Malaysia has *kui wajek*, a pudding of glutinous rice, coconut milk, palm sugar, and knotted pandanus (screw pine) leaves and tapeh, fermented glutinous rice with sugar.

The word *suman* is used in the Philippines for many kinds of steamed, leaf-wrapped glutinous rice rolls eaten with grated coconut and sugar and sometimes with ripe mangoes. *Bibingka* is a flat, golden rice cake cooked with coals above and below, and *puto* refers to innumerable steamed cakes of rice flour, some small and round, others platter-sized or cylindrical. A traditional Christmas food is *puto bumbong*, a violet-colored rice *(pirurutong)* steamed upright in bamboo tubes.

Rice is also cooked soft as a porridge, congee, snack, or breakfast food. Filipinos, who inherited rice directly from Chinese traders and migrants, serve it with condiments, such as minced vegetables, shredded meat, chopped nuts, and century egg slices; plain, especially for children and the sick; or cooked with fish, chicken (*arroz caldo* or rice soup), or tripe *(goto)* and served sprinkled with browned garlic, green onions, fish sauce, and lime juice. In a dish learned from Mexico, rice is also cooked with chocolate *(champurrado)* and served with bits of salted fish or dried venison.

Malaysian *kai cheok* is a rice porridge with shredded chicken meat, crisp-fried shallots, a little oil, pepper, shredded ginger, spring onions, and light soy sauce. Indonesia has a chilled rice soup made from soft-cooked rice with fresh coconut milk and small slices of sweet papaya that is served for breakfast or as a cool summer refresher.

The main dishes range through the region's favored flavors, including the Indonesian *sambal goreng udang* of prawns or shrimp and rice; the Hainanese chicken rice of Singapore and Malaysia with its soup, rice steamed in broth, and sauces hot and otherwise; and the Philippine *bringhe* of glutinous rice, coconut milk, chicken, and Spanish chorizo. Rice as staff of life—food for principal meals and for snacks, food for rituals and celebrations, food that shapes tastes and dietary patterns—certainly is a common denominator in Southeast Asia.

The Coconut

The "tree of life" is shared by Southeast Asia and the Pacific Rim. From Hawaii and Tahiti and all through mainland and island Southeast Asia, coconuts are grated, often on beautiful graters of folk design, and squeezed in water for the "first milk" or cream then again for the thinner milk, for which there are specific uses in dishes.

The milk is thick when used in *rendang*, the Minangkabau dish of buffalo meat or beef cooked long and spicy with shallots, garlic, ginger, turmeric, chilies, and *laos*. The dish can keep for months because the milk turns to oil in the course of cooking. The Malaysian *kambing korma* or lamb curry is mutton or lamb cooked in spices and thick coconut milk. The Javanese *pepes ikan*, on the other hand, is fish wrapped in banana leaves with herbs, spices, and desiccated coconut soaked in warm water for five minutes (not squeezed). The Philippine Bicol region is known for many dishes of meat (beef, chicken, pork), fish, shrimp, and vegetables (*santol* pulp, young jackfruit, chilies) cooked in coconut milk that is thick or thin or both.

Young coconut is also used. In Laguna province in Luzon it is cut in strips and sautéed like noodles or steamed with river shrimp in coconut water. In Iloilo Province in the Visayas it is cooked with chicken into a soup called *binacol*. Young and mature coconuts, including the "sport" coconut, called in Filipino *makapuno*, full, because it is flesh filled, make possible a stellar parade of candies and sweets, including the Philippine *bukayo* (coconut candy) and sweet *makapuno* (syrup, lime rind); the doughnut-like Malaysian *kuih keria* of sago, rice, and

SPICES OF SOUTHEAST ASIA

The range, subtlety, intensity, melding, and reinvention of flavors are made possible by the spice table shared by almost all of Southeast Asia. Among the spices are:

English	Malaysian	Indonesian	Filipino
garlic	*bawang puteh*	*bawang-putih*	*bawang*
ginger	*haliya*	*acuga, jahe*	*luya*
galingale	*lengkuas*	*laos*	*langkawas*
chili	*chilli-api, chabai*	*lombok kecil*	*siling labuyo*
lemon grass	*serai*	*seri*	*tanglad*
Kaffir lime	*limau purut*	*jeruk purut*	
curry leaves	*daun kari*		
mint	*pohok*	*janggat*	*yerba buena*
basil, holy	*sellaseh kemangi*	*kemangen*	*sulasi*
basil, sweet	*selaseh putih*	*selasih*	*balanoi*
coriander			
leaf cilantro	*ketumbar*	*katumber*	*wan soy*
coriander seed		*ketumbar*	*kulantro*
turmeric		*kunyit*	*dilao*
star anise		*bunga lawang*	*sangke*
cloves		*cengkeh*	*clavo*
cinnamon		*kayu manis padang*	
cumin		*jintan puteh*	*jinten*
pepper		*merica*	*paminta*
parsley	*shelwri*	*patraseli, seledri*	*parsli*
mustard seed	*biji savi*		*mustasa*
nutmeg		*pala*	
tamarind	*asam*	*asam Java*	*sampalok*

grated coconut; and the Indonesian *serikaya* (coconut custard) and *onde-onde* (small rice cakes rolled in grated coconut). The flavor of coconut at all its stages is savored throughout the region in recognizably compatible ways.

Spices, Herbs, Relishes

Southeast Asian tables generally bear not only serving platters with dishes to be shared and individual plates or bowls but also little satellite dishes for dipping sauces, spices, chopped herbs, and relishes like shrimp paste and fish sauce. The meal may be prepared by great cooks or chefs, but each diner has the right and freedom to fine-tune the dish to his or her individual taste by dipping, pouring, mixing, and sprinkling and thus giving the dish its final grace.

Among the possibilities are the Indonesian *sambal* and *sambel*, hot and spicy relishes served with food. They feature red and green chilies, hot bird peppers, *terasi* (shrimp paste, which is made by salting and mashing tiny shrimp and allowing them to ferment), lemon, lime, soy sauce, shallots, chili powder, tamarind water, salted yellow beans, and more, depending on the dish they are to accompany. Others are *serundeng* (roasted grated coconut) and *goreng bawang* (crisp-fried onions) to sprinkle on particular dishes.

In the Philippines dipping sauces are called *sawsawan* and could be basic vinegar, soy sauce, *patis* (fish sauce, made by salting and fermenting small fish); *calamansi* (lime) juice; combined vinegar-soy or *patis-calamansi;* or enhanced with herbs and spices, such as crushed peppercorns, ginger, garlic, chili peppers or seeds, coriander leaves, pork or crackling bits, and salted black beans. *Achara*, such as pickled papaya, mangoes, heart of palm, and chilies, are accompaniments as well. These make it possible to satisfy individual palates or to make each mouthful a different delight.

Parallels exist in Malaysian and Singaporean cooking, including prawn and shrimp pastes (*blacan terasi* and the mild Chinese liquid *hei-ko*); dried anchovy and fish sauce; the *rempah* spice mixture of *sambal* and *achar* (mangoes, mixed vegetables); and *goreng bawang* (crisp-fried onions). The famous Hainanese chicken rice of Malaysia and Singapore may come with *sambal belacan* (red chilies, shrimp paste, limes) or at least three sauces, a fresh-made chili sauce, finely crushed ginger and oil, and soy sauce. *Nasi lemak*, the Nonya-Malay rice steamed in coconut milk, and its satellite dishes constitute the traditional festal dish for the twelfth day of a wedding. The accompaniments may include *sambal udang* (shrimp), *ikan kuning* (small fried fish), cucumber slices, and sliced red chilies.

The renowned Indonesian *rijsttafel* (rice table), although based on feasts of yore, has become largely a Dutch custom. Rice, the central dish, is surrounded with smaller dishes and relishes. Popular in Indonesia is a miniature *rijstaffel* called *nasi rames* with some seven side dishes, like *dendeng ragi* (beef and grated coconut), *sayur lodeh* (spicy vegetable stew), *rendang* (beef cooked in spices and coconut milk), *kering tempe* (crisp-fried *tempe*), *kelia ayam* (Sumatran chicken curry), *sambal bajak* (mixed spice relish), and *krupuk* (prawn crackers). Each spice-enhanced dish introduces a flavor or flavors to harmonize with the rest in a whole Asian experience.

The sauces include fish, oyster, *hoisin*, chili, plum, black bean, yellow bean, chili bean, red bean, shrimp paste, sesame paste, and soybean; the cooking fats and oils are peanut, rape seed, coconut, sesame seed, palm, and chili; and the vinegars are rice, coconut, palm, sugar cane, and fruit. Combining all with the *sambals* and other made-up cooked or mixed combinations creates a repertoire of unnumbered possibilities, all Asian or Southeast Asian, a kaleidoscope of flavors and flavor makers.

Chinese and Other Foreign Influences

All three countries have significant Chinese populations, which even make up a full third of the population in Malaysia, that may or may not have integrated successfully in the cities and villages. Consequently all have strong Chinese dietary strains in their cuisines. Even during racial conflicts—riots in Malaysia, wars and ghetto burning in the Philippines, discrimination and segregation in Indonesia—the foods melded and the Chinese presence became a matter of fact, even of pride.

Nonya cooking in Malaysia originated among Chinese immigrants who settled in Malacca in the fifteenth century. Daughters of well-to-do Nonya women were trained in household and cooking skills from early childhood. The cuisine uses chilies, shrimp paste, coconut milk, and aromatic roots and leaves as in the Malaysian and Indonesian traditions but also retains pork and noodles from its Chinese past.

The *popiah* or spring roll is often served in its separate pieces—the wrapper pancakes; fillings, possibly including eggs, sausages, bean curd, bean sprouts, prawns, cucumber sticks, spring onions, lettuce leaves, pork, crab meat, bamboo shoots, and water chestnuts; and sauces and relishes—on a round table at which each diner creates a spring roll to taste. The Nonya pork *sate* is a compromise between a Muslim prohibition and a Chinese taste for pork. The resulting taste is Malay, with chilies, coconut milk, lemon grass, and coriander.

In the Philippines the first public eateries were Chinese establishments that served indigenized *comida China* (Chinese food) in restaurants called *carinderia*, a Spanish formulation from a native word *cari* or *kari*, cooked food. To accommodate the Spanish patrons, the food had Spanish names, such as *aletas de tiburon* (shark fins), *tortilla de cangrejo* (crab omelet), *camaron rebozado* (batter-coated shrimps).

Widely popular and variegated is the *lumpia*, a vegetable or pork spring roll in a thin flour wrapper, the local edition of the Malay *popiah*. The noodle dishes, generically called *pansit* from the Hokkien word for that which is quickly cooked, vary from region to region, indeed family to family, cook to cook. *Char kway teow* is the most popular Malay-Singaporean noodle, but in the Philippines the most popular is *pancit palabok*, noodles shaken in water or broth and covered with a sauce of shrimp, pork, vegetables, bean curd, and sometimes squid, oysters, crumbled crackling, and flaked smoked fish. In Indonesia it may be *mie jawa*, which includes *bakmie goreng* (fried noodles) or *bakmie godog* (noodle soup), egg noodles with beef or pork, shrimp or prawns, carrots, bean sprouts, shallots, candlenuts, and other seasonings.

Each country's colonial and social histories left deep imprints on its cuisine, the roots of many regional differences. The Spanish-Mexican and American colonial regimes, building on the indigenous and Chinese food already in place, shaped what is now known as Philippine cooking. Native to the soil are dishes like *sinigang*, a sour stew of meats, crustaceans, fish, or fowl soured with tamarind, *bilimbi*, green mango, or other sour fruits and leaves. Sour broths are cooling to the skin, especially in tropical weather. Indigenous too are fresh meat, fish, and fowl, steamed, simmered, boiled, or roasted, and vegetables cooked in coconut milk or steamed and flavored with shrimp paste or fish sauce.

Filipinos indigenized Chinese, Spanish-Mexican, and American dishes through the use of native ingredients and cooking by native cooks with homegrown taste buds. Among those dishes are Spanish stews *(cocido, puchero)* with eggplant or squash relishes; the Mexican tamale transformed from a corn snack wrapped in corn husks into a rice snack wrapped in a banana leaf; a Chinese porridge cooked in the Philippines with chicken and *kasubha* (a saffronlike spice) or including unhatched eggs; beef hamburgers with soy and chopped onions; and steaks marinated in soy sauce and lime juice before grilling. The foreign food has been accepted but adapted to local tastes.

The colonial experience gives Philippine dishes a European-American dimension, just as British colonization colored Malay-Singapore food and Dutch domination redefined Indonesian cooking. Of the latter two, however, the Dutch influence is the lightest, because the colonizers

OTHER REGIONAL CUISINES

Most Southeast Asian societies have been in contact with each other and with other societies, such as India and China, for many centuries. Within Southeast Asia food serves as an ethnic and national marker, distinguishing one group from another. The region is characterized by a great diversity of cuisines that have been shaped by local geography, ecology, religion, and history. Despite the diversity, distinct commonalities exist. Ingredients like coconut milk, lemon grass, galingale, ginger, Asian basil, mint, fish sauce, and shrimp paste are used throughout the region. However, cooking techniques and the ways these ingredients are combined vary greatly and give each cuisine its distinctiveness.

Lao People's Democratic Republic

Rice, especially the glutinous variety, is the staple for Lao meals. Other frequently used ingredients include fresh vegetables, freshwater fish, poultry, duck, pork, beef, or water buffalo. Lime juice, lemon, fresh coriander, and various fermented fish sauces give Lao food its characteristic flavor. *Pla daek,* a highly pungent fermented fish sauce, is often considered an ethnic marker. Additionally its heavy use throughout the country and the consumption of *laap* are indicators of the cultural and historical links with Northeast Thailand. Hot chilies, garlic, mint, ground peanuts, tamarind juice, ginger, and coconut milk are other seasonings that link Lao cuisine to others of the region. A soup, such as *kaeng nor mai* (bamboo shoot soup) or *kaeng het bot* (mushroom soup), is a common feature of Lao meals. One popular dish eaten by the Lao is *feu,* a noodle dish of Vietnamese origin. Another noodle dish, *klao poun,* is served cold with a variety of raw chopped vegetables and a flavored coconut milk sauce and is often a part of celebrations. *Or lam,* a regional dish in Luang Prabang, combines lemon grass, sweet basil, dried buffalo meant and skin, chilies, and eggplant.

Myanmar (Burma)

Myanmar is a diamond-shaped country bounded by China, Laos, and Thailand in the east, by Bangladesh and India in the north, and by the Indian Ocean in the west and south. The landscape is mountainous, and only about one-sixth of the country is considered arable. Of the arable land, approximately one-tenth is irrigated, mostly for rice agriculture. The cuisine is considered a blend of Burman, Mon, Indian, and Chinese influences, and hot and spicy dishes particularly show the influence of Indian and other Southeast Asian cuisines. Rice, the core of most meals, is often eaten with curries of fish, chicken, or prawns, and noodles and vegetables are common local ingredients. Taste combinations of onion, ginger root, garlic, turmeric, and chili pepper give the cuisine its distinctive flavor. The curries in Myanmar are the mildest in Southeast Asia, but the heat level can be intensified by adding *balachaung,* a condiment made from chilies, tamarind paste, and dried shrimp, or *ngapi kyaw,* a hot and pungent shrimp paste fried in oil with garlic and onions.

Kampuchea (Cambodia)

Kampuchea shares borders in the north with Laos and Thailand, in the east with Vietnam, and in the southwest with the Gulf of Thailand. Khmer is Cambodia's official language, and Theravada Buddhism is the dominant religion. Fish, rice, coriander, and lemon grass are common dish ingredients. A Cambodian meal almost always includes a soup, which is eaten with the other dishes. As elsewhere in Southeast Asia, freshwater fish is a mainstay. Some dishes reflect the influence of French cooking, as does the use of bread.

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were not too interested in changing the native culture of the colonized. However, Spanish colonization of the Philippines, which meant Christianization as well, was much more deeply engaged in culture change, as was American colonization, which made its impact through language and education. In Malaysia, the Indians, Chinese, immigrant elites from East and Southeast Asia, and Europeans influenced food more strongly than did the British.

Southeast Asian Cuisine in the Twenty-first Century

Although it is logical and true to speak of the individual sister cuisines of Southeast Asia, they are variations on regional themes. A common repertoire of spices, rice, coconuts, vegetables, fish, fowl, and animals exists. The lands and waters and the trade and interaction have made that inevitable. Thus the cuisines have compatible attitudes, common practices, and recognizable similarities. However, the differences wrought by history, especially the colonial experiences and the strategies of survival; social forces, including war, peace, trade, and population; and the countries' cultures, that is, the way people think, work, survive, and express themselves, have resulted in the kaleidoscope of tastes and dishes in Southeast Asia.

The Indonesian *pisang goring*, bananas mashed with sugar and flour, and the Philippine *linupak*, green bananas mashed with sugar and coconut, and *pinasugbu*, green banana slices dipped in molasses syrup, are variations on a theme. The Nonya pancake, a teatime snack filled with palm sugar and served with chocolate sauce, and the Philippine *piaya*, a flat cake filled with brown sugar and sprinkled with sesame seeds, are also variations. The similarities are clear, but regional circumstances gave them particular characteristics. On warm afternoons Indonesians enjoy *es cendol*, short strands of two kinds of flour sieved, flavored, and served with sugar syrup, coconut milk, and ice crushed or cubed. Malaysians have *bubor cha-cha* with yam and sweet potato cubes, tapioca, sweet coconut milk, and ice shavings. Filipinos serve instead *halo-halo* (literally mix-mix) with palm fruit, gelatin cubes, banana slices, sweetened coconut strands, milk, and crushed ice. The mixtures are analogous because the weather and the habits of refreshment are too.

The famous dishes of each cuisine may have tastes familiar and acceptable to the whole region, but they are different and make a rich repertoire. In Malaysia celebrations may include chili crab, *satays*, a steamboat, the Nonya *sambal sotong* (squid) or *sambal udang* (prawns), *bakwan kepiting* (a Nonya must for Lunar New Year's and birthdays), the Hokkien-Nonya *ngoh hiang* (five-spice rolls with prawns, pork, and crab meat), *rebong masak lemak* (chicken and bamboo shoots), *sambal kim chiam* (a salad of banana buds), Indian-based vindaloo (chicken or duck), and clay pot dishes and soups of Chinese origin. Malaysians and Singaporeans consider many other dishes connected to their multicultural family feasts and traditions.

Philippine feasting often features colonial food, such as Spanish stews *(cocido*, *puchero)* with sausages (chorizo, *morcilla*); sugar-glazed Christmas hams *(jamon en dulce);* stuffed turkeys and capons *(pavo embuchado*, *capon rellenado);* and American salads, pies, and cakes, once considered elite and thus appropriate for celebrations. To these time and custom have added specialties of Chinese origin, especially noodles, roast duck, roast pig, steamed fish chosen live from a tank, bird's nest and shark fin soups, and delicate dumplings and buns. The indigenous rice cakes, rolls, and desserts; stews like *kari-kari* (oxtail); and special dishes like *lechon* (tamarind leaf– or lemon grass–stuffed suckling pig skewered and roasted on an open fire) are the local contribution to a cuisine that combines the indigenous, the indigenized, and even the imported.

Indonesia, with so many regional traditions, has one of the richest cuisines, and the Western world, which has sent more scholars to Indonesia than to any other Southeast Asian country, has explored it. The names sound rare and enticing, like the famous beef *rendang;* the hearty *gado-gado* salad of cooked vegetables; the different *gulai* (vegetables like *pako*, fiddlehead fern) cooked in coconut milk; fish and fish cakes; *sates* of lamb, beef, and chicken; *bebek dengan bumbu betutu* (duck breasts in Balinese spices); *bubur ayam* (rice porridge with spicy chicken soup); and sweets like *rujak* (a spiced fruit salad), *marabak kubang* (Sumatran stuffed pancakes), and *lapis legit* (spiced layered cake). Southeast Asian ingredients, spices, cooking methods, dishes traditional and new, meal patterns, and border-crossing food and foodways remind readers of cookbooks, menus, and travel, ethnographic, and anthropological accounts that the words are the merest keys to cultures deep and rich, starting points for meals, for cultural interactions, and for rich conversations with national identities, time, and traditions.

See also **China**; **Rice**.

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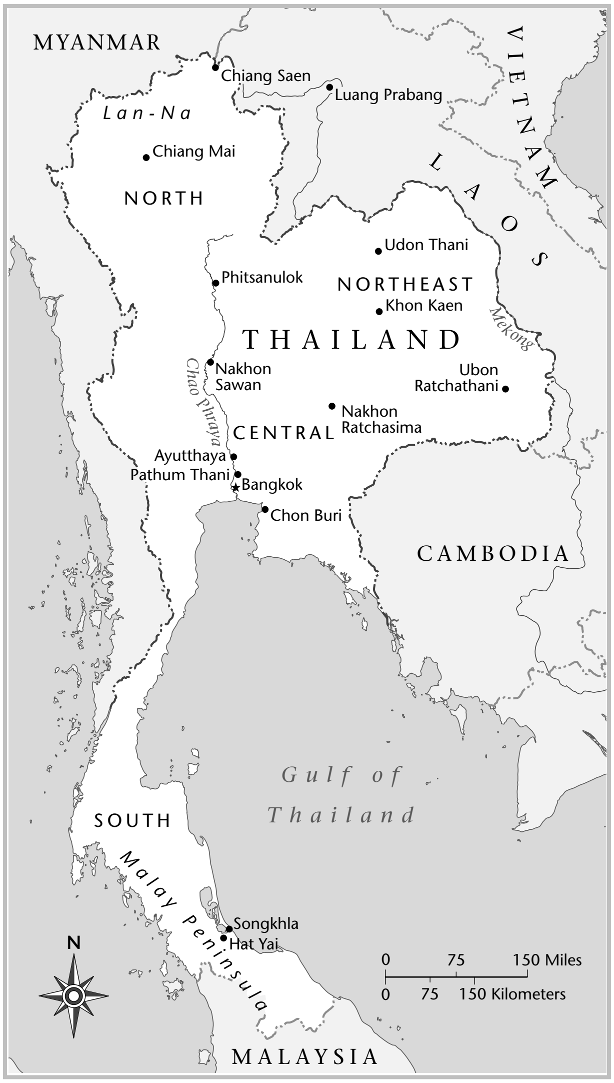
Doreen Fernandez

THAILAND

Thailand is situated in the heart of mainland Southeast Asia. Located between latitudes 5° and 21° north and longitudes 97° to 106° east, it borders the Lao People's Democratic Republic (Lao PDR) and Myanmar (formerly Burma) to the north, Cambodia to the east, Myanmar to the west, and Malaysia to the south. Tropical temperature and rainfall patterns predominate throughout much of the country and influence its culinary traditions. Thailand, once called Siam, is distinguished from most other Southeast Asian countries by the fact that it has not ever been ruled by a European power. The monarch is a member of the Chakri dynasty, which has led the kingdom since 1782. Much of the Thai cuisine evolved in the central region during the Sukhothai period (1238–1350 B.C.E.). The rise of Ayutthaya in the fourteenth century brought an increase in trade, and outside influences became more pronounced. China, India, Indonesia, and Cambodia exerted strong influences, as did some European countries. After the fifteenth century domesticates from the Americas, such as the chili pepper and the tomato, were introduced. The complex of seasonings and dishes regarded as Thai cuisine was probably well established by the 1800s.


MYANMAR
VIETNAM
Chiang Saen
Luang Prabang
Lan-Na
Chiang Mai
LAOS
NORTH
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Phitsanulok
NORTHEAST
Khon Kaen
Mekong
THAILAND
Chao Phraya
Nakhon Sawan
Ubon Ratchathani
Nakhon Ratchasima
CENTRAL
Ayutthaya
Pathum Thani
Bangkok
Chon Buri
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Gulf of Thailand
SOUTH
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MALAYSIA

Staples, Specialties, and Etiquette

Rice and fish were first used as metaphors for prosperity and security in the inscription from King Ramkhamhaeng (1283 C.E.): "In the water there are fish, in the paddies there is rice" *(nai nam mee pla—nai na mee khao)*. Rice, fish, and local fruits and vegetables form the centerpiece of Thai cuisine. Considerable evidence suggests that the domestication of wild rice occurred in the Yangtze Valley in China and later spread to Thailand and other areas in Southeast Asia. Rice is more than just a culinary staple. Rice agriculture is the primary farming activity nationwide, an integral way of life often portrayed in songs, poems, novels, and films. Rice is so central in the Thai diet that the most common term for "to eat" is "*kin khâo*," literally "eat rice," and a common greeting is "*Kin khâo láew réu yang?*" literally "Have you eaten rice yet?" Regional distinctions exist in the type of rice consumed. Sticky or glutinous rice *(khâaw niaw)* is consumed widely in the north and the northeast, and plain white rice *(khâaw jâo)*, especially jasmine rice, is popular in the central and southern regions (see "Thai Regional Cuisine" below). Glutinous or sticky rice is a variety *(Oryza sativa)* that requires a shorter growing season and contains a large amount of amylopectin starch. The high proportion of amylopectin causes the kernels to disintegrate when boiled. Consequently glutinous rice is usually soaked and then steamed in a container above the water.

Garlic harvest at Mae Hong Song, Thailand. © JOHN HUME; EYE UBIQUITOUS/CORBIS.

Eating in Thailand is usually done in a social context rather than alone. In Thai the word for "meal" is "*meu*," and meals usually consist of rice accompanied by various side dishes that are not eaten in any specific order. Frequently meals include a soup, a curry *(kaeng)*, a salad, a steamed or fried dish, and at least one dipping sauce, such as fish sauce *nam pla* or one of the various forms of the hotter *nam prik*. Dessert usually consists of fruits, although various sweets called *kanome*, which are sometimes eaten as snacks, can also be served at a meal. Specific foods are seldom limited to certain times of the day, and distinctive breakfast, lunch, or dinner dishes do not exist. Some Thai food is eaten with the fingers, especially in certain regions of the country or specific foods such as sticky rice. The use of a fork and spoon predominates in urban areas, where the fork is used to push

Thai cooking is noted for its elaborate presentation. This expert carver is sculpting fruit for the Sala Rim Restaurant in Bangkok. © RICHARD T. NOWITZ/CORBIS.

food onto the spoon rather than to bring food to the mouth. Knives are not commonly used because food is usually cut into small pieces before it is cooked.

Traditionally some distinction is made between food eaten by royalty *(ahaan chow wang)* and village food *(aahan chow bâan)*. The primary difference lies not so much in the ingredients as in the use of serving dishes, in the variety and number of side dishes, and in the presentation style as food is transformed by carving, shaping, or decorating to change its appearance. In addition to an artistic presentation, palace food has often required many hours of preparation. Traditional palace food is served in Bangkok at restaurants specializing in this type of cuisine. Some royal desserts such as *foi thong* (golden threads), a dessert made from egg yolks and sugar, and *luk choob*, small mung bean paste sweets, similar to marzipan, shaped into small replicas of various fruits, colored with vegetable dyes, and glazed in the gelatin-like agar-agar. These sweets also can be obtained in many large grocery stores and from some street vendors.

A twentieth-century development, especially in the urban areas, was the rapid rise in Thai street food. Sometimes considered a culinary form in its own right, street food is characterized by rapid preparation methods and includes a wide variety of categories. Snacks, such as sliced fruits or sweets, are common, as are noodle dishes and main dishes. Usually each vendor concentrates on one of these categories of food. Sidewalk food vendors are regulated by official authorities in each city. This form of culinary activity clearly fills an important niche in the cosmopolitan Thai lifestyle.

The Tastes and Flavors of Thai Food

The consumption of meals is guided by the qualities of taste, smell, and texture. Often these are the same qualities that guide health-promoting behavior. Foods are classified and categorized in a variety of ways. The ingredients selected for cooking frequently have medicinal properties. Penny Van Esterik (1988, p. 753) notes that the taste relationship is so close to concepts of health that the head teacher of the Traditional Medical College identified medicine *(ya)* as "anything which can be eaten to improve one's health." The basic taste qualities overlap with the medicinal tastes of traditional Thai medicine, which is related to the Indian Ayurvedic system. These taste contrasts guide the combination of ingredients or the combination of dishes with rice. The tastes are primarily derived from local plants, resins, oils, roots, insects, and algae, many of which are gathered wild from forests, ponds, and rice paddies.

Flavoring is a defining characteristic of Thai cuisine that imparts regional or ethnic identification, a sense of familiarity, and a sense of tradition. Most Thais speak of five important tastes as the hallmarks of Thai food, sweet, sour, salty, bitter, and hot-spicy. The ideal meal is often designed to include these tastes, and sometimes several of the tastes are subtly combined in an individual dish. Despite regional differences, much of Thai food is characterized by a combination of *naam plaa* (predominantly in the central, northern, and southern regions) or *plaa daek* (in the northeast), lemongrass, ginger, galingale, Thai basil, garlic, and chili peppers. A wide variety of chili peppers is used, different types imparting distinctive

REGIONAL CUISINES OF THAILAND

Thailand is divided into four regions, the North, Northeast, Central, and South, which vary in geography, natural resources, culture, and history of contact with outer societies. Consequently each is characterized by its own foods and style of eating, although the increase in communication and extensive internal migration has been accompanied by the movement of regional dishes into different areas within the country.

The North
Northern Thailand, site of the early Thai city-states Lanna, Chiang Mai, and Chian Saen, borders Myanmar, Laos (Lao PDR), and China. Consequently the food of the North is an amalgamation of cuisine from these areas. The importance of sticky rice in the North is a reflection of dietary influences from Laos. The use of pork, tamarind, and turmeric belies the influence of Myanmar, as does the regional specialty *kaeng hang le* (a pork curry). Mild-hot, salty, and sour tastes predominate, and local dishes contain bitter acacia leaf, eggplants known for their bitterness, sour tamarind juice, and pickled bamboo shoots. A traditional form of a meal in this region is the *khantok* (*khan* means bowl, *tok* means low, round table), during which diners sit on the floor around a low table.

The Central Region
The Central region dominates the nation politically and economically. Hot, salty, sweet, and sour tastes predominate there. The cuisine of Central Thailand is characterized by curries made with coconut milk and spices, such as *kaeng phèt* (red curry) and *kaeng khĭaw wăan* (green curry). Stir-frying with basil and curry paste *(phàt phèt)* is also common, as are the well-known soups *tôm yam gôong* (spicy shrimp soup) and *tôm khà gaì* (chicken coconut soup). *Yam,* the hot and tangy salad, is most popular served with squid or barbecued beef or pork. The Chinese community has had a large influence on Central Thailand as can be seen in *Kŭaytĕow,* noodle dishes, and the clear bitter soups made with green squash, bitter gourd, and ground pork. The eastern seaboard region is increasingly gaining attention as a separate region characterized by its reliance on seafood and distinctive fruits.

The Northeast (Isan)
Isan is characterized by hot, spicy, salty, and sour tastes. Food in this region reflects its relationship and similarity to neighboring Lao PDR. Some of the earliest archaeological sites in Asia with evidence of agriculture, pottery, and bronze work are located in the Northeast. Consumption of glutinous rice is a distinctive characteristic of Isan. The food is frequently flavored with *pla daek,* a fermented fish sauce. One special dish from the region is *laab* or *kôy.* This dish is a blend of minced meat, fish sauce, herbs such as cilantro and mint, scallions, lime juice, ground roasted sticky rice, and chilies either fresh or in powdered form. *Sôm tam,* a spicy green papaya salad, and grilled chicken are also characteristic of Isan.

The South
South of Bangkok the country rapidly narrows to a strip of land connecting Thailand with the Malay Peninsula. Culturally the South is distinctive, with a large Muslim and Chinese population. Hence much of the food of the South combines Thai, Malay, and Chinese elements, and the prevailing tastes are hot, spicy, salty, and sour. Curries in the Indian style, such as Massaman curry, are the predominant features of southern meals. Additionally influences from the Middle East and Pakistan are evident, for example in *roti* (flat Indian bread). The use of a pungent, flat bean, *sato (Parkia speciosa),* which imbues a bitter taste is also favored in this region.

tastes, colors, and levels of hotness, such as the small and extremely hot *prik ki nu.* In addition mint, coriander, lime, and kaffir lime leaves (*Citrus hystrix DC.)* are also frequently used.

Food in Thai Celebrations, Rituals, and Religion

Food plays an important role in the personal, social, and religious aspects of Thai life. Most Thais are Buddhists, and the daily offering of food to monks, called *tham boon tak bàat*, is one of the most important Buddhist acts. Every day throughout the country, in urban and rural communities, Thai Buddhist monks receive their daily food during a practice known as *bintábàat.* Walking through the streets and paths in the early morning, the monks are met by people offering food. Food is also offered at numerous religious shrines and is an important part of most Thai Buddhist ceremonies. Houses, office buildings, hotels, and rice fields have a spirit *(phii)* house *(san pra poom)*, where daily offerings are placed. The spirit houses, originating from past Brahman influences, may be elaborate and look like small temples or may be modestly constructed of plain wood or concrete. Thais give offerings to feed the spirits occupying the spirit house who protect the place from harm. As in secular life, rice has a central role in Thai spiritual life. The most common type of offering at spirit shrines is a small amount of rice, however, other food, such as fruits or sweets, may also be provided.

Thai candies are often made of exotic tropical ingredients. These confections were displayed in a shop in Bangkok. © DAVE BARTRUFF/CORBIS.

Buddhist monks perform many different ceremonies in which food offerings are integral. These include funeral rites, weddings, house consecrations, and inductions of new monks. Sweet offerings predominate at engagement and wedding ceremonies. The names of such sweets often signify a special aspect of the occasion. For example, *kanome* (sweet) *thong* (gold) *ake* (best) signifies bestowing wealth to the couple. The preparation and offering of food for religious ceremonies and rituals bestows merit on the person who provides the food. In preparing and giving ritual food individuals gain merit, and food is integrated into the spiritual and ceremonial fabric of Thai life.

See also **Buddhism**; **China**; **India**; **Rice**.

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Geraldine Moreno-Black

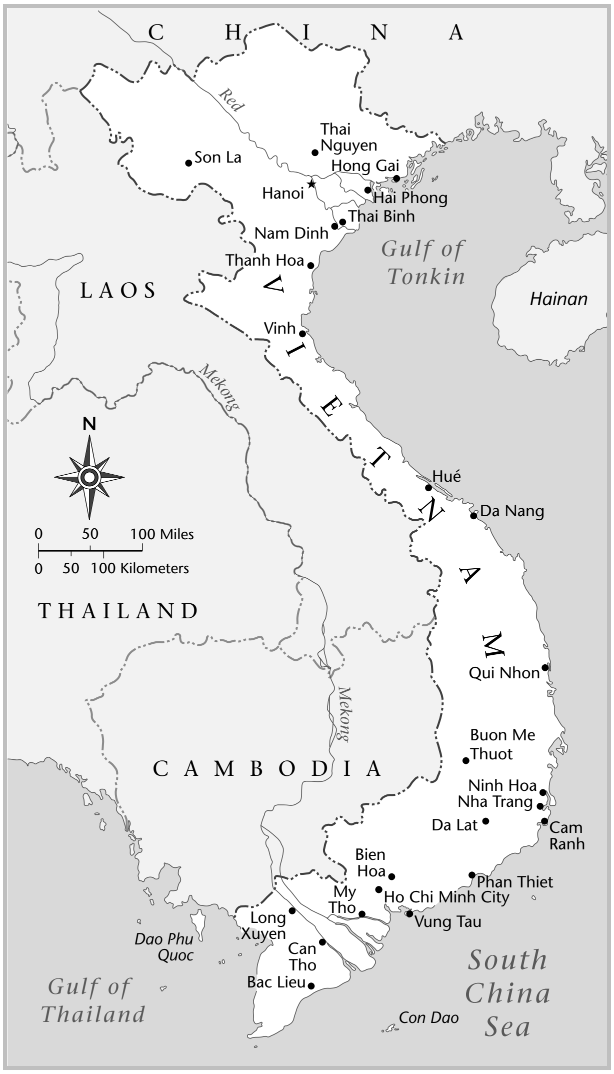
VIETNAM

The Vietnamese cuisine has been described as one of the most colorful and diverse in the world. The country's geography, climate, and history all play influential roles in creating its culinary range. The Vietnamese often describe their country as resembling a shoulder pole laden with two rice baskets. In fact, both the northern Red River delta and the southern Mekong River delta are rice-producing regions. The long coastline, rivers, and tributaries have ensured the place of seafood throughout the country, while the distinctive climates and cultures found in the North, Middle, and South, along with Vietnam's mountain-lowland ecologies have produced regional variation in the diet. Finally, Vietnam's relations with China (which controlled it for a thousand years, beginning in 111 B.C.E.), its Southeast Asian neighbors, India, France, and the United States have affected what the Vietnamese have chosen to eat, or been forced to eat, throughout their history.

Food Beliefs

Philosophy. Taoism, Buddhism, and Confucianism play an important role in Vietnamese food beliefs, but rural pragmatics are part of even the most cosmopolitan individual's belief system. According to Vietnamese from the countryside, there are two important qualities in food: quantity and taste. The elderly and guests, including spiritual ones, also require more prestigious food than is commonly eaten by everyone else. While the majority of Vietnamese profess a belief in Buddhism, relatively few adhere to Buddhist dietary prohibitions against meat and alcohol. The foods preferred in ancestor worship, and usually placed on an altar with incense and wine, were chicken and rice. These are the same foods that are served to company when possible. Pork is usually served at feasts.

Science. The Vietnamese regard two distinct health systems as scientific: Western medicine as practiced by the French and Western–trained physicians, and *thuoc bac*, literally "northern medicine," but colloquially "Chinese medicine." According to most sources, *thuoc bac* incorporates Chinese and Indian (Ayurvedic) traditions, and was possibly influenced by the humoral pathology of the classical Greek physician Galen (129–199 C.E.). In this frame of reference, health reflects a balance of two basic elements, *am* (the Chinese *yin*)—often translated as "cold"—and *duong* (Chinese, *yang*), or "hot." Ill health is the disequilibrium of these forces brought about by incorporating too much *am* or *duong* in the body. Foods share these designations, and can either upset the balance through deficit or overindulgence, or be used therapeutically.



A Vietnamese interpretation of the life cycle is that following childbirth, the mother and infant are both cold. As the infant develops, he or she becomes warmer. This warmth peaks in adolescence (teenagers are the hottest), and then the adult begins to cool down, maintaining neutrality (the desired state) through maturity. The body becomes cool again in old age. Foods are recommended according to these life stages. Immediately following birth, for example, the mother is given hot foods and treatments (which are shared with the infant through breast milk). Infants and young children, while frequently troubled by cold illnesses such as diarrhea and stomachache, are naturally warm, with a tendency toward rashes, fevers, and constipation. Adults can acquire hot or cold illnesses that need to be counterbalanced by treatments and diet. The elderly tend to be cold, and frequently require therapeutic warming. Cigarette smoking used to be advocated for the elderly (the Vietnamese term for tobacco is *thuoc la*, or "medicinal leaves").

As is true in all humoral systems, the food's temperature has little to do with its qualities of *am* and *duong*, boiled water being the exception (water boiled, then cooled, is warming, whereas cool water is cold. Ice is hot!). Most green vegetables are considered cooling; fatty foods such as meat, sugary foods, and red or orange fruits (such as papaya, mango, or watermelon) are considered heating.

A Vietnamese Meal

The majority of Vietnamese cuisine is relatively simple, relying on fresh fish, vegetables, fruit, and steamed white rice. Rice is so important in the diet that the words used to enquire if someone has eaten are *an com roi*, or, "eaten rice yet?" Fish sauce (*nuoc mam*) made from fermented anchovies is used much like soy sauce in Chinese cuisine. Few Vietnamese dishes do not include a drop or two, and Vietnamese have often subsisted on little more than fish sauce on rice, when they were lucky enough to have rice.

A typical Vietnamese meal requires rice, soup (with greens), a fried dish of fish, meat, or vegetables, and fish sauce on the side for additional flavoring. This meal would be prepared in sufficient quantity that it would be consumed for lunch and dinner. The primary factors normally taken into consideration when preparing a meal include the number of people needing to eat, their ages and associated needs (according to the theory of *am* and *duong*), taste preferences, cost of the foods, and ease of preparation.

The Vietnamese like to eat three meals a day, with breakfast often consisting of a thick rice soup (*chau*) like the Chinese congee, bread products, or foods identical to those consumed at other times of the day. The Vietnamese appreciate coffee, preferring a dense, slow-dripped preparation mixed with sweetened, condensed milk. Noodles (with or without soup); fresh or dried fruits; salted, roasted seeds; dried squid; and just about any salty, chewy food makes up the snack world.

Tea, various infusions of seeds or herbs (particularly lotus roots or seeds), soft drinks, and beer (usually drunk with ice) are consumed throughout the country, with beer (including the artisanal variety *bia hoi*) edging out the other drinks in terms of popularity among men in the South. Everyone drinks water, preferably rainwater collected in large earthenware jars. Water is also consumed from local ponds and streams, although much of it carries a heavy parasitic load.

Women taking breakfast in front of their house in Vietnam. Socializing with neighhbors is an important feature of this early morning meal. © John R. Jones; Papilio/CORBIS

Holiday Food

While rice is the "pearl of heaven," plain cooked rice is not a prestige food. Celebratory foods gain their prestige because of the limited availability of their ingredients or the difficulty of their preparation. Often rice flour cooked into sheets is the basis for delicate preparations, or pounded rice is used to make sumptuous cakes filled with bean paste, pork, or other delicacies. The principal holiday is Tet, the Vietnamese lunar New Year; it usually occurs in February. A child's first birthday (at which time he or she is considered to be two years old) is celebrated to mark survival of the perilous first year of life, when many infants die. Foods common in Vietnamese restaurants in the United States, such as *cha gio*, which require a lot of preparation, are normally reserved for Tet and first-year celebrations. Coca-Cola (seemingly the only U.S. contribution to Vietnamese cuisine) or beer are the accompanying beverages of choice. Urban birthday meals include colored rice cakes and purchased French layer cake with frosting. And the urban way of celebrating a wedding is to take the entire extended family and other guests to a Chinese restaurant. There eight to ten courses of meat, fish, and poultry, and very little rice, are served.

Regional Variation

The North of Vietnam, with its colder climate and proximity to China, is the home of *pho*, the famous beef broth with noodles and thin slices of meat. Accompanying herbs such as mint, basil, green onions, and bean sprouts grow in the northern climate. Grilled meat and stir-frying are more common food-preparation methods here. There are fewer vegetables and fruits available.

Central Vietnam has an important historical heritage that adds chili peppers, other spices and characteristic presentation style to the cuisine. A "kingly" table consisted of many small dishes instead of a common bowl, which is the "common" (and ubiquitous) way to serve the family. The cuisine of Hue, the ancient capital, is also more seasonal than in the North or South, reflecting not only the availability of vegetables, fruits, fowl, and seafood, but the humoral qualities of people at this time of year as well as the food. The sweet pudding *chè*, usually made with beans or lotus seeds, hails from this region.

The South's hot and humid climate produces a year-round, changing supply of vegetables, fruits, and livestock. The South is also the social pressure cooker of Vietnam, with a fourteenth-century origin as an Indianized Khmer region, followed by Vietnamese sovereignty in the eighteenth century. The French occupied the region from the nineteenth through the middle of the twentieth century, when the Vietnamese took power again. Dishes such as *bánh xèo* have been described as a Vietnamese crepe, or an Indian *dhosa*, depending on how far

Laotian serving basket for sticky rice. Laos, ca. 1975. Reed grass on wooden base. This server holds enough sticky rice for one person. The rice is eaten with the fingers instead of using chopsticks. These baskets are also made in regions of Vietnam and Thailand that border on Laos. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

back in time the form is thought to have originated. Curries, asparagus, avocado, little white potatoes, French bread, and mayonnaise all make their way to the table in Ho Chi Minh City (formerly Saigon). Many dishes combine fish with vegetables or sour fruits, such as tamarind or pineapple. And "pâté" can refer to anything from a mixture of ground pork used to fill the famous Vietnamese spring roll (*cha gio*) to a shrimp paste spread on French bread.

The hill tribes of Vietnam, such as the Hmong, are fewer in number today due to their collaboration with South Vietnamese and U.S. forces during the Vietnam War; many were evacuated to the United States at the end of the war. Tribal groups, however, respect national borders less than altitude, and move somewhat freely between Thailand, Laos, and Vietnam. They practice slash-and-burn agriculture, raise and consume pigs, and prefer glutinous (sticky) rice, which can be eaten with the fingers, to the long-grain variety preferred by lowlanders, which is always consumed in a small bowl with chopsticks. They trade the products of poppies (seeds; opium) and their renowned silverwork and embroidery for food products from the lowland areas.

It is impossible to not mention that millions of Vietnamese, highland and lowland alike, have known starvation throughout their history. Vietnam's struggle with the Chinese, with the French, with Japanese occupiers at the end of World War II, and with the Americans have resulted for varying periods in outright food shortages or broken distribution systems. Ho Chi Minh was able to gain support for his version of communism in part because of inequalities in the rice trade and widespread hunger in the North. The colonial system introduced many French delicacies to urbanites, but the rural poor subsisted on what they could grow on rented plots or fish from the irrigation canals of the plantations on which they worked for minimal wages.

Global economic downturns aside, Vietnam in the early twenty-first century appears to be well on the way to a stable economy. North-South differences in cuisine are still distinctive, even though the country has been unified since 1977. The hotel restaurant training school in Hanoi is bustling with noontime clients daily, with avocados and French onion soup prominent on the menu. Tens of thousands of Vietnamese now live outside the country, with most settled in the United States, Australia, France, and Canada. Expatriate Vietnamese have brought their cuisine to these countries, where it continues to evolve, incorporating a few local items into the rich Vietnamese culinary inventory.

See also **Buddhism**; **China**; **Fasting and Abstinence: Buddhism and Hinduism**; **Rice**.

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SOUTH PACIFIC. *See* **Pacific Ocean Societies.**

SOUTHWEST, THE (UNITED STATES). *See* **United States.**

SOY.

SOY. The symbiosis between the soy plant and Rhizobium bacteria in the soil underlies the soybean's success as a major source of protein for human populations in Asia and domesticated animals in many countries, as well as an important renewer of land fertility in traditional agriculture. Rhizombium bacteria enter the root hairs of the soy plant (and those of other legumes), helping to form nodules where they feed on the plant's carbon supply. In exchange, the bacteria convert atomospheric nitrogen gas in the soil to ammonium, rendering the nitrogen accessible to the soy plant for use in protein synthesis. The resulting soybean is high in amino acids in ratios that make it, when compared to other known plant sources of protein, strikingly "complete" as a human food. Additional benefits are imparted when legumes such as soy decay. Bioavailable nitrogen is released into the soil, becoming accessible to other plants that lack symbiotic relationships with nitrogen fixing bacteria. Soy and other legumes have therefore played a crucial role in crop–rotation farming, contributing to the growth of other crops and pasturelands. Soybeans are also high in oil content, and in the latter twentieth century became the world's top source of edible oil.

Physical Characteristics of the Soy Plant

Erect and bushy, the soybean plant can grow to over six feet high. It has ovate leaflets in groups of three; white, purple, or pinkish self–fertilizing flowers; and one to five beans in each pod. As with other legumes, at maturity the pod bursts open on both sides to expose the beans. Beans range in size from 1 to 3.5 centimeters or more and can be yellow, green, brown, black, reddish, or bicolored; their variations offer mute testimony to generations of selective breeding. The beans are 15 to 20 percent oil, and 35 to 45 percent protein, depending on the variety and farming conditions.

Timing of the soy plant's maturation is highly sensitive to day length; each variety requires a specific span of darkness to induce flowering. Known as photoperiodicity, this phenomenon makes the optimal choices of varieties different for each latitude where soybeans are grown. Soy's extreme photoperiodicity, along with its vulnerability to frost, probably slowed the early spread of its cultivation in China. Under the right conditions for any given variety, however, soy is a reliable crop that tolerates poorer soils. For this reason, in ancient China it was deemed invaluable as protection against famine should other crops fail.

Soy also has nutritional virtues beyond its protein and oil. Although their nutritional value varies with the growing conditions, in general the beans provide modest levels of vitamin A, vitamin E, thiamine, riboflavin, other B–complex vitamins, potassium, phosphorus, magnesium, calcium, and iron.

Origins, Domestication, and Diffusion of Soy

The soybean, *Glycine max*, is a cultigen that apparently does not exist in the wild. Botanists believe its wild ancestor was *Glycine ussuriensis*, a vine native to Taiwan, Korea, Japan, the north–central and far northern areas of eastern China, and adjacent areas of Russia. Chinese legend has it that sometime between about 2800 and 2400 B.C.E., the Emperor Shen Nung, father of Chinese agriculture, first extolled the virtues of the soybean in writing. Contemporary sinologists believe, however, that Shen Nung's famous treatise—indeed, Shen Nung himself—are the inventions of a much later era. As Theodore Hymowitz details in his "On the Domestication of the Soybean," botanical, archaeological, and linguistic research suggest instead that the trial-and-error process of domesticating soy began during the Shang Dynasty (circa 1600 B.C.E.–1027 B.C.E.), and that *Glycine max* did not emerge as a successful domesticate until the eleventh century B.C.E., probably in the north-central section of eastern China.

Soy cultivation gradually spread; evidence suggests that by the first century C.E., it had reached northern Manchuria, Korea, central and south China, and northern Vietnam. The expansion and contraction of Chinese dynasties was probably instrumental in this spread, as were the activities of Buddhist missionaries, who encouraged soybean cultivation as an expression of their vegetarianism. Buddhists were also the likely agents of early soy cultivation in Japan, beginning around the sixth century C.E. The emigration of ethnic Thais from China during the seventh century C.E. spread soy agriculture to present-day Thailand; traffic along the Silk Road brought soy to the northern Indian subcontinent in the eleventh and twelfth centuries. Between the first century C.E. and the sixteenth, soy was also introduced to Indonesia, the Philippines, Malaysia, Burma, and Nepal.

In the twentieth century, the bulk of the world's soybean production shifted to the New World. Although soy was first cultivated in what is now the United States in 1765, it was not a leading U.S. crop until World War II. In the 1970s, South American nations also began expanding soy production. Today the primary growers are the United States, which produces about half the world's supply, Brazil, China, and Argentina.

Developments in Soy Agriculture—Demand and Supply

Demand. Unless adequately processed, mature soybeans are difficult for humans to digest and contain antinutritive components. In early centuries, the Chinese considered soybeans important yet undesirable—poor man's food. But once they learned to make palatable and nutritious processed soy products, beginning around the third century B.C.E., demand for soy increased. For centuries, however, the demand for soybeans in Asia had little influence elsewhere.

In the 1920s, soy oil was used in the United States for industrial purposes; by the late 1930s, research was improving its flavor for American palates. At that time, the oil was lucrative; the protein meal was a cheap by-product fed to animals. During World War II, with imports of foreign vegetable oils cut off, the U.S. government promoted a huge expansion of soybean harvesting. Although the oil commanded a higher price per pound, the enormous surplus of meal came to provide more overall profits as Americans—and gradually people in developed countries worldwide—began to eat far more meat than ever before.

Today some 95 percent of the soy meal used in the United States is consumed by meat-, egg- or dairy-producing animals. This pattern is repeated in numerous countries that import soy from the United States, such as Mexico and in Europe. Even in Japan, where soy protein is an integral part of human diets, more soy is used for animal feed than for human consumption.

Supply. Early in the twentieth century, the development of tractors and combines made profitable, large–scale soy farming possible in America. A system was developed for storing soybeans at the right conditions of temperature and moisture at processing plants and in giant grain elevators; the Mississippi River became a crucial artery for soy exports. Soy agriculture worldwide has benefited as well from research on managing pests and diseases, including programs for breeding pest-resistant varieties.

Breeding programs have also been critical to the success of soy farming in varying growing conditions and for various desired traits (for example, higher oil or protein content), beginning with Asian farmers' patient work over centuries. More recently, plant breeders developed varieties tolerant of equatorial latitudes, making cultivation of soy in tropical Brazil profitable.

Since 1996, soy genetically modified with a gene from bacteria has become popular among farmers in the United States and Argentina. This soy is engineered to tolerate the Monsanto company's herbicide, Roundup, enabling farmers to use the herbicide easily without killing their crop. In the year 2000, over 50 percent of soy acreage in the United States was planted with "Roundup Ready" (RR) soy; it is currently the most grown genetically modified (GM) crop in the world.

RR soy is present in minute quantities in a wide array of American processed foods. Nutritionist critics worry that it could provoke allergic reactions in sensitive individuals, although to date there is virtually no scientific evidence of such a problem. Environmentalists fear that the gene for resistance to Roundup could "jump" to other plants, creating superweeds. Although some scientific evidence may support this concern, so far the problem has not materialized. Prestigious organizations such as the National Academy of Sciences have called for more government supervision of GM crops, however. There is, as well, a small but growing market for organic, non–GM soy used to make foods high in soy protein ("soyfoods"), both in the United States and in other developed nations.

Crates of tofu (soybean curd) await shipping in Kyoto, Japan. Water hoses are used to keep the tofu moist until it is delivered. © MICHAEL S. YAMASHITA/CORBIS.

Modern Trade in Soy

In the early twentieth century, Europe and the United States imported Manchurian soybeans for oil. Beginning in 1930, however, tariffs protected the American soybean industry. Gradually, soybeans (whole, as meal, and as oil) became the America's primary agricultural export; currently almost half the U.S. crop is sent abroad. This trade is controlled by a handful of powerful international grain companies. The expansion of U.S. (and Argentine) soy exports for human consumption is, however, hampered by concern in Europe (and to a lesser extent Japan) over the safety of GM soy; Brazilian soy is often preferred in these markets. Meanwhile, U.S. soy is making major inroads in the Chinese market, particularly with the entry of China into the World Trade Organization.

Processing Soy for Different Cuisines

Processing whole soy. In Asia, soy is prepared in many forms. Immature soybeans simmered in their pods (Japanese *edamame*) and sprouts from soybeans germinated in darkness are two vegetable uses. Soymilk is made by adding water to the beans, grinding and heating them, and filtering out the "milk"; in recent decades it has become quite popular in parts of Asia as a noncarbonated soft drink. Yuba is the thin protein film that forms on the surface of hot soymilk; skimmed off and sold in sheets, it is a delicacy in China and Japan. Tofu is made by curdling hot soymilk with a salt or acid coagulant and then pressing the whey out of the curd. Subsequent processing

Farm workers grading soybeans by hand in Vietnam, 1997. © TIM PAGE/CORBIS.

of tofu can include freezing, freeze-drying, deep-frying, or grilling, yielding different textures, flavors, and nutrient profiles. Okara is the pulp that remains after filtration of soymilk. It can be pickled or cooked with meat in stews. Soynuts are whole roasted soybeans consumed as a snack; when ground into a powder, they are used in pastry-making (China, Japan) or eaten with rice (Japan, Indonesia).

Asian societies have also developed many fermented soy products, including fermented tofu (sufu, or "Chinese cheese") and fermented okara. Fermentation increases soy's digestibility, preserves soy for long periods, and, crucially, provides flavoring to stimulate the appetite. Many fermentation processes use *Aspergillus* fungi, salt-loving yeasts, and lactic acid bacteria. Products include soy paste fermented with or without wheat, barley, or rice (for example, jiang in China; red, white, yellow, or brown miso in Japan); soy sauce, which is made from soy and wheat (either by fermentation or chemically); fermented soy nuggets ("salted black beans"); tempeh, an Indonesian soy cake fermented with *Rhizopus* mold, served as a main dish, and—when prepared in the traditional manner—often high in vitamin B_{12} from bacteria exposure during processing; and natto, a sweet, slippery, bacteria–fermented Japanese soybean dish served with soy sauce, mustard, and rice for breakfast or dinner.

In North America there is a small but growing market for soy products. Among those made from whole soybeans, the popularity of flavored soymilks and tofu is complemented by the marketing to vegetarians and health-conscious consumers of Western-style soyfoods such as soy yogurt, frozen soy desserts, and (unfermented) imitation cheese made from soy. In addition, full-fat soy flour is widely used commercially to bleach wheat flour and to condition doughs for Western-style breads.

Processing soy oil. Oil is extracted from soybeans either via chemical solvents such as hexane (the modern technique usually employed in developed countries) or by screw press (a lower-yield technique used at small extraction plants worldwide). Large processors refine the oil using techniques developed beginning in the 1940s. The removal of lecithin (itself used in many food applications—for instance as an emulsifier in chocolates) and other impurities is followed by bleaching and deodorization. The oil is then ready for use in salads and for home cooking. If hydrogenation is performed to enhance solidity and shelf life, soy oil can be blended with other oils to make margarine stock or shortening, including shortening for commercial deep-fat frying. Soy oil is also widely used in American prepared salad dressings and mayonnaises. Indeed, in the United States soy is by far the most commonly used oil in each of these applications. It is becoming increasingly popular worldwide because of its cheap price and high quality.

Processing defatted soy protein. Use of defatted soy protein has gone hand in hand with the development of large-scale hexane extraction of oil from the beans. Hexane, an organic solvent, dissolves the oil, thereby separating it from the soy protein. The hexane is then steamed out of the protein. Once desolventized, the protein is suitable for further refinement and processing into food-grade soy flakes, grits, defatted flour, concentrates (containing at least 70 percent protein), and isolates (containing at least 90 percent protein). Such products are used (1) in very small quantities as "functional" ingredients to improve the textures of a vast array of processed foods, including baked goods, soups, whipped toppings, and lunch meats; (2) as meat extenders in dishes for institutions such as schools and the armed forces; (3) as nutrition enhancers in products touted for their health benefits, such as protein-fortified breakfast cereals, weight-loss beverages, and "energy bars"; and (4) as the primary ingredient in dairy and meat substitutes ("analogs"). While some brands of dairy analogs are made directly from whole soybeans, others are made from defatted soy protein ingredients (or both). Those using defatted soy protein include some imitation cheeses, some frozen soy desserts, and soy infant formulas. American-style meat analogs, pioneered by scientists working for Henry Ford and by vegetarian Seventh Day Adventists, include soy burgers, steaks, "chicken," hot dogs, sausage, "bacon" bits, and lunch meats.

National Differences in Amounts of Soy Protein Consumed

Data from the United Nations Food and Agriculture Organization indicate that in 1999, North Koreans derived more daily protein per capita from soy than people in any other country (9.4 grams), followed by the Japanese (8.7 grams), Indonesians (7.2 grams), South Koreans (6.5 grams), and Chinese (5.1 grams). The many thousands of small tofu shops scattered throughout Japan, similar to bakeries in France, illustrate the dietary and cultural importance of soy protein to that society.

The rest of the world for which data are available had much lower rates of consumption in 1999, although some developing countries (for example, Libya, Uganda, Nigeria, and Costa Rica) have significantly increased their consumption in recent years. Average U.S. daily intake during that year was tiny but growing rapidly. Market studies suggest that soyfood sales are currently increasing at a rate of 30 percent per year in the United States.

Research on Soy's Health Benefits

Soy is the only commonly eaten food containing high levels of isoflavones—compounds similar to human estrogen that have hormonelike effects. In the past decade, hundreds of scientific studies have examined the potential of isoflavones and other components of soy to reduce cancer risks, reverse tumor growth, prevent osteoporosis, mitigate unpleasant symptoms of menopause, and decrease the risk of heart disease. Findings in many areas are still equivocal, but results have been promising with regard to prostate cancer and, especially, heart disease. In 1999, the U.S. Food and Drug Administration permitted manufacturers of foods meeting certain criteria to make claims on food labels linking consumption of soy protein to a potentially reduced risk of heart disease.

Ironically, while soy protein holds promise as a disease-fighting food of the future, and although natural, unhydrogenated soy oil has healthful properties, the hundreds of millions of pounds of hydrogenated soy oil used yearly in the United States to deep-fry fast foods contribute to high cholesterol levels and a national epidemic of obesity.

Future Directions for Soy

Many new varieties of soy are being developed, as conventional breeders and biotechnology companies focus on improving soy to benefit not only farmers, but also processors and consumers. Desired characteristics include improved shelf life and flavor of the oil; enhanced functional qualities of the oil for commercial food processing; improved nutritional profile for the oil or the protein; elimination of antinutritive elements and flatulence causing compounds; and reduction of soy's "beany" flavor. The new varieties are in differing stages of development; for some strains, the economic motivator is the improvement of animal feed or even the mitigation of environmental pollution caused by waste from animals fed conventional varieties. But much of the research has potential application to human foods.

Cultivating soybeans as a protein source for human foods is a significantly more efficient way to provide a population with protein than is raising mammals for meat: in the late 1990s, a pig raised in the United States required over three pounds of feed to produce a single pound of meat; a chicken required about two pounds. For this reason, soy has much greater potential than meat to provide critical protein to the world's hungry. The only flesh foods that currently approach soy's efficiency for protein production are farmed fish.

Development workers have labored, with varying degrees of success, to introduce soybeans into the cuisines of protein-deficient populations. For example, the International Soybean Program (INTSOY) of the University of Illinois has worked extensively in Egypt, the U.S. Peace Corps has introduced soyfoods in Malawi, and the Mennonite Central Committee has had a long-term soyfoods project in Bangladesh. Since according to United Nations estimates world population will grow by some four billion in the twenty-first century, such efforts will surely increase.

See also **China**; **Dairy Products**; **Genetic Engineering**; **Japan: Traditional Japanese Cuisine**; **Vegetarianism**.

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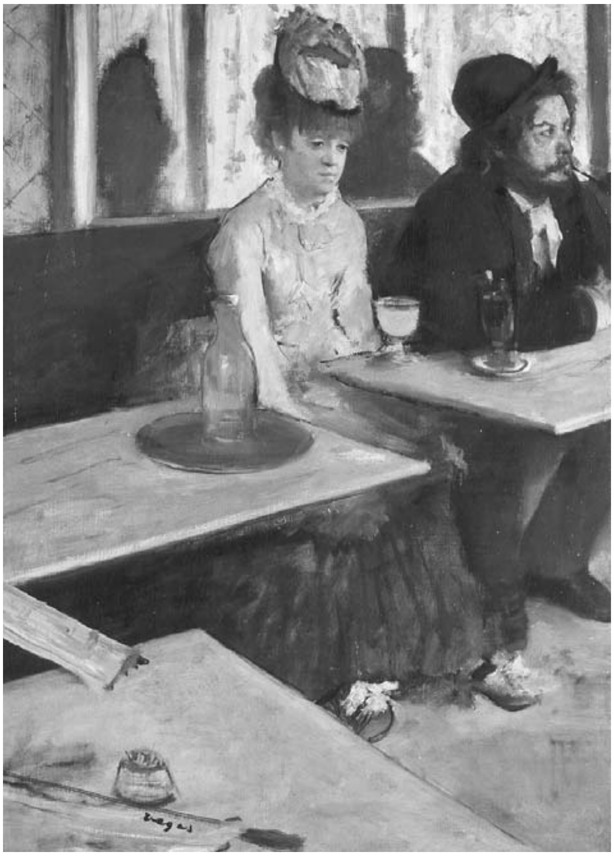
SPAIN. *See* **Iberian Peninsula.**

SPICES. *See* **Herbs and Spices.**



The social ramifications of absinthe and its powerful mind-altering effects were captured in this painting of a late–nineteenth-century Paris café by Edgar Degas (1834–1917). © MUSÉE D'ORSAY, PARIS/ART RESOURCE

SPIRITS. Distillation is the process of separating a liquid from a solid by boiling the liquid and condensing the vapors in another container to reform the liquid. The solid material that did not boil off is left behind. To the alchemist, the essence—or the spirit—of the thing was in the condensed vapors.

One can observe distillation in action when the steam from a teakettle condenses on a surface, such as the side of a refrigerator. The products of the distillation are the drops of water on white enamel and the mineral sludge that is left in the bottom of the kettle. (The word "distillation" is derived from the Latin *distillare*, 'to drip', and modern Italian retains the sense of the word as a 'concentration of the essentials'.)

Distillation can also be used to sort out mixtures of liquids that have different boiling points. If a mixture of alcohol and water is heated to more than 174°F but less than 212°F, the alcohol will boil and the water will not. If the vapors from the boiling are condensed and the condensate is collected, the collecting vessel will contain alcohol and the original cooking pot will contain water.

Imagine that the teakettle on the stove contains some boiling wine. (Wine is essentially a mixture of alcohol and water, the alcohol being derived from fermentation, by yeast, of the sugar in the grape juice.) If the temperature is kept below 212°F, the substance that boiled off would be mostly alcohol.

The simplest kind of alcoholic distilling apparatus is not much different from a teakettle. It is called a pot still, and it consists of a kettle loaded with a mixture of alcohol and water. The alcoholic steam, however, is not released into the air. Instead, the steam leaves the boiling chamber and goes into a long, downward-spiraling tube, where it cools and condenses back into a liquid. This liquid, called the distillate, is a mixture of alcohol, water, and substances called congeners, which are by-products of fermentation. However, as the alcohol evaporates, the boiling temperature of the mixture rises, and by the end of the batch, a lot of water vapor has boiled off and been condensed along with the alcohol. Thus, the by-products of fermentation—congeners—end up in the distillate. In the twelfth century an Italian physician, Salernus, discovered that the cooling action could be facilitated by spraying the tube with cold water or building an external tube through which a stream of cold water could flow.

Historically, there has been no liquid that is at once as ordinary and as precious as wine. Arnold de Vila Nova, a thirteenth-century alchemist, wrote of distilled wine

ABSINTHE

Ancestor of anise-based pastis, absinthe was the most popular and most notorious liquor in the nineteenth century, and possibly this combination of traits served to establish its reputation as the most notorious in history. Finally banned by the French government in 1915 because it was considered so harmful to one's health—it was 72 percent alcohol, or 144 proof—absinthe is inextricably linked to the artistic and literary life of Paris during the second half of the nineteenth century.

A favorite drink of Henri de Toulouse-Lautrec, Vincent van Gogh, Arthur Rimbaud, and Paul Verlaine, absinthe was popularized by French soldiers returning from Algeria in the 1830s. While stationed there, they had been prescribed the plant-based alcohol as an antiviral, antifever remedy, which they mixed in their drinking water. Upon returning to France, their taste for "*la fée verte*" (the green fairy), so named because of the drink's yellowish-green hue, soon spread throughout France to the general public, who sipped it sweetened with a lump of sugar in cafés. Crossing socioeconomic as well as gender lines, absinthe was enjoyed by all, from the top-hatted, well-fed factory owner to the penniless, tubercular laundress.

Absinthe was generally sipped as an aperitif between 5 o'clock and 7 o'clock in the evening. But those who were addicted drank it at any hour of the day, often consuming up to a dozen glasses in a single day. Part of the appeal of absinthe surely stemmed from the ritual surrounding its consumption. Unlike cognac, whiskey, gin, or eau-de-vie, which were imbibed in ordinary, shot-type glasses, absinthe was enjoyed in stemware designed expressly for the liquor. With an elongated cup measuring about four inches in height, the narrow, footed glass had a small depression at the bottom used to measure a dose of absinthe.

The liquor itself was clear, but when mixed with water, which was the customary way of drinking it, it turned cloudy and opalescent. First the absinthe was poured into a glass, and a perforated spoon was laid across the rim of the glass. Onto this spoon a lump of sugar was placed. Water was poured slowly over the sugar, which would melt into the glass and sweeten the drink. The long-handled spoon would then be used to stir the contents of the glass, at which point the drink turned cloudy.

With the increasing industrialization of alcohol as the century wore on and the subsequent lowering of prices, alcohol consumption of all kinds rose rapidly in France, making it the most "alcoholic" of all nations in the world by the end of the nineteenth century. Absinthe came under attack by the French Temperance Society and was the only alcoholic beverage officially banned in France. But the ban referred only to consumption and not to production, and in the late twentieth century some distilleries resumed production, but for export purposes only.

By the early twenty-first century about thirty brands of so-called absinthe were produced in countries where production was still legal. In addition to France, the Czech Republic, Bulgaria, and Spain distilled it. The Old Absinthe House in New Orleans, with its great, ornate water fountain in the center of the room, is a vestige of America's absinthe culture, which was introduced by the Louisiana French. After enjoying a certain degree of popularity at the turn of the century, the drink was banned in the United States in 1914, around the time most European countries also made it illegal.

The world's only absinthe museum (Le Musée de l'Absinthe), owned and operated by Marie-Claude Delahaye, is in Auvers-sur-Oise, France, an hour from Paris in the village where Van Gogh died and is buried. The tiny museum displays authentic glasses, spoons, absinthe fountains, and bottles with period posters advertising various brands of this unique liquor.

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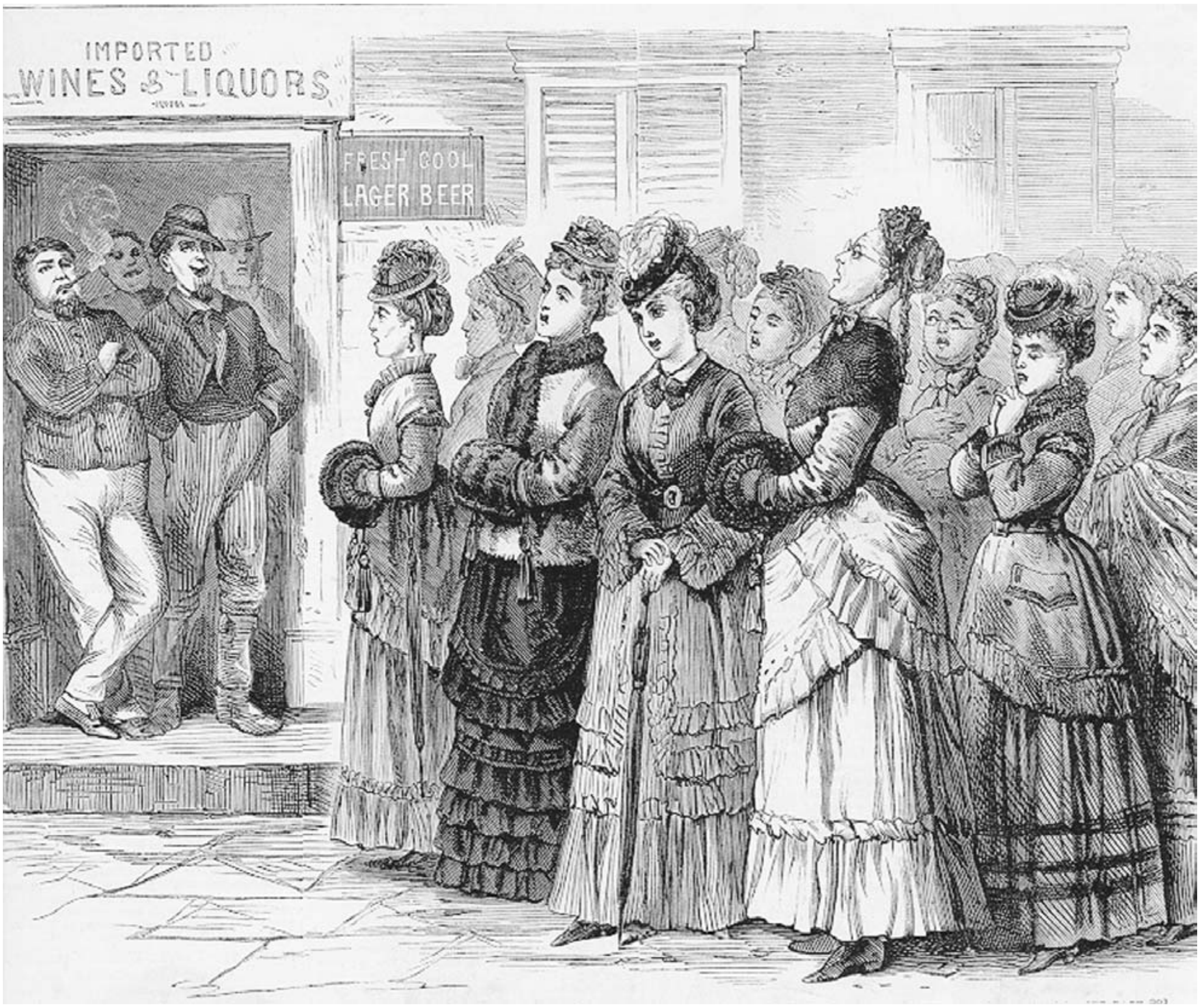
Alexandra Leaf

and its restorative properties, calling it *aqua vitae* or "water of life." Chinese sources from about the same time mention a "wine" that could be ignited.

The chronology of distilling is not settled firmly, for there is archaeological evidence that the Minoans and Egyptians practiced distillation, which may suggest a very early understanding of the process. It can be said with certainty that by the fifteenth century distillation had spread across Europe. Every region that had sufficient wood to fire a still developed a distilled version of its own wine or beer.

The simple still described by Salernus, called an "alembic" or pot still, was refined to permit redistillation and continuous loading and operation. The modern column still is capable of producing an almost pure and relatively tasteless alcohol.



The "Ohio Whisky War" made national headlines when the women of Logan, Ohio, carried the cause of Temperance to the doorsteps of local taverns. They are shown here singing Temperance hymns. From *Frank Leslie's Illustrated Newspaper,* 21 February 1874. ROUGHWOOD COLLECTION.

All of these early alcoholic substances were taken as medicines, if they were consumed at all, or were used to dissolve medicinal ingredients. They probably tasted unbearably harsh unless moderated with a dosage of sugar (another medieval novelty). It would be a century or two before refinements in the distillation process and the introduction of aging produced spirits that could be consumed in a pure form.

Aging

When spirits age in wooden barrels, maturation results from an interaction of the original mix of alcohol and congeners with the wood and the small amount of oxygen that enters the barrel. The more intense the original flavors, the greater need there is to moderate the effects of wood and air. Once spirits are removed from the breathable casks and put into bottles, no further maturation takes place. A bottle of ten-year-old rum purchased five years ago is still ten years old on the inside.

In the United States, small, new oak barrels are the norm for aging sprits in this manner. The wood has lots of extract to contribute to the finished flavor. Scotch whiskey, cognac, and rum are typically aged in older, larger barrels that have less oak flavor. When they were new, these barrels may have been used for storing wine.

Some governments specify storage time for spirits. The United States and Canada require a two-year storage period for most whiskey. Scotland and England mandate three years and Ireland five. Aging is never required for gin and vodka: In the case of these spirits, the problem of harsh flavors is addressed through precise column distillation and charcoal filtration. Brandies are typically aged for three to five years, but some are held in cask for twenty-five years or more.

Aging in dry warehouses promotes the evaporation of water, thereby increasing the alcohol content; humid storage encourages the opposite. After aging, spirits are diluted to the strength at which they will be sold, blended to achieve their final taste profile, and colored for uniform appearance.

Alcohol

Ethyl alcohol is the natural by-product of yeast acting on sugar in a water solution. This process is called fermentation, and it proceeds until either the yeast runs out of sugar, the alcohol concentration rises to the point where the yeast can no longer work, or the fermentation is artificially halted. The alcohol that most people drink is an organic chemical, C_2H_5OH. In 1536 the German alchemist Paracelcus first used the word "alcohol" in its modern sense.

Of great concern to alcohol producers and consumers is "how much alcohol is in this drink?" In the United States, containers of spirits are required to display the alcohol concentration of the drink as a percentage by volume. Alternatively, the strength of alcohol can be expressed as "proof," which is twice the percentage by volume: for example, 100-proof spirits are 50 percent alcohol by volume.

Alcohol and the brain. There are two reasons that alcohol has been so popular for so long. The first is that aside from wine or beer, alcohol was one of the few drinks upon which early civilized humankind could rely. A large sedentary population pollutes its own streams and ground water; deadly typhoid and cholera bacteria thrived in drinking water. Milk was unreliable and, for many adults, not digestible. Fruit juice, in the days before preservatives, was either turned into vinegar through bacterial activity or turned into wine by fermenting through its own yeasts. Only wine, which does not support any bacteria harmful to man, was consistently safe for consumption.

In places where grapevines did not grow, a hot-water extract of sprouted barley grains was used to make alcoholic beverages. The heating process activated enzymes that converted starch to sugar and sanitized the water from which it was made. This solution of barley sugar would also ferment in the presence of airborne yeast. When it did ferment, it was called beer. This beer probably did not resemble the modern beverage of the same name, but it was certainly safer to drink than water.

Of course, ancient cultures did know of other technologies that could have possibly sanitized the beverage supply. For example, the Chinese boiled water and infused it with herbs as both a culinary and sanitary device. However, the manufacture of alcoholic beverages triumphed over all of them for reasons that had nothing to do with sanitation. Alcohol's ability to demolish inhibitions, inspire enthusiasm, and encourage sociability lies at the heart of and accounts for the transcendence of the beverage business. People drink in company because both the drink and the company become more pleasant in the process.

Prohibition. Like other milestone inventions, alcohol is not entirely a blessing. In addition to the lightened spirits and occasional hilarity of moderate drinking are the recklessness of excessive drinking and drunkenness.

Some people deny some of alcohol's manifest virtues. Many people find the altered state of consciousness that alcohol induces to be threatening. Such a state brings out things in themselves and other people that they would rather not have called forth. People consuming alcohol are more likely to be sexual and boisterous. They are also more likely to be aggressive or otherwise obnoxious.

It is a short step from being repelled by one's own impulses to wishing to eradicate or at least camouflage them in others. In the United States that impulse, coupled with a prejudice against wine- and beer-drinking immigrants, led to the adoption of the Volstead Act in 1919, which made the sale and possession of alcoholic beverages illegal.

Prohibition was the thirteen-year period during which there was no legal beer, wine, (apart from that used in religious services), or spirits consumed in the United States. This movement had profound and lasting effects on the U.S. beverage industry. It changed U.S. tastes and created a nation of whiskey drinkers. Since it is easier to traffic in small volumes of a highly concentrated illegal substance, distilled spirits became more available and more desired.

Brandy

Brandy is a spirit distilled from wine. The source of the wine is usually grapes but it can be derived from any fruit. Dutch and English merchants in the seventeenth century promoted the production of brandy in the areas around the little towns of Cognac and Armagnac. Cognac produced an almost flavorless wine that yielded a relatively clean distilled product. Armagnac had no wine-growing tradition, but it did have large forests to fuel the alembics (used for distillation), as well as local farmers who saw the value of commerce.

Cognac at one time was a fiery, intensely flavored drink that combined complexity and power. It has since been tamed to compete with the smooth whiskeys in the American market, and brandy drinkers looking for intensity increasingly order Armagnac.

Whiskey (Whisky)

Whiskey (Whisky) is distilled from beer, which is itself a fermented drink made by converting the starch of grains into sugar and then introducing yeast. If the conversion process involves sprouting the grain and then toasting it, it is called "malting," and the result can be labeled "malt

COGNAC DECANTERS

Anything as rare and fine as cognac is bound to be surrounded by some paraphernalia. One of the nicest accessories in the liquor business is the lead crystal decanter filled with amber-gold liquid. Set on a white tablecloth, the crystal catches and refracts the room light and turns the cognac ritual into a ballet of sparkles. The colors and the magnificent weight of the decanter make the drink (and by extension, the host) seem very important.

Alas, researchers have discovered that the lead that makes the decanter weighty and sparkly dissolves in the cognac over a period of time and ends up inside the consumer. Unfortunately, this lead is also poisonous.

whisky." If the whisky is bottled unblended as the product of a single malt house, it can legally be called "single malt."

The word "whiskey" or "whisky" is derived from a direct translation into Gaelic (*uisge beatha*) of Vila Nova's *aqua vitae.* It is fitting that a Gaelic word is used here, since the spiritual home of whisky is Scotland and Ireland. The characteristic smoke and iodine flavors that are introduced during the making of the malt have created a peculiar and distinctive spirit that was at the height of fashion at the end of the twentieth century.

It is easy to account for the rise of Scotch whisky in general and single malts in particular: They are both expensive and exotic. Both types of whisky are produced almost by hand, in very small amounts, in two countries to which many Americans have a romantic attachment. Single malts are also expensive and the very epitome of an acquired taste. It is also easy to see the cause of their eventual downfall in the popular mind: They do not taste very good. Often they are described as having a taste between seaweed and peat smoke.

In colonial America, West Indian molasses was abundant, and the coastal drink was rum. Westward expansion after U.S. independence allowed for the cultivation of corn well in advance of a transport system that could carry it cheaply to market. Farmers on the frontier (then in Allegheny County, Pennsylvania) saw rye and corn-based whisky as a condensed and easily transportable cash crop. Their iron-free water supply helped to make that whisky appealing, and tax disputes with the new federal government in 1794 only entrenched the drink as part of an ongoing culture of rebellion.

Bourbon whisky is the product of Kentucky refugees from federal taxation. Their rye crops failed, but their corn whisky, called bourbon after the county where it originated, triumphed. Its cult is threatened only by the generalized decline in the spirits market.

Gin

Gin was the first industrially produced spirit. The same Dutch traders who created cognac developed this continuously produced neutral spirit (one without a flavor characteristic). Gin was distilled from grain through a matrix of crushed juniper berries, called *genever* in Dutch. In England, a government that did not tax grain or distillation encouraged the availability of cheap gin. In the mid-eighteenth century, gin's availability not only undermined local brewing, but it encouraged a wave of drunkenness among the newly urbanized poor that upset the gentry.

Gin remains the spirit of choice in England, where it is mixed with tonic or served "on the rocks" (over ice). In the United States, the martini dominates the gin market. Officially, it is a mixture of gin and vermouth shaken over ice and decanted to a dedicated, triangular martini glass. In practice, the vermouth is vestigial and save for differences in serving temperature and glassware, the martini is not much different from the plain gin that scandalized Georgian London.

Vodka

The key to vodka-making is the charcoal filtering of the distillate to remove any traces of flavor. The original starch that supplies the sugar for fermentation can come from grain, potatoes, or even directly from sugar itself.

Vodka is defined in U.S. law as a flavorless beverage, but that has not stopped the marketing of more and more expensive "flavorless" vodkas or the development of an army of flavored variations. One brand, Absolut of Sweden, has recognized that in the absence of any real difference, it is important to make distinctions among brands; to this end, the manufacturer has created a long-running ad campaign that presents its distinctively shaped bottles as interpreted by various artists.

Tequila

Young Americans have enthusiastically embraced tequila, an icon of Mexican culture, as a "bad-boy" drink. Cheap tequilas, distilled from pulque, the fermented sap of the blue agave plant, are allowed to contain up to 49 percent alcohol. More expensive versions are wood-aged and based entirely on agave starch. In Mexico there is a delimited tequila district. Any distilled pulque made outside of this area is simply called "mescal."

Rum

Sugar cane was being planted in Puerto Rico, Cuba, and Hispaniola a few years after Columbus arrived. The Spanish had learned about cane when they were an Arab colony, and they brought cuttings from the few small cane gardens to these areas from the homeland.

Sugarcane becomes sugar when it is crushed and its juice is extracted. The juice is reduced through boiling, and the sugar then crystallizes. The liquid left behind is called molasses, which contains about 5 percent sugar. Along with the fermentable sugar, this molasses contains the concentrated flavor of the cane itself and the flavor of sugar caramelized during the reduction of the original juice.

Fermented molasses is, with a few exceptions, the raw material of rum. Traditionally, molasses was fermented by wild yeasts in a slow fermentation process that introduced its own complex flavors. This is still the practice for most premium rums. Most modern-day rum is produced by distilling molasses in large column stills that operate continuously. These stills turn out a high-proof, highly refined, and neutral-tasting product that can be as much as 190 proof (95% alcohol). This is the rum that is mixed with three different kinds of fruit juices and served with a little paper umbrella on the edge of the glass. It is sometimes wood aged and sometimes very good. It is certainly an excellent foil for juices and sodas.

A small amount of the world's total rum production is made in pot stills. These stills are loaded with a batch of fermented molasses, which is then distilled at a fairly low 140 to 160 proof (70–80 percent alcohol). The rum is then aged in old wooden barrels. The results are said to rival cognac in complexity.

See also **Beer; Cocktail Party; Cocktails; Fermentation; Fermented Beverages Other than Wine or Beer; Whiskey (Whisky); Wine**.

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Lynn F. Hoffman

SQUASH AND GOURDS. Cucurbitaceae is a highly specialized and unique family of mainly trailing plants of subtropical or tropical, moist or dry habitats. Plants bear mostly palmately lobed, alternate, and simple leaves and have spiraling tendrils. Plants are mostly monoecious with yellow flowers, but sometimes with white petals, and inferior ovaries. The fruits are specialized berries called pepos and are of variable size. Some are among the largest fruits produced by any plant group. Because of their ability to produce large fruits, they lend themselves to competition. By the early twenty-first century the largest recorded fruit, which weighed a phenomenal 1,140 pounds (517 kilograms) was grown by Dave Stelts of Leetonia, Ohio, in 2000.

Plant Descriptions

Cucurbit is a general term used to describe all members of the Cucurbitaceae family, which includes the common vegetables cucumber, melon, and watermelon as well as the focus of this section, squash, pumpkin, and gourd. The common names in the three genera and seven species that represent the subject of this essay overlap considerably.

Products commonly called squash, pumpkin, or gourd are found in four of the seven species. The gourds are the source of least confusion since they are more or less readily identified by appearance regardless of species. Squash and pumpkin are used interchangeably depending on local custom. The sole exception is the decorative or Halloween pumpkin *Cucurbita pepo*, which is always referred to by that name. Defining characteristics of the cultivated *Cucurbita* species are in Table 1. Within squash it is useful to differentiate between summer and winter types. The summer types (yellow, zucchini, or scallop) are fast maturing, have soft rinds, are consumed when the fruit is immature, and are quite perishable. On the other hand, the winter squash take longer to mature, one hundred days versus fifty days, have a long storage life, several months versus two weeks, are consumed when the fruits and seeds are fully mature, and have durable rinds. Any confusion that may exist is among academics who quibble over nomenclature. Retailers, consumers, and cooks generally differentiate among squash, pumpkin, and gourd, and if not little damage is done.

History, Ethnography, and Symbolism of Production and Consumption

The word "pumpkin" is derived from the Old English *pompion* (originally Latin *pepo* and Greek *pepon*) and refers to a large melon or gourd. It was originally applied to the genus *Legenaria* but was later transferred to the New World *Cucurbita.* The more general word "squash" is a derivation of a New England Native American term "*askutasquash,*" meaning vegetables consumed while green, in other words, a summer squash. Cucurbits have cultural and economic significance cross-culturally. Ralf Norrman and Jon Haarberg (1980) examined the symbolic place of cucurbits in Western literature and culture and further extended their analysis to selected non-Western cultural settings. They noted that cucurbits have complex semiotic associations with sex and sexuality, fertility, vitality, moisture, creative power, rapid growth, and sudden death. Cucurbits also figure prominently in the symbolism and cosmologies of many non-Western societies.

TABLE 1

Some defining characteristics of the cultivated *Cucurbita* species

Species	Seed	Leaf	Stem	Peduncle	Fruit flesh
C. argyrosperma	Large, white, prominent margin that may be scalloped	Moderately lobed, short, soft pubescence	Hard, angular	Hard, corky, sometimes swollen	Very coarse, pale yellow
C. ficifolia	Black or tan, smooth margin	Deeply lobed, smooth margin, round, prickly	Hard, grooved	Hard, angled, slightly expanded at fruit attachment	Coarse, stringy, white
C. maxima	White to brown, oblique seed scar	Almost round, unlobed prickly	Soft, round	Round, corky, not flared at fruit attachment	Fine, not fibrous, deep orange
C. moschata	White to brown, rough margin, oblique seed scar	Shallow lobes, almost round, soft pubescence	Hard, ridged	Hard, angled, flared at fruit attachment	Fine, not fibrous, deep orange
C. pepo	Light tan, prominent smooth margin, rounded seed scar	Deeply lobed, very prickly	Hard, ridged	Hard, angled, ridged	Coarse, orange

Squash was domesticated in a variety of New World sites, including central Mexico, Peru, and the eastern United States, as early as 10,000 B.P. (Smith 1997). The more specific timing, locations, and hypothetical dynamics of the domestication processes of the five principal species of domesticated squash are reviewed in a number of texts. Squash, along with maize (corn) and beans, formed the staple carbohydrate cores of Mesoamerican crop complexes that were the basis for state formation in the region (Scarre and Fagan, 1997). These cultigens were also significant food sources for precontact Native Americans in North America. Squash diffused to the Old World after 1492 through the networks of trade, migration, and commodity chains linked to colonialism and the expansion of global capitalism.

Squash is cultivated in the twenty-first century throughout the Americas, Europe, Africa, the Middle East, China, India, and Indonesia. Virtually all parts of domesticated squash, including fruits, seeds, flowers, and leaves, can be eaten. Cross-cultural culinary uses are quite varied. The fruits are typically boiled, sometimes fried or added to soups or curries. Squash is also the basis of candy and fermented beverages in Latin America. The seeds of squash are consumed raw or are cooked in various forms in China, India, and Mexico. Some Native Americans, most notably the Sioux of the Great Plains, traditionally flattened strips of fresh pumpkins, dried them, and made them into mats. Squash seeds are also used in a number of traditional folk medicine applications.

Pumpkins have an important place in the social history, folklore, and cultural symbolism of the United States. In early colonial New England settlers sliced off the tops of pumpkins, removed the seeds, filled the insides with honey, milk, and spices or fruit and then baked the pumpkin in the hot coals of an open fire. Pumpkins were therefore the crust and not the filling of the early precursors of pumpkin pie. Settlers also used pumpkins in beer, breads, puddings, cookies, and many other foods, including pumpkin sauce, that is, pumpkins stewed with butter, vinegar, and spices. Many of these uses of pumpkins continue in the North American diet in the twenty-first century. The most common nonfood use of pumpkins in the United States is for decorative purposes, including the carving of Halloween jack-o'-lanterns.

Gourds are among the world's oldest domesticated plants, dating back to at least 8000 B.P. Three principal genera of gourds, *Legeneria* (including the bottle gourd), *Trichosanthes* (including the snake gourd), and *Momordica* (including the bitter gourd), originated in the Old World tropics. They have a wide range of economic, symbolic, ritual, and artistic functions cross-culturally. For example, Sally Price, in her ethnographic study of the Saramaka of Suriname, analyzes how elaborately carved and decorated calabashes (in this case the tree gourds *Crescentia cujete*, which are not cucurbits) figure prominently in women's labor, production, artistic expression, ritual exchanges, status, and power relationships in this Maroon society (Price, 1993).

Snake gourds are cultivated in the humid tropics and subtropics of Asia, Latin America, and Africa. The young fruits are consumed boiled or in curries, the stem tips and leaves may also be eaten, and the roots and seeds have a wide range of uses in traditional medicine throughout Southeast Asia. Bitter gourds were domesticated in Asia and diffused to the New World via the transatlantic slave trade. They are popular vegetables throughout India, China, Asia, Africa, the Middle East, Latin America, and the Caribbean. As with snake gourd, the plant is used both as food and in a range of medicinal applications cross-culturally.

Bottle gourd was widely distributed as an early cultigen throughout the New World but is generally believed to be of African origin. It remains unclear as to how the bottle gourd diffused from Africa to the New World, although both human agency and oceanic drift currents have been proposed as mechanisms. Bottle gourd is principally used as a “bottle or container for both liquid and dry materials” (Heiser, 1979, p. 71) but also for food, floats, musical instruments, medicine, artistic expression, and in some cultures penis coverings. Among the Dani, an indigenous culture of highland western New Guinea (Irian Jaya), “from the age of four or five, males wear a *holim* or penis gourd at all times except when urinating or having sexual intercourse” (Heider, 1979, p. 56). Karl Heider notes that each Dani man owns “whole wardrobes of penis gourds of different lengths and shapes . . . and the gourd itself is not a focus or symbol of masculinity or sexuality.” In the late twentieth century, Dani men continued to wear penis gourds in public, in defiance of Indonesian government attempts to ban the coverings, as a symbolic resistance to Indonesian state control over the region. In many societies bottle gourds have generally been displaced by the use of plastic and other industrially manufactured materials except in poorer regions or where gourds continue to have local cultural, ritual, or artistic significance.

Horticulture

Squash, pumpkin, and gourd are produced worldwide in temperate, subtropical, and tropical climates. They constitute an important but not life-sustaining part of the diet for many cultures. Production data is probably not reliable because these products do not usually enter into international commerce and are relatively minor in importance. For example, production data became available in the United States for these crops only in 2000. Michigan and New York are the leading producers of decorative pumpkins, and Georgia and Florida are the leading producers of summer squash. The available world data show that in the early twenty-first century Asia was the principal producer of these cucurbits and that China and India accounted for nearly half of the reported world production.

The nutritional value of these cucurbits on the whole is not exceptional since they are mostly water. Pumpkin fruits, flowers, and leaves and winter squash fruits are, however, good sources of vitamin A, which may be scarce in the diets of those in some developing countries. Pumpkin seeds are rich in protein, fat, and carbohydrate but usually are not consumed in large quantities. Many cucurbits are low in fat and carbohydrates, which makes them useful in diets of those concerned with weight control in developed countries.

The white-flowering *zucca rampicante* (vining gourd) or *zucca a tromba* (trumpet gourd) is an Old World cucurbit (*Lagenaria siceraria*) that has been grown in the Mediterranean region since ancient times. The edible baby gourds, shown here, were known as *zucchette* or *zucchini* in Italian and were the breeding model for the New World squash grown today under the name of zucchini. PHOTO WILLIAM WOYS WEAVER.

The principal *Cucurbita* species may be further grouped according to horticultural traits (Table 2). Fruit shape and color and rind durability are the main discriminating characteristics. Some of the types are arbitrary and of historical interest only. For example, cushaw squash, winter crookneck squash, and marrow squash are not commonly grown, but they may be regionally important. The gourds and pumpkins of *C. pepo* are mostly grown for ornamental rather than culinary purposes and are increasing in economic importance in the United States. Show pumpkins are grown exclusively for competition in the heaviest-fruit contests held in various parts of the United States. Note that the word “pumpkin” or “squash” has been attached to each type. Some may disagree with these designations. The hard-rind types are generally called winter squash, whereas the soft-rind types (cocozelle, crookneck, scallop, straightneck, vegetable marrow, and zucchini) are generally referred to as summer squash. Winter squash are mostly indeterminate

TABLE 2

Horticultural types in *Cucurbita* spp.

Species	Type	Description	Typical Cultivars
C. argyrosperma	Cushaw squash	Striped, green or white hard rind. Pear shaped or with a straight or curved neck.	Green Striped Cushaw (Figure13), Japanese Pie, Tennessee Sweet Potato
C. moschata	Tropical pumpkin	Round, oblate, or irregular shape. Green, buff, yellow, or piebald hard rind.	La Primera, Seminole, Solar, Borenquin
	Cheese pumpkin	Variable shape, smooth, hard, buff-colored hard rind.	Dickinson, Kentucky Field
	Neck squash	Long curved or straight neck. Smooth hard rind fruit, usually buff.	Golden Crookneck, Winter Crookneck, Waltham Butternut, Zenith, Ultra
C. maxima	Banana squash	Elongated fruit pointed at the ends. Orange or pink moderately hard rind.	Banana, Pink Banana
	Delicious squash	Top shaped. Orange or green hard rind.	Delicious, Golden Delicious
	Hubbard squash	Round in the middle tapering at each end. Blue, orange, or green hard warty rind.	Hubbard, Blue Hubbard, Golden Hubbard
	Marrow squash	Lemon-shaped with orange hard rind.	Boston Marrow
	Show pumpkin	Very large globular, sutured, light orange fruit. Moderately hard rind.	Atlantic Giant, Big Max
	Turban squash	Turban shaped with a large button. Hard rind.	Turks Turban, Warren, Turks Cap
C. pepo	Acorn squash	Acorn-shaped, grooved fruit. Dark green, orange, or white hard rind.	Table Ace, Tay Belle, Heart of Gold, Table Gold
	Cocozelle squash	Long, cylindrical, bulbous blossom end. Striped or variegated green soft rind.	Cocozelle, Long Cocozelle
	Crookneck squash	Elongated with narrow curved neck. Yellow soft rind.	Dixie, Yellow Summer Crookneck, Supersett
	Ornamental gourd	Variously shaped and colored. Smooth or warty hard rind.	Egg, Striped, Pear, Bicolor, Spoon, Orange Ball, Crown of Thorns, Warted
	Pumpkin	Large, round, oval oblate shape. Mostly orange, sometimes white relatively soft rind.	Connecticut Field, Small Sugar, Howden, Jack-Be-Little
	Scallop squash	Flattened with scalloped margins. White, yellow, green, or bicolored soft rind.	White Bush Scallop, Peter Pan, Sunburst
	Straightneck squash	Long, cylindrical, yellow soft rind.	Enterprise, Goldbar, Early Prolific Straightneck, Multipik
	Vegetable Marrow	Short, tapered, cylindrical. Light green to gray soft rind.	Clarita, Goya, Zahra, Caserta
	Zucchini squash	Uniformly cylindrical. Green or yellow soft rind.	Dividend, Revenue, Spineless Beauty, Gold Rush

or vining in growth habit, and summer squash are mostly determinate or have a bush growth habit.

Squash and pumpkin are frost sensitive, so field establishment by seeds or by transplants two to four weeks old is made when no threat of frost remains. Summer squash plants are spaced three feet (one meter) apart in rows six feet (two meters) apart, and winter squash plants are spaced six feet apart in rows six to nine feet (two to three meters) apart. Local recommendations for crop management should be followed. Wild or domesticated bees are necessary for pollination and subsequent fruit enlargement since separate staminate (male) and pistillate (female) flowers occur on these plants. Baby squash, harvested when the flower opens or shortly thereafter, do not require pollination.

With good growing conditions, summer squash should be ready for harvest in about forty days from establishment. Fruit should be harvested about six to eight days after pollination, when they are small and the rind has a distinctive sheen. The rind becomes dull in overmaturity with a concomitant loss of quality. Summer squash should be consumed soon after harvest for best quality but may be kept in a plastic bag in a home refrigerator for a few days. Summer squash fruits should be harvested every day or two in warm weather.

Winter or hard-shelled squash, because they are grown to maturity, require much longer to produce a marketable product, 80 to 110 days, depending on weather and cultivar. Fruits should be harvested when fully mature (when seeds are fully developed) but before they are injured by frost. Winter squash, unlike summer squash, have a long life after harvest. Storage at or near 50°F (10°C) and 50 percent relative humidity retains quality for several months. For instance, the tropical pumpkin *(C. moschata)* fruits have remained in good condition for two to three months in a garage in Florida in uncontrolled conditions.

Plant Improvement

The economically important types showed marked genetic improvement in the last half of the twentieth century. Previously improvement had been mainly by selection, first from wild types and later from landraces.

The use of F_1 hybrids allows incorporation of dominant genes from two parents into the hybrid. For example, earliness in one parent can be combined with high culinary quality in the other parent to produce a superior hybrid. Often cited advantages of hybrids include uniformity, earliness, disease resistance, and intense fruit color. The *B* gene, originally obtained from an ornamental bicolor gourd, has been used to obtain bright yellow color in many *C. pepo* types. Exclusivity is usually not listed among the advantages of hybrids, but since the developer controls both parents, the hybrid cannot be duplicated by others. This fact provides the economic incentive for private development and competition among seed companies. Hybridity has been exploited most fully in cultivar development in summer squash, especially zucchini squash, and in decorative pumpkins.

Traditional plant-breeding techniques are most commonly utilized for improvement of these cucurbits. However, transgenic summer squash with resistance to cucumber mosaic virus, watermelon mosaic virus, and zucchini yellow mosaic virus have been developed and are used in areas where these diseases are a severe threat.

See also **Cucumbers, Melons, and Other Cucurbits**; **Fruit**; **Mexico and Central America, Pre-Columbian**; **Vegetables**.

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SQUID. *See* **Mollusks.**

SRI LANKA. *See* **India.**

STAPLES. Staple foods are those that appear most often in a given diet and provide its highest energy content. Satiety is the state sought from their consumption. A good example of an optimum staple are the loaves made from thick red sorghum porridge (*Sorghum caudatum*

[Hack Stapf]) that the Masa in northern Cameroon consume. The flour is unsieved on purpose so that it takes longer to digest. Insufficient staples in the diet leave the consumer unsatiated; it is when staples are lacking that famines occur.

Ambiguity of the Concept

The concept of a staple can be considered in two ways: (1) as the raw food material that is most often consumed and that brings the highest energy contribution to the diet and (2) as the most common dishes made from it. In Europe, wheat is a staple. For the French, bread is the wheat staple, and for the Italians, pasta is the usual foodstuff produced from it. In Africa, sorghum is a staple, and the Masai use it to make daily loaves.

It should be mentioned that staple foods are typically accompanied by a relish providing palatability and flavor. In Chinese culture, the idea of food is illustrated by the combination of two words: *fan*, meaning grain (or rice), and *tsai*, meaning relish (Chang, p. 7). This association of a staple with a relish may be observed in many cultures.

In traditional societies, the primal cuisine consists of preparing and making palatable the staple foods according to local criteria. In Senegal, pearl millet is cooked in many ways, using various kinds of flour and semolina. It can be steamed, or cooked in water or oil. In Mexico, maize used as grain or flour permits the preparation of countless dishes.

Types of Staples

In many societies, staple foods are of plant origin. However, among the Inuit, meat and fat can be considered staples (Robbe, pp. 101, 184), and for pastoralists like the Ariaal, Turkana, and Maasai of East Africa, milk is a dietary staple, representing over 50 percent of food calories (Little et al., p. 74). Similarly, milk may be regarded as a staple commodity for Mongolian herders (Accolas and Aubin, pp. 55–83).

Among most hunter-gatherers, plant foods provide the highest amount of calories in the diet and, according to their seasonal availability, many species therefore assume the role of a staple. In the Central African Republic, pygmies rely on wild yams (*Dioscorea* spp.) for this purpose. The mongongo nut (*Ricinodendron rautanenii* Schinz) may be similarly regarded as a staple among the !Kung San of Botswana (Lee, p. 307).

Most fishing societies, although depending on predatory activities for their livelihood, use a carbohydrate as their staple—rice (*Oryza sativa* L.), for instance, in southern Asia (Firth 1966, p. 3).

Storage

Since the Neolithic period, agricultural societies have produced and stored the elements of their diet. This is, for the most part, an easy matter with tubers, which remain planted in the fields and are only dug out as needed. Cereals and pulses, on the other hand, have to be protected from moisture, fungi, insects, and rodents. This is done by using granaries, some of which quite cleverly repel the pests. For instance, the *horreos* of northern Spain repose on pillars with an overhang, which prevents rodents from reaching the crop. In the Old World, where invasions were common, silos were dug into the ground and the opening hidden to avoid plundering (Gast and Sigaut). There are no optimal traditional solutions, however, and losses amounting to a quarter of the crop may sometimes be observed.

Main Staples

Among staples, one is usually prevalent. This is the case of wheat (*Triticum aestivum* L.) in Europe, rice in Asia, maize (*Zea mays* L.) in Central America, cassava (*Manihot utilissima* Crantz) in South America or Africa. Yams (*Dioscorea* spp.) are a main staple in the Pacific (Pollock) and Africa. In 2001 the production figures for the main commodities used as staple foods on a worldwide basis were as follows: maize, 604 metric tons (Mt); rice (paddy), 585 Mt; wheat, 578 Mt; potatoes, (*Solanum tuberosum* L.), 304 Mt; cassava, 176 Mt; barley, (*Hordeum vulgare* L.), 138 Mt; sweet potatoes, (*Ipomoea batatas* [L.] Lam) 136 Mt; sorghum, 57 Mt; and pearl millet, (*Pennisetum* spp.), 28 Mt (information available at the Food and Argricultural Organization, or FAO website).

Secondary Staples

Secondary staples, whose role is more seasonal, should also be mentioned. Some have been abandoned, others are still in use. For example, in Europe and the Near East, typical secondary staples include buckwheat (*Fagopyrum sagittatum* Gilib.), barley, true millet (*Panicum miliaceum* L.), and rye (*Secale cereale* L.), and also pulses such as broad beans (*Vicia faba* L.), lentils (*Lens culinaris* Medik.), and chick peas (*Cicer arietinum* L.). Common beans (*Phaseolus vulgaris* L.), which originated in America, also continue to flourish in Europe, where they often contribute protein to the diet of the poorest in society.

African secondary staples include hungry rice (*Digitaria exilis* [Kipp. Stapf]), finger millet (*Eleusine coracana* [L.] Gaertn.), cowpeas (*Vigna unguiculata* [L] Walp.), and bambara groundnuts (*Voandzeia subterranea* [L.] Thouars). Soya beans (*Glycine max* [L.] Merr.) are the usual secondary staple in Asia.

In many tropical areas around the world, the plantain banana (*Musa paradisiaca* L.), tubers like the American cocoyam (*Xanthosoma* spp.), and taro (*Colocasia esculenta* L.) are consumed as secondary staples. Breadfruit (*Artocarpus altilis* [Parkinson] Fosberg) and jackfruit (*Artocarpus heterophyllus* Lam. L.) fulfill the same role in southern Asia and Oceania. The starch made from the pith of the sago palm (*Metroxylon* spp.) is also popular for a similar reason among various tribes in New Guinea.

Other secondary staples, though no longer in popular or widespread use, include the following: the European chestnut (*Castanea sativa* Mill.), a farinaceous fruit, consumed in southern Europe (Bruneton-Governatori, *Le pain de bois*), and the acorns of various oaks, for example, the California white oak (*Quercus virginiana* Mill.), that served as an important staple food for Native Americans (Hedrick, p. 480).

Diffusion

Staple foods are not necessarily indigenous to the place where they are today most frequently consumed (Garine, p. 240). For instance, maize, which has spread to southern Europe, Africa, and Asia, is native to Central and South America (Estrella, p. 72; Messer, pp. 97–112). Cassava, which found its way to Africa, southern Asia, and Oceania, also originated in South America. And, rather unexpectedly, potatoes and maize, which are nowadays staple foods for some Nepalese populations, are in addition of South American origin.

The routes and methods of diffusion for such staples is still a matter of discussion (Purseglove, p. 1; Chastanet, p. 265). It is likely that the way by which rice (native to southern Asia) reached the Mediterranean basin in ancient Rome will never be known, or why it only began to be cultivated in Lombardy in the sixteenth century (Barrau, p. 291), or how sorghum, native to tropical Africa, reached China (Simoons, p. 75).

The discovery of America contributed to the establishment of many new staple crops (Lewicki, p. 50) in the Old World after Christopher Columbus's voyage in 1492. For instance, maize was introduced at the beginning of the sixteeenth century in Spain and especially Portugal, where it rapidly became a main staple. It also enjoyed widespread popularity in Turkey (in fact, maize was commonly known as "Turkish wheat" in Europe) and spread to Africa through the Nile Valley. It was later transported to the west coast of Africa by Spanish and Portuguese merchants.

More extensively documented was the introduction of potatoes (*Solanum tuberosum* L.), native to South America, to Europe around 1540 by the Spaniards. At first a medicinal product, they later became a food in Ireland, France, the Netherlands, and Germany during times of famine and a cheap source of nourishment for industrial workers in the nineteenth century (Messer, p. 191). They are now a staple in many Eastern European countries.

The slave trade contributed to the development of maize and cassava production in Africa as high-yielding crops to feed the slaves on their way to America (Bahuchet and Philippson, p. 92). Colonial America later focused on the development of staples (Firth, "Sociological Study") that were easily produced and drought-resistant, such as cassava, or easy-to-store and prepare, like rice, in order to feed cheap labor engaged in cash cropping, industrial manufacturing, and mining (Chrétien, p. 76).

In 2001 the export of staples from countries with sophisticated technology and powerful means of commercialization, as in the United States and Europe, motivates harsh competition in their sale to developing countries (Barrau, p. 300). Low price, widespread availability, easy preparation, and prestige in adopting the tastes of thriving industrialized countries are underlying factors in such food changes. The French, for instance, promoted the importation of wheat into Africa. The urban elite in many African nations developed an interest in French cuisine as a result. Today, bread is widely consumed in French-speaking Africa, and in Senegal it is even delivered by car to small villages.

Prestige

In agricultural societies, the successful production of a staple formerly conferred prestige because it demonstrated technological skill and benevolent protection from supernatural powers. At harvest time, the display of vast quantities of yams still conveys success in the Trobriand Islands (Schiefenhoevel and Bell-Krannhals, p. 244) as it did seventy years ago (Malinowski, p. 171).

Staples and Cultural Superfood

As previously indicated, in most cultures one staple food is dominant. Some populations are restricted to a small number of staples, as is the case with the Masai population already mentioned. They consume their thick sorghum porridge loaves at 90 percent of their meals. Most traditional societies nonetheless have to adjust their range of staples according to the season and the habitat. This enables the Tamang, who live in the middle hills of Nepal, occupying a watershed ranging from 1,400 to 4,000 meters, to consume a wide range of basic foods: rice, maize, taros, potatoes, barley, and wheat.

It should be stressed, however, that a single staple normally becomes a key symbol in most traditional societies. This is certainly the role of rice among the Tamang and in most of India, of maize in Central America, and of wheat in Europe. Such a staple is what Jelliffe (p. 279) very adequately termed "cultural superfood" and it exists in a poulation's food supply as a "central core food," as described by Passin and Bennett (p.113).

Religious Aspects

Besides providing most caloric intake, a central staple also elicits emotional reactions in relationship to food: it is the "daily bread." Among the Masai, "to be alive" means eating the sorghum loaf. Its use is therefore strongly imbedded in their religious beliefs and mythologies.

Among the Serer of Senegal, pearl millet was considered a gift from god to prevent human starvation. Bread, made from wheat, is constantly referred to in the bible: It is a symbol of the body of Jesus Christ and also plays an important part in the Jewish Shabbat (Erlich, p. 227).

As such, staples are considered sacred foods to be handled with care and respect. The Kanaks of New Caledonia formerly carried yams in their arms like infants, since the crop grew on the land in which their ancestors are buried (Leenhardt, p. 83).

Staples are also often associated with particular deities. In Mexico, among the Aztecs, Tlaloc, one of the central deities, was linked to maize. In Greek and Roman mythology, Demeter, Mother Earth (Ceres for the Romans), is associated with agricultural products, especially wheat, symbolizing the resurrection of Persephone (or Proserpine).

Although a staple may be a revered food in a culture and is consequently to be respected, it may also elicit other responses during certain periods. For instance, in many rural societies, the harvest, marking the end of an annual cycle of food production, is an important time of celebration. Among the Koma of northern Cameroon, while sexual promiscuity is to be avoided during the maturation of staples, the threshing activities provide an opportunity for boisterous celebration, setting the stage for more permissive behavior.

Staples are additionally used in most religions as offerings to supernatural beings. In rural European societies, first-fruit offerings were formerly made with wheat, which has also been identified in Egyptian tombs dating from the dynastic period (Darby et al., p. 486). Offerings prepared with maize are presented to the deceased on All Saints Day in Mexico. Millet and sorghum are offered to deities in the form of grain, porridge, or beer in many African cultures.

Adaptability and Nutrition

Staple foods, the foodstuff to which infants are first introduced, are considered to be safe during weaning. They contribute to the development of a palate and organoleptic expectations. This can have important consequences in terms of food education and food relief programs, which might be more sucessful if they tried to provide the populations concerned with their own staples rather than those readily available or popular elsewhere.

In traditional societies, a staple is not necessarily chosen because it is the highest-yielding species with the best nutritional value. Many factors determine its selection. The elected staple might even provide little else than energy, as is the case with the false banana (*Ensete ventricosum* [Welw.] E. E. Cheesm.) among the Gurage of Ethiopia (Shack). In many areas of Africa, at the limit between the tropical savanna and equatorial forests, the cultivation of both maize and cassava is possible. Although the former is more nutritionally complete, it requires more work than the latter. Sometimes societies opt for the staple easiest to produce.

Since the staple, generally considered the safest food to consume, is also the first solid item offered to a child, its nutritional value may have important consequences during the weaning period. In this respect, cereal staples, which contain proteins, provide better nutrition than tubers. Relying on a single staple food in a monotonous diet amplifies its nutritional weakness. The lack of the amino acid thiamine can provoke beriberi among rice eaters, and pellagra occurs among maize consumers through an inadequate amount of tryptophane (FAO, *Maize* and *Amino-Acid Content*). Cassava contains toxic cyanide, which has to be carefully eliminated before consumption to avoid health risks. The pulse *Lathyrus sativus* L., which is consumed mainly by the poorest in Central India, can cause a paralytic disease called lathyrism (Kaul and Combes).

The Present Situation

Because of the significant progress in food production, distribution, and commercialization, it is possible today for anybody with financial means to consume any food, in any quantity, at any time of the year. The range has no limits. This minimizes the material importance of staple foods and the nutritional risks related to their exclusive consumption. What is the staple food of a European today? There has been a general worldwide decrease in the consumption of carbohydrates. As a result, someone living in present-day France is likely to eat only half the amount of bread an individual consumed in 1955, 63 kg per year as opposed to 122 kg. In France cereals represent only 23 percent of food energy, whereas in Italy that number is 32 percent (Collet-Ribbing and Decloitre). This difference is probably due to the maintenance of a very old style of eating in Italy, which combines an energy-rich staple like pasta with a relish of varied composition.

The globalization process has had a positive impact on food distribution worldwide by making a very wide range of foods and dishes available, but the choices made in some cultures as a consequence are not necessarily nutritionally sound. The greater consumption of white rice over brown rice and traditional staples, which contain more proteins, minerals, and vitamins, may have unforeseen negative nutritional consequences such as protein malnutrition and beriberi (FAO, *List of Foods* and *1972 Food Composition Table*).

Today staples retain some of their religious and symbolic value. This is the case of bread among Christians, and rice among many populations of Asia. Consuming one's traditional staple food is also psychologically satisfying. This is why a number of emblematic dishes involving a cultural superfood are still consumed on social occasions, especially by immigrants. They exist as a token of the past, a demonstration of a lasting cultural authenticity.

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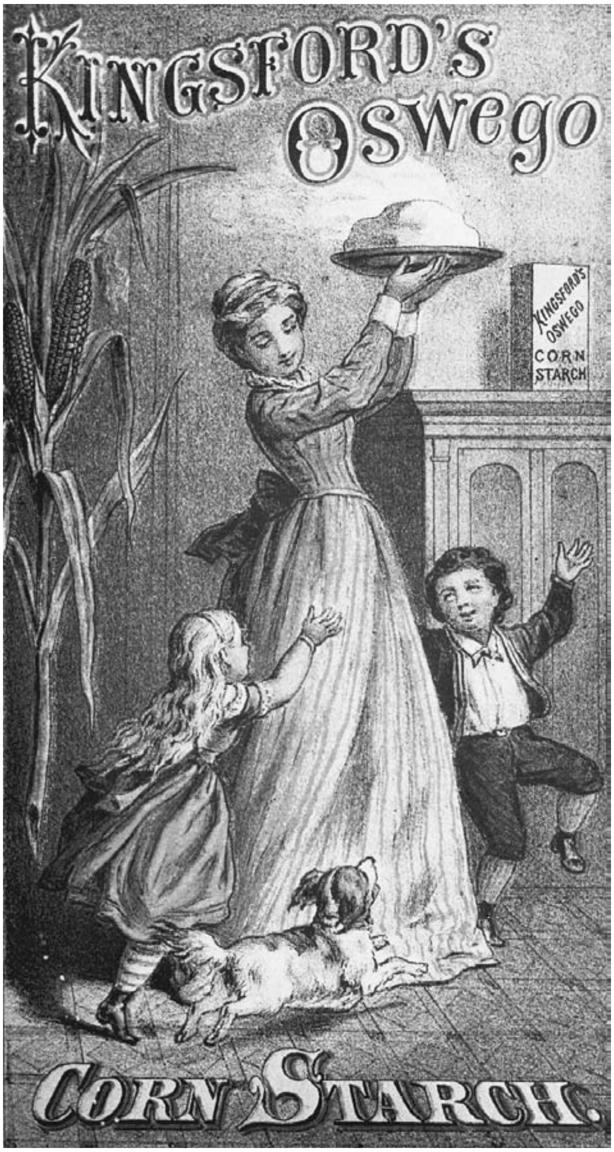
Igor de Garine

STARCH. Starch is a highly organized mixture of two carbohydrate polymers, amylose and amylopectin, which are synthesized by plant enzymes and simultaneously packed into dense water-insoluble granules. Starch granules vary in size (1 to 100 microns [μ m] in diameter) and shape, which are characteristic of their specific plant origin. Starch is the major energy reserve for plants; it is located mainly in the seeds, roots or tubers, stem pith, and fruit. Starch amylose is primarily a linear chain of glucose units. Amylose chains can coil into double helices and become insoluble in cold water. Amylopectin also is composed of chains of glucose units, but the chains are branched. This branched structure renders amylopectin soluble in cold water. The molecular architecture of the amylopectin and amylose within the granules is not entirely understood, but the granules are insoluble in cold water. The functional properties of native starch are determined by the granule structure. Both the appearance of the granules and their functional properties vary with the plant source.

Physical and Functional Properties

In home cooking and in commercial food processing native starches are used for their thickening properties. Starch granules when heated in water gradually absorb water and swell in size, causing the mixture to thicken. With continued heating however, the swollen granules



Starch is not only a food thickener but is itself the focal point of numerous recipes. The introduction of cornstarch led to the popularity of cornstarch pudding during the nineteenth century, as shown by the picture on this 1883 pamphlet cookbook. ROUGHWOOD COLLECTION.

fragment, the mixture becomes less thick, and the amylose and amylopectin become soluble in the hot mixture. This process of granule swelling and fragmenting is called gelatinization. Once gelatinized the granules cannot be recreated and the starch merely behaves as a mixture of amylose and amylopectin. Because of the larger size of the swollen granules compared to the size of amylose and amylopectin, the viscosity of the swollen granule mixture is much higher than the viscosity (the resistance to flow or a liquid or semi-liquid mixture) of the amylose/amylopectin mixture. Starches from different plant sources vary in their gelatinization temperatures, rate of gelatinization, maximum viscosity, clarity of the gelatinized mixture, and ability to form a solid gel on cooling.

The texture of heat-gelatinized starch mixtures is variable. Some gelatinized starch mixtures have a smooth creamy texture, while others are more pastelike. Some starches form gels after cooking and cooling. These starch gels may lack stability and slowly exude water through the gel surface. A similar breakdown of the gelatinized starch occurs in some frozen foods during thawing and refreezing. Although amylose is soluble in the hot gelatinized starch mixture, it tends to become insoluble in the cooled mixture. This phenomenon is called retrogradation and it occurs when the amylose chains bind together in helical and double helical coils. Retrogradation affects the texture of the food product and it also lowers the digestibility of the product. The proper starches must be employed for the different food products to minimize these problems. Certain starches are good film formers and can be used in coatings or as film barriers for protection of the food from oil absorption during frying.

Native and Modified Starches

The predominant commercial starches are those from field corn (maize), potato, cassava (tapioca), wheat, rice, and arrowroot. Field cornstarch (27 percent amylose and 73 percent amylopectin) is the major commercial starch worldwide. Genetic variants of field corn include waxy maize, which produces a starch with 98 to 100 percent amylopectin, and high-amylose starches, which have amylose contents of 55 percent, 70 percent, and higher. Waxy starch does not form gels and does not retrograde readily. High-amylose starches retrograde more extensively than normal starches and are less digestible. Their linear structure enables them to form films.

From the 1940s on the demand for convenience foods, dry mixes, and various processed foods has led to the modification of starches for food use and for other commercial products. These modified starches improve the textural properties of food products and may be more suitable for use in modern processing equipment. The Food and Drug Administration regulates use of the various modified food starches by stipulating the types of modification allowed, the degree of modification, and the reagents used in chemical modification. However, the food label is required only to state that "modified starch" is present. Only a small fraction of the sites available for modification of the food starches are actually modified. Although the degree of modification is small, the properties of the starches are significantly improved. This small degree of modification is sufficient to give a more soluble and stable starch after cooking. The clarity of the gelatinized starch as well as the stability of the cooked starch and starch gels are improved. The modification procedures are carried out under mild conditions that do not cause gelatinization of the native starch granules, and therefore the functional properties of the granule are preserved. The emulsifying properties of starch also may be improved by proper modification, improving the stability of salad dressings and certain beverages.

Physically modified starches include a pregelatinized starch that is prepared by heat-gelatinization and then dried to a powder. This instant starch is water-soluble and doesn't require further cooking. Because of its lower viscosity resulting from loss of granule structure, the starch can be used at higher concentrations. Certain confectionaries require high levels of starch to give structure to their products. These gelatinized instant starches serve this role. Cold water swelling starches represent a different type of instant starch. They are made by a proprietary process that retains the granule structure but lowers the granule strength. These cold water swelling starches give higher viscosities than the other instant starches. They are used in instant food mixes and for products such as low-fat salad dressings and mayonnaise.

Plant breeding has led to specialty starches with atypical proportions of amylose and amylopectin. Waxy maize starch with nearly 100 percent amylopectin is inherently stable to retrogradation. Chemically cross-linked waxy maize starch is a very high-quality modified starch. High-amylose starches have become available more recently and have led to lower caloric starches. Because of the crystallinity of these starches they are partially resistant to digestion by intestinal amylases and behave as dietary fiber when analyzed by the official methods of analysis for dietary fiber. Some of these high-amylose starches contain as high as 60 percent dietary fiber when analyzed.

The nutritional value of uncooked (ungelatinized) starchy foods (cereal grains, potato, peas, and beans) is relatively poor. Our digestive enzymes do not readily convert the native granular starch of uncooked fruits and vegetables into glucose that would be absorbed in the small intestine. Undigested starch passes into the large intestine where, along with dietary fiber, it is broken down to glucose and fermented to short-chain fatty acids. Some of these short-chain acids are absorbed from the large intestine resulting in recovery of some of the caloric value of the native starch.

Starch-Derived Dextrins and Corn Syrups

Modified starches as described above were developed to improve starch functionality in foods as well as their ability to withstand the physical forces of modern food processing systems. In addition to the food applications of starches and modified starches, the native starches are also converted into other products that serve food and other industries. These products do not require the granular character of native starches, which is lost by chemical or enzymic action during processing of the starch.

Dextrinization, a process requiring high temperatures and acid that has been in use since the early 1800s, converts native starch into dextrins that are composed of amylose and amylopectin chains of smaller sizes and altered structure. Consequently, food and nonfood industries have access to a range of dextrins of varying molecular sizes, solubility, and viscosity, but without the granular characteristics described above. Corn syrups are made in the same way as the dextrins, but they are converted to a higher degree such that glucose is a major ingredient. The more recent availability of an enzyme that converts glucose into fructose has led to a new industry in high-fructose corn syrups, which have found a strong market in beverages.

See also **Fats; Frying; Oil.**

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STEW. A stew has been described as an assortment of foods cooked in liquid within a container with a lid. Stews are usually made from several ingredients and may be named for the most important of these, for example, beef stew; for its point of origin, as in Irish stew; or for the pot in which it is cooked, as in Rumanian *ghiveci*, named for the Turkish *güveç*, an earthenware pot in which the stew is cooked.

The word "stew" is said to come from the old French word *estuier*, meaning to enclose. Most cultural groups have created a recipe for a special stew, and there are as many versions of them as there are cooks to make them.

In the Western world, meat stews are categorized as "brown" or "white." This means that the meat is browned in fat before liquid is added for the brown stew; meat for the white stew is not cooked in fat before liquid is added. Stews may contain meat, fish, or poultry; many of them, however, are meatless. There is also sometimes a fine line between stews and soups. Stews are usually thick, some so thick that they must be served on a plate and eaten with a fork. Others are served in soup bowls. Stews most often have several solid food ingredients. An exception is a seafood stew such as oyster or lobster stew, which contains fresh seafood, milk, and frequently butter.

Stews are commonly regarded as "comfort" foods, everyday dishes served to family or close friends in an intimate setting, rather than as fare in a more public setting or at special occasions. An exception would be *boeuf à la bourguignonne*, usually referred to as beef burgundy in the United States, a dish that is considered exceptional enough to be served to a guest. This stew is made with beef, tiny onions, mushrooms, wine, and herbs. M. F. K. Fisher once wrote that stews can be good enough to be haute cuisine, or the opposite, a meal fit for the lowest echelon of society, the imprisoned.

There are several important advantages to stews: Less tender cuts of meat can be tenderized with the long, moist cooking; more expensive ingredients that may be available only in small amounts can be stretched by adding less expensive foods; meat cut in small pieces cooks faster; and one-pot cooking conserves fuel and makes cleanup easier. Stews may be cooked on top of a range, in an oven, over an open fire, or in an electric Crock Pot.

In addition to being versatile in their ingredients, stews are versatile in their uses. Suggested uses include as filling for tarts or patty shells, or over mashed potatoes, rice, or biscuits.

Usually considered dishes that must be cooked for long periods, stews are, in fact, cooked quickly in countries where fuel is scarce. There are Asian chicken stews, made with young and tender chickens, that cook quickly, but are even more worthwhile because they conserve energy since the entire meal can be cooked in one pot.

Because stews are apt to use protein- and carbohydrate-containing food, as well as ingredients high in vitamin and mineral content, they are good sources of nutrients. Combining certain ingredients, for example, rice and beans, can enhance the nutrients in each food, making them more usable by the human body. Water-soluble nutrients are consumed in the sauces, or gravies, that are part of stews.

Kinds of Stew

Europe. In the eighteenth century, the term "made dish" was used to distinguish between a roast and various mixtures of ingredients. The made dishes in both France and England were often French stews, or ragouts, many still commonly served today. The term *daube* is more often used to describe beef stews in France. Patricia Wells's *Bistro Cooking*, published in 1989, contains a recipe for a *daube* containing wild mushrooms and oranges. An Alsatian meat stew (beef, pork, and lamb cooked with vegetables) is a tradition on Monday, washday, in certain regions. A family's stew pot is taken to the neighborhood bakery where the stew is cooked until noon, when a member of the family arrives to retrieve the meal.

Navarin is a popular French stew made with mutton, potatoes, and onion. In *The Food of the Western World*, Theodora Fitzgibbons tells us that if root vegetable are added, the stew should be called *ragout à la printanière*. Bouillabaisse, the renowned Mediterranean fish stew of France, has its counterparts in the fish stews of Greece, Italy, and Spain. There is also a less well-known bouillabaisse made with monkfish and aioli, the French garlic mayonnaise. The reader should, in addition, be mindful that the terminology can sometimes be misleading: There is a *bouillabaisse de Tante Paulette*, which is actually a chicken stew flavored with fennel, saffron, and Pernod or another licorice-flavored liqueur, and was frequently served at a legendary Parisian bistro, and a rabbit bouillabaisse.

The German *Eintopf* is another one-pot meal or stew. In the 1930s Hitler urged Germans to return to the austere meals of former days. It became law in 1933 that one Sunday a month, from October to March, was *Eintopfsonntag*, one-pot Sunday. Money saved from not eating more lavishly was to be donated to the poor. *Eintopfs* are still popular in Germany, especially in the north. *Linsentopf*, lentil stew, and *Pichelsteiner*, made with beef, veal, lamb, and pork, are popular forms of *Eintopfs.*

Said to be Poland's national dish, *bigos*—hunter's stew—has ancient origins. It was first made of vegetables such as cabbage (fresh or as sauerkraut), mushrooms, and onions, along with prunes or apples and leftover game. It was a staple for hunters and was reheated frequently over outdoor fires. Some say a poorly made *bigos* will improve with reheating due to the condensation of flavors, but that a well-made *bigos* is delicious the first day. The meat used may be fresh pork or ham, sausages, poultry—goose or duck are considered best—and any game available. Madiera wine may be added as flavoring. Over the years, *bigos* has assumed greater importance at Polish New Year's Eve celebrations.

Waterzooi is a well-known Flemish stew of fish or chicken, vegetables, and white wine. It is associated with the city of Ghent in East Flanders, Belgium. Most food experts claim the original stew was prepared with fish. Whether fish or chicken, the stew contains cream and is thickened with egg yolk.

Africa. Stews are used in some cultures for dipping bread or a type of porridge. The mainstay of the Ethiopian diet is *injera*, a pancakelike bread made from the nutritious grain *tef.* Pieces of *injera* are broken off and used to scoop up stew. *Wat* is the usual name for an Ethiopian stew, frequently seasoned with *berbere*, a dried spice and herb mixture that can be made hot with peppers. Milder Ethiopian stews are called *alechos.* Although meats, fish, and chicken are all used in preparing *wats*, the stew is more likely to be vegetarian because of the many meatless fast days required in the Ethiopian orthodox religion. Legumes are therefore often used in these stews.

The main carbohydrate for Nigerians is *fufu*, a thick pasty that may be made from cassava, plantain, or from a grain. Nigerian immigrants in the United States sometimes use Cream of Wheat cereal to make *fufu.* A diner will scoop up some *fufu* in his or her fingers, deftly roll it into a ball, and then use that to dip up some stew. Nigerian stews are often vegetarian dishes, but they may contain meat, fish, or poultry, and are usually made hot with peppers.

Zambians use pounded millet for their starchy dipping porridge. As in many cultures, meat stews are frequently preferred, but vegetarian stews are more likely to be readily available.

Asia. The ancient Chinese cooked *keng*, meat and/or vegetable stews, in cauldrons. Ceramic, and later bronze, cauldrons have been found in archaeological digs; some of these cauldrons are thought to be eight thousand years old. In *The Food of China*, E. N. Anderson describes the Chinese process of preparing and cooking a stew as a gentle, subtle, and slow art. The cook typically worked with a set of well-seasoned sand pots (sand-tempered earthenware); now metal woks with lids are used for cooking stews.

Tubu-tchigae, or bean curd stew, is a Korean meal that remains nostalgically popular. The dish is made with firm bean curd, pork, garlic, ginger, soy sauce, sesame oil, and *kochujang* (a red pepper, soybean, and glutinous rice paste).

The Japanese *iri-dori*, a one-pot chicken stew seasoned with mirin, sugar, and soy sauce does not require the long cooking times generally needed if a young chicken is used. A variation on this stew uses fish in place of poultry.

Filipinos make *adobo* from pork, chicken, and perhaps shellfish or fin fish. Seasonings include garlic, vinegar, and soy sauce, providing the sour-cool-salty taste the Filipinos desire. Another favorite stew in the Philippines is *puchero*, the traditional Sunday dinner. It is prepared with chicken, beef, tomatoes, sweet potatoes, and garbanzos and sometimes is served with a sauce made from eggplant.

South America. Argentineans cook their beef stews with fruits, perhaps peaches, and sometimes chunks of corn-on-the-cob. These stews may be baked in a pumpkin or squash shell. Stews are also everyday fare in Bolivia, Paraguay, and Uruguay. One is more likely to find fish stews in Chile than in other South American nations because of that country's long coastline.

North America. Traditional Mexican cooking included many stews because the meat and poultry used in that location were often not tender and they required the long, moist cooking characteristic of stews. In spite of the improved quality of meat and poultry in modern times, stews have prevailed as a favorite food. One stew, *mancha manteles de cerdo*, is prepared with three varieties of red chilis and tomatoes.

Mexico's *pozole de lujo* is often described as a "luxurious" pork stew. The recipe calls for a pig's head and pig's feet, with pork loin, chicken, and hominy. Mexican *caldos* (stews or soups) are traditionally served with tortillas.

First Nations in Canada and Native Americans in the United States made stews in birch bark containers or hollowed-out trees before Europeans introduced metal containers. Some tribes left a stew on the fire for hours; its members would then add gathered plants or hunted game as they returned to camp.

The culinary history of both Canada and the United States includes numerous examples of stews brought by European settlers. Beef stews have been the most popular recipes among this legacy.

On the Canadian prairies, chuck-wagon cooks made stews from less tender cuts of meat. In the Laurentian Mountains of Quebec, a stew would typically be placed inside a wood-stove oven; the fire was then allowed to die down. The stew cooked in the waning fire. Ontario Mennonites still prepare stews in iron kettles.

Stews have been important food for most of the world's people for thousands of years, and there is no indication that this will change any day soon. They are wonderful concoctions, savored for their flavorful combinations as well as their reminders of home and family.

See also **Chicken Soup**; **Lamb Stew**; **Porridge**; **Soup**.

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Mary Kelsey

STIMULANTS. Foods and drinks (and other substances) that stimulate the consumer to enhanced mental alertness, increased or prolonged physical activity, uninhibited conviviality, or fierce fighting are called "stimulants." This definition is intentionally a narrow one. It excludes the great majority of nourishing foods, for example, because a nourishing meal in itself produces, alongside a feeling of well-being, somnolence (sleepiness) rather than alertness and activity. It also excludes substances such as cannabis and opium (both occasionally taken as foods) that depress mental and physical activity: these are sedatives, not stimulants. We must distinguish enhanced mental alertness from hallucination, the tendency to see what isn't there; hallucinogens are, therefore, also excluded. Other exclusions include appetizers, which stimulate the appetite for food, and aphrodisiacs, which (to the extent that such foods really exist) stimulate sexual appetites and energies.

Using foods that have a stimulant effect provides ways of intentionally adjusting the body's metabolism, which carries risks. There is a good reason why a nourishing meal produces sleepiness: after such a meal, the body is occupied with digestion. Postponing or interrupting that activity may produce digestive disturbance. In any case, increased alertness and physical activity will eventually be paid for in greater-than-usual exhaustion, and there may be other undesirable aftereffects. For example, it may be necessary to compensate for the aftereffects of stimulants by using them again. If the desired effect lessens after frequent use, increased quantities might be needed. In this way, regular use turns into dependence and addiction.

It is even more true of stimulants than of foods in general that their use is not independent of its social context, but no simple generalization is possible. Some of the foods discussed here are nearly always taken in company, as part of a social ritual. Some are nearly always taken as part of, or immediately before or after, a meal. Some, however, are customarily taken when one is not in company and not eating a meal; such habits may vary from one culture to another. External observers focusing on individual psychology may see the solitary use of stimulant foods as posing a personal, social, or criminal problem, while social use might be perceived as no problem or as a different kind of problem. Furthermore, observers focusing on social groups will find users of these stimulant foods to be unexpectedly protective, even nationalistic, about the preferred means of preparing them, which may vary widely.

Stimulant foods have been identified, like nearly all other foods and like many thousands of medicinal plants, in the course of very long-term unrecorded experiments: each human community explores its environment, notes animals and plants that may be of use, finds ways to use them, sometimes begins to farm them, and to trade in them. The stimulant effects of these foods were discovered empirically, as were their associated side-effects and dangers. In the last two centuries, chemists and nutrition scientists have identified their active constituents, making possible for the first time a scientific explanation of their effects.

In general, stimulant foods and drinks are either taken in a neutral vehicle, such as hot water, or they are slowly extracted by chewing. Nonfood stimulants are often taken as smoke or snuff. These various methods all ensure gradual absorption with relatively little interference from other foods. Alcoholic drinks are unusual because they are frequently taken without admixture and often contain strong flavorings: however, water is the principal constituent of most alcoholic drinks, and more water is often added.

Most traditional cultures had one, or at the most two, familiar stimulants. Globalization has changed this, producing such effects as the worldwide fashion for coffee; the worldwide marketing of chocolate, instant coffee, and the "cola" drinks; and the complex social interplay between alternative stimulants of almost equal status, neatly symbolized by the ritual question at breakfast in a French hotel, *"Café? Thé? Chocolat?"* (Coffee? Tea? Hot chocolate?)

Caffeine

Caffeine is among the commonest of stimulants worldwide. It is the chief active constituent in coffee and tea, which are familiar in practically every country, and in maté, guaraná, and cola nut, which are popular in South America and West Africa. It is present in smaller quantities in some other stimulant foods, including chocolate.

Coffee. Coffee consists of the roasted, ground beans of *Coffea arabica*. Native to Ethiopia, its use spread in late medieval times to Yemen; from there it rapidly became popular around the Mediterranean. Both Arabs and Europeans encouraged its further spread. Details of its use vary. Boiling water is added; commonly sugar is used as a flavoring, and sometimes milk or cream. Often coffee is drunk after meals, but it is also often taken between meals, both by groups as a social drink and by workers as a stimulant. Several substances have been used as coffee substitutes. Most of them had the advantages of being cheap and of tasting somewhat like coffee but the

TABLE 1

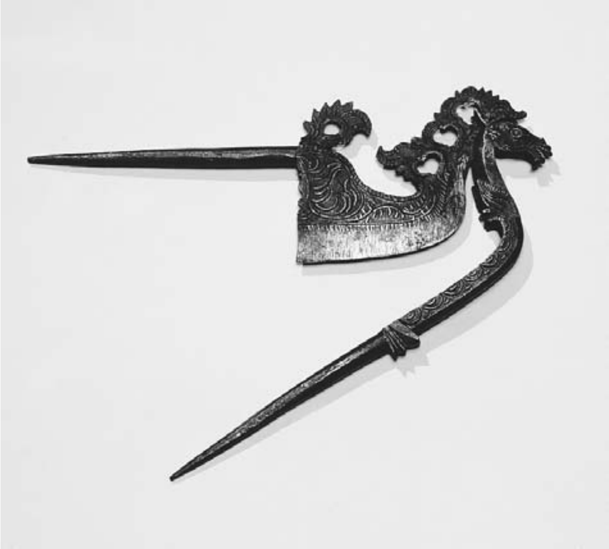
Traditional stimulants: Origin and spread

	Usual botanical source	Active constituent	Spread and current use	Analogues and substitutes
South America				
maté	*Ilex paraguariensis*	caffeine	Argentina, Paraguay, Uruguay, and southeastern Brazil	yaupon (*Ilex vomitoria*), cassine (*I. cassine*), American holly (*I. opaca*), and other Ilex species provide stimulant and narcotic beverages, mainly in North America
guaraná	*Paullinia cupana*	caffeine	Brazil only	
coca	*Erythroxylum coca, E. novogranatense*	cocaine	Western South America only. The derivative, cocaine, is widely used as an illicit drug.	*Erythroxylum cataractum, E. fimbriatum, E. macrophyllum* used locally in South America
Central/North America				
chocolate	*Theobroma cacao*	theobromine, caffeine	Central America. Worldwide; spread began in 16th century	Pataxte (*Theobroma bicolor*) used locally in Central America
tobacco	*Nicotiana tabacum*	nicotine	Eastern North America. Worldwide; spread began in 16th century	Wild tobacco (*Nicotiana rustica*) used locally in North America and elsewhere
Mormon tea	*Ephedra nevadensis*	pseudoephedrine	Western North America only	
West Africa				
cola	*Cola nitida, C. acuminata*	caffeine, theobromine	West Africa. Now an ingredient in some soft drinks worldwide	
East Africa/Arabia				
khat	*Catha edulis*	cathinone	Southern Arabia and northeastern Africa only	
coffee	*Coffea arabica*	caffeine	Ethiopia, then Yemen. Worldwide; spread began in 15th century mainly in Europe; instant coffee (*Coffea robusta*) now worldwide	Chicory root (*Cichorium intybus*) and other coffee substitutes
Western Asia				
wine	*Vitis vinifera*	alcohol	Northwestern Iran or southern Caucasus. Worldwide; spread began in 3d millennium B.C.E.	Also made from other fruits and other sources of sugar
beer	*Hordeum sativum*	alcohol	Mesopotamia; perhaps developed independently elsewhere	Also made from other cereals
South and East Asia				
tea	*Camellia sinensis*	caffeine	Southern China. Worldwide; spread began c. 9th century	There are many herbal teas, often sedative or medicinal, less often stimulant
betel	*Areca catechu*	arecoline	South and Southeast Asia only	
kratom	*Mitragyna speciosa*	mitragynine	Thailand only	
Australia				
pituri	*Duboisia hopwoodii*	nicotine	Australia only	
Oceania				
kava	*Piper methysticum*	kavalactones	Oceania only	

disadvantage of containing little or no caffeine. These substitutes have now been overtaken in popularity by instant coffee, a soluble product manufactured from the beans of *Coffea robusta*, which does contain caffeine.

Tea. Tea is made from the dried leaves of *Camellia sinensis*, native to southern China. The use of tea was already spreading beyond China in the ninth century; like coffee, it became popular in Europe in the seventeenth century and its use then spread worldwide. Again, like coffee, details of its use vary. Boiling water is usually poured onto the leaves, which are then allowed to steep for a few minutes. The resulting liquid is much lighter in flavor and color than coffee. Some add sugar to it: fewer, notably the British, add milk; some drink it iced. Tea is more often taken between meals than during meals; like coffee, it is used both as a social drink and by workers as a stimulant.

Caffeine beverages in South America. Maté, also called Paraguayan tea, is made by pouring boiling water onto the dried and roasted leaves of yerba maté (*Ilex paraguariensis*). Most of the leaves that are used come from wild trees gathered from the forests of southern South America. Maté is traditionally a social drink, made in a gourd or a silver pot and sucked through a shared straw or



Betel nut sheller, Sri Lanka, nineteenth century. Wrought iron. The sharp blade cracks open the nut while the pointed handles serve as nut picks. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

silver tube. It is drunk while still extremely hot, so added pleasure is provided by watching the reactions of unskillful foreigners who burn their lips and mouths while trying to drink it. It is usually taken without sugar, but sometimes orange zest is added as a flavoring. Maté is the national beverage of Argentina and Paraguay but has never spread beyond the region. The plant is a relative of European holly (*Ilex aquifolium*), whose leaves have occasionally been used to make a narcotic drink; more importantly, it is related to yaupon or Carolina tea (*Ilex vomitoria*) and other species that have been used to make stimulating and narcotic drinks by North Americans both before and after European settlement.

Guaraná (*Paullinia cupana*) is a tropical plant native to Brazil. Its seeds are traditionally roasted, pounded, and made into cakes called "Brazilian chocolate." They have this name not because they can be eaten solid, like modern chocolate bars, but because in pre-Columbian Mexico travelers used to carry similar cakes of powdered cacao for use in making an instant chocolate drink. Like those, cakes of guaraná are traditionally crumbled into water by tired travelers in Brazil, making a stimulating drink particularly rich in caffeine. Guaraná is now also used as a flavoring for soda, candy, and liqueurs.

Caffeine in Africa. The cola nut, a rich source of caffeine, is the usual native stimulant of West and Central Africa. It might rather be called a seed, since eight or ten of them are found in each fruit of the trees *Cola nitida* and *C. acuminata*. These seeds are white, pink, or red: the white ones are said to be the best. They are customarily chewed before meals: they have a bitter flavor but, perhaps as a result of this, foods and drinks taken afterwards seem sweet (water, taken after cola, tastes "like white wine and sugar," according to one observer). Apart from this effect as an appetizer, cola nuts have a high reputation among their traditional users, as stimulant, digestive, and aphrodisiac. Alongside caffeine, they contain theobromine (as does chocolate) and kolanin, a heart stimulant. Cola nuts can also be ground into powder and mixed with water as a drink, and cola extract is used to flavor sodas and candies: the names of Coca-Cola and Pepsi-Cola allude to cola nuts, which may well be an ingredient in these products.

Theobromine

Theobromine is the chief active ingredient in cacao beans, the seeds of the tropical tree *Theobroma cacao*. These beans, fermented, roasted, and ground, are the raw material for chocolate, the traditional stimulant of Mexico, familiar worldwide. In pre-Columbian civilizations, chocolate was used as a drink: the ground cacao was mixed into hot water, which was then poured from a height into the serving cup to produce the much-desired foam. Flavors (chili, vanilla, or others) and color (notably annatto) might be added. Popularized in Europe by the Spanish, chocolate became successively a sugary drink and a milky drink; many other flavorings were tried, including the cinnamon now favored in Mexico. Eventually (in the nineteenth century) chocolate was made into bars to be eaten solid, and in many countries this is now its most familiar form. In the Maya and Aztec civilizations, chocolate was a social drink, taken after dinner, serving as a stimulant (and, according to some, an aphrodisiac). Whole chocolate contains caffeine as well as theobromine, and it is also rich in cocoa butter, making it an extremely nourishing food and, therefore, unlikely to produce aftereffects such as exhaustion.

Nicotine

Tobacco, the fermented leaf of *Nicotiana tabacum*, is usually smoked; in that form it cannot be classified as a food. It can be chewed, however. In Western cultures, chewed tobacco has been typical of sailors and other manual workers subjected to extreme weather conditions that make smoking difficult. Tobacco's active ingredient, nicotine, a deadly poison in the pure state, acts as a stimulant when slowly absorbed.

In Australia, another plant, *Duboisia hopwoodii*, has leaves and flowers very rich in nicotine. Aborigines dry and grind the leaves, mix them with the ash of certain other plants, and roll them into balls, called "pituri," for chewing. These are used by solitary workers and travelers as a stimulant to stave off tiredness and hunger; they are also exchanged as a sign of friendship. They are, or were, used by warrior groups in preparation for a battle. There is a definite advantage in chewing ash in pituri (and also with coca and betel nut), because alkalis in the ash detach the active stimulant substance, in this case nicotine, from the plant acids, allowing it to be more rapidly absorbed. The use of ash in this way has developed, apparently independently, in Australia, southeastern Asia, and South America.

Cocaine

Coca is the dried leaf of a plant species native to western South America, *Erythroxylum coca*, and of a second species, *E. novogranatense*, which developed under cultivation. Coca leaves were known as a stimulant to the pre-Columbian peoples of the Andean region, and continued to be used by them and their Spanish conquerors. Their use is extremely widespread in South America. As with the nicotine plants, the principal use of coca leaves has been as a stimulant for workers and travelers. The usual way is to take some leaves, mix them with the ash of burnt coca or another wood, roll the mixture into a ball, and chew it. Coca leaves, like chocolate, are really nourishing, a property that tends to reduce the severity of the exhaustion that usually follows the use of stimulants. The active constituent of coca leaves was isolated (and named cocaine) in 1860. When taken in the pure form, cocaine was found to be a useful medicinal drug but also highly addictive. It was among the first stimulants to arouse strong medical and governmental disapproval. In the early twentieth century, many countries made it illegal. The name of Coca-Cola alludes to coca, and the early recipe for the product contained cocaine, like other soft drinks of the period.

Some other species of genus *Erythroxylum* contain cocaine or similar compounds and are used as stimulants by various South American peoples: *E. cataractum* by the Cubeo of Colombia; *E. fimbriatum* and *E. macrophyllum* by the Bora and Huitoto of Peru.

Other Stimulants

Betel. The commonest traditional stimulant of southern and southeastern Asia is betel. Like pituri and coca, betel is customarily made up as a chewing packet that includes ash. The active ingredient, arecoline, is contained in the areca nut or betel nut (the nut of the palm *Areca catechu*), which is cut into long narrow pieces and placed inside the packet along with a "lime" made from burnt coral and oyster shells. The packet is formed from a leaf of the betel pepper vine (*Piper betle*). In traditional households, the betel chews are made up each day from fresh supplies; as with pituri, it is a sign of friendship and hospitality to offer a chew to any visitor. The habitual chewing of betel eventually stains the mouth red and the teeth black. When it is first tried, betel can produce feelings of anxiety, excitement, and vertigo; to those who use it regularly, it is a mild stimulant.

Khat. Coffee, when it was introduced to Yemen from across the Red Sea, was not the country's first stimulant. That position belongs to khat (or qat), the leaf of *Catha edulis*. Khat is used in Yemen, Saudi Arabia, and a large area of East Africa from Ethiopia and Somalia to Mozambique and South Africa. It had not spread outside the region until some Americans acquired the taste for it while they were in Somalia with United Nations troops during the early 1990s. Khat is often taken as a tea, made by pouring boiling water onto the dried or fresh leaves. Fresh leaves can also be chewed; in this form its effect is said to be stronger than coffee but not as strong as alcohol. When chewed, khat is often used socially because it enlivens conversation. The principal active constituent in khat is cathinone, now classified as an illegal drug in the United States; however, cathinone is only present in fresh leaves. The second active constituent, cathine, which is still present in the dried leaves, is an appetite suppressant.

A milder stimulant of the same general type is Mormon tea, the leaf of *Ephedra nevadensis*. These leaves contain the active ingredient pseudoephedrine, and are made into a tea with boiling water.

Kava. The root of the plant kava-kava, *Piper methysticum*, is the source of kava, a familiar stimulant used in Hawaii and other Pacific islands. The fresh root is chopped or ground and then soaked and squeezed in water to produce a milky, spicy liquid, which is traditionally served in half coconut shells. Kava is a social drink whose effect is to produce a condition physically resembling drunkenness, though with apparent clarity of mind. The principal active constituents are known as kavalactones.

Kratom. Kratom, a stimulant indigenous to Thailand and little known elsewhere, consists of the leaves of *Mitragyna speciosa*. These leaves can be smoked or made into a tea. The active constituent is mitragynine, which, like cocaine, is a stimulant at low doses but a narcotic at higher doses.

Alcohol

Alcohol is an atypical stimulant because it is not naturally present in any fresh plant. It is produced from the fermentation by yeast of plant sugars. One starting point is a fruit juice. Grape juice makes wine; apple juice makes (hard) cider; pear juice makes perry. Several other fruits are used in various parts of the world. A second starting point is malted cereal: barley is the commonest choice, and the result is beer. Plant saps can be used if they contain sufficient sugar: liquid cane sugar is so used in India, while pulque, a Mexican alcoholic drink, is made from the sap of the maguey (*Agave atrovirens*). Finally, honey, mixed with water, can be used, and the result is mead (a beverage that figures importantly in the Old English epic *Beowulf*). There are two common adjustments to the process: adding cane or beet sugar to the original juice gives the yeast more raw material to work with, producing more alcohol; distilling the final product achieves much greater concentrations of alcohol, resulting in "hard liquor."

Wine and beer are both ancient inventions, going back to southwestern Asia several thousand years B.C.E.

But yeasts are naturally present in the air; therefore, alcoholic drinks might have been invented or discovered many times in human history; certainly, the origin of pulque is independent of those of wine and beer.

Alcoholic drinks have most generally, in traditional societies, been used as social drinks, and they have commonly been used in a ritualistic way as well. Their production is linked with the seasons (in general the required juices are available only when fruit is ripe, and the fermentation process takes time); therefore, by contrast with most other stimulants, the discovery of alcoholic drinks and the annual vintage (especially of wine) tend to be celebrated in major festivals. In many cultures, the ordinary, everyday consumption of alcohol follows precise rules, tending to ensure, for example, that everyone drinks equally. Both in the major festivals and in everyday social drinking, it is commonly the case that drunkenness is aimed at, at least to the extent of the loss of inhibitions, but sometimes going all the way to unconsciousness.

Like kava—and unlike many stimulants—alcohol tends to produce enhanced mental activity accompanied by physical incapacity. In traditional societies, travelers used coca, maté, guaraná, pituri, and other stimulants to keep them going; they would not use alcohol or kava till they had arrived. Likewise, coffee, tea, and some similar stimulants may enhance one's ability to drive safely, for a certain period, while kava and alcohol impair it.

See also **Alcohol**; **Chocolate**; **Cocktails**; **Coffee**; **Mexico and Central America, Pre-Columbian**; **Spirits**; **Tea**.

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Andrew Dalby

STORAGE OF FOOD. Civilizations are built upon a stable and reliable source of food that is provided by a combination of current production, imports, and the preservation of seasonally abundant crops. Preagricultural, nomadic people followed herds of migrating animals or periodically visited traditional locations to slaughter animals and gather fruits, vegetables, and grains as they matured during the year. Locally cultivated crops became the predominant source of food once agriculture became established and farmers tilled specific plots of land. Food that was locally abundant for only a short period of time had to be stored against times of scarcity. A poor harvest or the appropriation of food by marauding brigands could produce local famine. However, the most common and recurring cause of famine resulted from the farmer's inability to store enough food to last from one harvest to another. Summer was often not an idyllic time of plenty for primitive agrarian societies, but a time when many went hungry. It is not surprising then that the fall harvest festivals were such joyous times, for they heralded the end of the seasonal famine and ushered in a time of plenty.

Primitive storage techniques were well developed in prehistoric times. Early storage methods included the selection and growth of naturally dormant crops, and the drying, parching, smoking, and salting of meats, fruits, and vegetables. Mature grains, nuts, roots, and tubers have a period after harvest when they do not sprout and can easily be stored with the simplest of technologies and protective structures. Many cultivars of temperate fruits and vegetables such as apples, pears, and cabbage were selected for their natural storability. More perishable foods (meat, fruits, and vegetables) were sliced into thin sections and dried and/or smoked, or pickled in brine. Some of these techniques, such as sun drying (e.g., raisins), smoking (e.g., ham, fish), and pickling (e.g., dill pickle, pickled pig's feet) are still used today. The storage of food became more sophisticated as the population increased and more concentrated as demand for fresh fruits and vegetables increased. Storage was also used to provide planting materials or propagules for the next season.

The growth of large urban centers and the establishment of large standing armies at the end of the eighteenth century provided an impetus for the development of better storage methods. Canning was developed in 1809 in response to a competition sponsored by Napoleon to provide a better supply of food for his armies. A tin-plated metal canister (from which the term “can” is derived) was filled and a lid hand-soldered in place after the can was heated in a water bath for a specified time. Canned food has a very long storage life, especially when stored under low temperatures. Food in century-old cans that were discovered at an arctic base was not spoiled, although it did contain viable bacteria and was unappetizing as a result of flavor and textural changes. Like canning, many storage technologies such as fermentation remained an unpredictable art until Pasteur identified microorganisms as the scientific cause of spoilage and decay in the 1860s.

With the Industrial Revolution, storage became increasingly important as the population increased dramatically and people moved into dense urban areas. As an affluent middle class developed, commodities that had once been luxuries available only to the nobility became widely available because of increasingly better storage and transportation technologies. For example, meat from Australia and Argentina appeared in European butcher shops, while tropical fruit such as bananas, citrus, and pineapples became available in grocery stores. Increased concern for a healthy diet and a better understanding of the link between diet and health prompted public demand for higher quality food.

Food quality encompasses a remarkable number of attributes. Although all food is made up of the same elementary constituents (carbon, hydrogen, oxygen, nitrogen, potassium, sulfur, etc.), the atoms it contains are arranged into molecules of diverse size, shape, and function. The idea that foods differed in molecular structure developed in the 1830s as food was found to contain the three major components of carbohydrates, proteins, and fats. Since then, more discovery of minerals, vitamins, and amino acids has increased to more than fifty, the essential nutrients found in food. Animals are incapable of many of the elementary syntheses performed by plants and therefore rely on them for many complex molecules such as vitamin C and the twenty-four essential amino acids. Many foods are consumed because of their pleasant aroma, taste, or texture, others because of their presumed medicinal properties. Storage technologies are devised and selected to preserve those specific characteristics that are most important to the consumer.

Limits to Storage Life

The storage life of food is usually limited by the loss of acceptable visual appearance, palatability, or food value, and these criteria of quality are often lost in the reverse order listed. Food provides both nutrition and quality to our diet. Often a commodity can be physically preserved longer than the traits for which it is being stored. For example, the flavor, texture, and nutrition of many fruits and vegetables are reduced before visual appearance of spoilage. Many storage technologies have been devised to retain an acceptable appearance or taste while ignoring changes in food value. This is understandable since appearance and palatability can be easily assayed by examining and eating the commodity, while measuring food value requires sophisticated laboratory assays.

TABLE 1

Useful storage life of plant and animal foods

Food produce	Storage life (Days at 59˚ F [15˚ C])
Meat, fish, poultry	1 - 2
Leafy vegetables	1 - 5
Fruits	2 - 20
Root crops	7 - 90
Dried, salted, smoked meat or fish	>360
Dried fruit	>360
Grain and dried seeds	>360

Food spoilage results from three main causes: chemical changes from ripening and senescence processes, growth of unwanted microorganisms such as bacteria and fungi, and insect and rodent pests. However, many of the processes that cause food spoilage in one commodity are often necessary for high quality in another. Ripening of bananas and tomatoes harvested at a mature but unripe stage is necessary, but excessive ripening leads to poor quality. Insects are needed for the pollination of many crops, but they can also eat the plant and spread disease. Microorganisms cause spoilage, but yeast ferment wine, beer, and sauerkraut, while bacteria are needed for production of pickles and yogurt.

Often more than one series of reactions affects storage life. For example, the major factor influencing the storage life of fresh meat is microbial growth and fat oxidation. Meat is normally marketed after *rigor mortis* and a period of aging. The most common preservation methods for fresh meat are cooling (three to six weeks at 32°F [0°C]) and freezing (nine to fifteen months at −4°F [−20°C]). Fish is far more perishable than meat because it is an excellent substrate for microbial growth. Fish lipids are largely unsaturated and therefore very susceptible to oxidation.

Chemical deterioration. Many chemical reactions contribute to the loss of storage life. The majority are enzymatically driven while others are chemical reactions that occur because of the close proximity of reactive molecules within food. Maillard browning involves color, flavor, and odor changes that result from a chemical reaction between proteins and carbohydrates. The rate of this spontaneous reaction is rapid at baking temperatures, as in the browning of bread, much slower at room temperature, as in the browning of applesauce, and very slow at refrigerator temperatures. Removal of water during dehydration concentrates the reactants and accelerates Maillard browning.

Hydrolysis is the splitting of molecules, usually polysaccharides such as complex sugars, starches, and pectins with the chemical addition of water. During the processing of some fruits, the hydrolysis of sucrose into its components of glucose and fructose greatly affects the sweetness of the product. Storage of potatoes at too cold a temperature (32°F; 0°C) promotes the hydrolysis of starch to sugar. Sugars accumulating during this "sweetening" process turn dark brown when heated (i.e., Maillard browning), making the potatoes unsuited for the production of potato chips and French fries. Modification of amylopectins by hydrolysis contributes to textural changes and the formation of gels.

Oxidative rancidity is a chemical change in the unsaturated bonds of a fat or oil that produces chemicals giving food off-odors and off-flavors. Exclusion of oxygen and light combined with the addition of antioxidants retards rancidity. Vitamins C and E, which are antioxidants, can be destroyed by oxidation. Vitamin C, or ascorbic acid, is used as a reducing agent to prevent oxidative browning of cut fruits and vegetables. Both enzymatic and nonenzymatic reactions contribute to lipid oxidation. Blanching destroys enzymes responsible for rancidity reactions in fruits and vegetables. One of the functions of packaging is to exclude oxygen and light from processed foods. Cooked meats can become rancid within a day, but proper packaging or freezing can delay the process by several months. However, not all oxidation is detrimental; oxidative bleaching of pigments in flour during storage results in whiter flour.

Microbial contamination. Bacteria and fungus are everywhere in our environment, and most foods provide an excellent substrate for their growth. Packaging, whether natural (banana peel, seed coat, or egg shell) or artificial (glass bottle, metal can, or foil pouch) protects the enclosed food from microbial contamination. Some foods contain natural antimicrobial chemicals (for example, the tannins in unripe fruit), while other antimicrobial compounds, such as the fungicide in wax coatings, can be applied to food. Many foods are sterilized, pasteurized, or fumigated before packaging and storage to control microbes. Storage conditions of low temperature and humidity retard microbial growth. However, once these protective barriers are breached, microbial growth is often unchecked and rapidly destroys the commodity.

Food can be a vector and provide a growth medium for many pathogenic microbes (e.g., *Campylobacter jejuni*, *Escherichia coli*, *Listeria monocytogenes*, *Salmonella*, *Shigella*, *Vibrio cholerae*). However, common spoilage organisms (e.g., *Botrytis*, *Colletotrichum*, *Erwinia*, *Fusarium*, *Penicillium*, *Rhizopus*) are not human pathogens, although some bacteria (e.g., *Clostridium botulinum*, *Staphylococcus aureus*) and fungi (e.g., *Aspergillus flavus*) can produce potent toxins.

Insect and rodent pests. The major insect pests in stored food are moth (Lepidoptera) larva and beetle (Coleoptera) larva and adults. Insects have been controlled in stored food using physical methods for thousands of years. Neolithic farmers in the Nile Delta kept seeds cool and dry by storing them in clay jars buried in the ground. Exposure to high temperatures has been used since the sixteenth century to control insects in stored grain. Under many circumstances the easiest, most rapid, and most economical method of controlling insects is with insecticides, often in the form of fumigants. Fumigation has been the method of choice since the late 1940s, but the unwanted side effects of some of the chemicals used (for example, toxicity to other species, depletion of stratospheric ozone, acquired resistance by the pest) have promoted interest in physical control measures. Many physical conditions such as temperature, relative humidity, moisture content, and atmospheric composition can be manipulated to affect insect survival. The structure containing the commodity (granaries, elevators, bags, and packaging), forces on the commodity (compression and impaction), and irradiation are also used in controlling insect infestation.

In general, insect survival in stored food is dependent on temperature, relative humidity, and gas composition. Temperatures lower than 55°F (13°C) or higher than 95°F (35°C) dramatically reduce survival. Sublethal temperatures also have effects; for example, at 68°F (20°C), most insects survive but stop feeding. Additional reductions in survival occur when stressful temperatures are combined with reduced moisture or oxygen levels. Drying affects insect population directly by reducing survival and indirectly by causing cracks that increase the susceptibility of the commodity to insect attack. The respiration by large numbers of insects produces heat and moisture, favoring both mold and further insect growth.

Physical movement of grain increases insect mortality. Moving grain by auger or pneumatic conveyer increases mortality of larva and adults. Impacts from dropping grain six meters resulted in up to 90 percent mortality. Moving can directly kill or injure insects by crushing them, or it can prevent feeding and mating by disrupting the microecological niches required by some insects. However, handling can also increase the amount of cracked seeds and grain dust, which are the preferred diet of some insects.

Biological control with insect pathogens, predators, or parasites is an important component of integrated pest management strategies. Unlike other treatments, biological control agents can reproduce, so one inoculation may be sufficient to establish lasting control. In contrast, many physical treatments such as cold, heat, fumigation, and irradiation have no lasting effect, and reinfestation must be controlled by proper storage and packaging.

Over the centuries, feral rodents have adapted to living in or near houses and farms. The most common rodents are the brown or Norway rat (*Rattus norvegicus*), the black rat (*Rattus rattus*), and the house mouse (*Mus musculus*). Food storage facilities provide ideal conditions for rodents to multiply very rapidly with food, shelter, and a lack of predators. Common signs of a rodent problem are fecal droppings, tail and footprints in dust, droppings and urine stains in feeding areas, gnawing marks on wood, plastic, metal, pipes, and food containers, spilled food, smear marks from rodents' fur (distinctive dirty marks, particularly along skirting boards and around doors), rat holes, nesting sites, rat runs, and the rodents themselves. Constant gnawing is necessary to keep rats' teeth ground down; their gnawing of electrical wires has caused structural fires.

Rodents eat a lot of food, particularly in grain stores, but far more food has to be discarded because it has been contaminated with hairs and droppings. Apart from *salmonella* food poisoning, rats may carry as many as thirty-five diseases including rabies, plague, typhus, leptospirosis, rat bite fever, and hantavirus. Disease may be spread by eating food contaminated by rodent droppings or urine, contact with rat urine, parasites that live on rodents, and rodent bites.

There are biological factors, behavioral factors, and environmental factors to be considered in designing a rodent control program. Rats normally range no more than 150 feet from the nest; a male mouse will control an area of ten to twenty feet from the nest. Rats will migrate on their own; mice are often carried in boxes or crates into new locations. Rodents begin reproducing at a very young age, have large litters, and breed year around. A 90 percent population reduction may be replaced in as little as nine months. Rodents have a well-developed sense of taste and can remember foods that made them sick in the past. They are very cautious and wary of new objects introduced into their surroundings (such as bait boxes or traps) and of changes in the surroundings. Rodents can be controlled by using poisons and traps. Positioning of control measures can be optimized by using tracking powder to locate runs and nesting areas.

Storage Technologies

Storage technologies manipulate the extrinsic factors of temperature, water activity, and oxygen availability to control the rate of quality loss by stored commodities. Examples of these treatments include drying, salting, brining, fermentation, canning, cooling, freezing, altering storage gases, and ionizing radiation.

Temperature. Temperature is the key factor influencing the storage life and safety of fresh and processed food. Living organisms are best adapted to a narrow range of temperature. As the temperature diverges from this optimum range, the organism is first retarded in growth and then killed (Table 2). Most of the physiological changes that shorten the storage life of fruits and vegetables, as well as many of the reactions in meat, eggs, and dairy products, are enzymatic. Other reactions are purely chemical. The effect of temperature is usually much greater for enzymatically driven reactions than for purely chemical reactions. Each 50°F (10°C) drop in temperature halves the rate of most chemical reactions (i.e., a Q_{10} or temperature quotient of 2). In contrast, biological reactions often have Q_{10} values between 3 and 5, meaning that the reaction is decreased to a third or fifth by an 18°F (10°C) fall in temperature.

TABLE 2

Response of insects that are found in stored product to temperature

Area	Temperature °F	Temperature °C	Effect
Lethal	140 to 122	60 to 50	Death in minutes
	122 to 113	50 to 45	Death in hours
Sub-optimal	113 to 95	45 to 35	Development stops
	95 to 91	35 to 33	Development slows
Optimal	91 to 77	33 to 25	Maximum development
Sub-optimal	77 to 68	25 to 20	Development slows
	68 to 50	20 to 10	Development stops
Lethal	50 to 41	10 to 5	Death in days (un-acclimated)
	41 to 14	5 to -10	Death in weeks to months (acclimated)
	14 to -13	-10 to -25	Death in minutes

SOURCE: Modified from Fields and Muir, 1996.

Thermal processing. Food is not stored at elevated temperatures, but high temperatures such as those involved in canning and pasteurization are often used to arrest microbial growth, denature enzymes, and alter the structure of food prior to storage. Temperatures above 140°F (60°C) inhibit and kill growing microorganisms. Resting stages require much higher temperatures.

Canning is the heating of prepared food in hermetically sealed metal, glass, or foil containers to a specific temperature for a specified time to destroy disease-causing microorganisms, denature enzymes, and prevent spoilage. Low-acid foods such as meats and vegetables are heated to 240–265°F (116–129°C), while acidic foods, such as fruits and tomatoes, are heated to about 212°F (100°C). The length of heating depends on the type and size of the container, the food being canned, and the method of heating. Flat foil packets may require less than ten minutes, while large metal containers may require over forty minutes. The aseptic container keeps out oxygen and contaminating microorganisms. Canned food is very stable and can be stored for many months at ambient temperatures; however, storage life is extended when the food is stored at low temperatures. Once opened, canned food is prone to spoil rapidly and should be stored under refrigeration.

Pasteurization is the heating of a liquid such as milk, wine, or beer to between 131 and 158°F (55 and 70°C), to destroy harmful bacteria without substantially altering the liquid's composition, flavor, or nutritive value. In addition to destroying potential disease-causing bacteria, pasteurization can greatly increase the storage life of milk by inactivating enzymes that reduce quality. There are two basic methods of pasteurization, batch or continuous. In the batch method a vat of liquid is heated to 145°F (63°C) for thirty minutes, rapidly cooled, and stored below 50°F (10°C). This method is used for milk and its by-products (e.g. creams, chocolate). Beer and wine are pasteurized at about 140°F (60°C) for twenty minutes. Water can also be pasteurized at 149°F (65°C) for six minutes, or to a higher temperature for a shorter time, to kill germs, viruses, and parasites. In contrast, the most common continuous processing method uses high temperature, short time (HTST) pasteurization. Milk is heated to 161°F (72°C) for fifteen seconds, while beer and wine are heated to 158°F (70°C) for about thirty seconds, and bottled under sterile conditions. The continuous process has several advantages over the vat method, the most important being time and energy saving. Radiation pasteurization of foods uses low doses of gamma rays, X-rays, and electrons to control foodborne pathogens on beef, pork, lamb, and fish.

Refrigerated storage. *Cold storage.* Most food stores best at temperatures near 32°F (0°C) because chemical and biological processes are slowed down. Maximum storage life for meat, eggs, dairy products, and all processed food is at 32°F (0°C). Most fresh fruits and vegetables are also best stored at 32°F (0°C). They include apples, berries, broccoli, cabbage, carrot, corn, grapes, lettuce, and pears. However, some fruits and vegetables are sensitive to low temperatures and are damaged if stored below 50°F (10°C). These chilling-sensitive commodities include asparagus, avocado, banana, beans, cucumber, eggplant, grapefruit, melons, peppers, potatoes, squash, sweet potato, tomato, and watermelon.

Best product quality is maintained under constant temperatures. Typically the storage temperature should vary no more than ±1.8°F (1°C) from the desired temperature, but even this variability may be excessive if it allows the temperature to fall below the freezing point of the commodity. Large swings in temperature can result in unwanted freezing or chilling injury, condensation of water on the product that promotes microbial growth, accelerated water loss, and reduced storage life. All fresh fruits and vegetables lose water in storage and must be properly packaged and/or stored under high relative humidity to prevent excessive water and weight loss.

Freezing. Living cells are mainly dilute aqueous solutions of salts, sugars, organic acids, proteins, and lipids. These solutes lower the freezing point of pure water from 32°F (0°C) to 31.6°F (−0.2°C) for lettuce, 30.6°F (−0.8°C) for bananas, 29.5°F (−1.4°C) for carrots and sweet potatoes, 26.6°F (−3°C) for beef, fish and poultry, and 17.6°F (−8°C) for peanuts. Most frozen foods can be kept at 0°F (−18°C) for a year with little loss of quality. Both free and bound water exist in foods. Bound water exists in combination within an insoluble matrix such as cellulosic cell walls and muscle protein. As the temperature falls, ice crystals first form where the water is the purest and therefore has the highest freezing point. Growing ice crystals remove pure water from the solution, and it becomes more concentrated. Slow freezing produces large ice crystals and highly concentrated solutions, both of which are detrimental to quality retention. Rapid freezing retains quality by either producing small ice crystals or a vitrified solid. The differential effects of freezing on bound and free water give rise to the complex freezing pattern of foods.

Water activity and humidity. Drying is perhaps the oldest method used to store food. Drying fish, meat, fruits, and vegetables in the sun or over a fire or by ventilation with heated air is still used to prolong storage life. Both the harvested food and the spoilage organism (microbe or insect) need water to live. Removal of water by drying, brining, salting, cooling, or freezing prevents the growth of microorganisms and insects, deactivates enzymatic pathways, and reduces the many chemical reactions that accompany a reduction in quality during storage.

Different foods can have different equilibrium moisture contents under the same relative humidity and different microbial stability under the same moisture content. The idea of water activity (a_w) was introduced to better understand how water availability in foods affects microbes. The water activity (a_w) of pure water is 1.00. The a_w of an aqueous solution is calculated by dividing the vapor pressure of solution by the vapor pressure of water at a given temperature. Under steady state conditions, water activity in food can be approximated by dividing the relative humidity of the ambient air by 100.

Few spoilage and pathogenic bacteria can grow below a_w's of 0.90, while levels below 0.70 prevent the growth of most yeasts and molds. An a_w that influences microbial growth is usually lethal to grain, fruits, and vegetables. Food quality can still deteriorate at a_w's below 0.60 from the enzymatic and nonenzymatic oxidation of lipids, vitamins, and pigments.

For most fresh fruits and vegetables, a relative humidity of 90 to 95 percent is recommended during storage. A relative humidity close to 100 percent or the condensation of water on a commodity that frequently accompanies such high humidity may cause cracking of the skin. Surface condensation may also accelerate the growth and spread of microorganisms. Large evaporator surfaces will improve the relative humidity in direct expansion refrigeration systems. A 41 to 50°F (5 to 10°C) temperature split, as commonly designed, will maintain 70 percent to 80 percent relative humidity; a 32.9°F (0.5°C) split would be required to maintain 95 percent relative humidity. In practice, supplementary humidification with fogging nozzles, spinning disc humidifiers, or steam humidifiers is often used to maintain high humidity in the storage of fruits and vegetables.

Dry cereal grains have an extremely low respiration rate and show only slight reduction in total sugars and quality even after years at a cool temperature and low oxygen concentration. In general, grain in equilibrium with 30 percent and 50 percent relative humidity air has a moisture content of about 8 percent and 12 percent, respectively. Grain respiration is particularly affected by moisture, increasing as the water content of the seed rises above 14 percent. Respiration produces heat and water, both of which contribute to increased respiration and an accelerated loss of quality. Warm temperatures and higher humidity also facilitate the growth of insects and molds. The moisture requirement for the growth and reproduction of different insect species in grains varies from 8 percent to 12 percent.

Controlling the moisture content is extremely important in preventing spoilage. Grains (e.g., wheat, rye, oats, barley, soybeans, corn, and sorghum) must be dried to around 12 percent moisture for safe storage during warm weather. Most grains are dry enough to store when harvested. Artificial drying of grains that are harvested before they are dry enough can be accomplished in a few hours with heated forced air. Longer times are required using dry (>70 percent relative humidity) ambient air. Rice storages must have driers since rice is customarily harvested before it is dry enough for storage. Temperature differences and air movement within grain stored at the proper moisture level can redistribute moisture and cause local increases conductive to spoilage. Respiration of the grain and associated pests (e.g., mold and insects) produces water that promotes their growth. Periodic ventilation and turning can remove or redistribute moisture to maintain proper storage conditions.

Low oxygen and/or high carbon dioxide. Researchers in the 1920s showed that altered concentrations of oxygen and carbon dioxide in the storage atmosphere retarded the germination and growth of microorganisms on fruits, vegetables, and meat. Low oxygen and moderately elevated carbon dioxide atmospheres retard respiration and the synthesis and action of the plant hormone ethylene and extend the storage life of fruits and vegetables. High carbon dioxide levels are more effective in prolonging the storage of meat.

Modified atmospheres have many advantages for the storage of both living and processed food, but the long treatment period may be incompatible with the marketing system. If crops sensitive to ethylene are to be stored together with crops that produce large amounts of ethylene, then either periodic or continuous venting may be necessary to prevent deleterious concentrations of ethylene from accumulating.

Fermentation. Oxygen is necessary for respiratory metabolism. Exclusion of oxygen causes a shift from aerobic to anaerobic metabolism and the production of many fermentative products such as ethanol and lactic acid. Fermentation is an ancient, low technology method of preserving food. When Ch'in Shih Huang Ti was constructing the Great Wall of China in the third century B.C.E., the laborers were given mixed fermented vegetables as part of their rations. Fermentation is a complicated anaerobic process in which naturally present bacteria hydrolyze sugars to organic acids (e.g., acetic acid) or ethanol. Salt may be added to the initial mix to draw water from the vegetables and encourage brine formation. Brine promotes the growth of desirable bacteria; acid (vinegar or acetic acid) may be added to rapidly lower the pH and discourage the growth of undesirable bacteria.

Methods Used to Store Food

Natural methods

Harvest as needed (field storage)
  Slaughter animals as needed
  Keep plants in the ground (carrots, cassava)
  Keep fruit on the tree (avocados, citrus)
Harvest and keep alive
  Selection of naturally dormant plants (grains, nuts, bulbs, tubers)
  Store in field or natural (clamps, curing, root cellars)

Technological methods

Harvest and keep alive
  Cold storage
  Curing
  Controlled atmosphere
  Ionizing radiation
Harvest and process
  Additives
  Brining
  Cold storage
  Curing
  Fermentation
  Freezing
  Ionizing radiation
  Refrigeration
  Aseptic packaging
  Canning
  Controlled atmosphere
  Drying
  Freeze-drying
  Fumigation
  Pasteurization

Ionizing radiation. Ionizing radiation from gamma rays or electron beams is a cost-effective method of preparing food for storage. Low-dose irradiation controls insect infestation of grain and flour (0.2 to 0.7 kGy), food-borne parasites (1 kGy), and inactivates non-spore forming pathogenic bacteria (3 to 5 kGy). Higher dosages (20 to 50 kGy) are required to inactivate enzymes, kill spores and sterilize products. Levels of 0.2 to 1.0 kGy are not immediately lethal, and irradiated insects can survive for several weeks, but they feed less and are usually infertile. Higher dosages cause immediate mortality, but they can also reduce vitamin content and alter textural properties of grains. There is no residual effect of irradiation, so reinfestation must be controlled by appropriate handling

Storage basket for potatoes and onions made of willow and cherry branches, France, twentieth century. French farmhouse pantries were often furnished with several baskets of this type in varying sizes, the smallest for garlics, shallots, and fingerling potatoes. Food was removed through the trough at the bottom. Roughwood Collection. Photo Chew & Company.

and packaging. Low doses inhibit sprouting of potatoes and onions, but higher doses stimulate wound responses in fresh fruits and vegetables that lead to reduced quality. Spices and vegetable seasoning are the products most commonly irradiated. Aseptically packaged irradiated meat can be stored without refrigeration for many months. The U.S. military has used irradiated food for a number of years. Consumers view irradiated food either as being adulterated or as being additionally protected against spoilage.

Sanitation, fumigation, and quarantine treatments. Since the leading cause of food spoilage is pests such as insects, fungi, and bacteria, storage life can be extended by removing these organisms. Using acceptable cultural practices during production of the raw material and sanitation practices during harvest and preparation for storage significantly decreases the initial number of pests present in stored food. Since many pests increase rapidly under favorable storage conditions, a significant reduction in their initial number can greatly extend the storage life of a commodity before expensive control measures are needed. Once stored, there are only a few techniques available to eliminate pests already present in raw and processed food.

Some of the most important control measures are fumigation, heat treatments, and controlled atmospheres. The anaerobic storage of grains in airtight containers can reduce the need for chemical fumigation to control insects and mold and does not require the technical sophistication required for the safe application of toxic fumigants. The hermetic storage of living tissue such as grains, fruits or vegetables is a form of modified atmosphere storage that has been used for centuries. The respiration of the commodity creates an atmosphere rich in carbon dioxide and deficient in oxygen. Some of these fast-acting treatments can be used as quarantine treatments. Many production areas throughout the world contain pests that importing countries do not want introduced into their production areas. Increasing international trade in staples and exotic foods and the elimination of effective, commonly used fumigants (e.g., methyl bromide) are promoting the development of new quarantine treatments that are not only environmentally safe, but also fast-acting and effective on a wide range of commodities.

Methods of Storage

Food can be stored alive (apples, cows, tomatoes, wheat), or dead (applesauce, beefsteak, spaghetti sauce, flour). Storage technologies must produce drastically different environments to effectively store these many kinds of food. Cereal grains store best at a relative humidity below 50 percent to reduce respiration, while fresh fruit and vegetables need humidity above 90 percent to prevent excessive weight loss. Some ripening fruits (bananas and tomatoes) are injured if stored below 10°C (50°F), while others (apples and pears) store best at 0°C (32°F). Carbon dioxide levels above 50 percent reduce the spoilage of meat, and exclusion of oxygen prevents rancidity of potato chips and nuts, but most fruits and vegetables will not tolerate oxygen levels below 2 percent or carbon dioxide above 3 percent. Although the word “storage” may conjure up images of large grain elevators, warehouses, and sophisticated refrigeration technology, there still exists a range of less sophisticated techniques that are widely used today.

Storage before slaughter or harvest. Animals can be slaughtered as necessary where the climate is mild or protective structures exist, and where animal feed is available or can be stored. However, animal products (eggs and milk) may need to be collected periodically to maintain production.

For most perishable food, maturity occurs over a short period of time, and harvest must take place during that period. However, a range of crops can be left on the plant (or in the ground) for up to a few months. The storage of potatoes and other root crops in the ground and the storage of citrus and avocados on the tree are good examples of this. Storage on the plant overcomes the need for capital investment in storage facilities and delays exposure of the commodity to water and nutritional loss encountered during storage. It also reduces the damage and disease inevitably associated with harvesting, handling, and storage. Problems include exposure of the commodities to environmental disasters (hail, frost, diseases, and sunburn), the cost of keeping the land idle (for field crops) or of reducing the following seasons' yield (for tree crops).

Storage after slaughter or harvest. Food can be stored after slaughter or harvest as fresh, still-living commodities (fresh fruits and vegetables), or as a processed, dead product (cured meat, canned tomatoes, etc.). Low humidity and temperature are two traditional means of facilitating the storage of naturally dormant crops such as grains (wheat, corn, and rice), bulbs (onions and garlic) and, roots and tubers (carrots, potatoes, and yams). The rates of the many chemical reactions that reduce quality are naturally suppressed in these crops. Using chemicals or treatments that interfere with those physiological processes that naturally terminate dormancy can lengthen the duration of storage.

Common (unrefrigerated) storage. One of the oldest methods of storage of perishables is the use of "clamps," which are basically piles of a commodity laid in the field and then covered with straw and soil to insulate and waterproof the clamp. This method is still in use for the storage of potatoes, turnips, parsnips, celeriac, rutabagas ("Swedes") and other "hard" vegetables. In large clamps, ventilation with chimneys and perforated channels through the stack are needed to remove the heat of respiration, and reduce the risk of anaerobiosis or CO_2 toxicity.

A step in sophistication above field clamps is storage in rooms dug into the ground, such as root cellars, and natural or man-made caves, and buildings that are often heavily insulated. Temperatures in caves and underground (1 m) are fairly stable at 10 to 15°C (50 to 59°F) throughout the year. They have the advantage of low maintenance costs, stable temperatures, and high relative humidity. These unrefrigerated stores are best suited for long-lived commodities like potatoes, onions, and winter squash. But these structures are only effective in climates where the ambient temperatures during the storage period are low enough to maintain product quality for a reasonable length of time. Old-fashioned storage of apples, cabbage, and pumpkins in root cellars is a good example of this type of storage. This technique is still used for potatoes, particularly those intended as propagation material.

Grain storage facilities come in a number of sizes and shapes: rectangular wood-framed bins; cylindrical prefabricated metal structures; flat, ground-level piles on concrete floors in warehouse-type buildings; and overhead bins above driveways. One of the most common storage and processing facilities is the granary or grain elevator; a tall (c. 30 meters tall) cylindrical building equipped with machinery for unloading, weighing, cleaning, mixing, storing, and loading grain. Livestock farms may have a number of small granaries to store feed grain at locations adjacent to feedlots. Every town in a grain producing area has an elevator to accumulate grain from farmers and store it for a short period of time while it is cleaned, conditioned, dried, and graded. Larger elevators are located at terminal grain markets and shipping centers where the grain is stored for use by millers or to await shipment. Grain arriving by truck, railroad car, or ship is unloaded and moved by auger, or belt, bucket, or pneumatic conveyer to an area above the cylindrical storage bins where it is cleaned and weighed. A number of bins can be built side-by-side to form facilities that can store millions of bushels of grain. Governments in some countries subsidize the long-term storage of grain to stabilize prices and protect against famine. In contrast to a granary or elevator that stores grain, a silo is any structure or container used for the storage of large masses of high-moisture forage or silage for animal feed.

Once processed, food is more physically stable than the original living material, but it is also a better source of nutrients to microbes. Processed food can be preserved for extended periods by a combination of aseptic packaging such as canning or bottling to exclude microbes and oxygen and moderate to low temperatures.

Night air storage. In warmer climates, a modification of common storage can be used if there is a substantial difference between day and night temperatures during the storage season. The technique used is termed "night air ventilation." The produce is placed in a common storage room, which is well-insulated and supplied with a ventilation system to enable air to be drawn into it and distributed through the produce during the coolest part of the night. This technique can be used to remove field heat and cool produce before refrigerated storage. It can also be used to maintain produce at the proper storage temperature when the nights are cold. In modern stores of this type, microprocessor technology can be used to regulate the ventilation system to optimize the storage environment.

Refrigerated storage. By far the largest proportions of fresh commodities are stored in insulated rooms provided with mechanical refrigeration. At low temperatures, the biological activity (and deterioration) of the product is dramatically slowed, and the growth rate (and sometimes the viability) of microorganisms is reduced, as is the rate of water loss.

Several methods are employed to provide cold storage in the absence of mechanical refrigeration. In some areas, cold well or lake water may be used. The air of the store may be cooled to near the water temperature with a good heat-exchange system. In cold climates, ice harvested from lakes and ponds during winter can be stored and used for summer refrigeration.

In areas where the relative humidity is low, an evaporative cooler may reduce the temperature of the air sufficiently to be an economical source of refrigeration. In the western United States, for example, the mean wet bulb temperature in growing areas ranges from 8 to 21°C (46 to 79°F) during the harvest season. A well-designed evaporative cooling system will provide cooling air at one or two degrees above the wet bulb temperature. Chilling-sensitive commodities can be cooled very satisfactorily by this technique. An additional advantage is that the high relative humidity produced during cooling significantly reduces water loss from the commodity.

Mechanical refrigeration. Without a doubt, the invention of mechanical refrigeration in the 1850s and its commercial application starting around 1875 was crucial to the modern storage of perishable food. Mechanical refrigeration relies on the basic principle that substantial amounts of energy (i.e., heat) are absorbed during the vaporization of a liquid and released during the condensation of a gas. Using a mechanical pump, a gaseous refrigerant is compressed, cooled, liquefied, and stored in the receiver. When cooling is needed, the liquid refrigerant is allowed to enter the evaporator where it evaporates into a gas as it absorbs heat from the cold storage enclosure. Fans blow air warmed by the commodity over the cold evaporator coils where heat is transferred from the air to the refrigerant. Repeated cycles of condensation and evaporation of the refrigerant "pumps" heat from the cold storage enclosure. Ammonia was the first and most commonly used refrigerant for many years. The development of Freons has produced refrigerants that are less toxic to plants and humans but that are being reassessed for their environmental impact.

There are a number of different techniques for using mechanical refrigeration in the cold storage of food. In the direct expansion method, the evaporator coils are in the cooled space. This system is simple, but it results in low relative humidity. Special and expensive modifications are necessary to provide high humidity for the storage of fresh fruits and vegetables. However, low relative humidity is beneficial for the storage of some commodities such as grains and onionsand for canned or packaged processed food.

See also **Cereal Grains and Pseudo-Cereals**; **Frozen Food**; **Preparation of Food**; **Seeds, Storage of**.

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STROKE. *See* **Health and Disease; Salt; Sodium.**

STYLING OF FOOD. The styling of food, usually referred to as "food styling," is the art of preparing food to be photographed or filmed. The preparation, or styling, involved can be as deceptively simple as shopping for the perfect apple or as extreme as re-creating an elaborate, twelve-course belle epoque dinner party for fourteen. The creation of appealing images of food is a complex process. Whether the food is to be photographed for packaging, an advertisement, a cookbook, or a magazine, or to be filmed as part of a television commercial, cooking show, or movie, the styling of the food is an integral part of the process.

The People Who Do It: Food Stylists

Generally, those who work in the field of food styling are known as "food stylists." Since there is no formal training available for food styling, the particular skills and techniques required are usually learned while apprenticed to or assisting an established food stylist. While most people entering the field have a background in the culinary arts, additional skills that are invaluable include a knowledge of basic food chemistry, the principles of design, and the ability to improvise. Until the late twentieth century, courses on food styling were rarely offered, even at

Food styling is sometimes more complex than preparing a dish of food for the camera. In this instance, the subject is a model and an entire shopping cart full of food. Shot on a platform in a studio, the final image gave the impression that the shopper was walking through a store. Also note that in 1949, when this picture was taken, women dressed to go shopping, even for groceries. © Bettmann/CORBIS.

the top cooking schools. Where offered, these courses are primarily an introduction to the field.

While the term "home economist" is sometimes used, this is basically a holdover from the era when home economists on staff at women's service magazines (such as *Good Housekeeping*, *Ladies' Home Journal*, and *McCall's*), and large food corporations were responsible for the styling of food. Curiously, home economist is the term frequently used in the film industry.

Today, very few companies and magazines have food stylists on staff. Food stylists usually work on a freelance basis. The photographer, director, or production company hires them as needed, sometimes choosing a stylist that specializes in a certain area such as ice cream, chocolate, fast food, or baked goods.

Is The Styling of Food Necessary?

The need for food styling is a question that is often raised. The photographing or filming of food is very involved, and many techniques are employed to stabilize, sustain, and, if necessary, enhance the food to be photographed. Most important is that the food look as fresh and appetizing as possible until the image is captured on film, but this process can take hours. During that time, the food needs to be kept "alive," or replaced as often as needed, sometimes very often. For example, it is difficult to take a photograph of a barbecue grill with flames lapping up through an arrangement of jumbo shrimp, because the flames will char the food within minutes. The food might need to be replaced a dozen times and look identical each time so as not to affect the lighting or camera framing. Or to shoot a commercial that features a slice of pie with a piece being broken off by a fork, twenty takes with twenty perfect slices might be needed before the director gets the shot in which the crust looks flaky enough. Even a bowlful of salad greens demands a unique knowledge and set of skills to keep it looking crisp and moist. This knowledge and these skills are essential to successful food styling, and ensure that the process of capturing the needed image on film is efficient and cost-effective.

While there is a trend toward a more documentary style of photographing food that shuns food styling, this seemingly straightforward approach still involves many of the same considerations that go into typical food photography: props, lighting, camera angle. While food photographed straight out of the kitchen might have an inherent honesty about it, the end result is not always attractive. Most consumers, and more importantly the clients, still expect to see images of appealing food.

The Process and Techniques Involved

Each project a food stylist undertakes is unique and has its own set of demands. The approach the stylist takes in preparing the food—even the same food—varies greatly depending on how the image is to be seen and used.

But before the food is prepared, there are several preliminary steps involved. The stylist meets with the photographer/director, and sometimes the client, to discuss what will be shot. The appropriate recipes, layout, or storyboards are reviewed. And from this, the necessary food, material, and equipment are determined. While the stylist is responsible for the shopping and purchasing of the needed food, actual product to be used is usually sent by the client. Often the shopping involves locating out-of-season or difficult-to-find items. The stylist then confers with the prop stylist (the person responsible for providing the tableware, linens, flowers, etc.) to make sure the props selected are suitable.

The first step in the actual preparation of the food is to create a "stand-in." The stand-in is a close approximation of the finished food, and gives the photographer/director the time needed to compose and light the shot without worrying about the food "dying" on the set. Another important reason for preparing a stand-in is that it allows the client to make recommendations the stylist can incorporate into the final, or "hero," food.

The preparation of the hero food involves any number of specialized techniques food stylists have developed to deal with the demands of photographing food. The overriding concern of the stylist is to keep the food looking fresh and alive. Moisture is critical.

Depending on the food, moisture is retained (or replenished) by brushing or spraying the surface with water or a thin coat of vegetable oil, and keeping the food under cover until needed. This is probably the most basic technique employed by the food stylist. It not only creates the appearance of freshness but can also make the food look juicy or even hot, since it is often cold and undercooked when photographed. (Heat will cause the food to continue cooking, then wilt and appear dried out.) For instance, vegetables are undercooked and kept in cold water until needed to retain their color. Poultry and meats are also undercooked, or cooked at lower than normal temperatures, to prevent them from shriveling or shrinking. A finished, roasted look is then added to the surface by brushing on gravy coloring, or browning the surface with a blowtorch. For a grilled look, grill marks are branded onto the surface using red-hot skewers.

Stabilizing delicate foods is a common challenge. This can be as straightforward as using toothpicks, straight pins, or hairpins to hold things in place. Or it can simply be a matter of placing a thin piece of cardboard under a slice of cake, or even meatloaf, to keep it from breaking. More complicated stabilizing techniques involve the use of thickening agents such as gelatin or food starches. These can be used to keep sauces in place, or a slice of pie from collapsing.

Foods that oxidize easily (such as cut fruit) are dipped in lemon juice. Commercial antioxidants are also used; they are especially good for keeping leafy greens crisp or preventing the surfaces of sliced meat from turning gray.

Occasionally, substitutes for the actual food are used. This is done when the technical requirements of the photography or filming make it difficult or even impossible to use the real thing. A model might be made of a candy bar or a piece of cereal. Sometimes ice cream is made out of a mixture of confectioner's sugar, vegetable shortening, and corn syrup. Hair tonic might be used in place of milk in a bowl of cereal.

In short, these examples represent just some of the basics of what is involved in the styling of food. More than the mere ability to prepare an attractive plate of food, successful food styling is a demanding occupation that requires resourcefulness, skill, and artistry.

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SUGAR AND SWEETENERS. There are many sugars and sweeteners. Sucrose—the sugar obtained chiefly from sugar cane and sugar beets (see "Sugar Crops and Natural Sweeteners")—is the most important sweetener and the substance usually meant when people speak of sugar. In 2000, world consumption of cane and beet sugar marketed by industrial-scale processors reached almost 120 million metric tons (132 million short tons), in white quality terms, equivalent to roughly 20 kilograms (about 44 pounds) per inhabitant. In addition, upwards of 10 million metric tons of indigenous types of cane and palm sugar of different qualities—the product of small rural enterprises—were consumed, mainly in Asia and Latin America. Globally, sugar supplies around 9 percent of the total human dietary energy intake, as all but a small amount produced ends up in food and drink. At the country level, average annual per capita sugar consumption ranges from less than 5 kilograms to more than 60 kilograms, depending on economic factors—price, income, and availability—as well as national customs, habits, and tastes.

Sucrose

Ordinary refined, or white, sugar is at least 99.7 percent sucrose and is one of the purest products in common use. Like other carbohydrates, it is a stored form of energy, providing nearly 4 kilocalories (slightly more than 16 kilojoules) per gram. In the eyes of some Western food writers, this makes sugar merely "empty calories." If that were all there is to it, sugar would not play the dietary role it does. Without its sweetness and other functions, the fact that sugar generally tends to be one of the cheapest sources of dietary energy might not, by itself, enable it to compete against starchy foods—even if these did not, in addition to energy, provide other nutrients. What basically makes sugar a staple food is that it enhances the beverages and other foods in which it is ingested. Sugar cannot be consumed by itself in significant volume. Potatoes or rice can be eaten by the plateful with barely anything else; it is difficult to ingest a teaspoonful of granulated sugar without at least dissolving it in water. Even as a source of energy, sugar rides piggyback on whatever else we eat and drink. It can be consumed in large quantities because, while satisfying the innate human disposition for sweetness, it is sweet in a not very intense way, far less so than numerous other substances.

Nowadays, global sugar consumption grows roughly in line with the increase in world population. In high-income industrial countries, per capita usage tends to stagnate and even decline. In poorer and less developed countries, on the other hand, sugar remains, as a study at the beginning of the 1960s found, one of the first foods to respond to a rise in personal incomes, its chief appeal lying not in its function as a source of energy—often still expensive, compared with locally grown cereals and root crops—but in its ability to make a frequently drab and monotonous diet more appetizing.

Functional properties. Sugar provides not only energy and sweetness. It caramelizes on heating to form complex coloring and flavoring substances, and part of it is inverted (converted by acid hydrolysis or enzyme into a mixture of glucose and fructose) during food preparation, the resultant monosaccharides reacting with other recipe components to lend aroma and browning to the final article. This increases the color, luster, and flavor of bread crust, for example. Well-known, too, is sugar's antimicrobial effect—as in fruit preserves, marmalades, jellies, and jams—where the high concentration of sugar in solution inhibits the growth of spoilage microorganisms by raising the osmotic pressure.

In developed countries, the sugar used at home and in communal catering establishments represents only a minor portion of total consumption. German statistics for 1999/2000, for instance, show 71.7 percent of total domestic sugar sales going directly to industry (principally food manufacturers), 22.9 percent to wholesale and retail traders, 0.2 percent straight to end users, and 5.2 percent to unknown recipients. Even in the United States, where sucrose has been widely replaced by high fructose syrup in food processing (especially in soft drinks, previously the largest single outlet), direct industrial receipts accounted for 58.5 percent of total sugar deliveries for human consumption in 2000. Producers of baked goods and cereals are now in first place among industrial sugar users, followed by makers of sweets and manufacturers of ice cream and dairy products. In addition to its nutritional value, sweetness, and other sensory functions (taste and aroma, texture and appearance), and preservative action, sugar fulfills the specific requirements of different food industries for a binder, bulking agent, fermentation substrate, or stabilizer. This does not exhaust the list of its functional properties, and the fact that sugar always acts in more than one way explains its wide use in food and beverages.

The many types and grades of sugar available in the marketplace reflect the multiple uses to which it is put in households and in industry. More than a dozen different kinds could be encountered in 2002 in a single British supermarket, for example: white beet or refined cane sugar—granulated, caster, icing, and cubes; unrefined cane sugar—golden granulated and caster, Demerara granulated and cubes, light and dark brown soft, light and dark muscovado, and molasses sugar; specialty items—amber sugar crystals, preserving sugar (large crystals), jam sugar (with pectin and citric acid), and a reduced-calorie mixture of sugar and the high-intensity synthetic sweeteners aspartame and acesulfame-K. Several kinds were available also in "organic" versions. One important distinction is the size of crystal. Finer sugar tends to dissolve more rapidly than coarser sugar. Also, the smaller the crystal, the greater the total surface area of crystals per unit of mass or volume. In raw and recoated white or refined sugars, each crystal is surrounded by a film of molasses or syrup containing nonsucrose substances that, while nutritionally insignificant, have technical and sensory effects such as taste. Therefore, the smaller the crystal, the greater the proportion of syrup or molasses in the product, a desirable characteristic in making things like dark fruitcake and gingerbread.

Still other types of sugar reflect national or regional processing technologies, customs, and tastes. So-called amorphous sugar features prominently in Brazil, as does white soft sugar in Japan. The loaves of the sugar bakers, which in their blue wrappers graced the shelves of nineteenth-century grocers' shops before cubing processes were invented, live on in Germany, where they are required on festive occasions for the preparation of mulled wine. Loaf sugar also remains popular in North Africa and the Near East, a legacy attributed to the fact that the loaves were easy to transport hung from the backs of camels. More importantly, altogether millions of tons of sugar, the product of boiling cane juice or the sap of palms in open pans, are still consumed, notably in the countries of the Indian subcontinent and Southeast Asia, China, and Colombia.

Granulated sugar going to processing industries is shipped in bulk or bagged in sacks, for the greater part directly from the factory or refinery, and often tailored to customers' specifications, especially concerning grain size. Many applications, however, require an aqueous solution. Dissolving batches of granulated sugar stands in the way of continuous manufacturing operations. Hence, beginning in the United States in the 1920s, large sugar users have increasingly obtained bulk delivery in liquid form. What is known generically as liquid sugar comes in many guises, in accordance with industry demands: colorless and colored; uninverted sucrose or partially or totally inverted (converted into glucose and fructose); unblended or mixed with glucose syrups and other components. Depending on type, liquid sugar contains 67 to 77 percent dry substance.

Nutritional, health, and safety aspects. Whether robbing wild bees of their honey, as did our ancestors, or extracting sucrose from sugar cane or sugar beets, humans take easily assimilable energy from the environment because we are heterotrophs or feeders on others and cannot fix carbon dioxide from the air. Instead, we have to obtain our carbon in a more elaborate form. Nutritionally, we utilize sugar, like other carbohydrates, as a fuel to obtain the energy to function. Under normal physiological conditions, sucrose must be enzymatically hydrolyzed in the small intestine before it can be absorbed across the intestinal wall. Glucose is the body's preferred fuel and the only one that powers the brain.

As a food, sugar is now subject to international and national standards and public health regulations, on top of the quality assurances and specifications of producers and industrial users. Compliance is underpinned by a large body of sensitive analytical methods.

The Codex Alimentarius, drawn up by a joint commission of the Food and Agriculture Organization and the World Health Organization of the United Nations, recommends international standards for white, powdered, and soft sugars, among other products. The basic white sugar standard lays down the minimum content of sucrose and the maximum contents of invert sugar, conductivity ash, sulfur dioxide (a processing aid), and the contaminants arsenic, copper, and lead. Binding regulations impose similar specifications across the European Union. The U.S. Food Chemical Codex is an example of controls at the national level. Since sucrose is used in pharmaceutical preparations as a binder, bulking agent, and taste corrective, it is also included in international and national lists of drugs and medicinal preparations.

Virtually a pure carbohydrate—even raw sugar supplies practically no minerals or vitamins, no fiber, and no protein—sugar is widely attacked on nutritional and health grounds. The safety aspects of sugar and its impact on human health have been extensively examined by scientists and reviewed by expert committees such as the U.S. Food and Drug Administration (FDA) Sugars Task Force and the British Nutrition Foundation's Task Force on Sugars and Syrups. On the evidence, the consumption of sugar and other fermentable carbohydrates contributes significantly to the incidence of dental caries, which have multiple causes, however. Other than that, no conclusive proof has been found that dietary sugars pose a health hazard to the general public. They are not related to diabetes, except as a nonspecific energy source, nor to behavioral changes. They do not have a unique role as a cause of obesity or constitute an independent risk factor in cardiovascular disease, gallstones, cancer, or hypertension.

History. The word "sugar," like its cognates in many languages, comes ultimately from Sanskrit. Crystalline sugar has been made in northern India since the fifth century B.C.E., if not earlier. Sugar in solid form, possibly imported from Indochina, was also known in China by the third century C.E. To the west, however, the comparatively short move of the industry from India into Persia did not take place until c.600 C.E. From there, it rapidly diffused westward across the Middle East in the train of Arab expansion.

For the better part of 900 years between 700 and 1600, sugar production outside of Asia flourished on the islands and around the shores of the Mediterranean, with Venice initially the foremost center of refining and trading. The second half of the period saw the first exports to central and northern Europe, triggering what Sidney Mintz has called "the conquest of honey by sucrose," albeit that sugar was still a rare and expensive luxury, its use confined to kings and nobles. The Mediterranean industry began to decline from about 1450 onwards, in parallel with the appearance of more efficient producers in the new Portuguese and Spanish colonies in the eastern Atlantic and the Americas, although that was not the sole reason. For a while, Madeira, the Canaries, and São Tomé figured prominently in the burgeoning international sugar trade, forerunners of the West Indian "sugar colonies" and "sugar islands" that Adam Smith spoke of in his *Wealth of Nations*. But, like the Mediterranean industry, they, too, could not match the natural conditions and space for growing sugar cane that lay waiting in the Western Hemisphere.

When Christopher Columbus carried sugar cane to the Americas on his second voyage in 1493, shortly followed by other Spanish and Portuguese explorers with their cargoes, the seed was sown for a vast expansion of the industry. Within a few decades, supplies doubled and doubled again, prices fell, and consumption extended to the middle classes. Still, about a century and a half after sugar from Brazil and Hispaniola became the first example of profitable agricultural exports from the Western

Hemisphere, average per capita sugar consumption in Britain in the first decade of the 1700s is estimated to have amounted to just four pounds a year, less than two kilograms, or about a teaspoonful a day. On the other side of the Atlantic, the growth of the sugar industry had lasting political, economic, social, and cultural consequences: based on plantation agriculture and slavery on a scale many times greater than previously seen in the Old World, it was instrumental in the formation of new nations.

Until the early 1800s, cane sugar had the field to itself, leaving aside sweeteners of no more than regional significance. Honey was a competitor only so long as sugar was still a costly rarity. Even then, the two products complemented as much as competed with each other. All that changed with the arrival of beet sugar early in the nineteenth century, a historically significant event aptly described by Timoshenko and Swerling as "the earliest example of the market for an important tropical product being seriously eroded by the application of modern scientific methods in relatively advanced countries." Extraordinarily, the challenge came not from a substitute but from what was, for all practical purposes, the identical substance, obtained from an entirely different plant. High-grade refined sugar from beet or cane is indistinguishable except by analytical methods that find the difference in the carbon isotope ratio ($^{13}C/^{12}C$).

Beet sugar added another dimension to the world sugar economy. It allowed temperate zone countries to produce their own sucrose and greatly increased global availabilities, so that sugar could become a staple item of consumption for all classes of society. By 1880, Austria-Hungary, France, Germany, and Russia were turning out beet sugar on a scale comparable to the largest cane sugar producers. Europe's beet sugar industries contributed enormously to its economic development in the second half of the nineteenth century. The Germany of the 1890s, for instance, had around 400 beet sugar factories, producing roughly one-and-a-half million metric tons of beet sugar a year, and sugar briefly headed the list of German merchandise exports. In his work *Der moderne Kapitalismus*, the German economist Werner Sombart wrote: "The sugar and distilling industries were the industrial sectors through which Germany developed into a great capitalist power, rather as the cotton and iron industries laid the basis for England's greatness."

Nowadays, most countries cover their requirements at least partially with homegrown sugar, and some that do not, such as New Zealand, possess a refinery to process raw sugar imports. The bulk of the world's sugar is today consumed in the countries where it is produced. Not surprisingly, in view of its sundry roles, sugar has become deeply embedded in politics over the centuries, and how much is produced and where is heavily influenced by tariffs, taxation, and subsidies.

Several industry-specific factors have favored the growth of sugar production and consumption throughout history. Sugar's multiple functions, from its first uses as a medicine and condiment, have clearly been an advantage in boosting consumption. So was its long-time association in Europe with wealth and standing—demonstrated, for instance, by its conspicuous display in molded table decorations. In modern parlance, sugar enjoyed "snob appeal." Economists would say that it had a high positive-income elasticity of demand and confirmed Say's law that supply creates its own demand. Even as sugar becomes an inferior good in highly developed countries, consumption is sustained by increased demand for things like ice cream, sweets, and soft drinks, so long, of course, as these continue to be made with sugar and not other sweeteners.

On the production side, the by-products of sugar processing have always played a significant role in the viability of the industry. Sugar mills in many parts of tropical America survived deforestation and the scarcity of firewood because sugar cane brought its own fuel in the form of bagasse, the fibrous processing residue. Indeed, a modern raw cane sugar factory normally produces more bagasse or steam than it needs. The corresponding residue in the beet sugar industry—pulp—provides valuable fodder. Molasses, a by-product in both industries, is likewise utilized directly or in mixed feeds, or as a raw material for fermentation products. Students of U.S. history will be familiar with John Adams's statement in 1775: "I know not why we should blush to confess that molasses was an essential ingredient in American independence. Many great events have proceeded from much smaller causes."

The very nature of the industry facilitated its diffusion to and growth in new territories. A state-of-the-art sugar factory, operating at top technical efficiency, is an extremely sophisticated business—science-inspired, instrument-controlled, and automated. In essence, however, the methods of sugar processing are simple and robust. Although economies of scale have led to ever larger plants, sugar can be made in a wide range of plant sizes. The processes involved are easily scaled up, and factories can be enlarged and updated piecemeal by retrofitting new equipment. Right down to the present, the world cane sugar industry exhibits a technological diversity ranging from back-yard producers of a few tons of sugar, similar to that made centuries ago, to huge installations, pouring out hundreds of thousands of tons a year of high-grade product.

Technology. Sugar processing is basically a series of solid-liquid separations. The core processing stages are: (1) extraction of the juice, with bagasse or pulp the residue; (2) purification of the juice, removing non-sucrose substances; (3) concentration of the purified juice to syrup by evaporating water; (4) crystallization of the sucrose in the syrup by further evaporation; (5) separation of the crystals from the syrup. The methods employed after juice extraction determine the end product. One way leads to raw sugar, which is refined—on site or in a separate plant—by washing and redissolving the crystals and further clarifying and decolorizing the resulting solution. The clear syrup is then again boiled until crystals form, or made into liquid sugar. Much of the world's cane sugar is produced in this way. The alternative is to make white sugar directly after complex purification of the juice, the procedure followed in some cane-sugar factories and throughout the beet-sugar industry.

For two thousand years, machinery, apparatus, and processes underwent a slow and gradual evolution, highlighted by the crucial seventeenth-century innovations of the three-roller mill and the battery of cauldrons, which, once fitted with a single furnace and continuous internal flue, became known as the Jamaica train and survives to this day among small-scale producers of open-pan sugars (not made in closed vessels under vacuum). Development accelerated with the introduction of steam and the rise of industrial chemistry in the nineteenth century. By about 1880 the basic tool kit of the sugar industry was virtually complete, and that date marks the beginning of the modern era in sugar production.

Nonsucrose Sweeteners

High fructose syrups (HFS) and other caloric sweeteners. Sucrose substitutes fall into two categories: nutritive or caloric substances, which, like sucrose, provide energy and bulk, and high-intensity sweeteners, used principally for their sweetening power, although that is not their only property. The discovery of how to convert starch into sugar (saccharification) in 1811 was the first step toward the development of serious commercial competitors to cane and beet sugar of the first kind. Still, the glucose syrups produced over the next 150 years were less sweet than invert sugar syrup, which restricted their range of industrial applications. That limitation was lifted by the invention of isomerization processes leading to high-fructose syrup, known as high-fructose corn syrup in North America and isoglucose in Europe. While glucose syrups continued to be made, world HFS production rose in less than forty years from zero to an estimated 13.1 million tons, dry weight, in 2001/2002. The United States accounted for 73 percent of global output; another 18 percent was shared by Japan, the European Union, Turkey, South Korea, Canada, and Argentina, and the remainder by more than a dozen other countries.

Location and volume of HFS production are conditioned by several factors:

1. Price: World sugar price booms in 1963, 1974, and 1980 greatly stimulated development. In the United States and Japan, two large sugar importers, HFS progressed under the umbrella of protective sugar regimes that kept sugar prices at an artificial level and ensured that, however much HFS manufacturers undercut the price of sucrose, displacement of the latter reduced sugar imports and did not impair domestic sugar production;
2. Starch supply: Ample supplies of starch at a competitive cost, net of by-product proceeds;
3. Consumer demand: Sufficient sweetener consumption in the form of processed foods and beverages, and the existence of bulk-handling facilities for liquid products;
4. Money: Financial resources for investment in research and development as well as in capital-intensive plants and equipment;
5. Political climate: Supportive, or at least permissive, government policies; in the European Union, however, isoglucose manufacture—and, more recently, also that of insulin syrup—has been restrained, first by a levy, then by production quotas.

Besides syrups, starch saccharification leads to dextrose or crystallized glucose. Sold in anhydrous (at least 98 percent solids) or monohydrate (at least 90 percent solids) form, dextrose is used in food and other industries.

Also employed industrially as bulking, humectant (moisturizing), and texturizing agents and in diabetic foods are various sugar alcohols or polyols. These have lower calorific values than sucrose and, with the exception of xylitol, only about half the sweetening power. The main one, sorbitol, occurs naturally in many plants—as does its isomer, mannitol—and is used, among other things, to synthesize ascorbic acid (vitamin C). It is commercially obtained by the hydrogenation of glucose or of invert sugar, the latter yielding equimolar amounts of sorbitol and mannitol from the fructose and sorbitol only from the glucose. Other members of this class are maltitol, produced by hydrogenation from high-maltose syrup; isomalt, for which sucrose is the feedstock; xylitol, made from xylose-containing materials, such as corncobs and birchwood sawdust; and erythritol, found in lichens and made from glucose by fermentation.

High-intensity sweeteners. Artificial or natural substances with many times the sweetening power of sucrose, but no or negligible calorific value as used, are known as high-intensity sweeteners. Saccharin, the oldest of the kind, is about 300 times as sweet as sucrose. A derivative of the tar product toluene, it first achieved some market significance during the sugar shortages caused by World War I, when it began to be used as a substitute by people besides those who were unable to tolerate sugar. Newer sweeteners have, to a considerable extent, displaced saccharin, but it continues in demand, particularly in Asia, because it costs a small fraction of the price of sugar in terms of sweetness equivalence. Another older artificial sweetener, cyclamate, roughly thirty times as sweet as sugar, was discovered in 1937 and became popular after World War II, usually in combination with saccharin. Together, each masks the unsatisfactory taste of the other, producing an overall taste profile thought to approximate that of sugar.

Such blending of different sweeteners, nutritive as well as high-intensity, is a striking feature of sweetener usage in processed foods and beverages. One advantage lies in the resultant synergism—the sweetness effect of the mixture is greater than the sum of the sweetening powers of the individual components, enabling manufacturers to save costs and label certain products "reduced calorie." Blends may also produce other taste synergies and enhance the stability of the product.

The scope for blending was greatly increased in recent decades with the introduction of aspartame and acesulfame–K. Aspartame, a methylated amino acid dipeptide, actually has the same calorific value as sugar, but is about 180 times sweeter. Its taste profile closely resembles that of sucrose and, unlike saccharin, it has no bitter aftertaste. Widely used as a tabletop sweetener, aspartame is not suitable for all processed products because it can lose sweetness, depending on temperature, moisture, and degree of acidity. In contrast, acesulfame-K, the potassium salt of methyl oxathiazinone dioxide roughly 200 times as sweet as sugar, while more expensive, is very stable, blends well with other sweeteners, and is highly synergistic.

The latest artificial sweetener to acquire significant market presence is sucralose, which is 600 times sweeter than sugar. Technically trichloro-galactosaccharose, sucralose is actually made from sugar. It has the advantages of a good taste profile and of being acid and temperature stable. Several other substances, some with many thousand times the sweetness intensity of sugar, are waiting in the wings. High-intensity sweeteners are classified as food additives and require approval by national food safety authorities. Gaining approval tends to be a lengthy procedure and, once given, can be withdrawn. In the United States, for instance, cyclamate was banned in 1970, but it is allowed in many other countries.

Summary

Sucrose remains the benchmark against which the quality and price of substitutes are judged, but it has lost its former virtual monopoly as the sweetener and conditioner of food and drink. Not all the growth of nonsucrose sweeteners has been at the expense of sugar. Some of it reflects the development of new products, such as diet soft drinks. In certain applications, sugar and other sweeteners have to be blended in order to achieve the desired texture and consistency. Moreover, nonsucrose sweeteners compete not only against sugar, but also among themselves: aspartame against saccharin, and diet soft drinks sweetened with high-intensity sweeteners against regular soft drinks sweetened with HFS. Only in the United States was sucrose no longer the dominant sweetener at the beginning of the twenty-first century. Globally, sucrose still accounted for 70 percent or more of world sweetener consumption.

See also **Caribbean; Codex Alimentarius; FAO (Food and Agriculture Organization); Sugar Crops and Natural Sweeteners; Syrups; United States: Hawaii.**

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SUGAR CROPS AND NATURAL SWEETENERS. Chemically, the substance in the breakfast sugar bowl comes to us unchanged from the living organism in which it was manufactured. The familiar crystals are virtually pure sucrose, an organic chemical belonging to a large family of compounds classified as sugars. These, in turn, are members of a still larger group—the carbohydrates—that also includes starch and cellulose. The breakdown of carbohydrates into monosaccharides, oligosaccharides, and polysaccharides points to the relationship.

Carbohydrates are a product of photosynthesis, the complex biochemical process whereby green plants use light energy to combine aerial carbon dioxide and hydrogen from soil water, forming rings of carbon atoms to which atoms of hydrogen and oxygen are attached, usually in the ratio in which these elements occur in water (hence the name), surplus oxygen being released as free gas. Stripped of all detail, the photosynthetic reaction that produces the basic monosaccharide glucose may be summarized by the equation:

$$6CO_2 \text{ (carbon dioxide)} + 6H_2O \text{ (water)} + \text{light} = C_6H_{12}O_6 \text{ (glucose)} + 6O_2 \text{ (oxygen)}$$

Affinities

Various carbohydrates are made in the course of photosynthesis. Sugars are the simplest. Glucose, also called dextrose and grape sugar, is the most prevalent sugar in nature. It occurs in the free state in fruits, plant juices and honey, as well as in blood. Polymerization of glucose leads to starch and cellulose—the one a form of energy storage, the other the main structural material of plants—both nothing but chains of glucose units. Conversely, natural starches can be saccharified by acid hydrolysis and enzymes to yield different types of sweet syrups or crystalline dextrose. Another monosaccharide, fructose (also called levulose and fruit sugar), occurs in the free state notably in honey. Sharing the same chemical formula but differing in structure, glucose and fructose are in fact interconvertible by chemical and biological reactions.

Fructose and glucose combine to form the oligosaccharide — more precisely, disaccharide — sucrose, $C_{12}H_{22}O_{11}$, shedding a molecule of water in the process. Sucrose is found in the sap of many plants and like starch functions as a storage product. It is easily hydrolyzed by acid or enzyme to equimolar amounts of glucose and fructose, and the mixture is then called invert sugar.

A family trait of many mono- and oligosaccharides is their sweet taste. Fruits, young vegetables, the nectar of flowers, and the sap of certain plants and trees taste sweet because they contain saccharides. Sucrose is generally used as the standard for relative sweetness, but this also depends on concentration, temperature and other factors affecting the physiology of taste. Approximate relative sweetness values for the sugars mentioned are:

Fructose	120	Invert sugar	95
Sucrose	100	Glucose	65

Sucrose, almost all of which is obtained from sugar cane and sugar beet, is commercially by far the most important sweetener. Its origin in photosynthesis explains how two wholly dissimilar botanical sources can furnish a practically identical product. Sugar cane—currently providing roughly three-quarters of the world's sucrose supply—is a perennial monocotyledon, propagated from cuttings, except in the breeding of new varieties, and capable of giving repeated harvests. In contrast, sugar beet is a biennual dicotyledon, harvested in the first season and replanted annually from seed. Cane grows in the tropics and subtropics, beet in temperate climates. The cane's sucrose comes from the stalk, the beet's from its root. Sugar cane has been exploited industrially for more than two millennia, sugar beet for just two centuries.

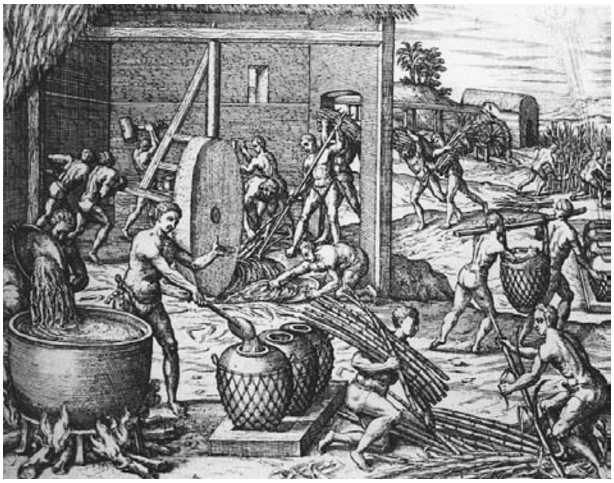
The origin of sugars in photosynthesis also explains the exploitation of other, more or less important sweetener sources, some going back to ancient times, for example boiled-down grape juice, fig and date syrup, the sap of palms, the maple tree, and sweet sorghum, and the exudations from certain trees and shrubs. Like the sugar from cane and beet, honey—the first concentrated sweetener known to humans—is ultimately a product of photosynthesis. In essence, bees making honey and humans processing cane or beet to crystal sugar are doing the same thing—both extract dilute sugar solutions from plants and convert them into forms that are easier to handle and storable by evaporating unwanted water.

Sugar Cane

Physical characteristics. Sugar cane is a giant perennial grass that tillers at the base to produce clumps of solid unbranched stems up to six centimeters in diameter and typically two to three meters long at maturity. It is grown for these thick stems which, stripped of tips and leaves, weigh between 500 and 2000 grams and, as a rule, contain 10–15 percent sucrose and 11–16 percent fiber. Each stem is divided into a number of joints comprising a node and an internode up to twenty-five centimeters in length. A node consists of a lateral bud in a leaf axil, a band containing root primordia, and a growth ring. Sword-shaped leaves, consisting of a sheath and a blade, are attached to the stem at the base of the nodes, alternating in two rows on opposite sides of the stem. The stems range in color from green or yellow to red, purple, violet, or striped, and have a hard wax-covered rind that reduces loss of water by evaporation. Depending on variety, plant age, and natural conditions, sugar cane may flower, producing plumelike panicles known as arrows or tassels that bear hundreds of small spikelets with inconspicuous flowerets. For sugar production, however, sugar cane is propagated vegetatively from stem cuttings or setts bearing at least one bud. Planted in moist soil, the bud develops into a primary stem, the basal buds of which form secondary stems, and so on, while rootlets sprout from the root primordia band on the sett. In time, the tillers throw out their own roots and, in favorable soil conditions, an established cane stool develops an elaborate root system of widely spreading superficial roots that absorb water and nutrients and buttress roots to provide stability, as well as a few vertical roots that may penetrate deep into the soil where moisture is available even during a severe drought.

Origin and geographical spread. All forms of sugar cane are species or hybrids of the genus *Saccharum*, a member of the large family of Gramineae in the tribe Andropogoneae, the sorghum tribe. Six *Saccharum* species are now recognized. Historically, sugar canes are derivatives of what is known as the *Saccharum* complex, which comprises the interbreeding genera of *Saccharum*, *Erianthus*, *Sclerostachya*, *Narenga*, and *Miscanthus*. The most primitive *Saccharum* species, *S. spontaneum* L., a highly variable and vigorous, but thin-stemmed, fibrous cane low in sugar, is believed to have originated in northern India. Subsequent modification, movement, and hybridization generated various Asian, Pacific, and African forms. Still being debated is the botanical lineage of *Saccharum officinarum* L., clones of which—so-called noble canes—furnished the raw material of plantation-based sugar industries from the latter part of the eighteenth century until the early 1900s. This species—thick-stemmed, soft-rinded, rich in sugar, and originally selected for chewing—is generally thought to have evolved in eastern Indonesia or New Guinea from the wild cane *Saccharum robustum* Brandes and Jeswiet ex Grassl. An alternative theory has *S. officinarum* derived from the Chinese sugar cane, *S. sinense* Roxb. emend. Jeswiet, which was carried to the Philippines, making that area the likely site of initial hybridization and development of *S. officinarum*. In any event, *S. officinarum* probably became a cultivated food plant about 5000 or 6000 years ago. In the course of time, sugar cane of one form or another spread eastward across the Pacific and northwestward to India, and thence via Persia and the Mediterranean basin to the Atlantic seaboard, finally reaching the New World in 1493 on the second voyage of Columbus.

The first cultivars grown in the Western Hemisphere were male-sterile, and the possibility of deliberately breeding new varieties was not generally recognized until the late 1800s after the fertility of cane seed was definitely established simultaneously in Barbados and Java. Finding that adaptability to less-than-optimal ecological conditions and, above all, resistance to diseases was unobtainable within the genetic variability of *S. officinarum*, breeders eventually began to cross noble canes with other *Saccharum* species and cross the progeny back with noble canes, a process called nobilization. Today, most cane-growing countries in the world pursue their own breeding programs. In addition to disease resistance and high yields in the local conditions over several seasons, the aim is to obtain varieties tailored to modern production methods such as suitability for mechanized harvesting and herbicide tolerance.



Early engraving by Theodore de Bry showing Caribbean Indians working as slaves in a Spanish sugar mill. COURTESY OF THE LIBRARY OF CONGRESS.

Environment and cultivation. Sugar cane is grown in about eighty countries between roughly 30° latitude north and 30° latitude south. Often described as a tropical crop, much cane is actually grown in subtropical areas. The ten leading producers are India, Brazil, China, Thailand, Australia, Mexico, Cuba, the United States, Pakistan, and South Africa. Sugar cane is a very adaptable plant that can be grown successfully on a wide range of soils. It grows best under ample sunlight in moist hot climates where a period of heavy rainfall is followed by a cool and dry season to increase sugar content and facilitate harvesting, or with controlled irrigation. Depending on location and other factors, the crop is ready for harvesting ten to twenty-four months after planting. In a harvesting period lasting between three and eleven months, again depending on location, the stems are cut, topped, and stripped of leaves by hand or machine. Yields vary widely from less than forty metric tons to more than one hundred metric tons of cane per hectare, equivalent, after processing, to upwards of four metric tons of sugar per hectare. Cut cane deteriorates rapidly and must be processed promptly to avoid heavy loss of sucrose. After the first harvest, underground buds on the stool throw out new shoots, and the plant develops a new root system. This allows the production of second, third, or more crops, known as ratoons, in a similar or shorter growth period and at less cost. The complete crop cycle usually lasts three to ten years, the field being replanted when the yield drops below an economic level.

Structural and economic aspects. As a perennial ratooning grass, sugar cane does not easily lend itself to crop rotation and is usually grown in monoculture. Extremely labor-intensive until mechanization, particularly at harvest time, sugar cane has been regarded as the archetypal plantation crop, produced in large enterprises employing many low-skilled workers under the supervision of a few skilled managers. Broadly speaking, this was true for the export-oriented sugar cane industries of the colonial period and lies at the heart of the historical association of sugar with slavery. However, the organizational structures of sugar cane agriculture have long exhibited great diversity, even in territories described as plantation economies, and range globally from smallholders with less than two hectares to miller-planter complexes in which a centralized management controls thousands of hectares as well as a factory.

Throughout the world, cane farming operations from soil preparation to harvesting and transport are increasingly mechanized. A bulky crop of low unit value, sugar cane presents formidable materials-handling problems. Until the 1960s, Hawaii, Louisiana, and Queensland were the only cane-growing areas to have mechanized both cutting and loading. Despite the arduous nature of the work, growers have tended to retain manual harvesting using heavy machete-type knives as long as economically feasible because mechanized harvesting systems entail extensive field reforms and modifications of transport equipment and factory reception facilities and because of the increased extraneous matter content in mechanically harvested cane, at least in the early years. Rising labor costs and better machines, however, have led to the progressive mechanization of harvesting operations in one country after another. In some areas, mechanization proceeded in stages, starting with the piling and loading of hand-cut cane or wholestalk harvesters; other areas have gone straight to combines that cut, chop into billets, clean, and load in a continuous operation.

Sugar Beet

Physical characteristics. The root of sugar beet, in which sucrose accumulates, consists, from the top down, of the epicotyl or crown, the hypocotyl or neck, and a swollen taproot. Roots vary greatly in size but average about 600 grams. The crown is the part above the lowest leaf scar; it is stem tissue with leaf buds and supports a rosette of leaves, the botanical engines that put the sucrose into the root. The hypocotyl, the region between crown and tap root and the thickest part of the root, extends from the lowest leaf scar to the uppermost lateral roots. Epicotyl and hypocotyl make up the part of the root that rises above ground. Depending on variety, plant population, and the various factors affecting growth, these two sections account for about 20 percent of the length and weight of the entire root. The white-fleshed tap root has two grooves on opposite sides from which lateral roots emerge. It tapers off to a tail less than one centimeter thick that with the hairlike ancillary roots often extends two meters or more deep into the soil.

The sucrose and nonsucrose constituents of sugar beet are not distributed uniformly in the root; sucrose content and purity are higher in the middle of the root than in the crown and tail. Hypocotyl and taproot together contain 14 to 20 percent sucrose. In harvesting, the beet is topped below the green leaf stalks of the epicotyl, a certain margin in the upper hypocotyl being allowed, while the tail usually breaks off in the lifting and subsequent handling of the root. A biennial, sugar beet flowers and bears seed in the second season, but is harvested for sugar in the first.

Origin and geographical spread. Sugar beet, *Beta vulgaris* L., is a member of the Chenopodiaceae or goosefoot family. Four distinct types of the species are cultivated: sugar beet, garden (red) beet, leaf beet and Swiss chard, and fodder beets. Sugar beet, the second major source of the world's sugar supply, is commercially by far the most important of the four types. Wild forms from which the crop could have been derived are widely distributed throughout the Mediterranean region and the Middle East. It is not known when the beet was taken into cultivation, but use of the plant medicinally and as a vegetable was already well established in Greek and Roman times. Cultivars with swollen roots, the result of human selection, are recorded in northern Europe from the sixteenth century onwards. The French agriculturist Olivier de Serres (1539–1619) compared the liquid from cooked red beet to sugar syrup. In 1747, Andreas Sigismund Marggraf (1709–1782), a member of the Berlin Academy of Sciences, reported having extracted from red and white beets a substance identical with cane sugar. Towards the end of the 1700s, another academician, Franz Carl Achard (1753–1821), began to grow white beets for sugar production, first near Berlin and then in Silesia where in 1802 he opened the first beet sugar factory. Achard's beets had a sugar content of up to 6 percent, but this was raised by simple mass selection to about 9 percent by the 1830s. Since then, thanks to advances in breeding methods, the sugar content in beets has roughly doubled. Average German beet yields per hectare have also more than doubled, so that a hectare of beets now produces approximately four times as much sugar as it did in the mid-1800s.

Environment and cultivation. Sugar beet is currently grown in nearly fifty countries, all save Chile in the northern hemisphere and most enjoying moderate summer temperatures and at least 250 millimeters of rainfall during the growing season except in areas where irrigation is available. Beet is successfully cultivated in many soils, but a deep loam, moist yet well-drained, is best. Member countries of the European Union, the United States, Turkey, Poland, Ukraine, Russia, and China are the leading producers. Sown in spring, the crop is lifted before the first frosts are expected. Different from cane, harvested beet can be stored for months under suitable conditions without intolerable loss.

Structural and economic aspects. Unlike cane, beet is grown in rotation with other crops and is closely integrated in the farming systems practiced in the regions where it is cultivated. As a root crop, it improves soil conditions. The beet tops can be used for fodder or, when plowed in, provide organic manure. The beet pulp remaining after sugar extraction is also used for animal feed, in contrast to bagasse, the fibrous residue of cane processing, which mainly ends up as factory boiler fuel. Like cane, beet was formerly an extremely labor-intensive crop. In the case of beet, however, not harvesting but thinning out the seedlings after emergence to create space between plants was the operation most resistant to the reduction of labor requirements. Until the advent of monogerm varieties with single flowers at each inflorescence node, sugar beet bore clusters of flowers which gave rise to multigerm seed balls. Even where animal- or tractor-drawn implements replaced the hand hoe in blocking out excess seedling clusters, the final singling to one plant per clump had to be done manually. Labor shortages in the United States during World War II spurred the introduction of mechanically segmented seed (followed after the war by decorticated seed) with a large proportion of single germs, better suited for precision drilling but at the risk of poorer germination and an uneconomic plant population in the field. The same drawbacks adhered to the seed of early genetically monogerm varieties, and the total elimination of manual labor in sugar beet agriculture did not become possible until the arrival of improved forms since the late 1960s.

Other Natural Sweetener Sources

Polysaccharide-bearing plants. In 1811, a Russian-German chemist, K. S. Kirchhof, working in St. Petersburg, discovered that adding diluted sulfuric acid to cooked potato starch produced a sweet syrup containing glucose. A year later, the first starch sugar factory was established in Germany. While the technological details would vary depending on the source of starch—cereals, roots and tubers, or stem pith, the door was opened to obtaining sweeteners from a wide range of plants. Syrup from corn (maize), rather than potatoes, has been made in the United States since the mid-1800s. Elsewhere, the raw materials could be sweet potatoes, tapioca (cassava, manioc), rice, wheat, and sago. But while such starch-based syrups could compete to some extent with cane and beet sugar in processed foods and drinks, their application was constrained by the fact that glucose is markedly less sweet than sucrose. This disadvantage was overcome in the second half of the 1960s and early 1970s by a new process of continuous enzymatic isomerization of glucose to fructose. (In essence, a glucose solution is passed through columns or beds containing immobilized enzyme, which changes the atomic arrangement of glucose into that of fructose.) The result is high-fructose corn syrup (HFCS), called isoglucose in Europe. Unlike the older glucose syrups, an equilibrium fructose–glucose syrup compares in sweetness and in other respects to invert sugar syrup made from sucrose. This greatly widened the possibilities of using starch sweeteners in industries such as the soft-drink industry, that were major users of sucrose. In the second half of the 1970s, further technological advances brought onto the market second– generation syrups with higher fructose contents, which deliver more sweetness with fewer calories, thanks to the fact that fructose is sweeter than sucrose. Since 1985, consumption of HFCS, glucose syrup, and dextrose, on a comparable dry basis, has exceeded that of beet and cane sugar in the United States, but this is so far the only country in which sucrose is no longer the leading sweetener.

Certain plants lay down fructose polymers as energy reserves in place of or in addition to starch. Inulin—found in, among other plants, chicory and Jerusalem artichoke—belongs to this category of polysaccharides. Inulin syrup is produced on an industrial scale in the European Union and falls under the EU's sugar and sweetener market regime.

Palms. Various species of palms have for centuries been tapped—notably in southern and southeastern Asia—for their sweet sap, which is drunk fresh or fermented. Alternatively, the sap has been boiled down until it sets to a solid mass of fudgelike consistency, called gur or jaggery, or is distilled to produce arrack. Among palm species exploited in these ways are the palmyra (*Borassus flabellifer*), the toddy fishtail or jaggery palm (*Caryota urens*), the coconut palm (*Cocos nucifera*), the nipa palm (*Nipa fruticans*), and a wild date palm (*Phoenix sylvestris*) related to the palm of commercial date production (*P. dactylifera*), the fruits of which are also a source of sugar.

Maples. Several species of the maple family, as well as birch and elm, can be tapped to make syrup and sugar, but the main source is the sugar maple, *Acer saccharum*. Maple syrup has been made in North America since before the arrival of the first European settlers. It was an important sweetener in the northern United States and Canada until overtaken by beet and cane sugar. A peculiarity of the maple sap run is that it takes place when the tree is still dormant. The sap that will make syrup differs from that circulating in the growing tree. Its flow is triggered by a thaw following a hard frost. The mechanics of the run are believed to involve changes in osmotic, water and gas pressures caused by the translocation of sugar stored in trunk xylem tissue the previous summer as the trunk warms up on a sunny late-winter day. Fresh sap contains up to 3 percent sucrose. Evaporation by boiling in open pans, which also adds color and the characteristic maple syrup flavor, raises the sucrose content to around 62 percent and reduces the water to 35 percent in the final product. At higher concentrations, the sugar crystallizes when the syrup cools. Thirty to 40 liters of sap make one liter of syrup.

Production methods have improved over the years. The Indian technique of cutting a wide gash in the trunk was hard on the tree. The colonists introduced the practice of making a small hole with an auger—now done with power drills—and fitting a spout from which a bucket was suspended. In recent times, plastic tubing has been adapted to collect the sap from an entire stand of trees, and central evaporator plants, with instruments to monitor boiling temperature and syrup concentration, now serve whole producer communities.

Sorghum. A near relative of sugar cane, sweet sorghum or sorgo (*Sorghum vulgare*), a native of Africa, was, for a while in the second half of the eighteenth century, thought to have the potential for becoming a mainstream source of sugar in the United States. Although it could not compete against the growing availability of beet and cane sugar from about 1880 onwards, sorghum syrup is still produced on a small scale.

Mahua or Mowrah Tree. Several trees of the genus *Madhuca* or *Bassia* (Sapotaceae) bear sweet fleshy edible flowers. Those of *M. indica***,** also named *M.* or *B. latifolia*, were mentioned in Indian medical writings as a source of sugar as early as the third to seventh centuries A.D.

Manna. The word "manna" has various meanings. The biblical manna may have been wind-borne edible lichens, *Lecanora* (*Sphaerothallia*) *esculenta* or other species of the same genus. Two Middle Eastern shrubs, *Alhagi maurorum* and *A. pseudalhagi*, exude a sweet resin that hardens and can be collected by shaking the bushes over a cloth spread on the ground. Insect punctures in the stem of the French tamarisk, *Tamarix gallica*, of the same region produce drops of a honeylike exudation called manna. The word is also used for the incrustations formed by the sap that flows when incisions are made in the bark of the Sicilian flowering ash, *Fraxinus ornus* L. (Oleaceae). Numerous other sources of resinous mannas are listed in herbalist and pharmacological literature. Although not in all cases, the principal chemical constituent of such mannas is mannitol, also called mannite, a colourless sweet-tasting crystalline alcohol.

Stevia. The leaves of *Stevia rebaudiana* Bertoni**,** a wild shrub of the Compositae family that is native to Paraguay, contain a complex mixture of sweet diterpene glycosides. Stevioside, a high-intensity sweetener 250 to 300 times sweeter than sucrose, is extracted from the leaves and used as a sweetener in South America and Asia. Because of unresolved toxicological concerns, Stevia and stevioside cannot be sold as food or food ingredients in the European Union.

Protein sweetener sources. A number of plants yield taste-modifying proteins that function as natural sweeteners of very high intensity (thousands of times sweeter than sucrose). Some are believed to have been used for centuries by indigenous peoples to improve flavor and suppress bitterness in food and drink. The most widely known, thaumatin, is contained in the aril of the seed of *Thaumatococcus daniellii* Benth. (Marantaceae), a West African shrub. Monellin from the berries of the West African *Dioscoreophyllum cumminsii* Diels (Menispermaceae) is another example.

See also **Candy and Confections**; **Syrups**.

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G. B. Hagelberg

SUPERMARKET. *See* Retailing of Food.

SUPPLEMENTS. *See* Nutrient Supplements.

SUSTAINABLE AGRICULTURE. From a technological and economic standpoint, agriculture today represents one of the success stories of the modern era. Despite an ever increasing global population, and a corresponding gradual decrease in the availability of nonrenewable natural resources such as energy, land, and water, farmers throughout the world have responded to the challenge by increasing total and per area production levels every year. This agricultural miracle is due to a long tradition of farmer self-reliance, ingenuity, and perseverance, and to the support provided to farmers by many private and public institutions. Especially noteworthy is the support provided by a network of agricultural research universities in North America and Europe. Furthermore, crop productivity has improved in the developed world, and in many Third World countries as well. By the 1970s, many Third World countries in Asia and Latin America had actually reached self-sufficiency with respect to several primary staple grains.

The race toward increased crop yields began in the mid- to late 1800s in precapitalist England. Ever since then, scientists, environmentalists, and economists have issued words of caution concerning environmental and social issues arising from modern agriculture. By the mid- to late twentieth century, some of the more negative en-

SOME KEY UNDESIRABLE SIDE EFFECTS OF MODERN AGRICULTURE

- Unsustainable irrigation programs throughout the world are resulting in an undesirable buildup of salinity and toxic mineral levels in one out of five hectares under irrigation. Thus, agricultural water, a nonrenewable resource whose use has tripled globally since 1950, has to be used more efficiently to minimize salinization problems.
- Excessive soil erosion, in the range of fifteen to forty tons per hectare annually, results in the loss of productive farmland in many parts of the world. Forested areas, a refuge for wildlife and biodiversity (biological diversity), are then often turned into agricultural fields to compensate for the loss of the abandoned eroded areas.
- The indiscriminate use of pesticides is affecting human health and wildlife populations, as first reported to the population at large in Rachel Carson's book *Silent Spring* (1962).
- The increased concentration of farms into larger and larger farm holdings is reducing the number of small family farms, believed by many to represent the heart of rural communities and to be key stewards of the environment.
- The trend toward larger farms and plantation-type monocultures is leading to a loss of global biodiversity. Biodiversity, many argue, may be a critical ecological feature that allows the continued survival of humans on earth.
- The excessive reliance on synthetic fertilizers, and the improper use and disposal of animal wastes is leading to the breakup of natural nutrient cycles. This causes an undesirable buildup of nutrients and salts in aquifers, affecting wildlife in aquatic habitats.

vironmental and economic side effects of modern capital-intensive agriculture became evident in many parts of the world. The increased realization that modern agriculture had serious side effects, resulting in reduced environmental quality, health concerns, and economic insecurity for the traditional family farm, led in part to what is known today as a global "Sustainable Agriculture" movement.

Definition

Because agricultural systems are so diverse, based on farm size, location, crop being grown, socioeconomic background, among many other factors, and because the movement has become so widespread globally, sustainable agriculture has come to represent different things to different people. Nevertheless there are some common threads, concepts, and beliefs. In the most general terms, sustainable agriculture describes systems in which the farmer reaches the goal of producing adequate yields and good profits following production practices that minimize any negative short- and long-term side effects on the environment and the well-being of the community. The major goals of this approach are thus to develop economically viable agroecosystems and to enhance the quality of the environment, so that farmlands will remain productive indefinitely.

Why Sustainable Agriculture? History and Future Prospects

Ancient history, ranging from the Egyptians to the Romans to the Mayans, indicates that poorly managed agriculture can lead to the eminent decline of entire civilizations. By the midpart of the twentieth century, symptoms began to appear, documented by scientists, that some aspects of modern agriculture were unsustainable, leading in many cases to a decline in environmental quality and human quality of life. The undesirable side effects of modern agriculture, some believed, were threatening

WHAT IS SUSTAINABLE AGRICULTURE? SOME KEY DEFINITIONS

Sustainable agriculture involves farming systems that are environmentally sound, profitable, productive, and compatible with socioeconomic conditions (J. Pesek, in Hatfield and Karlen, *Sustainable Agriculture Systems*).

Agroecology is a field of research used to implement sustainable systems. It is the application of ecological concepts and principles to the study, design, and management of sustainable systems.

A *systems* approach is used to study and research sustainable systems. The goal is to study the farm as an entity made up of all its components and their interrelationships, together with relationships between the farm and its environment.

Key components of sustainable systems include enhanced internal nutrient cycling on the farm; improved soil quality through additions of organic matter and reduced soil erosion; increased vegetational diversity to promote natural systems of pest control; and alternative marketing programs that increase profits and minimize overhead costs.

BASIC FEATURES AND CONCEPTS OF SUSTAINABLE SYSTEMS

1. The need to maintain or improve soil quality and fertility. This is often attained by increasing the organic matter content of the soil, and by minimizing losses from soil erosion.
2. Production programs are designed to improve the efficiency of resource utilization. This will result in the most cost-effective use of water, fertilizers, and pesticides.
3. An attempt is made to improve internal nutrient cycles on the farm, which will reduce the dependence on external fertilizers.
4. Efforts are made to improve biological diversity on the farm. This will result in improved natural suppression of pests, and may also help to improve internal nutrient cycling within the farm.
5. Farm management and marketing programs are designed to minimize overhead costs and to increase returns, often by following alternative marketing schemes.

the lands and the very livelihood that farmers were trying to sustain. In contrast, from a historical perspective, scientists knew that civilizations that did follow sustainable practices were indeed able to thrive for centuries. Thus, by incorporating the use of production techniques developed by the latest agricultural research, along with some of the farming practices that proved effective through centuries of farming in many areas, a set of recommended management practices was established in individual production regions.

The future goal of farming communities is to strive to use current sustainable practices and to utilize the latest production techniques to remain competitive in the global agricultural market. For this to take place, a close communication link has to be maintained between rural communities, researchers, and society at large. This link gives urban communities a better understanding of issues affecting farmers, including the farmers' role as stewards of the environment, and of the economic realities of providing the public with a consistently healthy and safe food supply.

Implementing Sustainable Systems

An important aspect of sustainable agriculture is that it does not represent a specific set of agricultural practices that farmers need to follow step by step, like one would a recipe, to reach a specific goal. Instead, the concept represents more of a paradigm shift that encourages farmers to seek their own path, one that best fits the farm's particular conditions, and leads toward a more environmentally friendly approach without sacrificing yields or profits. Similarly, sustainable agriculture is not a specific target, but instead is more of a process that every farmer pursues as part of the daily farm operations. Thus, because agricultural systems are so diverse, farmers may choose among a myriad number of agricultural practices and techniques available to produce crops more effectively.

See also **Agriculture since the Industrial Revolution; Agronomy; Crop Improvement; Ecology and Food; Environment; Green Revolution; Greenhouse Horticulture; High-Technology Farming; Horticulture; Organic Agriculture; Organic Farming and Gardening; Organic Food; Tillage; Water: Water as a Resource**.

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Hector Valenzuela

SWEETENERS. *See* **Sugar and Sweeteners.**

SWEET POTATO. Sweet potato *(Ipomoea batatas)* is in the botanical family Convolvulaceae along with common plants, such as bindweed and morning glory. The generic name *Ipomoea* comes from the Greek words "*ips,*" meaning bindweed, and "*homoios,*" meaning similar. Sweet potatoes should not be confused with ordinary potatoes *(Solanum tuberosum)* as they are entirely unrelated, although their uses can be similar. Orange-fleshed sweet potatoes are often known as yams, especially in the southern United States, but they are quite different from true yams (*Dioscorea* sp.) in growth habit and use. Furthermore, unlike true yams, the greens of sweet potatoes are edible and provide an important source of food in Africa and Asia.

Identification

Sweet potato is a perennial that is usually grown as an annual. It grows from underground tuberous roots with trailing, twisting stems that can be as long as twenty feet (six meters). Leaves are variable in shape, size, and color but are generally more or less heart-shaped and green with purple markings. The single flowers are funnel-shaped and white or pale purple but are rarely seen in temperate regions. Roots grow where stem nodes touch the ground, and most develop into the edible storage roots, usually four to ten storage roots per plant.

Diversity

The International Potato Center (CIP) in Peru holds the largest sweet potato gene bank in the world with more than 6,500 wild, traditional, and improved varieties. Many of these are unique to a particular country or region. For example, an anthropologist in Irian Jaya found forty different cultivars of sweet potato growing in just one community garden. In contrast, Stephen Facciola's *Cornucopia II* (1998) lists only twenty-five different varieties available for the whole United States. Sweet potato flesh can be white, yellow, purple, red, pink, violet, and orange, while skin color varies among yellow, red, orange, and brown. Varieties with pale yellow or white flesh are less sweet and moist than those with red, pink, or orange flesh. They also have little or no beta-carotene and higher levels of dry matter, which means their textures are drier and more mealy and they stay firmer when cooked. Sweet potatoes also vary enormously in size, shape, taste, and texture, although all are smooth-skinned with roots always tapered at both ends.

Nutrients

All varieties of sweet potato are good sources of vitamins C and E as well as dietary fiber, potassium, and iron, and they are low in fat and cholesterol (see the Table for more detail). The orange- and red-fleshed forms of sweet potato are particularly high in beta-carotene, the vitamin A precursor.

Origins

Scientists debate the exact place of origin of *I. batatas*, although the evidence points toward Central America rather than South America. They are no longer found growing in the wild, but it is possible that the wild Mexican sweet potato *I. trifida* is an ancestor. Sweet potatoes have been cultivated for more than five thousand years, and fossilized remains found in the Andes have been dated at about 8,000 years old. Genetic studies suggest the likelihood that in early times sweet potatoes were carried by the local people from island to island, spreading gradually across the Pacific from Central and South America to eastern Indonesia, New Guinea, Polynesia, and New Zealand. Christopher Columbus is credited with taking sweet potatoes from the New World back to Spain, from where they spread through the warmer regions of Europe and were transported to other parts of Asia and to Africa by Spanish and Portuguese explorers and traders. Sweet potatoes were grown in gardens by North American Indians and were an important staple food during the American Revolutionary War and the American Civil War. They were also an essential part of the diet of the slave population in southern states. Most large plantations had a sweet potato plot and root cellars beneath cabins for potato storage.

TABLE 1

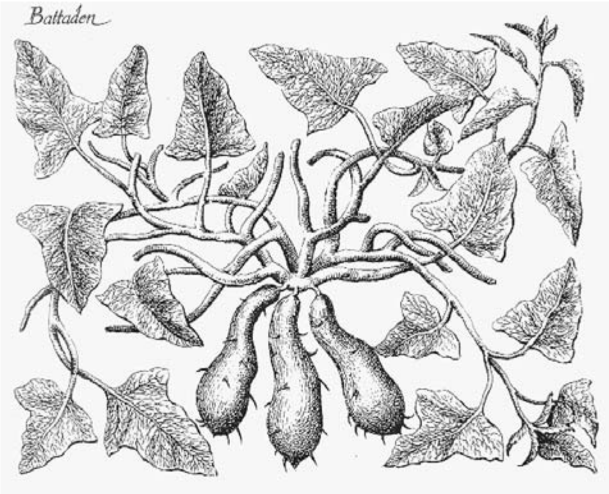
Constituents of the sweet potato: values per 100g (3.5 oz.) edible portion

	Units	Raw sweet potato	Cooked, baked in skin	Cooked, boiled without skin
Water	g	72.84	72.84	72.84
Energy	kcal	105	103	105
	kj	439	431	439
Protein	g	1.65	1.72	1.65
Total lipid (fat)	g	0.30	0.11	0.30
Carbohydrate by difference	g	24.28	24.27	24.28
Fiber, total dietary	g	3.0	3.0	1.8
Ash	g	0.95	1.06	0.95
Calcium Ca	mg	22	28	21
Iron Fe	mg	0.59	0.45	0.56
Magnesium Mg	mg	10	20	10
Phosphorous P	mg	28	55	27
Potassium K	mg	204	348	184
Sodium Na	mg	13	10	13
Zinc Zn	mg	0.28	0.29	0.27
Copper Cu	mg	0.169	0.208	0.161
Manganese Mn	mg	0.355	0.560	0.337
Selenium Se	mcg	0.6	0.7	0.7
Vitamin C	mg	22.7	24.6	17.1
Thiamin B_1	mg	0.066	0.073	0.053
Riboflavin B_2	mg	0.147	0.127	0.14
Niacin B_3	mg	0.674	0.604	0.64
Pantothenic acid B_5	mg	0.591	0.646	0.532
Vitamin B_6	mg	0.257	0.241	0.244
Folate, total	mcg	14	23	11
Vitamin B_{12}	mcg	0	0	0
Vitamin A, IU	IU	20,063	21,822	17,054
Vitamin A, RE	mcg-RE	2,006	2,182	1,705
Vitamin E	mg-ATE	0.280	0.280	0.280

SOURCE: U.S. Department of Agriculture. Agriculture Research Service Nutrient Database for Standard Reference, Release 14, 2001.

Popularity

At the beginning of the twentieth century sweet potatoes were the second most important root crop in the United States. In 1920 the per capita consumption of sweet potatoes was thirty-one pounds (fourteen kilograms), but consumption steadily declined. In 1999 consumption was only 4 pounds (1.8 kilograms) per person (U.S. Department of Agriculture, 2000).



A sweet potato plant depicted in Johann Sigismund Elsholtz's *Diaeteticon* (1682), one of the first works to discuss the health and medical value of this New World vegetable. ROUGHWOOD COLLECTION.

Sweet potatoes grow in all warm, humid areas of the world and at the beginning of the twenty-first century were the seventh largest world food crop, 95 percent of which is produced in developing countries. They are typically grown by small farmers, often on marginal ground. This crop plant has a long history of saving lives. It matures fast, is rich in nutrients, and is often the first crop planted after a natural disaster, providing abundant food for otherwise starving populations. In eastern Africa the sweet potato is known as "the protector of children" or *cilera abana* because it is often the only food that stands between a child's survival and starvation.

Growing Sweet Potatoes

Sweet potatoes are tropical plants that can also be grown in the summer in temperate regions as long as they have at least five frost-free months combined with fairly warm days and nights. They can be grown from vine cuttings or by planting pieces of the roots. To grow new plants, place one or more sweet potatoes in a bed of sand and cover with a couple of inches of moist, sandy soil. When the sprouts reach about 10 inches (25.4 centimeters), detach by twisting and transplant to the place they are to grow. Push sprouts about 3 inches (7.6 centimeters) into the ground and water well. Leave a distance of about 1 foot (30 centimeters) between plants and 3 feet, 3 inches (1 meter) between rows. Sweet potatoes do best in full sun with fertile, open sandy-loam soils. They also like some added manure (well rotted) and compost, although they should not be given too much nitrogen as this encourages leaf growth at the expense of root growth. They benefit from regular additions of potash. Roots will be bigger and easier to harvest if sprouts are planted into raised mounds about 1 foot (30 centimeters) high. This is particularly important in heavy or wet soil. Once established, apart from occasional weeding, sweet potatoes need little care.

Harvesting

Roots are harvested as the leaves begin to yellow in the fall. They are then brushed clean and left to cure. Traditionally curing involved stacking the potatoes in the field or garden, covering them with sand, and leaving them for several weeks. Sweet potatoes in commercial production are cured in rooms with humidity between 75 percent and 80 percent and temperatures between 80°F and 86°F (27°C and 30°C). Curing heals cuts and reduces decay and shrinkage during storage, and it converts some starches to sugars, improving the flavor. Once cured, sweet potatoes can be stored for several months, and white-fleshed varieties last as long as ten months.

In the United States most of the sweet potato crop is canned. These are usually the smaller roots. Roots of good size are sold fresh, and any that are too large are generally processed into baby food.

Buying

When buying sweet potatoes, always choose ones that are firm with even skin coloration and no signs of decay. They should never be stored in the refrigerator. Keep them in a cool, dry, well-ventilated container (a basket is ideal) at about 55°F to 60°F (13°C–16°C). Generally they should be used within two to three weeks of purchase because it is not possible to determine how long they have already been stored before purchase.

Who Grows Sweet Potatoes?

According to figures released by CIP, more than 148.77 million short tons (135 million metric tons) of sweet potatoes are grown worldwide. China is by far the largest producer with about 87 percent of the crop, nearly half of which is fed to animals. The rest of Asia accounts for 6 percent, Africa 5 percent, Latin America 1.5 percent, and the United States 0.45 percent. In most developing countries, where the sweet potato is part of the staple diet, the white- or cream-fleshed forms with a bland taste are usually grown. These potatoes have a high dry matter content, which means they are a good energy source, which is vital for a staple food. In developed countries, where the sweet potato is used more as a vegetable or for sweet dishes, the red- or orange-fleshed types are preferred for their moist flesh and sweet flavor. The U.S. sweet potato crop was worth $214,980,000 in 1999, and just under a third of the crop was grown in North Carolina. Louisiana, Mississippi, and California also grow significant quantities. The largest European producer is Portugal with only .02 percent of world production. These figures clearly illustrate that sweet potatoes are an important crop in third world countries but are a secondary foodstuff in first world countries.

Preparing and Eating

Sweet potato roots can be boiled, steamed, baked, and fried. They are also canned or dried and made into flour, cereal, and noodles. Like pumpkins, sweet potato roots are often used in sweet dishes, such as pies, puddings, biscuits, cakes, and desserts. In some countries roots are processed to produce starch and fermented to make alcohol. Cooked red- or orange-fleshed sweet potato roots are sweet, soft, and starchy with a flavor that resembles roasted chestnuts and baked squash. Sweet potatoes are prepared by scrubbing and cutting into appropriately sized pieces. Leave the skin on if they are to be baked, boiled, or steamed; peel before frying. Cooking in the skin preserves more of the nutrients. Once the roots are cooked (when a knife can be easily inserted), they can be served whole or peeled and mashed, pureed, or sieved and served as a sweet or savory vegetable, depending on what is added.

In the United States sweet potatoes are probably best known for their use in pies and as a candied vegetable. They are a traditional accompaniment to Thanksgiving dinner and often appear on the menu at other festival times, such as Christmas and Easter. Sweet potatoes can be substituted for potatoes, apples, or squash in almost any recipe. Cooked, mashed sweet potatoes are also used to replace some of the wheat flour in breads, cakes, muffins, and cookie recipes, as is sweet potato flour. Sweet potatoes cooked in their skins can be frozen. Wrap each piece in aluminum foil or freezer wrap, place into a freezer bag, and freeze.

In third world countries sweet potatoes are processed into starch, noodles, candy, desserts, and flour. This allows the farm household to extend the availability of the crop. In China, for example, sweet potato starch production has become an important cottage industry, while in Uganda sweet potatoes are sliced and dried, which allows them to be kept for about five months. The dried pieces are also ground into flour, which is then rehydrated and eaten as a thick porridge known as *atapa.*

Although usually the roots are eaten, young leaves and the tips of vines can be harvested, washed, and boiled as a green vegetable or added to stir-fries. All parts of the sweet potato are used as stock feed, although the roots are often cooked first.

As a Medicine

Sweet potato roots and leaves are used in folk remedies to treat illnesses as diverse as asthma, night blindness, and diarrhea. Easily digestible, they are good for the eliminative system. It is believed they bind heavy metals, so they have been used to detoxify the system.

Sweet Potatoes in Africa

In eastern and southern Africa some 3 million children under the age of five suffer from xerophthalmia or dry eye, which causes blindness. Dry eye is caused by a lack of vitamin A in the diet, and many of the affected children die within a few months of becoming blind. The yellow- and orange-fleshed varieties of sweet potatoes are high in beta-carotene, which can be converted into vitamin A in the intestines and liver. It has been shown that even small amounts of these sweet potatoes as a regular part of the diet will eliminate vitamin A deficiency in adults and children. African countries have traditionally grown white-fleshed sweet potatoes, which are low in vitamin A. A ten-year research project concluded that varieties high in beta-carotene could compete with production levels of the white-fleshed varieties and would be acceptable to local tastes. Consequently CIP and related organizations launched a regional effort to encourage African women to also grow orange-fleshed varieties.

At the same time researchers at CIP have combined parental clones of sweet potatoes to yield a group of yellow and orange potatoes with high dry matter (a characteristic of the white-fleshed forms of sweet potato) that they believe will be more acceptable to African consumers. In Kenya sweet potatoes are mostly grown in the densely populated Western Province, where often more than half the crop is destroyed by a virus. In 2000 the Kenyan Agricultural Research Institute released genetically modified sweet potatoes with increased disease resistance and assured the public that these potatoes would be largely resistant to the virus.

Twenty-first Century Changes

In the last four decades of the twentieth century the uses of sweet potatoes diversified beyond their classification as subsistence, food security, and famine-relief crops. In particular the last decade of the century saw a concentrated, coordinated effort to fully realize the potential of this crop. The hoped for result is that millions of subsistence landholders in Africa, Asia, and Latin America will be able to use sweet potatoes for food, stock food, and processed products and to generate income.

The United States is also exploring the potential of sweet potato products. A patent was granted for the production of bread made from 100 percent sweet potato flour. It is hoped that these products will appeal to consumers who are allergic to grain breads and flours. Also scientists at two different institutes in the United States have developed genetically modified sweet potatoes containing edible vaccines. One of these vaccines works against hepatitis B and the other against the Norwalk virus found in food that has not been handled or stored correctly. Edible vaccines such as these may provide cheap protection for some of the poorest people in the world.

See also **Columbian Exchange**; **Potato**; **Tubers**; **Vitamins**.

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Penny Woodward

SWEETS. *See* **Candy and Confections.**

SWIDDEN. Swidden is an agricultural strategy that necessitates the slashing, cutting, felling, and burning of forested areas for the planting of impermanent garden plots or agricultural fields, and that has been the mainstay of horticulturalists and peasant farmers in the tropics and primeval forests of the world for the better part of the past four to eight thousand years. This method of agricultural intensification, more widely known as "slash-and-burn" agriculture, is called *tlacolol* or *milpa* agriculture in Mesoamerica. It is often associated with patterns of shifting cultivation or extensive agriculture via which soil exhaustion or weed intrusion necessitates plot rotation and fallow cycles.

Tropical soils are extremely fragile, and agriculture in the tropics tends to deplete soil-based nutrients rapidly, resulting in decreasing yields from such parcels after just a few seasons. In order to stimulate the regeneration of soil nutrients through the growth and decay of tropical vegetation, swidden agriculturalists typically abandon or fallow such plots for as many as twenty-five years. These cycles of slash-and-burn field preparation, cultivation, and fallow, and the necessity of shifting or relocating cultivation to adjacent or new fields on a cyclical basis, play a key role in the social, economic, and political configurations of those societies that resort to such strategies of agricultural intensification in tropical or otherwise forested environments.

Swidden and Shifting Cultivation

According to cultural ecologist Robert Netting, a broad spectrum of agricultural systems exists within traditional or otherwise "technologically simpler" societies in what today constitute some of the nations of the Third World. Such systems range from those that require a constant shifting from field to field within virgin forests to intensive agriculture supported by irrigation works in year-round production. Within this spectrum can be identified a variety of swidden system strategies that include short-term as opposed to long-term fallowing, sectorial fallowing, forest-fallow, bush-fallow, and short-fallow cultivation (pp. 65–66). The latter three types, originally identified by agricultural economist Esther Boserup, are defined on the basis of land-use types and the total period of cultivation as opposed to periods of fallow. Whereas forest fallow may see the cultivation of a single swidden parcel for a period of one to two crop years, that same field may then lie dormant (fallow) for a period of twenty to twenty-five years. On the other hand, bush fallow may encompass a period of one to eight successive years of cultivation, and only six to ten years of fallow. Finally, the short-fallow system may range from a very short or variable period of months or seasons of cultivation to a one-to-two-year fallow cycle. In each of these systems, the extent to which productive yield is maintained or enhanced by the regeneration of tropical vegetation and its subsequent slashing and burning is key to the nature of the system employed. Similarly, in those areas where population growth and settlement place constraints on the availability of viable forest parcels, agricultural intensification may necessitate an increase in the number of parcels devoted to short-fallow cropping.

Origins and Development

Archaeologist Richard E. W. Adams has noted broad similarities in the nature of settlement patterns and artifact distributions between the ancient Maya swidden farmers of Mesoamerica and early Danubian swidden agriculturalists of Europe. According to Adams, the expansion of Danubian farmers into western Europe at 5000 B.C.E. resulted in the rapid and extensive spread of Danubian settlements and traditional arts and technologies across a vast area. Adams attributes this pattern to the use of slash-and-burn (swidden) agricultural systems in the primeval forests of Europe. Such a pattern resulted in the rapid establishment, abandonment, and reoccupation of villages over vast areas in a pattern reminiscent of that identified with swidden agriculturalists the world over (p. 119). According to Robert Gary Minnich, similar demographic and cultural patterns have been identified with swidden practices introduced by the Slavs to the eastern Alps and northern Balkans in the sixth century (pp. 96–98). Such practices, in fact, persisted well into the twentieth century in the hilly and forested regions of Slovenia (p. 221).

Similarly, Myrdene Anderson has documented the introduction of swidden agricultural strategies into Norwegian Lapland from Finland at the beginning of the eighteenth century. In fact, a further review of swidden-related documents in the eHRAF Collection of Ethnography (the online version of the Human Relations Area Files) will readily produce references to some forty-eight societies the world over whose cultural histories center on swidden agriculture or similar forms of agricultural intensification. Those societies range across the length and breadth of Africa, Asia, Europe, Middle America and the Caribbean, North America, Oceania, and South America.

Traditional Crops and Agriculturalists

Swidden agriculture is practiced by diverse societies across a broad range of habitats, with the result that the methods, settlement patterns, cropping cycles, and traditional crops also vary widely. For instance, Bernard Sellato reports that the Dayak peoples of Borneo practice a range of agricultural pursuits, swidden being but one of many adaptive strategies. Among those Dayak groups that engage in swidden agricultural practices, crops consist of a variety of plant foods that are multicropped (planted within the same fields). According to Sellato, while the customary Dayak practice centers on the swidden cultivation of hill or dry rice in rain-forest clearings, such fields are seldom used to cultivate any more than a single crop of rice per year. However, while two crops of rice may be harvested on some occasions, cassava or manioc is sometimes cultivated within the same fields after the rice harvests. Once harvested, such fields are left to fallow for ten to twenty years. Sellato has also observed that the declining productivity of those swidden gardens closest to the communal dwelling place or longhouse often necessitates the relocation of village settlements and, thereby, accounts in large part for the shifting or semi-sedentary nature of the Dayak communities of Borneo, as is typical of other swidden farming communities the world over (p. 13).

In addition to hill or dry rice plantings in swidden parcels, Dayak communities also cultivate cassava, taro, yams or sweet potatoes, maize, sugarcane, beans, cucumbers and leaf greens, and various semiwild fruits. Despite a reliance on swidden crops, Dayak farmers nevertheless supplement their diets with fishing, hunting, and a pattern of animal husbandry centered on the consumption of dogs and cats, as well as chickens, pigs, and some ducks. While traditional Dayak swidden agriculture is largely reliant on the aforementioned crops, other cash crops include pepper, cloves, coffee, cocoa, coconut and oil palms, and rubber. In other contexts, permanent year-round garden plots and irrigation agriculture have displaced swidden practices in those contexts where population growth has resulted in the abandonment of traditional swidden patterns.

Swidden Ecology and Its Consequences

Cultural ecologist Roy Ellen provides a detailed analysis of the cultural and ecological benefits and constraints posed by swidden agriculture. According to Ellen, declining crop yields identified with swidden farming are largely the result of pest infestations, plant disease, weeds, the deterioration of soil nutrient content and composition, topsoil erosion, and changes in the number and composition of soil organisms or root biomass in any given parcel (p. 36). Because tropical soils are typically low in organic matter, slash-and-burn agriculture enriches soils to a limited extent and for a limited period of time by adding phosphorous, nitrogen, and potassium from the burned vegetation.

On the other hand, H. J. Albers and M. J. Goldbach found a correlation between the duration of cropping periods in swidden systems and the onset of species competition, resulting in an irreversible ecosystem transformation away from forest cover to grassland ecological regimes (pp. 262–263). In such instances, deforestation was the inevitable result of poor choices made by swidden farmers who were not concerned with the long-term benefits of longer fallow cycles.

In sum, despite the inherent challenges of farming in the tropics or primeval forests of the world, swidden remains a relatively efficient, and ecologically sound, system of agricultural production and resource management for the peoples of the Third World. This is particularly so when compared to those labor- and resource-intensive permanent and irrigation-based systems that dominate the nation-states of the First World. While the latter systems are ultimately more productive in terms of total crop yields, such productivity comes at great cost. The massive investment in agricultural equipment, fertilizers, pesticides, and personnel necessary to sustain intensive farming systems often outweighs the viability of such agricultural systems for the majority of those farmers whose only access to potentially viable agricultural land is largely restricted to the tropical and primeval forests of the Third World.

See also **Agriculture, Origins of**; **Inca Empire**; **Mexico and Central America, Pre-Columbian**.

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SWITZERLAND. *See* **France; Germany, Austria, Switzerland; Italy.**

SYMBOL, FOOD AS. A symbol is an object, image, or action that is conventionally understood to represent something else. Food is particularly powerful as a symbol because it is so deeply embedded in everyday as well as celebratory life, and can therefore be read in many ways. Because it fulfills physical as well as emotional and psychological needs, it may be intentionally utilized as a symbol in some instances but not in others. And because food engages all the senses, it tends to evoke strong sensory and emotive as well as cognitive associations. This range of association adds to the potential symbolic power of food.

Three properties of symbols as defined by anthropologist Victor Turner are clearly demonstrated in food. The first is condensation: many ideas or actions are represented in a single formation. For example, turkey represents the American holiday of Thanksgiving, standing for the family gatherings, feasts, specific menus, and football games that commonly occur with the celebration. A second property is unification: symbols link disparate references. The turkey as symbol evokes abundance of natural resources, a romanticized New England heritage, patriotism, family harmony, and the fall season. The final property of symbols is polarization of meaning: they contain both ideological meanings (representing values, ethos, social norms) and sensory meanings (related to the objective properties of the symbol and representing physical aspects of life), merging these two poles and grounding conceptual references in felt experience. For example, apple pie is an American symbol of both patriotism and maternal nurturing, strengthening the referential power of each yet also lending the emotional associations of each to the other.

Foods become symbolic either through the presence of analogous qualities or by association in fact or thought with a particular reference. Analogous, or like, qualities include the physical structure or appearance of the item, its texture, color, flavor, and even its nutritional components. For example, bananas are commonly used to represent a phallus; apples used to represent wholesomeness and innocence, as in "apple-cheeked children"; peaches to represent female attributes; caffeinated drinks to represent energetic and fun-filled personalities or activities.

Symbolic references for foods are also developed by association in fact or thought. Cherry blossoms bloom in early spring and are therefore used as a symbol to celebrate the change in season. Similarly, other crops ripen in the fall and become associated with that season. In the United States, pumpkins, corn, and apples are used to celebrate both autumn and the harvest-based holidays falling within that season.

Symbolic foods that develop their meanings through use and practice over time are "organic" symbols; they emerge from everyday usage, and their meanings are seemingly logical and inevitable within that cultural context. Symbols can also be created and imposed upon a culture. For these "invented symbols," individuals or institutions intentionally attach particular meanings to a food and attempt to control the interpretation given to that food.

As communicative tools, symbols can be manipulated for a multitude of purposes, on a personal as well as a cultural level. Food symbols are commonly exploited in marketing and advertising. Restaurant chains frequently attempt to associate themselves with a particular food item, for example, Red Lobster and Long John Silver with seafood, Wendy's with chili and square hamburgers, MacDonald's or Burger King with hamburgers and french fries. Similarly, advertising symbols can become attached to particular foods: the Jolly Green Giant with vegetables, Aunt Jemima with pancakes, the dignified Quaker with oatmeal.

Food's symbolic potential is also utilized for national, ethnic, and regional identity and pride. Americans rally around hot dogs, Spaniards around ham, Koreans around kimchi. Conversely, specific foods may be held up as distinguishing one group from another and as demonstrating that group's lesser worth.

Food symbolism occurs in all the activities surrounding the procurement, preservation, preparation, presentation, and performance of food as well as the food product itself. "Foodways" refers to this network of activities.

Procurement refers to the processes of obtaining food. Hunting, for example, can function as a symbol of manhood, of family tradition, of regional heritage. Purchasing groceries from specialty shops or catalogs rather than a local supermarket can signify economic status. Similarly, procurement can affect the referential meanings of a food item. Even though the food items are structurally identical, a bagel bought from the local corner deli can carry completely different emotional associations from one bought from the frozen bread aisle of a chain supermarket.

Preservation includes the means by which food is stored and kept for later use, the material forms used, the types of foods selected for specific types of preservation, and the physical arrangement of preserved goods. Smokehouses used for curing hams can reference a southern U.S. heritage; similar structures for smoking fish represent a Midwestern background.

The size and design of refrigerators can symbolize social status (custom-designed to fit kitchen decor represents up-scale wealth), ethnicity (Americans tend to use large refrigerators and frequently possess an additional freezer to allow for the weekly or monthly shopping habits in the United States), or even occupation (university students use half-size ones to fit their smaller dorm rooms).

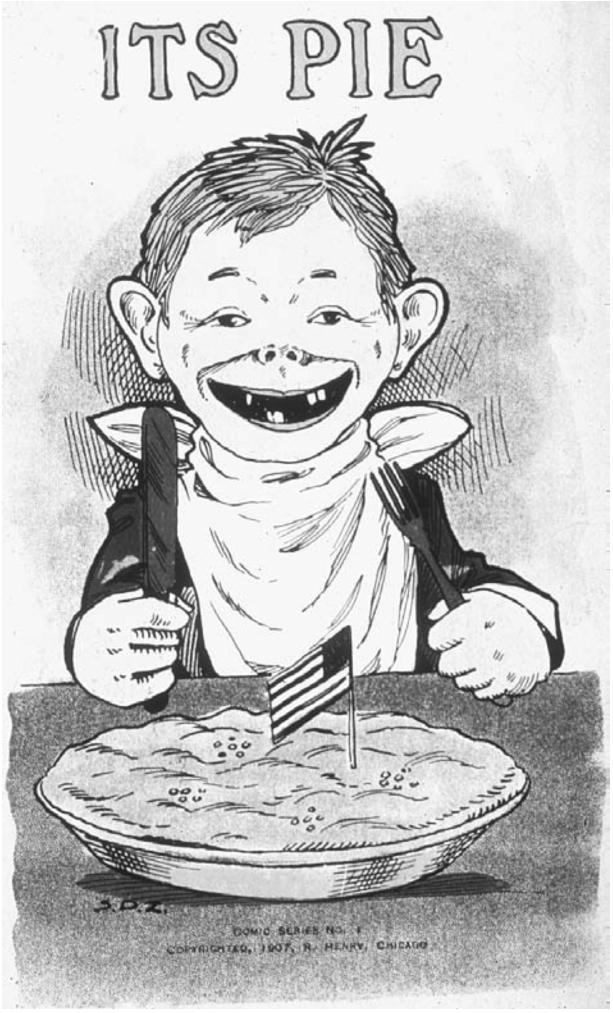
Preparation refers to the actual processes of turning the raw ingredients into a cultured and edible food. This involves methods of cutting, cooking, mixing of ingredients, selecting of ingredients, and adapting of the recipe. The process may be as simple as picking an apple from a tree or taking a handful of raisins from a box to complex and sophisticated techniques requiring refined skills and extensive experience.

Presentation refers to how food is physically arranged and presented for consumption. Presentation can frame the act of eating as a social event and as a meal genre and can also communicate the emotional responses intended to occur. Candlelight implies romance; fine china a formal, celebratory event; paper plates an informal and casual occasion.

Performance includes two aspects. First is the manner in which the food is consumed, the utensils used, and the immediate context: the time and place of consumption and other people present. Performance also refers to the cultural use of food, to the meanings intentionally attached and elicited to the food item or meal, and the occasion for consumption.

Foodways can be performed as symbol in any number of arenas—cookbooks, festivals, restaurants, cooking competitions, family holiday meals. Each of these offer sites for the articulation and manipulation of the meanings of the foodways. Similarly, food symbols occur in a variety of forms: as objects, activities, relationships, events, gestures, and spatial units within a ritual.

Food as a symbol can refer to any aspect of a culture's or individual's history and identity. Commonly recognized and articulated referential domains include ethnicity, region, gender, religion, ethos, social status, and social relationships



Food has always served as a potent symbol of identity, religious preference, festivities, even nationalism. This 1907 postcard celebrates apple pie as the ultimate symbol of American patriotism. ROUGHWOOD COLLECTION.

Ethnicity is one of the most common references for food. These foods become symbolic frequently because they stand in contrast to host foods and mark the ethnic group as different and separate. This marking is frequently, though not always, negative, emphasizing the strangeness of the ethnic group, and the particular foods functioning as symbols depend on the specific cultural context of that group.

Foods may also become symbolic of ethnicity because of their ubiquitousness in the cuisine of that ethnic group—rice in Asian cultures, beans and tortillas in Mexican cuisine, curry spices in Indian cuisine. Through their consistent use, these foods become associated with that identity; however, they may or may not be felt by members of that ethnic group to symbolize their heritage. Symbols of ethnicity are frequently ascribed by primary cultures or institutions.

Food can be used to refer to another ethnic group, frequently in a derogatory manner—French are called "frogs," Germans "krauts." Again, the food used as symbol represents the difference between two cultures and is often an item considered inedible, or at least, unpalatable to one culture, stigmatizing the other as less civilized or even less human.

Region is another major referential domain of food. As with ethnicity, regional foods are frequently those that stand in contrast to foods found in other regions, therefore marking differences rather than representing the culture. American regional food symbols include grits for the South, lobsters for Maine, cheese for Wisconsin, meat and potatoes for the Midwest. Region and ethnicity can be closely connected. For example, much historical Southern cooking is derived from African American traditions; the upper Midwest is closely associated with Scandinavian foods.

Religion and ethos are emotionally powerful references for food, representing individuals' and cultures' worldviews and value systems. Some food symbols invoke an entire foodways system and its underlying ethos: Kosher foods embody Judaism; meatless meals reference vegetarianism; diet foods may represent a status-quo valuing of physical appearance and traditional gender roles. Specific foods may also symbolize ritual acts or occasions within a belief system: bread and wine represent the body and blood of Christ and the ritual of communion in Christianity.

Gender is another referential domain, with some cultures designating particular foods as symbolizing specific genders and maintaining strict taboos to ensure social and psychological distance between genders. Other cultures demonstrate less formalized perspectives; having stereotypes rather than taboos. In the United States, large portions of any food, thick slabs of meat, beer, and "hearty" foods are associated with masculinity, while foods thought to be light—salads, quiche, poultry, and fish—are associated with femaleness.

Food as symbolic of social relationships includes status and place within a social group as well as relationships between individuals. Food can be used to mark one's socioeconomic standing, since certain items are associated with particular classes: for example, caviar, fine wine, and gourmet cooking with upper classes; beer, white bread, and junk food with lower classes. Some foods, such as hot dogs, apple pie, chili, and barbecue, cut across class divisions and are sometimes used to intentionally signify a democratic and "all-American" event or institution.

Individuals can also use food as social capital, in that by demonstrating competence with a particular food, they demonstrate a mastery of knowledge needed to belong to a particular social group. For example, being able to discern quality of wine can signify membership in an upper class; being able to ingest extremely spicy peppers can signify masculinity. Food can also be used to signify relationships between individuals. The referential meaning, however, is situational and frequently tied to celebrations or rituals. A box of chocolates often represents romance, particularly on Valentine's Day; however, it can also be a gesture of thanks for hospitality.

Overall, food is a rich resource for symbolic communication, expression, and action.

See also **Art, Food in; Gender and Food; Humor, Food in; Icon Foods; Language about Food; Literature, Food in; Metaphor, Food as; Presentation of Food; Proverbs and Riddles; Sacrifice; Sex and Food; Sin and Food; Taboos; Thanksgiving.**

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SYRUPS. Syrup is essentially sugar dissolved in water, with or without flavors. Candy making relies almost exclusively on the special qualities of hot sugar syrups. Other foods which use them as ingredients are ice creams, baked items, drinks, and preserved fruit.

Maple syrup, made in eastern Canada and in the northeastern part of the United States, is a special product, made by boiling down sap from maple trees. It is made in early spring, and the special flavor of this product is much appreciated on pancakes and waffles and in frostings, desserts, and candies. Other countries also make syrups from fruit juices or tree sap. Grape juice syrup is known as *pekmez* in Turkey and *dibs* in the Arabian Gulf states (*dibs* can also be based on date juice). Pomegranate juice is boiled down to make syrup for drinks and cooking in Syria, Iran, and neighboring areas, and carob pod syrup is used in Cyprus, Lebanon, and Asia Minor. Honey, although regarded as a different commodity entirely because of the production method, is chemically related to syrups and shares similar characteristics.

In some countries, residues from sugar refining are called syrup, notably Golden Syrup, a branded product sold in the United Kingdom. It has a blander flavor than molasses and is a light gold color. In China and Japan, rice is mixed with malt, whose enzymes break down starch from the grain to give sugar. Corn syrup, produced from maize by a similar method, is an industrial product, important in candy, baking, and drinks manufacture.

Sugar Syrup

Sugar syrups are simple to make but have no agreed formula. Cooks and pastry chefs prepare "stock syrup" using the proportions of sugar to water that are demanded by specific recipes. A basic formula is five cups sugar to four cups water (one kilo to one liter). The two are stirred together until dissolved, brought to the boil, then cooled and refrigerated. Old recipes sometimes call for "light syrup" or "heavy syrup"; only experiment shows what quantities are best. This hit-and-miss system is inadequate for industry, so methods for measuring syrup density (and therefore its sugar content and properties in food) have been devised. The saccharometer, a weighted glass bulb that floats upright in the syrup so that a figure can be read off a scale, has been used since the early nineteenth century. Two types of scale—degrees Baumé (devised by the French chemist Antoine Baumé, 1728–1804) and a modern decimal system—are used. Special thermometers were devised for candy makers in the late nineteenth century. Modern industry relies on more complex devices.

Maple Syrup

This runny brown syrup with a wonderful flavor is produced from the sap of various maple species, especially the hard or rock maple, *Acer saccharum*, and the black maple, *Acer nigrum.* The trees are tapped in early spring when the sap runs in large quantities, especially after a very cold winter and when there are relatively high daytime temperatures and cold nights. A small hole is bored in each trunk and fitted with a spout; the sap is collected in buckets underneath. Several gallons can be collected from a tree without damaging it.

Maple sap contains about 3 percent naturally occurring sugar (sucrose). The accumulated sap is concentrated by boiling until the sucrose content is about 62 percent. It takes between thirty and forty gallons of sap to produce a gallon of syrup. The heating process leads to reactions between the sucrose and amino acids contained in the sap, which produces the color and unique flavor of the syrup. Until the late nineteenth century, the sap was concentrated to a point at which it would form crystals of sugar. This has left a legacy of terms such as "sugar house," "sugar bush," and "sugaring off" that are still in use. However, most production is now aimed at making syrup and maple candy.

Native Americans had their own methods for making maple syrup since they had only flammable birch bark or fragile clay vessels. One method they used for concentrating the sap was heating it with hot stones. Another was allowing it to freeze so that some of the water could be lifted off the top as a block of pure ice, leaving syrup with a higher sugar concentration. European settlers introduced metal kettles, which made boiling easier.

Pure maple syrup has an excellent flavor but is expensive because production is affected by the weather, and it is a labor-intensive cottage industry. Several grades varying in flavor and color are produced, and pale syrup is considered the best quality. The containers bear a controlled symbol of a maple leaf as a guarantee. "Maple-flavored syrup," made by stretching a little true maple syrup with corn syrup, is much cheaper.

Maple syrup is considered very much a North American product, but there were old-world precedents for the idea. Birch sap was collected and used in parts of Europe to make syrup or alternatively, fermented to make "wine." In the Middle East and India, the sap of date palms is still used to make syrup and sugar.

Corn Syrup

Corn syrup is produced by soaking maize kernels. This extracts the starch, which consists of long chains of glucose molecules. Acid or an enzyme is used to break the starch down into shorter lengths, including maltose (the sugar which provides sweetness in malt, two glucose units linked together) and individual glucose molecules. The process can be halted at different stages to give a thick texture (many long chains of glucose molecules) or a sweeter one (more individual molecules); taste and texture can therefore be tailored to the needs of the food industry.

Another enzyme is used to "invert" the glucose to become fructose for high-fructose corn syrup. This has an identical chemical formula but a different molecular structure and tastes intensely sweet. The process is called inversion because glucose rotates a beam of polarized light to the right (hence its alternative name of dextrose), whilst fructose (also known as levulose) rotates it to the left.

Thick corn syrups are much used in candy making because their long-chain molecules help to inhibit the formation of crystals in soft candies without making them overly sweet. Fructose syrups, significantly cheaper than ordinary sugar and more convenient to use, are increasingly important in the soft drinks industry. Other uses for corn syrups include cakes, cookies, pie fillings, jellies, and various composite food products.

The process for making corn syrup is known as hydrolysis. It was discovered by the German-Russian chemist K. S. Kirchhof in 1811 when he heated potato starch in the presence of sulfuric acid and found that it yielded sweet crystals and a syrup. The technique was developed into an industrial process. In 1865 the Union Sugar Company of New York began manufacturing corn syrup.

Uses of Syrup

Syrups of sugar and fruit juice or other essences are used to make drinks and are diluted as required at home or in bulk to make branded drinks at a bottling plant. This use echoes the origin of the word "syrup." It is derived from the Arabic *sharab*, which originally meant a sweet drink ("sherbet" also comes from this root). Simple sugar syrup is an important ingredient in other drinks such as juleps, a word that has an equally exotic derivation from the Persian *golab*, meaning rosewater. Fruit syrups are also used as dessert sauces and, when poured over crushed ice in a paper cone, are essential to that summer favorite, the snow cone.

Concentrated syrups are much used in cooking and preserving fruit. They add a sweet flavor and inhibit the growth of spoilage microorganisms. Weak syrups sweeten fruit salads and compotes. Stronger ones are used in canning although concerns about excessive sugar consumption led to the substitution of fruit juices in the late twentieth century. Fruit is candied or crystallized by steeping it in increasingly concentrated syrups. Starting with a light syrup, osmosis allows the sugar to penetrate the cells of the fruit. The syrup strength is concentrated progressively over several days until enough sugar has been absorbed to prevent the fruit from rotting. This technique was brought to North America by the earliest European settlers. Compotes and candied fruit represent a cooking and preserving spectrum which goes back to medieval Europe.

The chemical and physical properties of syrups make them exceptionally useful in industrial baking. Many syrups are hygroscopic, that is, they attract water. Because of this, corn syrup is added to cakes and cookies, where it softens the texture and extends shelf-life. Honey has long been used in this way, for example, in *Lebkuchen*, the traditional German gingerbread.

Many cultures use syrups in traditional baking. The English use sugar syrup to glaze the hot cross buns made for Good Friday and put golden syrup into treacle tarts, distant relations of shoofly pies, which are made with molasses. Babas, small rich yeast cakes of eastern European origin, are soaked in rum-flavored syrup. In the eastern Mediterranean and the Middle East, many pastries require syrup as a sweetener. A well-known example is baklava, made of layers of thin pastry with a nut filling, over which syrup is poured after baking (sugar syrup sometimes substitutes for the traditional honey). *Jellabies* (also *jalebi*), deep-fried batter spirals widely made in the Middle East, and *gulab jamun*, Indian confections of flour and reduced milk, are sweetened and stored in syrup. Chinese and Japanese cultures use malt syrup in traditional desserts and candies.

Nutritionally, syrups provide concentrated energy but little else. They also tend to be used in energy-dense foods such as candies, desserts, and baked goods, all of which are considered undesirable for good health in large quantities. Diets high in sugars and other carbohydrates are also less likely to be high in essential nutrients. Particular worries are expressed by nutritionists over soft drinks. They are consumed in large amounts by certain sectors of the population in the developed world, and they are thought to be especially bad for the teeth. However, the food and drink industries consider syrups of enormous value in enhancing the flavor and texture in numerous foods and drinks. Corn syrup in particular is simple to use and relatively cheap, so it is likely that syrups will continue to be used in large quantities.

See also **Candy and Confections; Fruit; Sugar and Sweeteners; Sugar Crops and Natural Sweeteners.**

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Laura Mason

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TABLE DÉCOR. *See* **Presentation of Food; Styling of Food.**

TABLE MANNERS. *See* **Etiquette and Eating Habits; Table Talk.**

TABLE TALK.

All human societies take advantage of the fact that meals are physically necessary, normally frequent, and often eaten with others. They turn dinnertimes into opportunities to express and to practice "culture." Because talking is the primary mode of human communication, mealtimes commonly provide occasions for conversation. Every culture has its own ideas about the management of verbal interaction or of silence at meals.

When to Talk

Most of the time human beings who are sharing a meal prefer to eat without saying much. They simply concentrate on what they are doing, appreciating and enjoying their food. When talking takes place, it is often socially regulated, its timing clarified by rules. In some societies talk is completed before dinner. The meal then serves as a contented celebration of togetherness and agreement, after the discussions that have preceded it (Ortner, 1978; Fitzgerald, 1941). In others the eating comes first, and only when hunger is satisfied should talk break out (Chao, 1956). Formal meals might require silence, conversation being reserved for intimacy among family and friends (Toffin, 1977, ch. 4). In modern Europe and North America the opposite is the case. On formal occasions or when invited out, people should talk; it is rude not to. For this very reason eating together in "companionable" silence can be a sign of great intimacy. On the other hand, everybody eating without talking might be the expression of an oppressive tension.

The Japanese begin a banquet in silence but warm up as time goes on. Barriers fall, and discourse increases accordingly (Befu, 1974). Sometimes it is thought proper that only elders and important people should speak (Okere, 1983). Although it is commonly accepted that mealtimes are excellent opportunities for small children to learn to talk, in many places and times older children have been forbidden to speak during meals taken with adults. In the modern West, middle-class children are likely to be encouraged to talk during meals. Such family meals have even been described as "class[es] in oral expression" (Bossard and Boll, 1966, p. 141).

Until the early twentieth century in the United States and until the late twentieth century in Britain, it was thought proper at formal upper-class meals to send the women away from the dining room table into the drawing room, originally called a "withdrawing" room, owing to this practice. They took tea and engaged in conversation, leaving the men behind to move together around the table to drink port and discuss politics and other "male" subjects. (The men had been separated during the meal owing to "promiscuous" seating, men and women alternating around the table.) The host decided when the segregation should cease and then shepherded the men to "join the ladies" again (Post, 1922, pp. 223–224).

Often entertainment is laid on, and then of course talking is minimal. Watching television during meals is a modern instance of an ancient tradition that includes entertainers dancing and juggling during pauses between courses (as in the medieval and Renaissance entremets), someone reading aloud as monks eat silently in the refectory, musicians performing, and even the host dancing, singing, or playing a musical instrument for his or her guests.

Drama and Dialogue

At aristocratic ancient Greek dinner parties, talk was mostly limited, during the actual eating, to reaching a decision about what subjects to discuss afterward. Later the wine drinking began, the *symposion* or "drinking together," and then people were expected to be able to sing in turn and to have something intelligent to say about the topics proposed. From this custom a literary genre developed in which an imaginary dialogue after dinner is reported by the author. Plato's *Symposium* (on the subject "What is love?"), Xenophon's *Symposium*, Plutarch's *Symposiacs* and *Banquet of the Seven Sages*, Macrobius's *Saturnalia*, and Athenaeus's fifteen-volume *The Sophists at Dinner* are surviving examples of the type. They are ancestors of collections of table talk or *propos de table* that have continued as a minor tradition of European and American belles lettres down the centuries.

Meals have often been the locus of drama, the eating companions filling the roles of both actors and audience. Every organized feast has a theatrical aspect, and what is said on the occasion is at least as memorable as what is eaten or what is done. Where it is that people sit (and therefore who will most easily talk to whom) is often decided by the host, the "producer" of the performance. In many cultures it is incumbent upon the host before, during, or after the meal to give a speech. Dramatic rituals requiring speech have often been inserted into mealtime festivity. One highly developed and still surviving custom in this class is that of drinking toasts with the eloquence traditionally required (Dickson, 1981). In medieval Europe a rich feast was incomplete without a nonpartaking audience looking on.

All religions include ritual eating events, usually with important speaking roles for those present. Examples are the Jewish seder (Quesnel et al., 1999, pt. 1) or the Javanese *slametan* (Geertz, 1960). During the last supper that Jesus ate with his friends, he instituted the Eucharist and asked that his disciples repeat his words and actions. In the course of the meal his betrayer was revealed. The discourses of Jesus during this meal are of central importance to Christian belief (John 13–17; Luke 22). Prayer, either before meals, or after meals, or both, is common the world over.

Rules of Behavior

Modern Western societies make talking an important component of a formal meal and of many other eating events as well. (These very societies have rigid requirements about eating silently, with mouths shut. The necessity of nevertheless talking constitutes the kind of complication that is typical of manners in general.) Where people talk, everybody should do so. Not talking is not joining in, where conviviality is the aim. The silence of one individual in these cultures and in others can be interpreted as hostility, incompetence, or even greed, a plot to take advantage of the others' conversation in order to eat more than anybody else.

It is forbidden at a dining room table to reach past people, and especially across their plates, for what one might need. It is therefore necessary to ask and then to thank the neighbor who obliges. Before helping himself or herself to more food, the polite diner first asks others whether they want some more. Such simple exchanges, made mandatory by table manners, create a ready-made, basic fabric of verbal interaction with others.

Since all have the duty, all should also have the opportunity to talk. Politeness therefore commonly demands, to varying degrees in different cultures, no drowning out of others' words by shouting and no interrupting. All the manners governing conversation may apply even more strictly than is usual. Where the guests are seated around a table, on view to all those present, it is bad manners to talk, whisper, and laugh with one companion to the exclusion and possible covert ridicule of others. A guest should not be singled out and so closely questioned that he or she has no time to eat the food.

Good Manners

Let Noise of lewd Disputes be quite forborn,
No Maudlin Lovers here in Corners Mourn,
But all be Brisk, and Talk, but not too much.
On Sacred things, Let none presume to touch,
Nor Profane Scripture, or sawcily wrong
Affairs of State with an Irreverent Tongue.
Let Mirth be Innocent, and each man see
That all his Jests without Reflection be.
(*The Rules and Orders of the Coffee House,* 1674)

The turning of the table is accomplished by the hostess, who merely turns from the gentleman (on her left probably) with whom she has been talking through the soup and the fish course, to the one on her right. As she turns, the lady to whom the "right" gentleman has been talking, turns to the gentleman further on, and in a moment everyone at table is talking to a new neighbor. [To refuse to change partners is to cause the whole table to be blocked,] leaving one lady and one gentleman on either side of the block, staring alone at their plates. At this point the hostess has to come to the rescue by attracting the blocking lady's attention and saying, "Sally, you cannot talk to Professor Bugge any longer! Mr. Smith has been trying his best to attract your attention." (Emily Post, 1922, p. 221)

I knew a man who had a story about a Gun, which he thought a good one and that he told it very well; he tryed all means in the world to turn the conversation upon Guns—but if he failed in his attempt, he started in his chair, and said he heard a Gun fired, but when the company assured him that they heard no such thing, he answered, perhaps then I am mistaken, but however, since we are talking of Guns,—and then told his story, to the great indignation of the company. (Lord Chesterfield, Letter to his Godson, no. 141)

It is rude, the etiquette books repeatedly remind their readers, to upset people with descriptions of what might disgust them or shock them (the last thing people want while eating is to be perturbed or "put off their food"). Dinnertime conversationalists are often advised against controversial or overly important subjects like politics or religion. Talking shop is frowned upon and also long-winded technical explanations nobody wants to hear. There should be no holding forth so that only one person is heard from. The host in particular is enjoined not to praise the culinary excellence of the meal or otherwise to put himself or herself forward. He or she should concentrate instead on encouraging the guests to shine (Morel, 1977; Staffe, 1899).

At a Japanese *cha no yu* or tea ceremony, the host goes to great trouble to make the dining space beautiful with flower arrangements and utensils chosen to express appreciation for the season of the year. The host might deliberately and delicately absent himself at a certain point to give guests the opportunity to comment, without embarrassing the host with too much praise, on the tea bowls, their beauty and their perfect taste, and the room and its furnishings. Contemplation, heightened sensitivity, and admiration are the aim of the ceremony. Spoken expression of people's responses is an essential aspect of the experience (Kondo, 1985).

Wit, Creativity, Social Bonding

Among people prosperous enough to eat in company for pleasure and entertainment, meals have often been occasions for the display of wit. Brilliant conversation was what writers of "table talk" attempted to recapture. Table talk is different with every gathering; it is on each occasion the group's own improvised creation. The conversation may range from the boring or unpleasant to a memorable art form, as may the preparation of the meal itself. At times dinnertime discourse can become artificial and competitive and even part of power struggles, since being invited to the right dinner parties and so consorting with important people has often been essential to an ambitious career. Dinner guests invited in order to dazzle others with their famous wit have frequently prepared themselves with stories ready to insert into the conversation, have sharpened their sallies in advance, and have polished their bons mots and their paradoxes.

Dinnertime conversation of course takes time. This has often meant that it was, as a social skill, highly developed only among people with money, leisure, and servants as well as verbal polish. In modern society, where time is money or "at a premium," table conversation may be forced into a minor role in people's lives. Yet it is often still customary for people to make time for talking at meals. Conversation after dinner is an institution in Hispanic cultures, with its own name, *hacer la sobremesa*, "doing the over-the-table" or "doing the tablecloth." The dishes are removed for this part of the event. Such conversations knit families and groups of friends together, ensuring contact, constant negotiation, and understanding. They are important occasions for identity building and for self-expression.

"It's not what's on the table that matters but what's on the chairs." The adage expresses what has been an almost universal insistence among human beings, that we people should strive not to let the material necessities dominate our their lives, that the food should not be the only attraction when we people sit down to eat together.

See also **Etiquette and Eating Habits**; **Greece, Ancient**.

PLUTARCH'S *SYMPOSIACS*

Examples of subjects for discussion at a symposium:

- "Whether the host should arrange the placing of his guests or leave it to the guests themselves."
- "Why men become hungrier in autumn."
- "Why we take pleasure in hearing actors represent anger and pain but not in seeing people actually experience those emotions."

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TABOOS. A food taboo is a prohibition against consuming certain foods. The word "taboo" (also spelled "tabu") is Polynesian and means 'sacred' or 'forbidden'; it has a quasi-magical or religious overtone. The term was introduced in the anthropological literature in the second half of the nineteenth century. In the field of food and nutrition, food taboos are not necessarily connected with magical-religious practices, and some nutritionists prefer to speak of "food avoidance." In this article these terms are used interchangeably.

Food is a culturally specific concept. In general, anything can function as food if it is not immediately toxic. But what is edible in one culture may not be in another. The concept of food is determined by three factors: biology, geography, and culture. Certain plants and animals are not consumed because they are indigestible. Geography also plays a role. For example, dairy products are not part of the food culture of the humid tropical regions since the geographical conditions for keeping cattle are unfavorable. Milk is often a taboo food in such cultures. Insects are not considered food in Europe and most of the United States despite attempts to introduce them in the late twentieth century. This is because there are few edible insects in regions with temperate climates. In Mexico, by contrast, insects are packaged in plastic sachets, cans, or jars for sale. Cultural reasons for food taboos often have a geographical basis—unknown or exotic foods will be rejected as unfit for consumption.

It is of interest to note that food avoidance most frequently relates to animal meat, since in most cultures human beings have an emotional relationship with animals they have to kill to eat. One of the few taboos of a food of vegetable origin is the prohibition against alcohol for Muslims and some Christian denominations.

Food may establish a cultural identity of an ethnic group, religion, or nation. Food taboos in a society function also as a means to show differences between various groups and strengthen their cultural identity. Refraining from eating pork is not only a question of religious identity but is likewise an indication of whether or not one belongs to the Jewish or Muslim cultural community. In order to better understand the range of food taboos, it is useful to distinguish between permanent and temporary food taboos or food avoidances.

Permanent Food Taboos

Foods that are permanent taboos or avoidances are always prohibited for a specific group. The classic example of a permanent food taboo is the prohibition against pork by Jews and Muslims. The Jewish prohibition against pork is found in Leviticus 11:1. Some anthropologists point out that food taboos are based on the failure of these foods to fit into the usual systems of classification. Foods that do not fit into these classifications are unsuitable for consumption, or unclean. According to the Qur'an (2, 168), Muslims should not only avoid pork, but also blood, non-ritually slaughtered animals, and cadavers and alcohol. In the case of both Jewish and Muslim food taboos, the foods themselves are considered unclean. A different concept of food avoidance is found in Hinduism. Hindus abstain from eating beef because cows are considered sacred. Various arguments have been used to explain the origins of such food taboos or food avoidance including religion, culture, and hygiene.

Marvin Harris has rightly pointed out that when people reject certain foods, there must be a logical and economical reason for doing so. The pig is an animal of sedentary farmers and unfit for a pastoral way of life because pigs cannot be herded over long distances without suffering a high rate of mortality. Herdsmen generally despise the lifestyle of sedentary farming communities.

In Western society cats and dogs are not consumed because of the emotional relationships developed with these pets. Increasingly pets are being "humanized" in such a way that eating them is seen as an act of anthropophagy or cannibalism. The feeling of closeness to certain animals can also be found in the savannah regions of West Africa. Certain West African clans consider dogs clan animals, based on the fact that they have been beneficial to the clan in the past; as clan animals they are unfit for consumption. Hippocrates (460–377 B.C.E.) regarded dog meat favorably as a light meal, but in later antiquity, dogs were considered unclean and unfit to eat. This is still the case in the Mediterranean area and the Middle East. By contrast, dog meat is popular in China and the mountainous regions of the Philippines. From a nutritional point of view, dog meat is an excellent source of animal protein, and dogs do not require the grazing area demanded by cattle or other large ruminants.

Temporary Food Taboos or Avoidances

Some foods are avoided for certain periods of time. These restrictions often apply to women and relate to the reproduction cycle.

The times of temporary food avoidances related to particular periods of the life cycle include:

- Pregnancy
- Birth
- Lactation
- Infancy
- Initiation
- Periods of illness or sickness

From a nutritional point of view, temporary food avoidances are of great importance as they concern vulnerable groups: pregnant women, breast-feeding women, and infants and children during the period of weaning and growth. Food regulations and avoidances during these periods often deprive the individual of nutritionally valuable foods such as meat, fish, eggs, or vegetables. In a number of African countries pregnant women avoid green vegetables. They also do not consume fish. When asked why, women say the unborn child might develop a head shaped like that of a fish. Some of these avoidances may seem odd from a scientific point of view, but there is often an unnoticed logic behind it. In the first place, women are aware of the critical period and know that much has to be done to ensure the successful delivery of a healthy child. Observing the rules of avoidance will give her the strength of knowing that everything possible has been done for the benefit of the child.

In Central Africa nutritionists observed that young children did not eat eggs. They were worried that a nutritious food was not available for this vulnerable group. The village elders gave a convincing explanation of why eggs should be avoided by children. In the past the wise ancestors were much concerned about young children roaming around the villages searching for eggs and even chasing the brood hens away from their eggs. In order to avoid a depletion of the poultry stock, the elderly decided that eggs were harmful to young children and should be avoided.

A different form of temporary food avoidances involves the rules of fasting. In medieval Christianity the most important period of fasting was Lent (the period from Ash Wednesday to Holy Saturday), during which meat and animal products were forbidden. There were also other days (Ember Days, Fridays, etc.) on which people were required to abstain from eating meat. The Reformation broke the tradition of fasting to a large extent. The Ethiopian Orthodox Church has a wide and complicated system of dietary rules and fasting, as does the Eastern Orthodox Church. In the Muslim world, Ramadan, the ninth month of the Muslim year, means strict fasting, even from beverages, from sunrise to sunset (Sakr).

Do Food Taboos Change and Disappear?

Food taboos may seem rather stable, but they are often under pressure because the society is changing. Migration is a powerful factor in the process of changing food culture. In Europe and North America, most Muslim migrants from the Middle East and South Asia try to maintain their food habits, but some cannot fully resist the food culture of their new home country. A substantial number of Muslims begin drinking beer, wine, and even stronger spirits. Women tend to be less inclined to give up the avoidance of alcohol. The fear of pollution from pork often remains strong, however. In some European countries Muslims refrain from eating in factory canteens out of fear that meals may be polluted with pork fat or pork meat. In contrast, many Jewish Europeans and Americans eat pork from time to time, or even on a regular basis.

Nutrition and health education have reduced the temporary food avoidances of the vulnerable groups in a great number of countries. In the humid tropical countries of Africa and Asia, where the raising of dairy animals is unfavorable, the rejection of milk as a food is diminishing. Despite the occurrence of lactose intolerance among the population, the use of milk and milk products has extended since colonial times. Primary lactose intolerance occurs from an apparent decrease in the intestinal enzyme lactase and can occur between the ages of two and five years. This condition is present in about 75 percent of the world population. However, small but significant quantities of milk consumed throughout the day can be tolerated among ethnic groups known to be lactose intolerant. At the beginning of the twenty-first century, milk products and a little fresh milk are available for the upper and middle classes. This availability seems to have increased due to dairy exports from Western countries and dairy food aid during the 1950s through the 1970s. In a country without a dairy tradition such as Indonesia, the importation of canned sweetened condensed milk can be traced back to around 1883. In the high lands of Java, the Dutch introduced dairy farming on a small scale in the nineteenth century. From the colonists, a modest use of milk spread gradually among the emerging Indonesian upper and middle classes.

In the United States and other countries with Anglo-Saxon traditions, horsemeat is not part of the food culture. This is in contrast to continental Europe, in particular France, where horsemeat is a well-known and appreciated food. The history of horsemeat gives insight into how attitudes toward food avoidance change over the course of time. In Europe it started with a decree by Pope Gregory III (d. 714) that the Christian communities of Germany and the Low Countries refrain from eating horsemeat because the horse played an important role in pagan rituals. The purpose of the decree was that the Christian community should distinguish itself from the pagans by avoiding a typical pagan symbol, horsemeat. Gradually the consumption of horseflesh disappeared. The meat was considered to be unfit for consumption. In the nineteenth century the attitude toward horsemeat changed dramatically. Food emergencies connected with war and promotion of horsemeat as a food were the driving forces for change. During the Napoleonic Wars, hungry soldiers were forced to eat their horses. To their surprise, the meat was fit to eat and even had a reasonably good taste. French pharmacists promoted the idea that horsemeat was suitable for consumption, and from a scientific point of view no threat at all to health. Discarded workhorses became a source of good and cheap meat for the growing working classes in urban France. The concept of horsemeat as food spread to other European countries, but not to the United Kingdom, where the horse remained a noble animal, and the idea of eating horsemeat was viewed with disgust.

In periods of emergency, dietary rules including food avoidances can be temporarily ended. The West African Fulani pastoralists avoid the consumption of fish. During the dry season the herdsmen have to move with their cattle from the northern savannahs to the land along the Niger River in the south. Because of the seasonal food shortage, herdsmen are more or less forced to turn to eating fish. In rural areas with a dry and a rainy season, people will collect in the period of seasonal food shortage the so-called hungry foods. Hungry foods are mainly wild foods, often not very attractive and tasty and as such normally avoided. They are consumed only in an emergency.

See also **Africa; Anthropology and Food; Christianity; Fasting and Abstinence; Feasts, Festivals, and Fasts; Hippocrates; Hinduism; Islam; Judaism; Lent; Middle Ages, European; Ramadan; Religion and Food; Shrove Tuesday.**

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TAILLEVENT. Taillevent (c. 1315–1395), whose real name was Guillaume Tirel, was employed in the kitchens of the French court from the 1320s to until his death in 1395. The recipes from the manuscript cookbook with which his name is associated, *Le Viandier*, were copied and widely disseminated both during and long after Taillevent's lifetime and had an enormous influence on French cookery, as evidenced by the different versions to be found in various existing manuscripts. Toward the end of the fifteenth century, as the first cookbook to be printed in France, a greatly enlarged version of *Le Viandier* remained in circulation for over a century and had an enormous influence on French cookery. Because of the success of his cookbook, Taillevent can rightfully be called the first chef to achieve "star" status in France, where his name became synonymous with "master chef."

Taillevent's recipes, destined principally for festive occasions, give us a glimpse of the kind of cuisine practiced in the aristocratic households from the fourteenth to the sixteenth century. Characterized by the use of a wide range of spices—in keeping with the dietetic principles of the time that demanded that the cold, wet "humors" of meats, fish, and vegetables be tempered by the hot, dry "virtues" of spices—they call for such familiar ingredients as veal, capon, or pike, as well as much more exotic foods like crane, swan, or sturgeon, prized for the beauty of their feathers (placed back over them to serve), or for their sheer size. Among the new recipes included in the printed *Viandier* at the end of the fifteenth century, the importance of pâtés and tarts in the French culinary landscape is documented for the first time.

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Mary Hyman
Philip Hyman

TAKE-OUT FOOD. Take-out food is food prepared for consumption away from the location where it is purchased. As a term, its first appearance was in James Cain's novel *Mildred Pierce* (1941), in which the main character expressed her desire to sell pies to the take-out trade. Synonyms for "take-out" include "carry-out," "take-away," and "food to go."

Origins of Take-out Food

From Roman antiquity onward, people have been buying foods to consume elsewhere that have already undergone some form of preparation. Roman cook shops, early precursors to restaurants, were an early example of today's modern gourmet to-go shop. A variety of production kitchens were available to the Romans. Not only did the Roman soldiers get food from a centralized kitchen, but large towns such as Rome had areas where food was prepared for eating on the premises or to take out. Cooks in ancient Greece and Rome were often itinerant, bringing their prepared foods to theater audiences, predating ballpark hot-dog vendors by millennia. In ancient Rome, according to historian Maguelonne Toussaint-Samat, prepared foods were available for sale to be consumed in the markets or elsewhere. In fact, Trajan's Forum in Rome could be viewed as an extension of the idea of the Greek agora, where all kinds of goods were freely exchanged.

Cooked-meat vendors date back to ancient Mesopotamia, where a wide variety of foods were available to take out, from roasted meats to fish to almond paste–based desserts.

The custom of buying ready-cooked food was found, as recorded by historian Reay Tannahill, in twelfth-century London, where

> you may find viands, dishes roast, fried and boiled, fish great and small, the coarser flesh for the poor, the more delicate for the rich, such as venison, and birds both big and little. If friends, weary with travel, should of a sudden come to any of the citizens, and it is not their pleasure to wait fasting till fresh food is bought and cooked….they hasten to the river bank, and there all things desirable are ready to their hand (Tannahill, p. 164).

Even in late-sixteenth-century France, more than two hundred years before the term "restaurant" takes on the meaning now associated with it, prepared foods were available from "the roasters and the pastrycooks, [who] in less than an hour, will arrange a dinner for you, or a supper," to eat on the premises or to take out to consume elsewhere. Only from 1786 onward did Parisian caterers and restaurateurs open their doors to the public for consumption of meals. It was at this time that the custom of the table d'hôte ("host's table") took hold, an expression that meant that paying customers were invited to partake of foods in the caterer's place of business at the very table where the caterer dined, instead of having to take the meal out to eat elsewhere.

Across the English Channel, a hundred years later, fast-food eating shops had become London institutions, frequented by members of all classes. In 1671 in Munich, Germany, the luxury food store Dallmayr opened, purveying box lunches to the noblemen of the day. The tradition continued with the founding of Fortnum and Mason in London in 1707. By 1788 Fortnum's was selling foods to go, including boned portions of poultry and game in aspic jelly, decorated with lobsters and prawns, all prepared so as to require no cutting, for a distinguished clientele that resided nearby. By 1851 ready-to-eat dishes had become all the rage: to sustain life during such ceremonies as the Coronation festivities, the new queen's review of 6,000 troops in Hyde Park, and the Great Exhibition of 1851. Harrods in 1849 began purveying high-quality foodstuffs to royalty and upper-class Londoners alike.

Hédiard (founded in 1854) and Fauchon (1886) brought a taste of what were then considered exotic foods to the Parisian elite. The German-born Leonardo Peck opened an epicurean delicatessen in Milan, Italy, in 1883, specializing in artisanally prepared smoked and cured meats and cheeses. The large department store Kaufhaus Des Westens (KaDeWe) in Berlin, Germany, established in 1907, devoted considerable space to foods to go. These and other stores featured imported fruits, spices, teas, and coffee; foods prepared on the premises for take-out set new standards in elegance and luxury that retailers in the United Sates wished to emulate.

Packaging

Packaging is an essential component of foods to go. In the United States, paper bags for holding purchases were introduced around the 1860s, a significant development that catalyzed the growth of carry-out foods. Prior to this, clerks had often placed small purchases for customers who were without baskets, bags, or other containers into cones made of rolled paper, twisting them at the bottom to create a kind of primitive bag. By the 1860s the process of making paper containers was becoming mechanized. By 1875, a full-scale manufacture of paper bags was under way. Coupled with stepped-up mechanized production of food, improved refrigeration technology, and transportation of food by rail, a multiplicity of food choices was becoming available nationwide.

The late nineteenth century saw the establishment of grocery store chains. A&P was established in 1869, Kroger in 1882, and Gristede Brothers in 1891. Department store food halls, such as New York City's Macy's food department of 1908, would eventually serve as a model for Dean & DeLuca (founded in 1977 in lower Manhattan), a specialty-foods store with boutiquelike departments, each of which specialized in a different category of food (cheese, meats, prepared foods, pastries) displayed artfully.

Convenience and Education

In one of a number of attempts to educate the working class about healthful eating habits, Ellen Richards, a founder of domestic science who was a chemist and the first woman appointed to the faculty at the Massachusetts

Take-out food has been a feature of urban cookery for centuries, but industrialization and mechanization have altered many sectors of this market, especially in the area of fast foods. This is a scene from McDonald's in Moscow. © AP/WIDE WORLD PHOTOS.

Institute of Technology (1884), helped open the New England Kitchen in 1894 as a place where neighborhood people could purchase foods to take home. Through it, she intended to promote the values of home and family life over the trend toward eating out. Ahead of its time, Richards's effort could be seen as the precursor to the delivery of prepared meals by the then new automobile. In the early 1900s, food delivery services in New Jersey (an offshoot of a communal dining experiment) and Illinois lasted only a few years but served as early models for the pizza delivery services that dominated the take-out food market from the 1970s onward. In the period after World War I, small independently owned grocery stores sprung up in cities and in their surrounding bedroom communities throughout the country, offering prepared foods to the carriage trade. One such operation, William Poll in New York City, started out as a grocery and catering establishment in 1921. Offering some of the earliest prepared take-out of the modern era (1951), a marvel of freezer and packaging technology in the form of shish kebab, cooked and ready for reheating, Poll continued into the twenty-first century. In 1934 the Zabar family started what was to become one of the largest delicatessen-prepared food establishments in New York City; its take-out operations have continued to the present.

In the modern era of food retailing, from the 1960s onward, in the United States the rise of two-career couples created a demand for fast food and prepared foods, available for take-out or delivery. Those early revolutionaries of the Boston experiment such as Ellen Richards, who said that home cooking as traditionally defined would soon be a thing of the past, were more prescient than they may have realized, given how much modern industrialized society has come to depend on sources for ready-to-eat food outside of the home. Among the upwardly mobile and working-class alike, a once weekly pilgrimage to the local Chinese restaurant, a phenomenon begun in the 1950s, defined take-out for many Americans. The growing ethnic diversity of populations nationwide in the succeeding fifty years enabled Americans to experience the cuisines of other countries, including Mexico, Thailand, Vietnam, and the Middle East. Restaurants with limited seating often capitalized on the demand for convenience and offered their complete menus "to go." Take-out food was no longer limited to pizza, burgers, or fried chicken. From the late 1980s, the percentage of take-out foods purchased increased year by year. Take-out and delivery of foods accounted for 57 percent of all restaurant traffic, with more than nine out of ten table-service restaurants offering take-out options. In the last three decades of the twentieth century, Americans strayed far from the nightly ritual of eating a home-cooked meal with all members of the family congregating around the dinner table. In 2001, according to the National Restaurant Association, 47 percent of Americans aged eighteen to twenty-four said purchasing take-out food is essential to the way they live, with 29 percent of all age groups in agreement. With convenience and variety in increasing demand, the trend is not likely to cease.

See also **Fast Food**; **Fauchon; Food Politics: U.S.; French Fries; Hamburger; Hédiard**; **Marketing of Food**; **Places of Consumption; Preparation of Food; Restaurants; Retailing of Food; Sandwich**.

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Robert Wemischner

TEA.

This entry includes two subentries:
Tea as an Icon Food
Tea (Meal)

TEA AS AN ICON FOOD

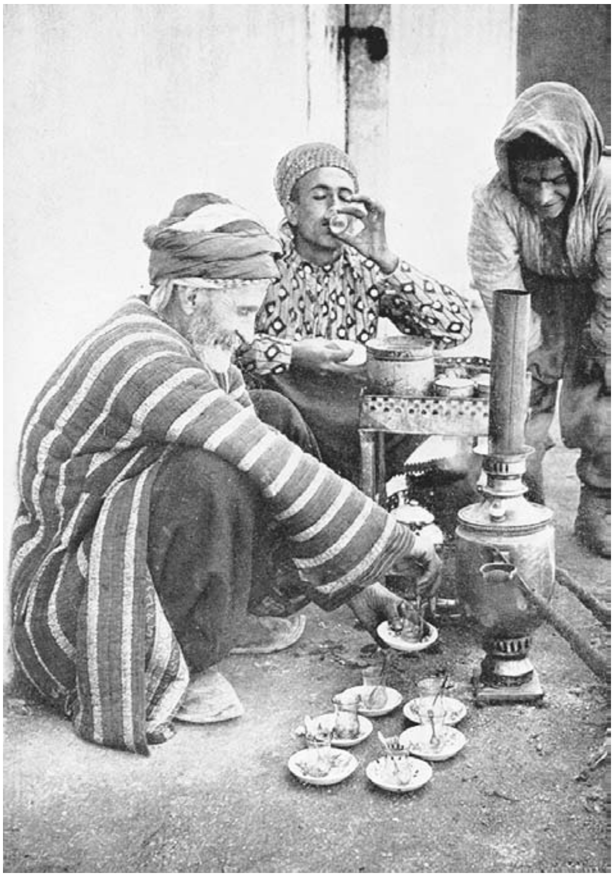
The origins of tea drinking are shrouded in historical obscurity and legend. While some scholars maintain that tea drinking began in ancient India, most place its beginnings in China as early as 2700 to 3000 B.C.E. A commonly cited account is more recent, however (Qin dynasty, c. 221–206 B.C.E.). According to the story, tea was created one day when the Emperor Shen Nung was boiling water next to a fragrant bush when a gentle breeze blew a leaf from the bush into the pot, creating a pleasing aroma—and tea. Although this story is probably apocryphal, it is likely that plain boiled water or rice water were most commonly drunk in ancient China, and that tea was used occasionally and boiled in combination with other ingredients such as ginger, shallots, orange peel, and mint. The first documented reference to tea occurs in a Chinese dictionary, in 350 B.C.E.

More important than any exact date, however, is the idea of tea as a linchpin and iconic food type in Chinese and other Asian and world cultures. Tea has had social, medicinal, economic, political, and class implications for centuries, being used as a chew, a beverage, a vehicle for familial and business bonding, a curative, a preventative, a stimulant, and a soporific. The preferred drink of many nation's ruling classes, and a measure of economic prosperity among all classes, it is also associated with the British opium trade and the Opium Wars in China, the economic development of the Indian subcontinent and the North American continent, and the beginnings of the American Revolution.

Tea and Chinese Culture

Published accounts of tea cultivation and enjoyment surfaced in the sixth century B.C.E. when Lao-tzu (c. 604–520 B.C.E.), author of the Tao Te Ching and founder of Taoism, is reputed to have proclaimed tea an "elixir of immortality." That description is supported by tales of a monk who extended his lifespan considerably by drinking forty cups of tea a day. While Chinese drink the beverage with meals and at numerous other points throughout the day, consistent with a culture deeply committed to an ideal life of balanced opposites, they also recommend against drinking too much because overindulgence might have negative effects.

Factual accounts of tea as a bona fide drink surface most convincingly in China during the Han dynasty (c. 206 B.C.E. to 220 C.E.), when it became a widely popular drink, and lacquered cups, manufactured specifically for the use of tea ("tea cups"), appeared. Tea has continued to be popular in China throughout its history, but most notably during a high point of Chinese civilization, the Tang dynasty (c. 618–907 C.E.). During this period, the rituals of tea preparation and drinking were codified and spread throughout northern China and Asia, along with other aspects of China's culture. Tea was also taxed during this period, eventually becoming a valuable asset in Chinese households, where it was used as currency and referred to as "green gold." Tea bricks (compressed tea leaves) were used to buy horses (and, for example, in the case of the British, were exchanged only for precious metals such as silver and later for opium).



Preparing tea from a samovar, Baghdad, Iraq, circa 1920. The tea is drunk hot from small glasses. Roughwood Collection.

During the same period, the poet and philosopher Lu Yü (d. 804 C.E.) wrote the *Ch'a Ching* (c. 780 C.E.; later translated as *The Classic of Tea*). Respected among tea enthusiasts, connoisseurs, and amateurs alike it became a definitive book on the subject. Concisely and beautifully written, it describes various forms and types of tea, explaining the selection and use of proper utensils, and discussing the water used for brewing. Water collected from natural springs located near Buddhist monasteries was believed to possess spiritual qualities, for example. Lu Yü also recommended water from the mouth of Szechuan's Yangtze River (where some of the best teas in China are cultivated) and mountain water. The precise instructions of Lu Yü raised tea drinking to an art form, earning him the status of tea "divinity." It is likely that his *C'ha Ching* became the basis for the highly ritualized and formal Japanese *chado* ("tea ceremony"). Teahouses were also established during the Tang dynasty, where people could enjoy pungent bitter tea with savory and sweet bite-size morsels or dumplings, early snack foods. (The popular Chinese expression *yam cha* literally means "drink tea," but figuratively it refers to eating *dim sum* ["touch of the heart"], steamed or fried dumplings stuffed with a variety of fillings, for example, bean paste.)

Two women perform a tea ceremony in a traditional home in Kyoto, Japan. © CATHERINE KARNOW/CORBIS.

The appearance of teahouses further ritualized tea drinking as an essential component of Chinese life, connecting it to business negotiations, social encounters, relaxation, and other facets of Chinese culture. In this sense, it parallels the use of alcohol and other stimulants as social lubricants in other cultures. Tea is also a preferred drink at wedding banquets, and is traditionally presented to the bride and groom as a symbol of unification. Additionally, tea, along with fruit, is used as an offering at ancestral altars. It is also customary, if not mandatory, in Chinese culture to offer a cup of tea to a guest at any time of the day.

Tea in Japan

While the date of tea's introduction to Japan is difficult to pinpoint, Okakura Kakuzo, the great twentieth-century Japanese philosopher and tea master, wrote that the Japanese Emperor Shomu (c. eighth century C.E.) offered tea brewed from Chinese leaves sent by Japanese ambassadors to the Tang court to one hundred monks. The Japanese monk Saicho (767–822 C.E.), who had spent time in China, is believed to have offered a cup of tea to the Emperor Saga in 815 C.E. Saga was said to be so fond of the drink that he ordered the planting of a bush in order to establish tea as the beverage of choice in Japan. The tea proved to be too strong for many Japanese, however, and its popularity has proven less consistent than with the Chinese. Nonetheless, Japanese tea cultivation began during this period and was well established by the thirteenth century C.E.

Revivals of interest occurred during the thirteenth century, and reached a plateau during the sixteenth century (a period of cultural consolidation and political reunification), when tea cultivation spread, making the drink widely available. With this cultural shift came the traditional teahouse, a small bamboo hut created by tea master Sen Rikyu, who developed the *chado* (*cha-no-yu*, "hot water for tea"), or tea ceremony. The Japanese came to consider tea a way of life, and, like the Chinese, saw it as a symbol of hospitality, relaxation, and consolation. The *chado* both reflected and extended the preparation and drinking of tea as a ritual, codifying the preparation, serving, and drinking of tea according to strict rules. This codification is sometimes tellingly referred to as "the law of tea," and is closely associated with the principles of Japanese Zen Buddhism.

The Japanese ceremony involves the whipping and frothing of powdered green tea (*matcha*) with a slit bamboo brush while introducing hot water. It derives from a

Chinese Sung Dynasty (c. 960–1279 C.E.) tradition in which steamed and formed tea cakes are pounded into a fine powder. (The Japanese serve *kaiseki-ryori*, a meal masterfully prepared and eaten prior to the tea ceremony.) Due to its rather complex preparation, *matcha* is usually reserved for tea ceremonies or special occasions. Japanese *sencha*, loose tea leaves, was brought from China during the seventeenth century, and remains a more convenient and common form of tea. While the tea's popularity eventually waned, it was revived in the twentieth century, and the Japanese people have come to perceive it as a convenience food, ideally suited to their fast-paced lifestyle, something to accompany a light meal carried in a Japanese lunch box.

JAPANESE TEA CEREMONY

The rituals known collectively as the Japanese tea ceremony are based on practices brought to Japan from China by Zen priests in the 1200s. Their style of tea preparation became popular among military and merchant elites, and these practices were later codified by Sen no Rikyuu (1521–1591). The art is organized by "schools," such as Ura-senke and Omote-senke.

Finely powdered green tea is put in a bowl, hot water is added, and the tea is whipped into a suspension with a bamboo whisk. The tea is prepared by a host for guests, who are expected to know the elaborate etiquette. For the first several years, students tend to focus on performance aspects, learning when to bow or how to carry utensils into the room. For elite practitioners, however, the key to the art lies in their connoisseurship of the many art pieces used in the ritual, such as the tea bowl, the hanging calligraphy, or the lacquered tea container. Hosts manipulate the symbolism of utensils to create complex themes for each gathering, and guests are expected to read these allusions.

The most complex ritual, called *chaji,* lasts four or more hours and involves the serving of an elaborate meal. The food should be simple and seasonal yet arranged with casual artistry on understated, elegant dishes. After the meal, sake is served. Moist sweets *(omogashi)* are served before the preparation of thick tea *(koicha)* and dried sweets *(o-higashi)* before the preparation of the thin tea *(usucha).*

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James-Henry Holland

Tea and Europeans

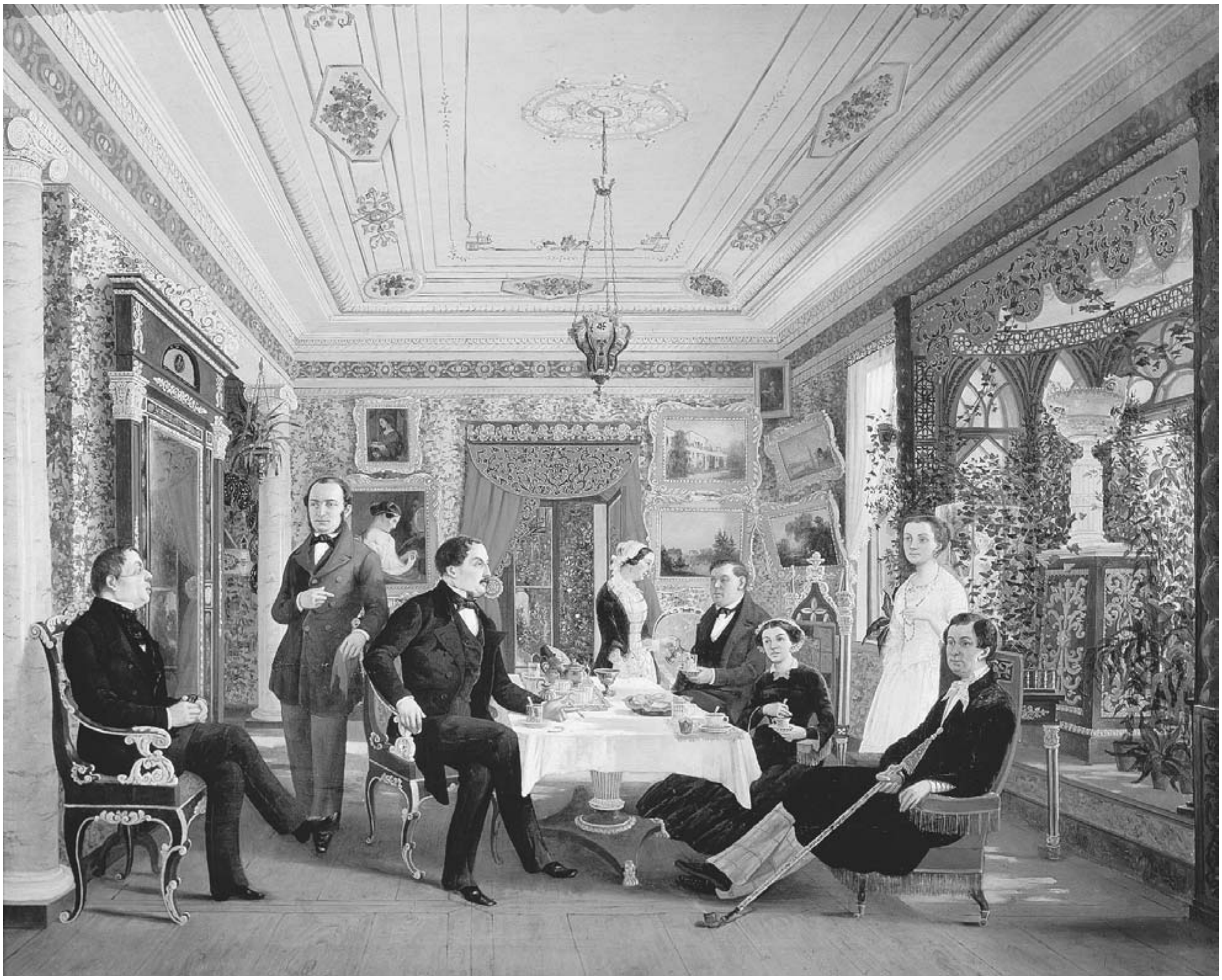
While the Portuguese were the first Europeans to trade and drink Chinese tea in their Macao colony during the early sixteenth century, the Dutch established the Dutch East India Company during the same period and were the first to import tea to Europe. It was the British, however, who most took tea to heart, making it an integral part of their culture, trading it under the English East India Company out of Java, popularizing it globally, and mastering its cultivation.

The first public tea sale in Britain took place in the mid-1600s, beginning a commerce that would increase in volume to several million pounds annually by the late 1700s. The suspicious, protective (and perhaps wise) Chinese successfully denied information about the cultivation of tea to the British for so long that they did not fully understand that green, black, and oolong teas came from the same bush until the late nineteenth century. Tea plants were eventually discovered in Assam (between Burma and India) in the early nineteenth century, enabling the British to circumvent the Chinese and establish tea cultivation in India shortly thereafter, and in Ceylon during the later nineteenth century.

Tea services developed by the British were known as high tea or low tea and were common throughout their empire by the late seventeenth century. Low tea was served during the afternoon, usually around four o'clock, with sweets and bite-size sandwiches. High tea was served as an early dinner with a hot entrée and other tidbits. A tradition among the aristocracy, English teas are rather complex and precise rituals, employing a tea strainer (to hold back the brewed leaves) while pouring the infusion into the cup. Tea service was popularized in Hong Kong during its British colonization, and one of the best remaining examples of formal British tea service can still be experienced at the Peninsula Hotel, located in Kowloon, Hong Kong.

Tea in India

Some Indian scholars argue that, like Buddhism, tea originated in India. This is often connected with the idea that wild tea plants were discovered in ancient Assam and then transplanted to China. While this is possible, the first records of the Indian aristocracy drinking tea date back only to the seventeenth century. Tea cultivation flourished in India under the British, however, and today India is the largest exporter of tea in the world.



This 1851 painting by Russian artist A. Voloskov shows a family gathered around a tea table for an elaborate afternoon repast. © ARCHIVO ICONOGRAFICO, S. A./CORBIS.

Darjeeling tea, for example, is grown in the foothills of the Himalayas, and is a prized Indian black tea. The use of milk and sugar in tea is also linked to India: while the Chinese and Japanese believe that the only way to drink tea is pure—without milk and sugar—Indians drink theirs with both. This convention may have originated with the British, who enjoy tea "light and sweet" to this day. It is also possible, however, that the Indians, who had enjoyed the milk of their sacred cows as a favorite beverage, developed it on their own and passed it on to the British.

Tea in North America

Tea has frequently been associated with political turmoil historically. One well-known event has been credited with precipitating the American Revolution. The mid-eighteenth century was a time of both illegal Dutch tea smuggling and economic exploitation of the tea trade by the British in their North American colonies. The notorious Tea Act of 1773 epitomized British manipulation of the tea market and pointed the way to possible future British abuse of American colonial tax law. Protests erupted in New York, Charleston, South Carolina, and, most famously, in Boston, Massachusetts, culminating in the Boston Tea Party of December 1773. Boston merchants marched to Griffin's Wharf disguised in Mohawk headdresses, smashing and dumping tea chests from British East India boats into the water as an act of political defiance, instigating broader rebellion and, eventually, the American Revolution (1775–1782), which secured the independence of America from the British Empire.

Americans were able to plant and cultivate their own tea in the South, with particularly large plantations in South Carolina. It is said that tea, as part of that state's overall agricultural wealth, allowed South Carolina to finance the Confederacy substantially during the American Civil War. The Charleston Tea Plantation in South

Carolina was established in 1799, eventually growing teas crops that originated in China, India, and Ceylon. It remains the only tea plantation in America today, producing an excellent orange pekoe black tea under the label American Classic Tea.

Varieties of Tea

Tea can be broadly divided into three common types: green (unfermented), oolong (semi-fermented), and black (fermented). These are usually sold as loose whole leaves, pearled, crushed, powdered, cakes (preferred by Tibetans), and—beginning in modern times—the twentieth century, as individual tea bags. The Chinese prefer the green varieties for their unique and delicate floral notes. Understood to be the healthiest of all teas, fresh green tea is sometimes recommended as a modern cancer preventative and curative, primarily because of its high concentrations of antioxidants. The best of the green teas are considered to be those produced in the province of Szechuan, including a highly regarded, fragrant, and semisweet type variety called "Dragon's Well." The fresh varieties require a bit of fussing in their preparation and, for this reason, are usually reserved for both formal and informal social rituals as a result. Fermented teas were developed as a means of preservation, especially preservation related to early international trade and shipping, when long sea voyages would have caused the leaves to rot. Accordingly, black teas have enjoyed greater historical popularity in the West, where they were the prevalent type most readily available.

The price of tea—essentially its value—is determined by the quality and rarity of the leaf. As such a pound of tea can range from roughly ten dollars to one thousand dollars, with the best most expensive teas usually being those in the green tea category. Today's quality teas come from China (Gunpowder, Pu'erh, Lapsang Souchong, Dragon's Well), Taiwan (Imperial Oolong, Formosa White Tip, Jasmine), Japan (Sencha, Bencha, Matcha, Genmaicha), India (Assam, Darjeeling), and Sri Lanka (Ceylon). The word "blend" is used to describe teas composed of various tea leaves from different locales. Good examples of blended teas include English and Irish Breakfast teas. Scented teas are perfumed with ingredients such as oil of bergamot, magnolia, cassis, and other fruits or herbs. Examples of classic scented teas include Earl Grey and Jasmine tea.

Tea as a Cooking Ingredient

Tea is also used as a cooking ingredient, imparting a bitter, sweet fragrance to dishes. Classic Chinese recipes include tea-boiled eggs, Hunan tea-smoked duck, and shrimp cooked with tea leaves—a specialty of the Imperial Court of Beijing. In Southeast Asia, especially Burma, pickled tea leaves—steamed, pressed into bamboo culms, and then buried until the tea is properly aged—are a popular snack, these having been steamed and pressed into bamboo culms, which are then buried until the tea is properly aged.

Tea in the Contemporary World

Tea has spread throughout the world, becoming an important part of Southwest Asian, Central Asian, African, European, North and South American, and Australian culinary cultures. International tea drinking has been affected by invention and innovation. Ice (or "iced") tea was invented early in the twentieth century, introduced by an Englishman, Richard Blechynden, at the 1904 World's Fair, Louisiana Purchase Exposition, in St. Louis, Missouri, and helped to sustain the beverage's popularity. Since then, ice tea is offered in private homes, public events, diners, fast-food chains, and restaurants the world over.

Tea bags were invented by Thomas Sullivan in 1908, which made it convenient to brew single servings of tea in individual cups quickly and simply. (It also kept the leaves from spreading into the drink, at once solving a problem and stripping the beverage of some of its ritual.) Tea bags rapidly became the most popular form of making tea. Fruit-flavored, sweetened teas have become increasingly popular, too, not only as stimulants but satisfying the American (and increasingly international) taste for sweet drinks. Powdered, "instant" ice teas also exist, a cultural counterpoint to periodic revivals of more complex teas such as Indian milk-based chais.

See also **British Isles: England; China; Coffee; India; Southeast Asia; Stimulants.**

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Corinne Trang

TEA (MEAL)

The year 1840 is a landmark in culinary history. Antoine's restaurant had its beginnings in New Orleans, San Francisco consumed the first vintage of commercially produced California wine, and London society imitated Anna, the seventh Duchess of Bedford (1788–1861), with her cure for what she described as "a sinking feeling" she suffered each afternoon. It was then customary in England for the aristocracy to eat a huge breakfast, make do with a small lunch, and sit down to a substantial meal for dinner at eight o'clock or after. Milady's late afternoon discomfort was shared by many another and so was her cure: She ordered tea and a collation of sandwiches and cakes to complement the tea to be served daily at the stroke of five and invited friends to join her.

From the 1840s on, the tradition of afternoon tea with sandwiches and pastries trickled down from the aristocracy to enter English life at large. By the year of Anna's death, the conservative Mrs. Beeton's authoritative *Household Management* pronounced afternoon tea—"a meal of elegant trifles"—to be obligatory in any well-run Victorian household. Not long after Anna's death, the novelist George Gissing was to write, as if in tribute to her, "Nowhere is the English genius for domesticity more notably evidenced than in the festival of afternoon tea." As it began, so it remained essentially a female ritual, but gradually two distinct "teas" evolved.

Aristocratic homes served what was called "low tea" in the afternoon. This was a repast of "elegant trifles" like cucumber sandwiches and other finger foods rather than solid nutrition; the emphasis was placed upon presentation of the foods and socializing over the delicacies. This "terribly, terribly nice" affair became known as "low tea" in contrast to the petty bourgeois and working class custom of "high tea," which has also been called "meat tea" or "farmhouse tea." These are family affairs—hearty, lavish spreads to satisfy the appetites of workers home from toiling and children hungry after school. High tea serves the humbler classes in Britain as the evening meal and often consists of such left-overs as cold joints of mutton, with fresh baked scones, buns, or biscuits and tea in abundance to warm the belly and banish fatigue. "High tea" is not parallel to "high church"; the more elegant and ceremonious the tea, the further it departs from high tea. In Britain during Victoria's later years, teatime migrated from five o'clock to four, and its ceremonial aspects attained the very height of ostentation. Besides the evidence of Oscar Wilde's play *The Importance of Being Earnest* and Saki's short story "Tea," we have historical accounts of these excesses. Margot Asquith, second wife of the British Liberal prime minister Lord Herbert Asquith (1852–1928), writes in her autobiography how the Rothschild family kept great state in, among other places, their home in Waddesdon, where one day Prime Minister Asquith was waited on at teatime by the butler. "Tea, coffee, or a peach from the wall, sir?" "Tea, please." "China, Indian or Ceylon, sir?" "China, please." "Lemon, milk, or cream, sir?" "Milk, please." "Jersey, Holstein, or Shorthorn, sir?" Volumes could be written.

See also **British Isles; Coffee; Dinner; India; Lunch; Meal; Restaurants; Stimulants.**

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James Norwood Pratt

TELEVISION. *See* **Art, Food in.**

THANKSGIVING. The classic representation of Thanksgiving—a crowded dinner table set in the open air on a golden autumnal afternoon in Plymouth Colony, 1621—might include some anachronisms such as apples, potatoes, corn-on-the-cob, and cranberry sauce, but the gathered Pilgrims and their Wampanoag Indian guests are sure to have one of the "great store of wild turkeys" if not the geese, ducks, and venison that founded the historic feast, bowls of assorted root vegetables, and pumpkin pies. It is an idyllic scene, but it has nothing to do with how the Thanksgiving holiday historically began in America.

There never was a true "first" American Thanksgiving from which all subsequent celebrations derived. Thanksgiving did not originate in America at all, but arrived with the intellectual baggage of New England's Puritan colonists. Having banished the medieval roster of holidays including Christmas and saint's days, the reformers admitted only three holy days: the Sabbath, fast days, and Thanksgivings. Fasts and Thanksgivings subsequently appeared independently in each of the New England colonies (except Rhode Island). Each was like an extra Sabbath during the week, requiring church attendance and sober activity, but a big dinner following the meeting was customary on days of thanksgiving and praise. Eventually, fast days were relegated to the spring (when there was nothing to eat) to petition God for a successful season, while autumnal Thanksgivings celebrated the cumulative blessings of the year, including the fruits of the harvest.

As Puritans metamorphosed into Yankees, the social and gustatory character of the day overtook and then equaled the religious observation in consequence. The preparation for the feast began weeks before with Sunday readings of the governor's proclamation. Apples, spices, suet and lean beef were chopped for mincemeat. Massive numbers of pies and tarts were baked of mince, pumpkin, apple, cranberry, and other fillings, intended to last well beyond the holiday. Livestock and fowl were slaughtered and prepared for the spit, pot, or chicken pie (which might take six birds, bones and all). The requisite turkey was gotten from the barnyard, market, or turkey shoot where poor shots underwrote the costs of better marksmen. Charity was an important holiday element. Food supplies, unprepared (including flour, rice, sugar, and even turkeys) or cooked, were given to the poor by prosperous families and sent to prisons by town officials.

As Thanksgiving approached, family and friends assembled at the patriarchal homesteads. Thanksgiving balls were very popular, and women made sure that their clothes were the best and newest possible, despite grumbling about impious frivolity among the more devout. On the day itself, the more respectable attended morning service in the meetinghouse, before returning for the customary feast prepared by the women and servants of the household. The significators of a true New England Thanksgiving dinner were firmly established by the time of the American Revolution: the all-important turkey in place of honor, the massive chicken pie flanked by ducks, geese, and cuts of "butcher's meat," plum pudding, bowls of vegetable and fruit "sass" (sauce), and of course the pies. Following the dinner, the company might relax around the fire with wine or cider, dried fruits, and nuts to play games, tell stories, or in more pious households, to continue their religious exercises in the private sphere and welcome the minister's evening call. Alternately, sleighing visits to other households were popular, as were dances and weddings.

Even before 1800, many households got their holiday foodstuffs not from the family farmstead but in the marketplace. The food was processed, prepared, and served by the housewife to as many family, friends, and dependents as could be accommodated. Later, the emphasis shifted to kin rather than community, but the classic Thanksgiving bill of fare, based on what was available in November in colonial New England, remained sacrosanct. Over the years the ideal of a home-prepared meal and informal family gathering has sent generations of women seeking the advice of experts from Catherine Beecher to Martha Stewart. Regional and ethnic variations were allowed, but the iconic turkey, cranberry sauce, and pumpkin (or squash) pie consecrated all true Thanksgiving meals.

Thanksgiving dinner is one of the most important occasions for American families of all faiths and ethnic backgrounds to come together and enjoy a large home-cooked meal. © STEVE CHENN/CORBIS.

The first of ten national Thanksgivings was declared by the Continental Congress in 1777. After 1815, there were no further presidential proclamations despite annual editorial pleadings by Mrs. Hale in *Godey's Magazine*, but the popularity of the holiday grew apace. By the 1850s, Thanksgiving was celebrated in almost every state and territory, its national character assured. Abraham Lincoln declared two Thanksgivings in 1863, the second in November being the first of our modern national holidays, but it was not until 1941 after Roosevelt fiddled with the date with an eye to Christmas sales that Congress established the fourth Thursday as a legal holiday. Aside from packaged versions of traditional foods, expenses associated with holiday travel, and a moderate amount of decorative kitsch, the holiday also escaped the exploitive commercialism of other American holidays. Restaurants take advantage of the holiday to sell turkey dinners, and those dedicated purveyors of classic Thanksgiving fare, the armed services, do their best, but Thanksgiving retains its strongly domestic focus.

In light of their modern importance as the symbols of the holiday, it might be asked. "What about the Pilgrims?" The fact is that the famous description of the 1621 harvest festival in Mourt's Relation had been entirely forgotten before being rediscovered in 1822 and identified as the "First Thanksgiving" by Alexander Young in 1841.

No one had associated the Plymouth colonists and Indian guests with the holiday before. However, in 1841 the event resembled contemporary Thanksgivings, even if it had not been so regarded by the original participants. The concept took time to catch on, as the Pilgrims had other symbolic burdens to bear, and Thanksgiving still implied family reunions, turkeys, and Yankee homesteads to most people. It wasn't until a fictional account appeared in the bestselling *Standish of Standish* (1889) that the Plymouth association gained widespread popularity, and only after World War II did the Pilgrims become the primary significators of the holiday.

See also **American Indians; Christianity; Fasting and Abstinence; Feasts, Festivals, and Fasts; Holidays; Icon Foods; Religion and Food; United States: New England.**

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THIAMINE. *See* **Vitamins.**

THIRST.

Thirst is a conscious sensation that results in a desire to drink. Although all normal humans experience thirst, science can offer no precise definition of this phenomenon because it involves numerous physiological responses to a change in internal fluid status, complex patterns of central nervous system function, and psychological motivation. Three factors are typically recognized as components of thirst: a body water deficit, brain integration of central and peripheral nerve messages relating to the need for water, and an urge to drink. In laboratory experiments, thirst is measured empirically with subjective perceptual scales (for example, ranging from "not thirsty at all" to "very, very thirsty") and drinking behavior is quantified by observing the timing and volume of fluid consumed.

Psychologists classify thirst as a drive, a basic compelling urge that motivates action. Other human drives involve a lack of nutrients (for example, glucose, sodium), oxygen, or sleep; these are satiated by eating, breathing, and sleeping. Clark Hull published a major, relevant theory describing the nature of human drives in 1943. He observed that learned habits, in addition to the thirst drive, influence drinking strongly. If a behavior reduces thirst, that behavior is reinforced and learned as a habit. Irrelevant behaviors (for example, sneezing, grooming) provide no reinforcement, have no effect on drinking, and do not become habits. Further, Hull realized that external incentives, such as the qualities or quantity of a fluid, also influence fluid consumption. On a hot summer day, for example, a cold beverage is more attractive than a cup of hot tea. Yet when chilled to a very low temperature, a cold beverage becomes an aversive stimulus to drinking behavior. Physiologists have popularized the term *alliesthesia* (from Greek root words referring to altered sensation) to describe the fact that the sensation of thirst may have either pleasant or unpleasant qualities, depending on the intensity of the stimulus and the state of the person.

Numerous investigations have verified that thirst and drinking behavior are complex entities. For example, drinking behavior (that is, the timing and the amount of fluid consumed) is not linearly related to the intensity of perceived thirst. Nor should we infer that individuals experience thirst simply because they drink. These facts indicate that thirst and drinking behavior are distinct entities that influence each other and are influenced by numerous internal and external factors.

Physiological Components of Thirst

Thirst is often viewed by physiologists and physicians as a central nervous system mechanism that regulates the body's water and minerals. The significance of the thirst drive is emphasized by three facts: 50 to 70 percent of adult body weight is water, the average adult ingests and loses 2.5 liters of water each day, and body weight is regulated within 0.2 percent from one day to the next. Clearly, water is essential to life and the body responds in a manner that ensures survival.

In 1954, Edward Adolph and colleagues proposed a multiple-factor theory of thirst that has not been refuted to date. This theory states that no single mechanism can account for all drinking behavior and that multiple mechanisms, sometimes with identical functions, act concurrently. Because water is essential to life, the existence of redundant mechanisms has great survival value. Among these, thirst appears to be regulated primarily by evaluation of changes in the concentration of extracellular fluid, measured as the osmolality of blood plasma. (Osmolality is a measurement that describes the concentration of all dissolved solids in a solution, that is, dissolved substances per unit of solvent. In research and clinical laboratories, the unit for osmolality of blood is mOsm/kg or milliosmoles per kilogram of water.)

Below a certain threshold level of plasma osmolality, thirst is absent. Above this threshold, a strong desire to drink appears in response to an increase of 2 to 3 percent in the level of dissolved substances in blood. The brain's thirst center lies deep within the brain, in an area known as the hypothalamus. This anatomical site contains cells that respond to changes in the concentration of body fluids. When the thirst center is stimulated by an increased concentration of blood (that is, dehydration), thirst and fluid consumption increase.

As the brain senses the concentration of blood, it allows a minor loss of body water before stimulating the drive to drink. This phenomenon has been named voluntary dehydration. Specifically, several research studies since the 1930s have observed that adults and children replace only 34 to 87 percent of the water lost as sweat, by drinking during exercise or labor in hot environments. The resulting dehydration is due to the fact that thirst is not perceived until a 1 to 2 percent body weight loss occurs. Interindividual differences, resulting in great voluntary dehydration in some individuals, have caused them to be named reluctant drinkers.

Reduced extracellular fluid volume, including blood volume, also increases thirst. Experiments (for example, reducing blood volume without altering blood concentration) have demonstrated that volume-sensitive receptors in the heart and blood vessels likely regulate drinking behavior by increasing the secretion of hormones. This effect is relatively minor, however. Animal research suggests that a change in extracellular fluid concentration accounts for most (for example, 70 percent) of the increased fluid consumption that follows moderate whole-body dehydration, whereas a decrease of fluid volume per se plays a secondary role.

Thus, thirst is extinguished when body fluid concentration decreases and fluid volume increases. Osmolality-sensitive nerves in the mouth, throat, and stomach also play a role in abating thirst. As fluid passes through the mouth and upper gastrointestinal tract, the sense of dryness decreases. When this fluid fills the stomach, stretch receptors sense an increase in gastric fullness and the thirst drive diminishes.

As dehydration causes the body's extracellular fluid to become more concentrated, the fluid inside cells moves outward, resulting in intracellular dehydration and cell shrinkage, and the hormone arginine vasopressin (AVP, also known as the antidiuretic hormone) is released from the brain. AVP serves two purposes: to reduce urine output at the kidneys and to enhance thirst; both serve to restore normal fluid balance. Other hormones influence fluid-mineral balance directly and thirst indirectly. Renin, angiotensin II, and aldosterone are noteworthy examples. As dehydration reduces circulating blood volume, blood pressure decreases and renin is secreted from blood vessels inside the kidneys. Renin activates the hormone angiotensin II, which subsequently stimulates the release of aldosterone from the adrenal glands. Both angiotensin II and aldosterone increase blood pressure and enhance the retention of sodium and water; these effects indirectly reduce the intensity of thirst. Angiotensin II also affects thirst directly. When injected into sensitive areas of the brain, it causes a rapid increase in water consumption that is followed by a slower increase in sodium chloride consumption and water retention by the kidneys.

Down through the centuries, potters, glassblowers, and metalsmiths have devised clever and decorative ways to quench thirst. These Roman glass tumblers, discovered at Pompeii, were made by blowing the glass into wooden molds in order to create the raised patterns. Raised patterns helped the drinker hold the glass more firmly, thus lessening the likelihood of having it slip through the fingers when tipsy on wine. © MIMMO JODICE/CORBIS.

Host Factors

Repeated training sessions in cool or hot environments alter fluid consumption in four ways. First, physical training increases the secretion of the hormone AVP, which stimulates drinking and body water retention. Second, exercise-heat acclimation (that is, adaptations due to exercise in a hot environment over eight days) increases the volume of fluid consumed and the number of times that adults drink during exercise. Third, frequent rest periods, in the midst of labor or exercise, will increase fluid replacement time and enhance fluid consumption.

Factors That Alter Thirst

Increase Thirst	Decrease Thirst
increased concentration of blood	decreased concentration of blood
decreased blood volume	increased blood volume
decreased blood pressure	increased blood pressure
mouth and throat dryness	increased stomach fullness
increased angiotensin II	decreased angiotensin II

Humans tend to drink less when they are preoccupied or are performing physical or mental tasks. Fourth, learned behaviors can enhance fluid consumption when thirst is absent. This phenomenon is widely appreciated among military personnel and athletes who are trained to consume water at regular intervals, whether they are thirsty or not.

Several research groups have reported that chronological age influences thirst and drinking behavior. Elderly men experience a blunted thirst drive and reduced fluid intake, perhaps due to their brains' reduced ability to sense changes in plasma osmolality or blood volume. Further, elderly individuals experience a decrease in the ability of their kidneys to conserve water. This suggests that the elderly are predisposed to dehydration when illness increases water loss (that is, vomiting, diarrhea) or when physical incapacity prevents access to water.

Fluid and Environmental Characteristics

Many fluid characteristics stimulate or enhance drinking, during or after exposure to a hot environment. Fluid temperature (consumption is greatest at 14 to 16ºC, reduced above 37ºC), turbidity, sweetness, fruit flavorings (for example, cherry, grape, orange, lemon), addition of citric acid which imparts a citrus flavor, and addition of sodium chloride or other minerals are examples. These components enhance palatability and increase fluid consumption. The addition of a small amount of salt (sodium chloride), besides enhancing palatability, may result in thirst and increased drinking, due to the specific action of sodium on fluid movements. An increased sodium concentration outside of cells causes water to leave cells via osmosis. The resulting cellular dehydration is an important stimulus for drinking. Increased beverage carbonation tends to reduce the palatability of a fluid as well as the volume of fluid consumed, without an increase in thirst. In addition, intakes of food and water are closely related. During 24-hour observations of fluid intake, most studies report that the majority of fluid (69 to 78 percent) is consumed during meals. The foregoing characteristics, therefore, tend to reduce the magnitude of voluntary dehydration.

Conversely, fluid characteristics may influence drinking behavior negatively, regardless of the intensity of thirst. Experiments conducted during mild prolonged exercise have shown that the following qualities are perceived as undesirable: nausea, bloating, an objectionable feeling in the mouth, excessive viscosity, and excessive sweetness (see Passe, 1996). Exercise and high ambient temperature may independently alter an individual's perception of fluid palatability. For example, drinking behavior increases when air temperature exceeds 25°C. Fluid consumption can also be enhanced by changing the shape of a fluid container, proximity of fluid containers to the drinker, volume of fluid that is available, and time allowed for drinking.

Societal customs may influence fluid consumption, as evidenced by cross-cultural differences in beverage preferences. Even rituals, such as accepting the friendly offer of a beverage in a social setting, may enhance fluid intake beyond that driven by physiological cues. These factors usually involve learned habits. Similarly, when people repeatedly drink fluids with initially unfamiliar flavors, the palatability of the fluids is enhanced.

Although a comprehensive theory of thirst and fluid balance eludes description, it is likely that the thirst drive increases and diminishes because multiple factors (for example, oral dryness, gastric distension, osmolality, volume, fluid qualities) are integrated concurrently by the brain's thirst center.

See also **Alcohol**; **Appetite**; **Beer**; **Cocktails**; **Coffee**; **Grapes and Grape Juice**; **Sensation and the Senses**; **Tea**; **Water**; **Wine**.

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Lawrence E. Armstrong

TILLAGE. Farmers perform tillage when they prepare soil for the raising of crops. Soil tillage has three primary purposes. Prior to planting, farmers use tillage to mix compost, manure, and other fertilizers into the root zone where growing plant roots may reach it. Tillage also aids seed germination by creating a smooth, uniform soil surface for planting. After planting, farmers use tillage to control weeds between crop plants—including vegetable, fruit, forest, medicinal, and farm crops. Since early agriculture, tillage has been the first step in the process that makes it possible to harvest food from plants. However, soil tillage has come under close scrutiny since soil is recognized as a natural resource that deserves protection. Agronomists (scientists who study crop production and soil management) are concerned because erosion (soil loss) from tillage is one of the most significant problems in agriculture. If left unchecked, soil erosion leads to loss of soil productivity, as well as off-site deposition of sediments and farm chemicals that pollute surface and groundwater.

Early History of Tillage

Soil tillage had its beginnings ten to twelve millennia ago in the Near East, as early farmers used a digging stick to loosen the soil before planting seeds. The tool evolved from digging stick to spade to triangular blade, and was made of wood, stone, and ultimately metal. One or more people likely used their bodies to pull the first wooden plows. Animals began pulling plows around 3000 B.C.E. in Mesopotamia. Jethro Tull (1674–1741), a pioneering British soil physicist, was the first to recognize that loosening soil helps to supply plant roots with nutrients.

In North America, agricultural innovators copied European trends. Charles Newbold patented the first cast-iron plow in the late 1700s. In 1837, John Deere and Leonard Andrus began manufacturing steel plows. By the 1840s, the growing use of manufactured equipment had increased the farmers' need for cash, thus encouraging the rise of commercial farming. Agriculture, society, and economics were closely linked, as George Marsh said in an address delivered in 1847 to the Agricultural Society of Rutland County, Vermont: "Pure pastoral life, as I have said, advances man to but an humble stage of civilization, but when it is merged in agriculture, and the regular tillage of the soil commences, he is brought under the dominion of new influences, and the whole economy of domestic and social life is completely revolutionized." Marsh explained that once cultivation of soil begins, all aspects of society are affected by changes: "Hence arises the necessity of fixed habitations and store houses, and of laws which shall recognize and protect private exclusive right to determinate portions of the common earth, and sanction and regulate the right of inheritance, and the power of alienation and devise, in short the whole frame work of civil society."

Horses and mules had taken over the work of draft oxen by the late 1800s. As agriculture became increasingly mechanized and commercialized, tractors became more common and replaced most draft animals by the early to mid-1900s. Until then, the size of most family farms was restricted to the land that a man could work using several horses. With the advent of the light, gasoline-powered tractor, both family and commercial farms added crop area and prospered.

The Dust Bowl

Tractors helped to create farm fields that stretched far westward, setting the stage for the Dust Bowl in the 1930s. Open grassland in the southwestern Great Plains region of the United States was settled and farmed by

Tilling with draught animals is a dying art, for both farmer and team must be well-trained to accomplish plowing in the quickest and most efficient manner. This elderly farmer is using a horse team in fields near Melk, Austria. © ADAM WOOLFITT/CORBIS.

homesteaders who planted row crops and grazed their cattle. Before farmers came, the region was covered by hardy grasses that held the soil in place despite long droughts and torrential rains. Tillage combined with drought left the soil exposed to wind erosion. Lightweight soil components—organic matter, clay, and silt—were carried great distances by the winds, while sand and heavier materials drifted against houses, fences, and barns. This drifting debris buried farm buildings and darkened the sky as far as the Atlantic coast. Over a period of ten years, millions of acres of farmland became useless, and hundreds of thousands of people were forced to leave their homes.

The Dust Bowl gave impetus to the soil conservation movement; nevertheless, mechanization continued to spread. In 1938, Hugh Bennett and Walter Lowdermilk of the United States Soil Conservation Service wrote in the *Yearbook of Agriculture*: "Soil erosion is as old as farming. It began when the first heavy rain struck the first furrow turned by a crude implement of tillage in the hands of prehistoric man. It has been going on ever since, wherever man's culture of the earth has bared the soil to rain and wind."

Conservation Tillage and Sustainable Agriculture

By 1954, the number of tractors on farms exceeded the number of horses and mules for the first time. The increasing availability of agricultural chemicals in the mid- to late-1900s, including weed killers that did not harm crop plants, further changed crop and soil management practices. "Conservation tillage"—a broad spectrum of farming methods that help to reduce soil erosion due to wind and water and help to reduce labor and fuel—gained a following among farmers in the 1980s. Early methods of conservation tillage, such as no-tillage, were *un*sustainable since they relied heavily on chemical weed killers called herbicides. The no-tillage method worked well to control both soil erosion and weeds, while requiring less energy. However, herbicides were highly toxic to people and wildlife and their manufacture and use caused environmental pollution. Tillage reduction methods were fine-tuned to suit local conditions throughout the United States.

By 1989, a far-sighted handful of new-generation farmers became interested in lowering costs, avoiding agricultural chemicals, and saving soil. They started the agricultural movement that became known as "sustainable agriculture." Low-input methods meet the needs of more farmers each year. They are promoted by a program of the United States Department of Agriculture called Sustainable Agriculture Research and Education (SARE). Farmers practicing sustainable agriculture produce food and fiber while enhancing environmental quality and natural resources, make the most efficient use of nonrenewable resources and on-farm resources. Further, they integrate natural biological cycles and pest controls and sustain the economic viability of farm operations.

Today's tillage practices reflect society's concern with environmental quality, and the farmer's need to reduce costs while preventing soil erosion and compaction. However, significant amounts of soil are still lost annually around the world where soil is not protected.

See also **Agronomy**; **Greenhouse Horticulture**; **Horticulture**; **Organic Farming and Gardening; Sustainable Agriculture**.

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Patricia S. Michalak

TIME. "Time" may not spring to mind immediately when one thinks of food, but time is always a factor. After all, recipes generally incorporate an element of time (for example, "let rise for four hours" or "bake for forty-five minutes"), cooking preparation involves time, and various demands drive the length of meals. Thus, time has an impact on one's daily food and food-preparation routine, and this impact is a particularly gendered process.

In nearly all parts of the world, cooking is a female task (Murdock and Provost, 1973). Women's time is bounded by food-preparation tasks, particularly if they must perform those tasks several times a day (for example, tasks such as tortilla preparation, millet pounding, and the preparation from scratch of several meals a day). Alteration of a daily routine, for example, the intrusion of a more "urban" or fast-paced schedule, can alter food-preparation patterns. If women enter a market economy, they have less time to prepare food, which leads to, among other things, increased purchases of prepared food and more business for the fast-food industry. Time and food preparation are also markers of rank or class, since elaborate meals are generally costly in terms of time preparation as well as ingredients—in most societies, only the well-to-do, who have either time or help or both, can prepare elaborate meals. These widespread changes in food-preparation patterns are part of urban Western culture, where convenience and fast-food items (the names of which indicate their purpose) are replacing daily meal preparation. The Italian "slow food" movement is counterpoised against this trend.

Food Preparation

The preparation of foods—the transformation from a raw or unprocessed state to one suitable for consumption—occupies a major portion of many women's time throughout much of the world. For rural women and those in developing nations, preparation of meals may take up the major portion of a woman's waking life. Since staple foods must undergo a lengthy preparation process, women can spend much of their time processing grain, nuts, or tubers, in addition to meal preparation itself. (This pattern has antecedents in the West, as well: consider the time needed to make bread and churn butter.)

Accompanying this ongoing preparation of staples is the routine of meal preparation. For example, Andean Ecuador meal preparation, which is performed from scratch twice a day, generally involves two to three hours of potato peeling, water boiling, and construction of the soup that constitutes the staple meal (Weismantel, 1988). In southern Mexico, rural Maya women may prepare up to two hundred tortillas per day, grinding and cooking them at each of two or three meals (Eber, 2000). In rural Africa, women farmers grind the standard grains, usually millet or sorghum, into flour for porridge or soup on a daily basis. Pounding millet, as this process is called, occurs at least once a day, and sometimes more often as needs demand. African women are also responsible for preparing and assembling meals. In Western urban settings, the food-preparation process may be slightly less rigorous, but often remains time-consuming, since the cook must peel, chop, and cook.

Scheduling and Meals

The timing of meals is culturally determined and is linked to preindustrial work patterns, particularly the agricultural cycle. Throughout Latin America, the main meal of the day traditionally falls in mid-afternoon. The siesta, stereotypically seen by North Americans as a sign of indolence, is actually the main meal of the day. This pattern remains intact in smaller cities and rural areas, though the demands of global business are increasingly pushing urban workers into the short noon lunch typical of the United States. Among rural indigenous peoples, however, mealtimes may differ, following much more closely the requirements of subsistence farming. Breakfast is eaten very early in the morning, and a second, larger meal follows in the late morning or early afternoon. Another meal occurs in early evening, with an occasional snack before bedtime (which also occurs early, often shortly after sundown). At the same time, much of the urban world has already adopted a meal schedule that better conforms to the demands of industrialism. Such changes may alter or eliminate traditional meals or reduce the time families spend together (Rotenberg, 1992).

Food, Time, and Class

Social standing shapes the ways in which food and time intersect. For those with sufficient income, only one member of a family need work, leaving the other family members at home to prepare traditional meals. Another alternative to preparing food for oneself is to hire a professional cook, who is also able to prepare meals from scratch.

For those with little money and little time, the options decrease. Convenience and fast-foods are expensive for what they provide, and they are often limited to single or perhaps two servings. Time, money, and class intersect in other ways that affect meals, as well. For the working poor, hours of overtime, or even two jobs, may take up the time that would otherwise be spent preparing and eating meals; meager wages may also reduce one's housing choices. In her book on the working poor, *Nickel and Dimed*, Barbara Ehrenreich describes this housing process: Unable to afford housing with a kitchen, the worker cannot purchase foods to prepare in bulk and cannot store or freeze these foods. Such workers are sometimes entirely dependent on meals they can purchase and eat immediately, such as fast-food or the kinds of overpriced but affordable snack food sold in convenience stores.

Changing Time and Changing Food

The impact of urban work patterns has affected mealtimes, food choices, and diet throughout the world. As workers move from an agrarian life to one driven by waged work, they shape their mealtimes to that of the workplace rather than the farm. The kinds of foods workers choose to eat are likely to be those that can be taken to the workplace or eaten on the run. The rise in sales of prepared foods appears to inevitably accompany women's entry into the workforce, and sometimes women themselves enter the workforce to provide the prepared food, a pattern seen in Peru (Babb, 1998), rural Africa (Clark, 1994), and elsewhere. The ability to bring home prepared food enables women to spend longer periods of time working in a pattern that parallels western women's purchase of fast-food dinners for the family. For the westerner and the rural worker alike, elaborate meals requiring lengthy preparation become increasingly associated with ritual and holiday feasting. The role of time in the preparation of holiday foods rather than (or in addition to) the use of special ingredients marks them as special treats. This stands in contrast to the faster and less elaborate meals consumed during a regular workweek. Sidney Mintz, in his work *Sweetness and Power*, has further suggested that the increasing consumption of sugar in tea allowed the shift of displaced rural English into industrial labor—they could consume cheap quick meals of tea and bread and spend much of their time working.

The speedy meal is familiar also in the form of the fast-food industry that the demands of postindustrial capitalism shaped. The busy worker can order, pick up, and pay for a quick and generally tasty meal, all without ever leaving the car. Eric Schosser has described in-depth the quite extensive impact of the fast-food industry on diet, food production, and meal patterns in his book *Fast Food Nation*. While answering the demand for quick, easily consumed meals, the fast-food industry has also shaped marketing, taste preferences, and even agricultural practice.

The "slow food" movement has arisen in opposition to the pervasiveness of the fast-food industry. Founded in Italy, "slow food" promotes local and organic foods, family mealtimes, and the role of food in social life. In general, this movement opposes the increasingly mechanized and driven work life that the fast-food industry and North American culture represent (Inouye, 2001).

See also **Class, Social**; **Division of Labor**; **Fast Food**; **Preparation of Food**; **Slow Food**.

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TOMATO. The *Lycopersicon* genus of the Solanaceae family originated along the coastal highlands of western South America. The genus is composed of nine generally accepted species, of which only two are used for culinary purposes: *L. esculentum*, the common tomato, and, to a much smaller extent, *L. pimpinellifolium*. Ripe, raw tomatoes consist of approximately 93 percent water. Consuming one hundred grams of raw tomatoes provides seventeen grams of carbohydrates, three grams of protein, twenty-three grams of vitamin C, or about forty percent of the adult recommended daily allowance (RDA), and about nine hundred international units of vitamin A, or about 30 percent of the adult RDA. Today, the tomato is one of the most commonly eaten foods in the world with almost every cuisine employing them in some form.

In the United States, tomatoes are second only to potatoes in U.S. vegetable consumption. During the 1980s and 1990s, U.S. annual per capita use of tomatoes and tomato products has increased by nearly 30 percent, reaching an annual total fresh-weight equivalent of 91 pounds per person by 1999. By that date, the total world production was 111.1 million short tons. Until recently, the United States was the world's largest tomato producer. However, during 1999 China was ranked the largest tomato producer with 18 million short tons, followed by the United States (12.7 million short tons), Turkey, Egypt, and Italy.

The Spread of the Tomato

Although the tomato originated in South America, little evidence has surfaced indicating that indigenous peoples in South America ate tomatoes before the Spanish conquest in the sixteenth century. In pre-Columbian times the tomato migrated by unknown means to Central America, where it was domesticated by Mesoamerican peoples. When the Europeans arrived, tomatoes were consumed only in a narrow geographical area from Central America to Mexico City. This lack of widespread diffusion has led observers to conclude that tomatoes were a late addition to the culinary repertoire of Mesoamerica. The Spanish first encountered tomatoes after their conquest of Mexico began in 1519. Tomato plants were disseminated first to the Caribbean, and then to Spain and Italy. From Central America, domesticated tomatoes were introduced into South America by the Spanish Conquistadors. Toward the end of the sixteenth century, tomatoes traveled west to the Philippines, from where they were introduced into Indonesia and later onto the Asian mainland.

Tomatoes were consumed in southern Italy and Spain by the mid-sixteenth century. The first published record of the tomato appeared in an 1544 Italian herbal. By the late seventeenth century, the first known tomato recipes appeared in the cookbook *Lo scalco alla moderna* (Naples, 1692), by Antonio Latini. By this time, tomatoes were also consumed in the eastern Mediterranean and North Africa. Tomato cookery took off in southern France late in the eighteenth century and tomato recipes appeared in French cookbooks by the early nineteenth century. Tomatoes were cultivated in England by 1597; however, little evidence for British consumption has been found prior to the mid-eighteenth century.

Beginning in the seventeenth century, Spanish colonists introduced tomatoes into their settlements in Florida, New Mexico, Texas, and California. As English settlers visited and occupied territories previously controlled or influenced by Spain and Mexico, they were exposed to tomato cookery. Some American colonists ate tomatoes as early as the mid-eighteenth century, although only one colonial cookery manuscript is known to have contained a tomato recipe. From the Southern states, tomato culture slowly spread up the Atlantic coast and into rural areas. By the early nineteenth century, tomato recipes frequently appeared in American cookery manuscripts and cookbooks. By the mid-nineteenth century, tomatoes were a common part of cookery throughout western Europe, the Mediterranean and the Americas. Tomato cookery later expanded into Northern and Eastern Europe, and finally spread to sub-Saharan Africa, and South and East Asia.

Procurement

Traditionally, all aspects of tomato sowing, growing, and harvesting were accomplished by hand. Beginning in the late nineteenth century, machinery began to assist farmers in planting, sowing, and weeding. Although all fresh tomatoes continue to be picked by hand today, tomatoes used for processing are picked by mechanical harvesters, which were first successfully employed in California during the 1950s.

Beginning in the early nineteenth century, tomatoes were bottled by the Frenchman Nicholas Appert. In the United States, tomato canning and bottling began in New Jersey during the 1840s. It expanded during the Civil War, and by 1870 tomatoes were among the top three canned products in America. Tomato cultivation increased in northern states, such as Maryland, Delaware, Pennsylvania, and Ohio, and spread south and west after the war. Today, California grows the largest number of tomatoes, with about 80 percent of total U.S. production.

THE FIRST KNOWN AMERICAN TOMATO RECIPE

To Keep Tomatoos for Winter use
Take ripe Tomatas, peel them, and cut them in four and put them into a stew pan, strew over them a great quantity of Pepper and Salt; cover it up close and let it stand an Hour, then put it on the fire and let it stew quick till the liquor is intirely boild away; then take them up and put it into pint Potts, and when cold pour melted butter over them about an inch thick. They commonly take a whole day to stew. Each pot will make two Soups.

N.B. if you do them before the month of Oct they will not keep.

SOURCE: Harriott Pinckney Horry Papers, 28. The Collections of the South Carolina Historical Society.

Tomato Canning

The major use of tomatoes is the canning of four major products: whole tomatoes, tomato sauce, tomato paste, and tomato soup. The first canneries processed whole tomatoes. These efforts began in the 1850s and were labor-intensive operations. The fruit were skinned, cored, and trimmed. Cans were fashioned by hand, and the seams were soldered on. These were then boiled in water. The cans were hand-filled, then given to the cappers, who soldered on the lids one at a time. A few days later the cans were hand labeled, loaded onto wagons, and carted to stores.

Before long, every stage of the canning operation had a machine associated with its operation. Devices for capping, filling, scalding, topping, and wiping were introduced, as were power hoists and cranes. Wrapping and boxing machines also soon came into use. Equipment manufacturers developed lines of interconnected equipment. New machinery was released about 1903, providing for the fully automated manufacture of sanitary cans. By the 1920s, the process of canning tomatoes was fully automated. From the time tomatoes arrived by truck until the canned goods were shipped out the back door, the tomatoes were never touched by human hands. Subsequent developments in machinery sped up the process and made it more efficient.

During the 1950s, evaporators originally developed for the dairy industry were adapted for use in tomato processing. The evaporators rapidly remove water and concentrate the pulp to forty-two percent solids. Some concentrate is frozen via flash coolers, which remove water and heat, as the paste falls through the machine. The chilled concentrate is then stored in drums and used when

THE TOMATO: VEGETABLE OR FRUIT?

The edible portion of the tomato is botanically a fruit (defined as a ripened ovary!) as is the edible portion of melons, cucumbers, eggplants, and hot and sweet peppers. However, these plants are considered vegetables both horticulturally and in common English usage. A vegetable in the culinary sense is thought of as an edible herbaceous (soft-stemmed) plant of which some part is eaten, often in the main part of a meal; this includes the fruit as in tomato, the leaves in lettuce, the stem in asparagus, the root in beet, and the seed in the garden pea. The edible portions are also referred to as vegetables. Fruit plants in the horticultural sense are plants in which a more or less succulent fruit or closely related structure is eaten (but usually as a dessert or a snack). In this case the edible portion is also called a fruit, even if it is not clearly a fruit botanically. We call a strawberry a fruit, but it is the hard little seeds that are the botanical fruits (one-seeded fruits called achenes). Fruit plants are most often perennial and usually woody (exceptions include strawberry and banana, which are not truly woody). Fruit plants with fruits borne on trees are termed tree fruits, fruits borne on low-growing plants are called small fruits, and those on vines are called vine fruits. Nuts are a special subcategory of fruits characterized by having a hard shell separating the inner kernel of the seed. There is no precise distinction that can be made between the terms "fruit" and "vegetable." In the case of tomato, confusion can be avoided by referring to it as a "vegetable fruit." In 1893 the U.S. Supreme Court ruled that the tomato was legally a vegetable in a decision resolving a dispute concerning import duties, making an important legal point that the meanings of terms used in laws and statutes refer to common everyday meanings, not necessarily the scientific meanings.

See also **Fruit: Temperate Fruit; Horticulture; Naming of Food; Nuts.**

Jules Janick

needed. Other concentrate is pumped into aseptic bags, which exclude outside air. Framed in collapsible wooden boxes, the bags are placed on trucks and shipped to factories for conversion into tomato products.

Ketchup Production

Another major use of tomatoes in the United States is in the production of ketchup. Initially, ketchup production began as an attempt to use leftovers from the canning process. These scraps were placed in barrels during the high canning season in September and October and were saved for later conversion into ketchup. As tomato ketchup became more popular, factories emerged that specialized solely in its production. Because the bright red color of the ketchup was an important selling point, ketchup was placed in bottles so that the consumer could see its color. Long narrow-nosed bottles with small holes were employed to reduce contact with air, which oxidized ketchup and turned it a deep dark color. Early ketchup bottlers had great difficulty preventing the introduction of air through the cap. In the early part of the twentieth century researchers developed improved glass bottles that would not shatter during the manufacturing process. Corks were covered with a metal cap that effectively sealed the bottle from contact with outside air. As capping technology improved, screw caps replaced corks.

Early ketchups were thin and were easy to pour out of the small hole at the top of the bottles. After the passage of the Pure Food and Drug Act in 1906, thick ketchup became the norm in order to meet the new federal standards. Thick ketchups were difficult to pour through the narrow spout, but consumers were already familiar with the narrow nosed bottle and commercial manufacturers had invested time, effort, and funds in creating an image for their bottle.

Packaging changes since the 1970s have greatly increased ketchup usage. The H. J. Heinz Company, the largest ketchup producer in the world, introduced the Vol-Pak, a plastic bag filled aseptically with ketchup. Designed for foodservice operators, restaurants placed the bag on a rack and refilled plastic bottles. The Vol-Pak soon replaced cans. During the 1980s, two additional packaging revolutions occurred: the single-serve ketchup pouch, for which production increased from half a million cases to five million cases in just ten years; and the squeezable plastic ketchup bottle, which was easier to use, and almost unbreakable. By the 1990s, sixty percent of all U.S. ketchup was sold in plastic containers.

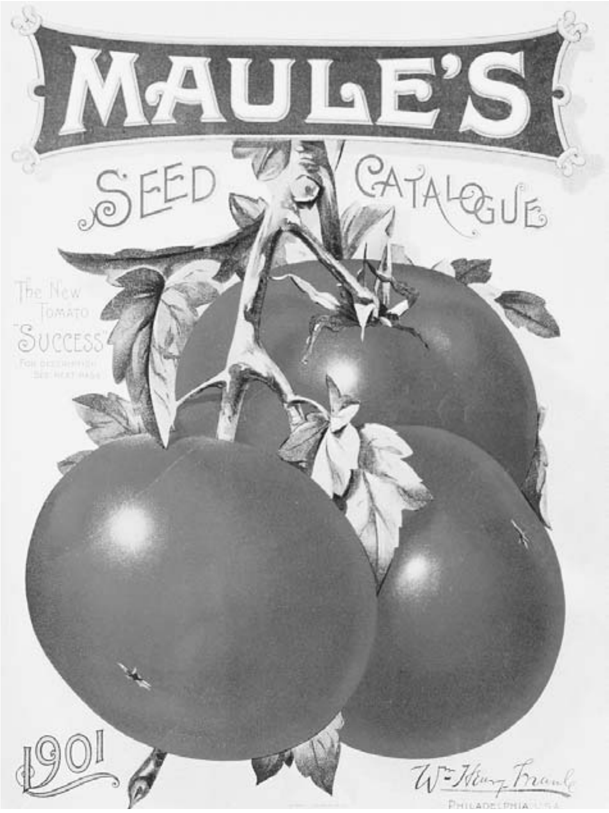
Preparation and Consumption

Tomatoes were employed by pre-Columbian Aztecs and other indigenous peoples of Central America for making sauces, particularly in combination with chili peppers and ground squash seeds. After the Spanish conquest, vinegar was added to the tomato and chili peppers to produce salsa. Numerous other uses for the tomato were developed in Mexico and Central America. In Europe, the first tomato recipe appeared in an 1544 Italian herbal, which recommended that tomatoes should be fried in olive oil and seasoned with salt and pepper. Variations of this recipe were published regularly in Europe and later in the Americas. Within a hundred years, tomatoes were well established in southern Italian cookery. The first tomato recipe appeared in a British cookbook in the late eighteenth century. The first known American tomato recipe appeared in Harriott Pinckney Horry's cookery manuscript, dated 1770.

Tomato recipes regularly appeared in American cookbooks by 1792. Early recipes fell into several major categories; the most important was tomato sauce, which originated in Italy and Spain and had migrated to southern France before 1800. Tomato sauce was used on beef, veal, fowl, chicken, rabbit, sweetmeats, pork, macaroni, fish, shrimp, and pigeon. Tomatoes were used to make marmalades, soups, gumbos, gazpacho, ketchups, sweetbreads, jumbles, dumplings, puddings, jelly, figs, omelets, and many other dishes. Tomatoes were stewed, baked, fried, stuffed, hashed, pickled, broiled, scalloped, forced, pickled, and preserved. Green tomatoes were consumed from the beginning, and sometimes were used for seasoning and gravy. Tomatoes were combined with many other vegetables to be consumed as side dishes, including okra and potatoes. Tomatoes were served raw at all meals. Raw tomatoes were seasoned with sugar, molasses, vinegar, salt, pepper, mustard, or milk. The most common way to eat raw tomatoes was sliced and seasoned, like cucumbers, with vinegar, salt, and pepper. Others plucked them from the vine and ate them like ripe fruit, without seasoning.

American restaurants were opened toward the end of the eighteenth century, mostly by French refugees. Their clientele consisted of businessmen and an increasingly affluent upper class. Tomatoes were served in these restaurants at least by the 1820s and probably much earlier. From their inception, restaurants offered a variety of tomato dishes. Tomatoes were noted on hotel menus by 1825. By the 1840s the diversity of tomato dishes dramatically increased.

Tomatoes were also employed to make beverages. The earliest beverages were alcoholic: beer, whisky, champagne, and wine, none of which were particularly successful. The drinking of tomato juice was a mid-twentieth-century phenomenon. According to several accounts, tomato juice was the creation of the American-born French Chef Louis Perrin, who in 1917 served tomato juice to his guests at a resort in French Lick Springs, Indiana. However, none of the early products yielded juice with just the right color and flavor. The reason for the failure of canned tomato juice was that tomato solids settled at the bottom of the can or in the glass when poured out. In 1928, this problem was solved by Ralph Kemp of Frankfort, Indiana, who used a viscolizer previously employed in the manufacture of ice cream. Tomato juice was an instant hit with the American public. Heinz and the Campbell Soup Company moved into high gear to produce tomato juice. One reason that tomato juice was so successful was the end of prohibition. A cocktail made of tomato juice and vodka was probably first developed at Harry's Bar in Paris by Ferdinand "Pete" Petiot, who moved to New York in 1933 and introduced his new creation. After experimentation, he added Worcestershire sauce and called it a Bloody Mary.



The "Quarter Century Tomato" introduced in 1901 by Philadelphia seedsman William Henry Maule. During the fifty-year period from about 1875 to 1925, American seed companies vied with each other to develop newer and better tomatoes every year, owing to the popularity of tomatoes among home gardeners. Cover graphics from the Maule 1901 seed catalog. © CYNTHIA HART DESIGNER/CORBIS.

Another tomato product was V8 vegetable juice, a blend of eight vegetables along with several flavor-enhancers. It had been conceived in 1933 by W. G. Peacock of Evanston, Illinois. Several people worked on the formula. Peacock interested three investors, and the New England Products Company was created. The product was first created in 1936 under the name "Veg-min" juice. At the first store that sold it, a clerk suggested that they change its name to "V-8," which Peacock did. Later the hyphen was removed and the product was marketed as V8 Cocktail Vegetable Juices. Peacock's entire operation was accomplished by hand, and he only had the ability to produce twenty-five cases per day. V8 juice was a success, but he did not have sufficient manufacturing capability to meet the demand. Peacock sold the V8 formula, and in 1948 the product ended up at the Campbell Soup Company, which is the largest tomato user in the world.

Relation to Human Biology

While there are many reasons for identifying the tomato as a healthy vegetable, the specific attributes that have generated the latest interest are the carotenoids, a family of pigments found in yellow, orange, and red vegetables and in green leafy vegetables. There are over six hundred carotenoids, but the predominant one in tomatoes is lycopene, a pigment that gives tomatoes their red color. The human body cannot manufacture Lycopene or other carotenoids. Some studies have offered evidence that foods rich in antioxidants and carotenoids may play a role in preventing certain types of cancer. Dr. Edward Giovannucci, an assistant professor in the Department of Nutrition at Harvard School of Public Health and the Department of Medicine at the Harvard Medical School, examined responses of fifty thousand participants in the Harvard University Professionals Health Study that began in 1986. He concluded that the consumption of four vegetables and fruits were associated with lower prostate cancer risk: three of the foods he cited were tomato sauce, tomatoes, and pizza. Lycopene is present in each of these. The risk of prostate cancer was one third lower in men who ate tomato-based products. In another study in northern Italy, a high correlation was drawn between tomato consumption and the lack of cancers of the digestive track. Of the 2,700 respondents, those who consumed seven or more servings of raw tomatoes every week had 60 percent less chance of developing cancer of the colon, rectum, and stomach.

Love Apples

I gather love-apples very ripe, when they have acquired their beautiful colour. Having washed and drained them, I cut them into pieces, and dissolve them over the fire in a copper vessel well tinned. When they are well dissolved and reduced one third in compass, I strain them through a sieve sufficiently fine to hold the kernels. When the whole has passed through, I replace the decoction on the fire, and I condense it till there remains only one third of the first quantity. Then I let them become cool in stone pans, and put them in bottles, &c. in order to give them one, good boiling only, in the water-bath.

SOURCE: Nicholas Appert, *The Art of Preservation.* New York: D. Longworth, 1812. pp. 53–54.

Diets with abundant tomatoes cooked in oil were more readily absorbed than other forms of tomato. Pizzas and raw tomatoes were also protective against prostate cancer, but tomato juice was not. Giovannucci believed that cooking broke down the tomatoes' cell walls, releasing more lycopene, and that the oil enhanced absorption of the fat-soluble carotenoid. In the case of raw tomatoes, salad oil may have contributed in a similar manner.

Symbolism

The tomato has become deeply entwined with popular culture throughout the world. In Japan a bank is named for it. In America tomato is slang for an attractive woman. Perhaps the most universal activity has been tomato throwing, a tradition that dates from the mid-nineteenth century. This tradition started in rural areas and moved to theaters to express lack of appreciation. Recently politicians have been the favorite target of tomato throwers. During the late 1940s, tomato throwing became an organized event in Bunyol, a town 25 miles west of the Mediterranean city of Valencia, Spain. The Tomatina festival, held on the last Wednesday in August, has been officially sponsored by the city since 1979. More than 30,000 people pelt each other and the city with tomatoes for a hour.

Other tomato festivals are held in other countries, including the United States. The Reynoldsburg Tomato Festival in Ohio attracts 35,000 residents who engage in tomato contests and consume tomato cookery. The Kendall-Jackson Heirloom Tomato Festival, held just north of Santa Rosa, California, featured tastings from more than 100 heirloom tomato varieties.

Contemporary Issues

Beginning in the 1950s, botanists induced genetic mutations with X rays and chemicals. These mutants were mainly of interest to researchers. The research, however, encouraged further investigations into the chromosomal structure of the tomato, making more sophisticated alterations possible. During the late twentieth and early twenty-first centuries, this research began to be productive. In a project funded by Campbell's Soup Company, Calgene, Inc., in Davis, California, genetically engineered the first tomato, called MacGregor's, which was slow-ripening and transportable over great distances.

Calgene had conducted research concluding that the rapid softening of ripe tomatoes was caused by an enzyme called Polygalacturonase, or PG. Calgene spliced into the tomato's genes an extra one to cancel out the effect of the PG enzyme, and thus created the Flavr Savr. Thus, the tomato remained firmer in its last week and could be left on the vine to ripen for extra days. After a week or so of extra firmness, the Calgene tomato softens and decays like other tomatoes. The company voluntarily presented their genetically altered tomato to the U.S. Food and Drug Administration (FDA) for approval. The genetically engineered tomato was approved by the FDA's Food Advisory Committee. Since 1994, genetically altered tomatoes have been sold in grocery stores. Other genetically engineered tomatoes are under development. Other companies with strong biotech programs include DNA Plant Technology, Petroseed, Monsanto, Pioneer, and Dupont.

Many critics have strongly opposed genetic engineering of the tomato as presenting an unacceptable risk for humans. Some grocery stores have refused to sell genetically engineered tomatoes, while others have agreed to identify them as genetically engineered. Restaurants have announced that they will boycott the new "mutant" tomatoes. A major concern is that there is no requirement that the genetically altered foods be labeled as such. Many critics believe they have the right to know which products have been altered and which are natural.

See also **Fruit**; **Genetic Engineering**; **Packaging and Canning, History of**; **Potato**; **Vegetables**.

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Andrew F. Smith

TOOTH DECAY. *See* Dentistry; Fluoride.

TORTILLA. *See* Maize.

TOURISM.

Food has always been a component of tourism. As a physical necessity and as a prominent arena for expressing creativity and for embodying cultural and individual identity, food has functioned as destination, venue, and vehicle for tourism. As destination, food is the primary experience sought. The preparation, consumption, and even the viewing of a foreign dish gives the tourist a sense of otherness and the exotic. As vehicle, food offers an entry point for viewing another culture. The sensory attributes of food enable consumers to feel a deeper level of experiencing; by ingesting food representing another culture, they can feel that they ingest that culture. As venue, food offers a site from which a culture can be explored. These aspects can be commercial or domestic, public or private, festive or ordinary. Restaurants, festivals, cookbooks, grocery stores, private festive food events, cooking classes, cooking shows, advertising, literature, films, tourism brochures, food tours, and other such sites are physical loci for experiencing tourism. They also offer a tangible, knowable base from which other facets of culture—history, religion, artistic traditions, customs—can be understood and experienced.

Tourism is generally thought of as an activity in which individuals explore a culture that is foreign to them. Valene Smith defines a tourist as "a temporarily leisured person who voluntarily visits a place away from home for the purpose of experiencing a change" (*Hosts and Guests*, p. 1). The theme of tourism as spiritual and emotional quest appears frequently in scholarly works. Dean MacCannell sees tourism as a modern phenomenon in which tourists are on a quest to recover lost authenticity: it offers a way for modern man to explore the "real life" of others (*A New Theory of the Leisure Class*, p. 91). Mark Neumann suggests that "tourism is a metaphor for our struggle to make sense of our self and world within a highly differentiated culture" ("Wandering Through the Museum: Experience and Identity in a Spectator Culture," p. 22). Most scholars of tourism now see tourism both as a state of mind in which anything, including the everyday and the local, can be subjected to the "tourist gaze"—to borrow John Urry's book title—and as a continuum of types of experiences involving otherness. Erik Cohen offers a typology of tourists based on their concept and concern with authenticity: existential, experimental, experiential, recreational, and diversionary tourists ("Authenticity and Commoditization in Tourism"). Valene Smith, in *Going Places*, outlines a typology of tourists based on aspects of culture being explored and on the motivations of the tourist: ethnic, cultural, historical, environmental, recreational. Maxine Feifer adds the "post-tourist" who sees tourism as a game and inherently inauthentic in its experiencing of another culture.

Culinary tourism is a theoretical framework for analyzing the role of food in tourism. It refers to the "intentional, exploratory participation in the foodways of an Other." It is voluntary and consciously contains an element of curiosity—that is, people eating out of choice, not only physical need.

The term "foodways" involves all the other aspects of food, referring to the network of activities and systems—physical, social, communicative, cultural, economic, spiritual, and aesthetic—surrounding the product itself: procurement, preparation, preservation, presentation, consumption, clean-up, and conceptualization. In this sense, culinary tourism can occur in any aspect of foodways, from purchasing familiar ingredients from a new grocery store to adding exotic ingredients to a familiar recipe. It can also include behaviors connected to thinking and talking about food: collecting recipes, watching televised cooking shows or films incorporating food, conversing about restaurants, reading cookbooks and food columns, reminiscing about food experiences.

The culinary Other is simply anything different from the known and familiar. It can be broken into six overlapping categories. National or cultural identity is the most commonly perceived category and includes "ethnic" foods as well as "foreign" foods. Foods become a cultural Other by being placed in a context in which they are different. Thus, kimchi is standard fare in Korea, but is ethnic and foreign in the United States.

Region is the second category of Other and refers to groupings within a culture, differentiated by geographic location and physical resources. Within the United States, regional foods from areas such as the South (grits, fried chicken, hominy, corn bread), New England (baked beans, lobster, boiled suppers), the Southwest (chili peppers, Mexican-based foods), the Mid-Atlantic states (crab and seafood), and even the Midwest (meatloaf, mashed potatoes); and from specific cities, such as New Orleans (gumbo, jambalaya), Kansas City and Memphis (barbecue), and San Francisco (nouvelle cuisine) are advertised as culinary Others appropriate for tourism.

Time as Other refers to both past and future. Foods from the past are commonly found in museums, reenactment events, and cookbooks, and are used as a way of touring a historical era. Similarly, visions of the future can be translated into foodways—astronaut foods, freeze-dried ice cream, foods compressed into pills and vitamins. Ethos and religion as Other offer foods representing different or novel worldviews and value systems. Religions specifying food taboos or guidelines, such as Judaism, Islam, and Hinduism, can be explored as tourism by experiencing their foodways. Vegetarian foods—textured protein, veggie burgers, and foods commonly used in the United States as meat substitutes, such as bean curd and tempeh—are frequently tried out of curiosity rather than ethical belief.

Socioeconomic class is another category of Other. Gourmet foods, fine wine, and expensive restaurants are associated with the upper class, and individuals can get a taste of that lifestyle through these foodways. Conversely, foods associated with lower classes—white bread and bologna sandwiches, junk foods, processed "cheese food," opossum meat or roadkill, meager portions—can be tried in order "to see how the other half lives."

Gender represents the final Other. Although strict taboos do not exist in the United States, there are certain foods associated with each gender: women eat salads, "light" foods, poultry and fish, dainty portions; men eat red meat, large portions, hearty foods. By trying the foods associated with another gender, an individual can try out that identity.

Culinary tourism involves three realms or continua of experience: the exotic, the edible, and the palatable. Based on the perceptions of consumers, the exotic ranges from those food experiences that are familiar and commonplace to those that are strange, new, and different. The edible-to-inedible continuum represents concepts of which items are physically, conceptually, and morally possible for ingestion. These concepts are culturally constructed but also draw upon the consumer's personal ethos. Palatable refers to pleasant and satisfying tastes, and represents individual preferences as well as social trends identifying desirable foods and designating their symbolic associations. Since the placement of foods and food experiences within these continua is a matter of perception and experience, this placement can shift over time or place and between individuals. Foods, therefore, that are perceived as appropriate for culinary tourism can become mundane and familiar, and then may be eaten out of hunger or taste preference rather than curiosity. For example, in the United States, foods that were recently touristic but have become standard fare in many American diets include Japanese sushi; Thai noodles with peanut sauce; Chinese chop suey, chow mein, and egg rolls; Mexican tacos and burritos; and Middle Eastern pita. These and other foods range in the extent of their adaptation to American tastes and resources. As these foods become more familiar, those eaters seeking more touristic experiences tend to seek more authenticity and depth of understanding of a foreign cuisine.

Food will be a part of tourism as long as people are curious about the world around them, but both are multivocal and multivalent domains of activity. And it is important to remember that although foodways can offer an entry into another realm of Other, culinary tourism is frequently not as much a window into other cultures as a mirror on our own.

See also **Comfort Food; Gender and Food; Travel; United States: Ethnic Cuisines.**

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TOXINS, UNNATURAL, AND FOOD SAFETY.

Toxins may be released into the environment through industrial processes and agricultural products. These toxins are unnatural and may become harmful when they enter the food chain through crop and animal uptake.

Many agricultural products are known to contain heavy metals and other contaminants. In fact many, such as fertilizers, pesticides, fumigants, sludge, liming agents, animal feed supplements, and soil amendments, are known or are suspected to be derived from industrial waste. Waste disposed in this manner includes but is not limited to that generated by leather tanneries, steel mills, coal-fired power plants, mines, film processors, nuclear fuel processors, pulp and paper, tire incinerators, and petroleum refineries.

Little regulation and even less oversight is devoted to this method of disposal. If the waste contains just one of the macronutrients or micronutrients or if it possesses a soil-amending quality, industry can call it a product. Theoretically, anything can go into fertilizer. It is frequently contaminated with arsenic, mercury, cadmium, lead, dioxin, radionuclides, nickel, beryllium, and more. The only requirement for these wastes is that they meet the standard for disposal in a lined hazardous waste landfill. In other words, they are too toxic for standard disposal, but because of a loophole in the law, they are not too toxic for disposal on farmland. Even mined fertilizers, such as phosphate rock, may contain high levels of toxic metals.

Fertilizers, soil amendments, and liming materials are of particular concern since they are applied to agricultural soils in high volume. Over 110 billion pounds of fertilizer are land-applied each year in the United States, approximately 90 percent of it on farmland. The Environmental Protection Agency, whose charge it is to regulate hazardous waste disposal, admits that it does not know how much hazardous waste is disposed as fertilizer or the fate of these chemicals in the environment.

It is the fate of these chemicals that is cause for greatest concern. Increased soil concentrations, differing soil types, and pH levels can affect plant uptake of contaminants. Sandy soils and low pH, for example, increase plant uptake, while clay soils and high pH reduce it. Many of these contaminants have half-lives of hundreds of years and can change form in the environment as new chemicals are added. These new compounds may differ from the originals in toxicity, solubility, and plant availability.

In addition to crop uptake, these contaminants may also pollute waterways and become available for uptake by other plant and animal species. Forty percent of waterway pollution is attributed to runoff. Additionally, some of these wastes, such as zinc from steel mill flue dust, are used as animal feed supplements. Animals ingest thirteen toxic metals, which concentrate in organ meats, such as liver and kidney, and dioxin, which is stored in fat.

A TOXICITY GLOSSARY

Arsenic—Known carcinogen. Highest concentrations are in seafood, rice and rice cereal, mushrooms, and poultry. Root crops, such as carrots, onions, and potatoes, are the most vulnerable.

Cadmium—Low levels are found in all foods. Largest dietary contributors are grains and cereal products. Highest levels are found in leafy vegetables, potatoes, and other root crops. Long-term exposure to low levels may cause kidney disease, cancer, lung damage, and fragile bones.

Dioxin—Endocrine disruptor. Causes birth defects, developmental problems, and cancer.

Lead—Neurotoxin. Lowers IQ and damages the immune system. Fruits, grains, cereal products, and legumes contain the highest concentrations. Fetuses and pregnant women are most at risk.

Mercury—Possible carcinogen. May cause brain, kidney, or fetal damage. Highest concentration is in fish. Grains and meat account for half of the dietary intake.

Macronutrients—Examples include nitrogen, phosphorous, potassium, sulfur, calcium, magnesium.

Micronutrients—Examples include boron, molybdenum, copper, manganese, zinc, selenium, iron chloride.

These toxins find their way into the food supply, as documented by the Food and Drug Administration (FDA) Total Diet Study. Since 1961 the Total Diet Study has monitored the U.S. food supply for industrial contaminants, toxic elements, radionuclides, essential minerals, and pesticides. The study has found that, on a body-weight basis, infants and toddlers consume on average two to three times as much cadmium, arsenic, and mercury and three to four times as much lead as do teens and adults.

Infants, toddlers, and developing fetuses are the most vulnerable populations. Many toxins pass from the mother to the fetus, potentially altering the developing brain, nervous system, and orderly development of the body.

See also **Agronomy; Crop Improvement; Ecology and Food; Food Safety; Government Agencies; Government Agencies, U.S.; Health and Disease; High-Technology Farming; Inspection; International Agencies; Water: Safety of Water.**

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TRACE ELEMENTS. Early in the twentieth century, scientists were able to qualitatively detect small amounts of several elements in living organisms. At the time, these elements were often described as being present in "traces" or "trace amounts." This apparently led to the term "trace elements," which today is usually defined as mineral elements that occur in living systems in micrograms per gram of body weight or less. A majority of elements of the periodic table probably could be considered trace elements. However, the presence of most of these elements in higher animals quite likely is just a manifestation of our geochemical origin or the result of environmental exposure. Only eight trace elements are generally accepted as being essential for health and well-being in higher animals through the consumption of food and beverages; these are cobalt, copper, iodine, iron, manganese, molybdenum, selenium, and zinc. Persuasive evidence has recently appeared that indicates two other trace elements, boron and chromium, may also be essential; however, general acceptance of their essentiality is still lacking. Based on findings with experimental animals and lower life forms, numerous other trace elements have been suggested as being essential for higher animals including aluminum, arsenic, fluorine, lithium, nickel, silicon, and vanadium. However, conclusive evidence for essentiality, such as a defined biochemical function, is lacking for these elements. Thus, their nutritional importance remains to be determined. Of the elements mentioned, assuring the consumption of foods providing adequate amounts of iodine, iron, and zinc is of greatest practical concern for human health. Evidence is emerging, however, suggesting that the amount of cobalt (as vitamin B_{12}), copper, selenium, boron, and chromium provided through foods should be considered a practical nutritional concern in assuring or promoting health and well-being. These eight elements will be emphasized in this review.

Physiological Roles of Trace Elements

Trace elements have several roles in living organisms. Some are essential components of enzymes where they attract substrate molecules and facilitate their conversion to specific end products. Some donate or accept electrons in reactions of reduction and oxidation, which results in the generation and utilization of metabolic energy. One trace element, iron, is involved in the binding, transporting, and releasing of oxygen in higher animals. Some trace elements impart structural stability to important biological molecules. Finally, some trace elements control important biological processes through such actions as facilitating the binding of molecules to receptor sites on cell membranes, altering the structure or ionic nature of membranes to prevent or allow specific molecules to enter or leave a cell, and inducing gene expression resulting in the formation of proteins involved in life processes.

Homeostatic Regulation of Trace Elements

The ability of the body to maintain the content of a specific substance such as a trace element within a certain range despite varying intakes is called homeostasis. Homeostasis involves the processes of absorption, storage, and excretion. The relative importance of these three processes varies among the trace elements. The homeostatic regulation of trace elements existing as positively charged cations (for example, copper, iron, zinc) occurs primarily during absorption from the gastrointestinal tract. Trace elements absorbed as negatively charged anions (for example, boron, selenium) are usually absorbed freely and completely from the gastrointestinal tract. Thus, they are homeostatically regulated primarily by excretion through the urine, bile, sweat, and breath. Storage of trace elements in inactive sites or forms is another mechanism that prevents inappropriate amounts of reactive trace elements to be present, for example, storage of iron in the form of ferritin. Release of a trace element from a storage site also can be important in preventing deficiency.

Iodine

This trace element has one known function in higher animals and humans; it is a constituent of thyroid hormone (thyroxine, T_4) that, after conversion to triiodothyronine (T_3), functions as a regulator of growth and development by reacting with cell receptors, which results in energy (adenosine triphosphate, ATP) production and the activation or inhibition of synthesis of specific proteins.

Recognition that iodine was nutritionally important began in the 1920s when it was found that iodine prevented goiter, and increased iodine intake was associated with decreased endemic cretinism, the arrested physical and mental development caused by the lack of thyroid hormone. Today, the consequences of iodine deficiency still are a major public health problem in the world. In fact, iodine deficiency is the most prevalent global cause of preventable mental retardation. Briefly, the spectrum of iodine deficiency disorders is large and includes fetal congenital anomalies and perinatal mortality; neurological cretinism characterized by mental deficiency, deaf mutism, spastic diplegia (spastic stiffness of the limbs), and squint; psychomotor defects; goiter; and slowing of the metabolic rate causing fatigue, slowing of bodily and mental functions, weight increase, and cold intolerance.

Although homeostatic mechanisms allow for a substantial tolerance to high intakes of iodine, iodine-induced hyperthyroidism has been recognized for nearly two centuries. People who have had a marked iodine deficiency and are then given high amounts of iodine as part of a preventative program are at risk of getting hyperthyroidism with clinical signs including weight loss, tachycardia, muscle weakness, and skin warmth.

Iodide, an anion, is rapidly and almost completely absorbed from the stomach and upper gastrointestinal (GI) tract. Most other forms of iodine are changed in the GI tract to iodide and completely absorbed. When thyroid hormone is ingested, about 80 percent is absorbed without change; the rest is excreted in the feces. Absorbed iodide circulates in the free form; it does not bind to proteins in blood. Iodide is rapidly removed from circulation by the thyroid and kidney. Urinary excretion is a major homeostatic mechanism. If iodine intake has been adequate, only about 10 percent of absorbed iodide appears in the thyroid, the rest appears in the urine. However, if iodine status is inadequate, a much higher percentage, up to 80 percent, can appear in the thyroid. The thyroid gland is essentially the only storage site for iodine, where it appears mostly as mono- and diiodotyrosine and T_4, with a small amount of T_3.

The recommended intakes of iodine for various age and sex groups are shown in Table 1, which shows that the recommended dietary allowance (RDA) for adults is 150 μg/day. Iodized salt has been the major method for assuring adequate iodine intake since the 1920s. Other sources of iodine are seafood and foods from plants grown on high-iodine soils.

Iron

This trace element is a component of molecules that transport oxygen in blood. Numerous enzymatic reactions involving oxidation and reduction (redox) use iron as the agent through which oxygen is added, hydrogen is removed, or electrons are transferred. The classes of enzymes dependent on iron for activity include the oxidoreductases, exemplified by xanthine oxidase/dehydrogenase; monooxygenases, exemplified by the amino acid oxidases and cytochrome P450; dioxygenases, exemplified by amino acid dioxygenases, lipoxygenases, peroxidases, fatty acid desaturases, and nitric oxide synthases; and miscellaneous enzymes such as aconitase.

Among the trace elements, iron has the longest and best described history. By the seventeenth century, a recognized treatment for chlorosis, or iron deficiency anemia, was drinking wine containing iron filings. Despite the extensive knowledge about its treatment and prevention, and the institution of a variety of effective interventions, iron deficiency is the primary mineral deficiency in the United States and the world today. The physiological signs of iron deficiency include anemia, glossitis (smooth atrophy of tongue surface), angular stomatitis (fissures at the angles of the mouth), koilonychia (spoon nails), blue sclera, lethargy, apathy, listlessness, and fatigue. Pathological consequences of iron deficiency include impaired thermoregulation, immune function, mental function, and physical performance; complications in pregnancy, including increased risk of premature delivery, low birth weight, and infant mortality; and possibly increased risk of osteoporosis.

Concerns have been expressed about high intakes of iron being a health issue. This has come about through epidemiologic observations associating high dietary iron or high body iron stores with cancer and coronary heart disease. Further experimental studies, however, are required to confirm whether the high intakes of iron increase the risk for these diseases. The toxic potential of iron arises from its biological importance as a redox element that accepts and donates electrons to oxygen that can result in the formation of reactive oxygen species or radicals that can damage cellular components such as fatty acids, proteins, and nucleic acids. Antioxidants are enzymes or molecules that prevent the formation of oxygen radicals or convert them to nonradical products. When not properly controlled by antioxidants, reactive oxygen damage can lead to premature cell aging and death. An iron overload disease known as hereditary hemochromatosis is caused by a defective regulation of iron transport with excessive iron absorption and high transferrin (transport form) iron in plasma. Clinical signs appear when body iron accumulates to about 10 times normal and include cirrhosis, diabetes, heart failure, arthritis, and sexual dysfunction. Hemochromatosis also increases the risk for hepatic carcinoma. The treatment for hereditary hemochromatosis is repeated phlebotomy.

Absorption from the GI tract is the primary homeostatic mechanism for iron. Dietary iron exists generally in two forms, heme and non-heme, that are absorbed by different mechanisms. Heme iron is a protoporphyrin molecule containing an atom of iron; it comes primarily from hemoglobin and myoglobin in meat, poultry, and fish. Non-heme iron is primarily inorganic iron salts provided mainly by plant-based foods, dairy products, and iron-fortified foods. Heme iron is much better absorbed and less affected by enhancers and inhibitors of absorption than non-heme iron. Iron absorption is regulated by mucosal cells of the small intestine, but the exact mechanisms in the regulation have not been established. Both iron stores and blood hemoglobin status have a major influence on the amount of dietary iron that is absorbed. Under normal conditions, men absorb about 6 percent and menstruating women absorb about 13 percent of dietary iron. However, with severe iron deficiency anemia (functionally deficient blood low in hemoglobin), absorption of non-heme iron can be as high as 50 percent. Iron loss from the body is very low, about 0.6 mg/day. This loss is primarily by excretion in the bile and, along with iron in desquamated mucosal cells, eliminated via the feces. Menstruation is a significant means through which iron is lost for women. It should be noted, however, that nonphysiological loss of iron resulting from conditions such as parasitism, diarrhea, and enteritis account for half of iron deficiency anemia globally. Excess iron in the body is stored as ferritin and hemosiderin in the liver, reticuloendothelial cells, and bone marrow.

The recommended intakes of iron for various age and sex groups are shown in Table 1, which shows that the RDA for adult males and postmenopausal women is 8 mg/day; and that for menstruating adult women is 18 mg/day. Meat is the best source of iron, but iron-fortified foods (cereals and wheat-flour products) also are significant sources.

Zinc

This trace element is the only one that is found as an essential component in enzymes from all six enzyme classes. Over 50 zinc metalloenzymes have been identified. Zinc also functions as a component of transcription factors known as zinc fingers that bind to DNA and activate the transcription of a message, and imparts stability to cell membranes.

Signs of zinc deficiency in humans were first described in the 1960s. Although it is generally thought that zinc deficiency is a significant public health concern, the extent of the problem is unclear because there is no well-established method to accurately assess the zinc status of an individual. The physiological signs of zinc deficiency include depressed growth; anorexia (loss of appetite); parakeratotic skin lesions; diarrhea; and impaired testicular development, immune function, and cognitive function. Pathological consequences of zinc deficiency include dwarfism, delayed puberty, failure to thrive (acrodermatitis enteropathica infants), impaired wound healing, and increased susceptibility to infectious disease. It has also been suggested that low zinc status increases the susceptibility to osteoporosis and to pathological changes caused by the presence of excessive reactive oxygen species or free radicals.

Zinc is a relatively nontoxic element. Excessive intakes of zinc occur only with the inappropriate intake of supplements. The major undesirable effect is an interference with copper metabolism that could lead to copper deficiency. Long-term high zinc supplementation can reduce immune function and high-density lipoprotein (HDL)-cholesterol (the "good" cholesterol). These effects are seen only with zinc intakes of 100 mg/day or more.

A primary homeostatic mechanism for zinc is absorption from the small intestine. Absorption involves a carrier-mediated component and a nonmediated diffusion component. With normal dietary intakes, zinc is absorbed mainly by the carrier-mediated mechanism. Although absorption can be modified by a number of factors, about 30 percent of dietary zinc is absorbed. The efficiency of zinc absorption is increased with low zinc intakes. The small intestine has an additional role in zinc homeostasis through regulating excretion through pancreatic and intestinal secretions. After a meal, greater than 50 percent of the zinc in the intestinal lumen is from endogenous zinc secretion. Thus, zinc homeostasis depends upon the reabsorption of a significant portion of this endogenous zinc. Intestinal conservation of endogenous zinc apparently is a major mechanism for maintaining zinc status when dietary zinc is inadequate. The urinary loss of zinc is low and generally not markedly affected by zinc intake.

The recommended intakes of zinc for various age and sex groups are shown in Table l, which shows that the RDA for adult males is 11 mg/day and for adult females is 8 mg/day. The best food sources for zinc are red meats, organ meats (for example, liver), shellfish, nuts, whole grains, and legumes. Many breakfast cereals are fortified with zinc.

Cobalt (Vitamin B_{12})

Ionic cobalt is not an essential nutrient for humans. Cobalt is an integral component of vitamin B_{12}, which is an essential nutrient for nonruminant animals and humans. Vitamin B_{12} is a cofactor for two enzymes, methionine synthase which methylates homocysteine to form methionine, and methylmalonyl coenzyme A (CoA) mutase which converts L-methylmalonyl CoA, formed by the oxidation of odd-chain fatty acids, to succinyl CoA.

In the nineteenth century, a megaloblastic anemia (functionally deficient blood containing primitive large red blood cells) was identified that was invariably fatal and thus called pernicious anemia. The first effective treatment for this disease was 1 pound of raw liver daily. In 1948, the anti–pernicious anemia factor (vitamin B_{12}) in liver was isolated and found to contain 4 percent cobalt. Vitamin B_{12} deficiency most commonly arises when there is a defect in vitamin B_{12} absorption caused by such factors as atrophic gastritis, *Helicobacter pylori* infection, and bacteria overgrowth resulting from achlorohydria and intestinal blind loops. Because vitamin B_{12} only comes from foods of animal origin, absolute vegetarianism will lead to deficiency in vitamin B_{12} after 5 to 10 years. The physiological signs of severe vitamin B_{12} deficiency are megaloblastic anemia, spinal cord demyelination, and pe-

TABLE 1

Recommended Dietary Allowances for Selected Trace Elements Established by the Food and Nutrition Board, Institute of Medicine, National Academy of Sciences (see bibliography).

	Recommended Dietary Allowance					
	Copper (µg/day)	Iodine (µg/day)	Iron (mg/day)	Selenium (µg/day)	Vitamin B_{12} (cobalt) (µg/day)	Zinc (mg/day)
0–6 months	—	—	—	—	—	—
7–12 months	—	—	11	—	—	3
1–3 years	340	90	7	20	0.9	3
4–8 years	440	90	10	30	1.2	5
9–13 years	700	120	8	40	1.8	8
14–18 years	890	150	11 M/15 F	55	2.4	11 M/9 F
19–50 years	900	150	8 M/18 F	55	2.4	11 M/9 F
51 years and greater	900	150	8	55	2.4	11 M/8 F
Pregnancy						
18 years or less	1,000	220	27	60	2.6	13
19–50 years	1,000	220	27	60	2.6	11
Lactation						
18 years and less	1,300	290	10	70	2.8	14
19–50 years	1,300	290	9	70	2.8	12

Abbreviations: F, female; M, male.

ripheral neuropathy. The pathological consequences of deficiency include pernicious anemia, memory loss, dementia, an irreversible neurological disease called subacute degeneration of the spinal cord, and death. Recently, mild vitamin B_{12} deficiency has been cited as a cause of high circulating homocysteine, which has been associated with an increased risk for cardiovascular disease. Vitamin B_{12} is essentially nontoxic. Doses up to 10,000 times the minimal daily adult human requirement do not have adverse effects.

Vitamin B_{12} absorption is a relatively complex process. Digestion by the saliva and acid environment of the stomach releases vitamin B_{12} from food, then it is bound to a haptocorrin called R protein that carries it into the duodenum. A binding protein, called intrinsic factor, released by gastric parietal cells binds vitamin B_{12} after the stomach acid is neutralized in the duodenum, and digestive enzymes remove the R binder from the vitamin. The intrinsic factor–bound vitamin B_{12} is carried to a specific receptor in the ileum called cubilin and internalized by receptor-mediated endocytosis. Because vitamin B_{12} is water-soluble, excessive intakes are efficiently excreted in the urine.

The recommended intakes for vitamin B_{12} for various age and sex groups are shown in Table l, which shows that the RDA for adults is 2.4 μg/day. Food sources of vitamin B_{12} are of animal origin and include meats, dairy products, and eggs. Fortified cereals have also become a significant source of vitamin B_{12}.

Copper

Copper is a cofactor for a number of oxidase enzymes including lysyl oxidase, ferroxidase (ceruloplasmin), dopamine beta-monooxygenase, tyrosinase, alpha-amidating monooxygenase, cytochrome C oxidase, and superoxide dismutase. These enzymes are involved in the stabilization of matrixes of connective tissue, oxidation of ferrous iron, synthesis of neurotransmitters, bestowal of pigment to hair and skin, assurance of immune system competence, generation of oxidative energy, and protection from reactive oxygen species. Copper also regulates the expression of some genes.

Although copper is a well-established essential trace element, its practical nutritional importance is a subject of debate. Well-established pathological consequences of copper deprivation in humans have been described primarily for premature and malnourished infants and include a hypochromic, normocytic, or macrocytic anemia; bone abnormalities resembling scurvy by showing osteoporosis, fractures of the long bones and ribs, epiphyseal separation, and fraying and cupping of the metaphyses with spur formation; increased incidence of infections; and poor growth. The consequences of the genetic disorder Menkes' disease (copper deficiency caused by a cellular defect in copper transport) in children include "kinky-type" steely hair, progressive neurological disorder, and death. Other consequences have been suggested based upon findings from epidemiological studies, and animal and short-term human copper deprivation experiments;

these include impaired brain development and teratogenesis for the fetus and children, and osteoporosis, ischemic heart disease, cancer, increased susceptibility to infections, and accelerated aging for adults.

Copper toxicity is not a major health issue. The ingestion of fluids and foods contaminated with high amounts of copper can cause nausea. Because their biliary excretion pathway is immature, accumulation of toxic amounts of copper in the liver could be a risk for infants if intake is chronically high; this apparently caused cases of childhood liver cirrhosis in India.

Intestinal absorption is a primary homeostatic mechanism for copper. Copper enters epithelial cells of the small intestine by a facilitated process that involves specific copper transporters, or nonspecific divalent metal ion transporters located on the brush-border surface. Then the copper is transported to the portal circulation where it is taken up by the liver and resecreted in plasma bound to ceruloplasmin. Transport of copper from the liver into the bile is the primary route for excretion of endogenous copper. Copper of biliary origin and nonabsorbed dietary copper are eliminated from the body via the feces. Only an extremely small amount of copper is excreted in the urine. The absorption and retention of copper varies with dietary intake and status. For example, the percentages of ingested copper absorbed were 56 percent, 36 percent, and 12 percent with dietary intakes of 0.8, 1.7, and 7.5 mg/day, respectively. Moreover, tissue retention of copper is markedly increased when copper intake is low.

The recommended intakes for copper for various ages and sex groups are shown in Table 1, which shows that the RDA for adults is 900 μg/day. The best sources of copper are legumes, whole grains, nuts, organ meats (for example, liver), seafood (for example, oysters, crab), peanut butter, chocolate, mushrooms, and ready-to-eat cereals.

Selenium

Selenium is a component of enzymes that catalyze redox reactions; these enzymes include various forms of glutathione peroxidase, iodothyronine 5′-deiodinase, and thioredoxin reductase.

Although selenium was first suggested to be essential in 1957, this was not firmly established until a biochemical role was identified for selenium in 1972. The first report of human selenium deficiency appeared in 1979; the subject resided in a low-selenium area and was receiving total parenteral nutrition (TPN) after surgery. The subject and other selenium-deficient subjects on TPN exhibited bilateral muscular discomfort, muscle pain, wasting, and cardiomyopathy. Subsequently, it was discovered that Keshan disease, prevalent in certain parts of China, was prevented by selenium supplementation. Keshan disease is a multiple focal myocardial necrosis resulting in acute or chronic heart function insufficiency, heart enlargement, arrhythmia, pulmonary edema, and death. Other consequences of inadequate selenium include impaired immune function and increased susceptibility to viral infections. Selenium deficiency also can make some nonvirulent viruses become virulent.

Recently, however, not only selenium deficiency, but effects of supranutritional intakes of selenium have become of great health interest. Several supplementation trials have indicated that selenium has anticarcinogenic properties. For example, one trial with 1,312 patients supplemented with either 200 μg selenium/day or with a placebo found the selenium treatment was statistically associated with reductions in several types of cancer including colorectal and prostate cancers.

Selenium is a relatively toxic element; Intakes averaging 1.2 mg/day can induce changes in nail structure. Chronic selenium intakes over 3.2 mg/day can result in the loss of hair and nails, mottling of the teeth, lesions in the skin and nervous system, nausea, weakness, and diarrhea.

Selenium, which is biologically important as an anion, is homeostatically regulated by excretion, primarily in the urine but some also is excreted in the breath. Selenate, selenite, and selenomethionine are all highly absorbed by the GI tract; absorption percentages for these forms of selenium are commonly found to be in the 80 to 90 percent range.

The recommended intakes for selenium are shown in Table 1, which shows that the RDA for adults is 55 μg/day. Food sources of selenium are fish, eggs, and meat from animals fed abundant amounts of selenium and grains grown on high-selenium soil.

Boron

Recent findings with this trace element suggest that it may be of nutritional importance, although a clearly defined biochemical function for boron in higher animals and humans has not been defined. It has been hypothesized, however, that boron has a role in cell membrane function that influences the response to hormones, transmembrane signaling, or transmembrane movement of regulatory cations or anions. Human studies suggest that a low boron intake can impair cognitive and psychomotor function and the inflammatory response, as well as increasing the susceptibility to osteoporosis and arthritis.

About 85 percent of ingested boron is absorbed and excreted in the urine shortly after ingestion. Because boron homeostasis is regulated efficiently by urinary excretion, it is a relatively nontoxic element. A tolerable upper level intake of 20 mg/day was determined for boron by the Food and Nutrition Board of the United States National Academy of Sciences.

An analysis of both human and animal data by a World Health Group suggested that an acceptable safe range of population mean intakes for boron for adults could be 1 to 13 mg/day. Foods of plant origin, especially fruits, leafy vegetables, nuts, pulses, and legumes are rich sources of boron.

Chromium

A naturally occurring biologically active form of chromium called chromodulin has been described that apparently has a role in carbohydrate and lipid metabolism as part of a novel insulin-amplification mechanism. Chromodulin is an oligopeptide that binds four chromic ions and facilitates insulin action in converting glucose into lipids and carbon dioxide.

The nutritional importance of chromium is currently a controversial subject. Chromium deficiency has been suggested to impair glucose tolerance, which could eventually lead to diabetes. Supranutritional chromium supplementation (1,000 μg/day) has been found beneficial for some cases of type II diabetes. Supplements containing supranutritional amounts of chromium in the picolinate form have been promoted as being able to induce weight loss and to increase muscle mass. However, most ergogenic (work output) oriented studies have found chromium picolinate supplementation to be ineffective for increasing muscle mass, strength, and athletic performance, and there are no data from well-designed studies to support the claim that chromium picolinate supplementation is an effective weight loss modality. Chromium in the +3 valence state is a relatively nontoxic element.

Chromium homeostasis is regulated by intestinal absorption, which is low. Estimates of absorption range from less than 0.5 to 2 percent. Absorbed chromium is excreted in the urine.

The Food and Nutrition Board of the United States Academy of Sciences determined that there was not sufficient evidence to set an estimated average requirement of chromium. Therefore, an adequate intake was set based on estimated mean intakes. The adequate intake for young males was set at 35 μg/day, and that for young females was set at 25 μg/day. Some of the best food sources of chromium are whole grains, pulses, some vegetables (for example, broccoli and mushrooms), liver, processed meats, ready-to-eat cereals, and spices.

Conclusion

It is likely that not all the essential mineral elements for humans have been identified. Moreover, numerous biochemical functions for trace elements most likely remain to be identified. Thus, the full extent of the pathological consequences of marginal or deficient intakes of the trace elements has not been established. Furthermore, some trace elements such as selenium, fluoride, and lithium in supranutritional amounts are being found to have therapeutic or preventative value against disease. Thus, the determination of the importance of trace elements for human health and well-being should be considered a work in progress with some exciting advances likely in the future.

See also **Antioxidants; Bioactive Food Components; Dietary Assessment; Dietary Guidelines; Iodine; Iron; Microbiology; Minerals; Nutrient Bioavailability; Nutrition; Proteins and Amino Acids; Vitamins.**

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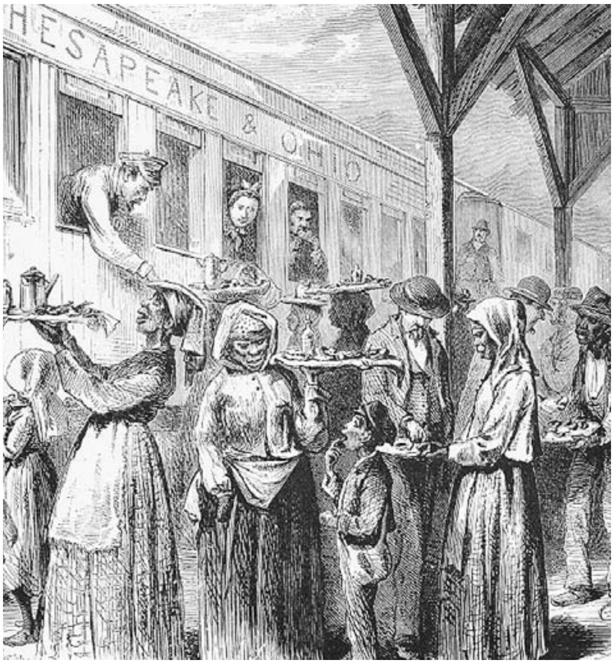
Forrest H. Nielsen

TRAVEL. During the course of history, the impact of travel on the relationship between food and man has been manifold. Encounters with new foods have often caused reactions of dissociation or of rejection—not only of the foods themselves, but also of the people eating them. The widespread idea that the food consumed by a group of people is closely connected with their level of civilization has been a way to express and underscore differences between neighboring populations. Food being an inoffensive category, it readily lends itself to becoming a means of distinguishing between "us and them," both geographically, in relation, for instance, to regions or countries, and socially, setting "us" apart from people within the same region we consider to be at a lower level in the social hierarchy.

Food habits are closely linked to a person's conception of identity. The acceptance of different foodstuffs, or their avoidance—taste or distaste—is a mixture of cultural conditioning and personal idiosyncrasies. It is natural, therefore, that the food consumed by one's own group is considered to be the "proper food," whereas the food of the others encountered during one's travels is accepted with some reluctance. Foods associated with a higher status are more easily adopted, as are those associated with lifestyles one wishes to share.

Obviously the reason for traveling will have some bearing on the attitude toward the food encountered.



American railroad fare is not much better today than in the nineteenth century. Travelers on the Chesapeake & Ohio line were obliged to buy their bad coffee, railroad cakes, hardtack, and Sally Lunns from vendors who congregated at stations along the way. FROM JOHN BACHELDER'S POPULAR RESORTS (BOSTON, 1875). ROUGHWOOD COLLECTION.

People who have been forcibly displaced (through war, disasters, slavery [but see below], economic hardships, or religious persecution) are more likely to maintain earlier food habits, where possible—partly through lack of means, partly from nostalgia for a lifestyle that has been lost. If, on the other hand, travel is undertaken on a voluntary basis, especially for pleasure (most notably tourism), people are more likely to try new foods.

Historically, little is known about travelers' food. It may be said that in general those who could took their food (and even people in charge of preparing it) with them, which meant that they tried to emulate their usual food habits. Others would make do with the local fare at wayside inns or the tables of hospitable notables. After the emergence of restaurants at the beginning of the nineteenth century in Europe, an internationalized bourgeois cuisine became available to travelers. Regional cooking did not start to come into focus for the general public until the period between the two World Wars, alongside the emergence of automobile tourism. And only recently has local and regional food become a focus of scientific as well as of touristic discourse. To better understand the role of food in travel one needs to distinguish different categories of travelers. Professional travelers of the past, such as sailors and military men, would in the main take their own food with them; however, at the same time, they were often adventurers and would typically experience extremely foreign foods, though they would only rarely bring these back with them.

In many instances on the other hand, food became the very reason for travel: explorers set out from Europe to reach the homelands of desirable foods, particularly spices. In a second phase, explorers were followed by tradesmen, civilian officials, and others establishing colonies on other continents. From these activities came sugar, tea, coffee, and many fruits, vegetables, and grains (for example, pineapples, potatoes, and rice), now everyday commodities in the Western world. Their history is intertwined with that of major empires. In some cases, myths have been constructed around them (for instance, the one claiming that Marco Polo brought pasta to Italy from China—belied by the fact that there was a flourishing commerce of pasta in the Mediterranean before the time of his travels). The rise and fall of food trends is clearly reflected in more general world history, as exemplified by the passion for spices in the Middle Ages and Renaissance leading to journeys of exploration, or the court culture of Italy and France, which, through traveling notables, influenced the food habits in many European countries from the sixteenth century onward.

For immigrants, the acquisition of new food habits is dependent on the time spent in the new environment (usually it is a matter of generations). As for any traveler, the reaction to the different food habits experienced will be related to the scope and duration of the travel. A special case is that of the American Pilgrims adopting the food of Native Americans, with the event evolving into a national commemorative meal: the Thanksgiving dinner. On the other hand, the slaves brought to America from Africa, who had no possibility of either maintaining their own food habits or having a free choice among those they met in the new country, have developed a very different symbolic food: soul food.

However, food habits may also be affected in the opposite direction. Colonies of foreign nationals have introduced new items in the diet of the new environment. Thus, for example, in the Middle Ages, gingerbread spread throughout Europe with German immigrants, and more recently Chinese food has become a familiar food in Western countries. Following the rise of charter tourism in the 1950s, pizza and pasta started to become a familiar food in many countries outside Italy, having in some places even replaced potatoes as an everyday staple food.

During the second half of the twentieth century, food began to play a significant role in tourism. In the meeting with the unfamiliar that takes place during travel, food plays a central role, since everybody has to eat every day, and so the deviation from what is habitual and accepted cannot be avoided or disregarded. Travel thus brings about an awareness of differences between the self (the learned and shared culture at home) and others (notably, their culture and habits), as it forces the individual to venture into the realm of sensory experiences that belong to the others. In parallel with the increased movement of people we see in recent times, the establishment of international restaurants and sale of foreign foodstuffs means one no longer needs to travel to experience foreign foods. This highlights some of the paradoxes of the international world today, where tourists may oscillate between the attraction of what represents "other" and adventure, and the unchallenging ease of familiarity and security. Tourists typically want to escape boredom, but to do so while staying within their comfort zone.

See also **Comfort Food; Herbs and Spices; Thanksgiving; Tourism; United States,** *subentries on* **African American Foodways** *and* **Ethnic Cuisines.**

Renée Valeri

TRUFFLES. *See* **France.**

TUBERS. Tuber is a loan word deriving from the Latin verb *tumere* (to swell). It was introduced into colloquial English via botanical Latin during the Renaissance and retains a number of related meanings: a swelling, a growth resembling a knot, or even a truffle. When applied to vegetables, tuber is now understood to mean a fleshy underground swelling on root strands that normally contains varying proportions of starch. In reality, this definition is quite imprecise given the huge diversity of tuberous-like roots and stems that exist in nature.

For example, taro (*Colocasia sp.*), is sometimes referred to as a tuber and sometimes as a corm since it straddles the definition of both. Other vegetables, like the arracacha (*Arracacha xanthorrhiza*) of South America, are often classified as "tuberous rooted" since the swollen part is not distinctly separate from the crown or herbaceous (above-ground) parts of the plant. The potato is considered a classic example of a common tuber, since the swollen part forms along various root strands and is only connected to the rest of the plant in this fashion. However, it is possible to induce this feature in any number of wild tuberous-rooted plants once domesticated and carefully selected.

Most true tubers are capable of reproducing themselves vegetatively and when reproduced in this manner, they become true genetic clones of their parents. This reproduction technique allows beneficial characteristics, such as flavor, texture, storing qualities, or resistance to certain pests and diseases to be preserved from one generation to the next. It would appear, however, that most tubers originally appealed to humans for their starch or sugars, especially tubers that could be consumed raw. Only later did cookery expand the list of choices, since many tubers like cassava are toxic until exposed to heat or some other processing step.

Nutrient rich and relatively easy to gather, tubers have played a major role in the history of human diet, since they could be collected from the wild and stockpiled against times of food shortage. This dietary shift from happenstance to organized gathering, which required calculations regarding collection, storage, and distribution, brought about profound changes in human social organization and development, even more so after tubers were brought under cultivation.

Pre-agricultural societies relied heavily on foraged tubers, especially those that required little or no processing. Bog potatoes or groundnuts (*Apios tuberosa*) supplied the hunter-gatherers of eastern North America with an easy to collect source of small, starchy tubers that could be stored in pits for later use and eaten like nuts. Even for societies that later turned to intensive agriculture, such wild tubers remained an important supplement to the diet. However, many tuberous vegetables like the water parsley (*Oenanthe sarmentosa*) and wood sunflower (*Helianthus strumosus*) of North America, the bagana (*Amorphophallus abyssinicus*) of Ethiopia, and the kudzu (*Pueraria lobata*) of New Guinea, were never brought under cultivation by the native peoples of those areas, but simply gathered from the wild and traded, or allowed to grow in patches kept free of competing weeds. These managed plants were the preliminary steps toward gardening and primitive agriculture.

There is no precise record of when the first tubers were brought under cultivation on an organized basis, but in all likelihood the taros of India (if we allow that *Colocasia* and *Alocasia* are tubers) were among the first since they are mentioned in Sanskrit sources and terms for them are known in pre-Sanskrit languages. Doubtless they were followed or even preceded by potatoes in the high Andes, the yam bean (*Pachyrrhizus erosus*) in Central America, and the chufa (*Cyperus esculentus*) of the Mediterranean region. Vestiges of many tuberous plants have been found in caves, but this does not mean they were cultivated. Unless there are corroborating written records, or artifacts depicting tuberous vegetables, archeology cannot safely establish that a tuber was in fact cultivated since traces of pollen, preserved seeds, or actual dried tubers can originate from wild as well as cultivated sources. Furthermore, even where there are physical depictions of the plant, as in the case of chufa and coco grass (*Cyperus rotundus*) in ancient Egyptian paintings of pleasure gardens, this only proves that they were appreciated as ornamentals.

Yet, over time, many tuberous vegetables were indeed brought under cultivation in order to increase the supply and the reliability of the harvest. The highest percentage of indigenous cultivated tubers of different species is found in South America, where there is presently a concerted attempt to analyze and promote their uses. Elsewhere, many tubers gathered from the wild have fallen into neglect even where this nutritional diversity supplied a more balanced diet. Additionally, except for the Pacific islands, almost all of the lesser sorts of cultivated yam, such as the White Yam (*Dioscorea* *rotundata*), and the Buck Yam (*Dioscorea pentaphylla*), have decreased in production because of the introduction of commercially improved sweet potatoes. No tubers have done more than the potato and sweet potato (*Ipomoea batatas*) to alter human agriculture and diet, since both of these plants can be grown in a wide variety of soils and microclimates on a large commercial scale.

In the tropics, however, taros and yams (*Discorea sp.*) remain key food crops, followed by the New World cassava (*Manihot esculenta*) and to a limited extent malanga or yautia (*Xanthosoma sp.*). Consumption patterns vary from country to country and from one cultural group to the next, and practical growing considerations should not be overlooked. For example, in some areas, cassava and malanga have become important agricultural supplements since they will grow where taro will not and like sweet potatoes, they yield a ready supply of nutritionally rich greens. Since the 1500s, Old and New World tubers have moved out of their original habitats to such an extent that there is often a great deal of confusion as to where the plants came from. The inventory that follows deals with tubers based on their continent of origin, but with brief comments on how they have spread to other parts of the world, or how they are employed in local cuisines.

Africa (Sub-Sahara)

When we consider that yams, taros, sweet potatoes, and cassava are all exotics introduced from other continents, the range of indigenous tuberous vegetables available to Africans is extremely small. The African landscape is rich in leafy vegetables, but until the introduction of yams about 1000 C.E., there was no large tuberous vegetable serving as a staple on a continent-wide scale. Only here and there, locally occurring tubers provided limited food supplies for those willing to gather them. Most of Africa's indigenous tubers are small in size and few of them have ever been brought under cultivation. Furthermore, to date, there are no complete continent-wide inventories of native tuberous plants, a task made doubly difficult because of so many common synonyms that exist in the numerous languages of Africa, not to mention the political instability in several key countries.

While there has been a large amount of research devoted to African foodways and tribal cultures, little has been devoted to traditional gardening. The growing, gathering, and cooking of traditional plants is largely a woman's task in Africa, and in the past, this has been treated as an activity of low status. Fortunately, there is now a shift of interest in promoting the conservation and use of underutilized and neglected foods, particularly in Botswana, Ethiopia, Kenya, and Nigeria.

Many of the native tubers listed below are presently being inventoried for study and evaluation for possible breeding programs in conjunction with sustainable agriculture. However, very few of them are mentioned in cookbooks. Aside from these, *Arisaema schimperianum*, *Campanula edulis*, *Commelina benghalensis* and *latifolia*, *Cyperus esculentus*, *Dioscorea quartiniana*, and *Dioscorea schimperiana* all provide a source of indigenous tubers that are collected from the wild in several parts of Africa.

***African yam bean* (Sphenostylis stenocarpa).** This plant produces protein-rich seeds, edible leaves, and a large spindle-shaped tuber that can be cooked like a potato. The yam bean is mostly consumed by villagers in West Africa and even appears in cookbooks from that region.

***Anchote* (Coccinia abyssinica).** This perennial occurs as a wild vine in several parts of East Africa. The small tubers are cooked like potatoes in Ethiopia. Coccinia grandis and Coccinia triloba, both relatives of anchote, are gathered by some tribes in Kenya.

***Hausa potato* (Solenostemon rotundifolius).** Formerly classified *Coleus rotundifolius*, these black tubers are prepared like potatoes and may be eaten either raw or cooked. This plant has been introduced into Southeast Asia, where it is employed in curries or eaten with coconuts.

***Jacob's Coat or Sayabana* (Coleus blumei).** Both the leaves and tubers are eaten. The leaves are also added to fermented beverages. Now introduced into tropical Asia.

***Livingstone potato* (Coleus parviflorus).** Also known as the country potato and African potato, this handsome tuber is widely cultivated in the dry regions of East and West Africa. The tubers resemble the crosnes of east Asia, but have yellow skin and white flesh. They are also dried and then ground to make a flour for dumplings. The Arabs are thought to have introduced this into India. From there the Portuguese introduced it into Malaysia and Indonesia.

***Serendipity berry* (Dioscoreophyllum cumminsii).** Known as *utobili* in Nigeria, this shrub produces a number of products useful to the native peoples of West Africa. The tubers are employed in soups, especially as thickeners and are considered one of the distinctive ingredients in regional Nigerian cookery.

Eurasia (Including the Mediterranean Basin and Pacific Islands)

The Eurasian land mass represents a huge diversity of tuberous plants, and some of the earliest ones brought into cultivation. This includes all the cultivated taros (two species each of *Alocasia* and *Colocasia*, one species of *Cyrtosperma*), most of the agricultural yams (roughly ten species out of 600), and innumerable lesser tubers such as the kudzu (*Pueraria lobata*), which has become an invasive pest in the southern part of the United States. Historical information on many of the tubers from this part of the world is good, since their cultivation is often noted in the records left by peoples residing in ancient China, India, the Near East and Mediterranean Basin. It should be noted, however, that most of the Eurasian staple tubers are of tropical origin.

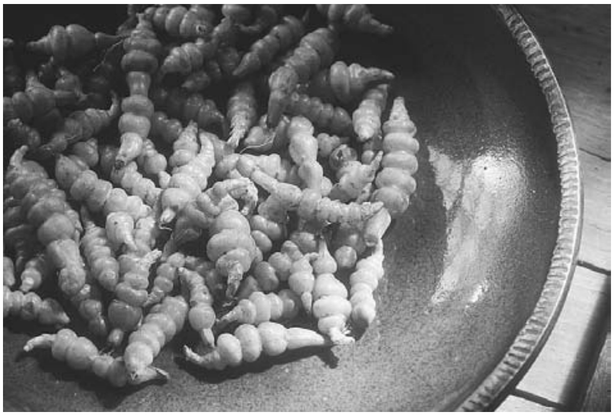
Adder's grass **(Dactylorhiza maculata).** This is technically an orchid whose tuber was ground to yield a starchy powder employed in the preparation of *salep. Salep*, a word of Turkish and ultimately of Arabic origin, was a beverage served cold during hot weather and hot during cold weather. The actual drink is of Byzantine origin (or perhaps even Lydian as some historians have suggested), since the orchid tubers with which it is made are found primarily in Asia Minor and Armenia. The starch was also used to thicken milk and more recently to make a line of elastic ice creams popular in the Middle East.

Historically, salep was also popular in seventeenth- and eighteenth-century England and America, especially in coffeehouses, but in general it was regarded as a health drink. It was also thought to contain aphrodisiac qualities. It has been replaced by cornstarch or arrowroot.

Asphodel **(Asphodeline lutea).** A native of the Mediterranean, the Egyptians, Greeks, and Romans prepared it like a potato. It prefers sandy soil and was probably a minor crop in some parts of North Africa during classical antiquity. It also yields a starch that was highly valued as a food thickener for making medieval blancmanges, sauces, and thickened soups.

Chufa **(Cyperus esculentus).** Chufa is found throughout the Mediterranean Basin and in parts of sub-Saharan Africa. It has been taken to most parts of the world where it is either maintained as a garden plant or has managed to escape into the wild (as in the case of North America). Wild chufa, which is often called nut grass in English speaking countries, produces small tubers resembling brown shriveled peas. Their flavor is similar to almonds and when pressed, they yield an oil similar to almond milk. The tubers of cultivated chufa are much larger, sometimes the size of a lima bean, and much easier to employ in cookery.

Chufa was domesticated thousands of years ago and was probably an important food source for the ancient Phoenicians. The Egyptians grew it both for its ornamental leaves and its tubers. The Byzantine Greeks used it both in cookery and medicine. It is still employed in modern Spain in the preparation of *horchata*, a milky beverage popular in the fall. The British Isle imitation was called orgeat in eighteenth century cookbooks.



Crosnes (*Stachys affinis*) is a tuberous rooted relative of mint native to Asia. The nutty tubers are extremely popular in China and Japan both in stir-fries and pickles. The plant was introduced into Europe in the early 1880s and takes its name from the village of Crosnes, France, where it was first grown. PHOTO BY L. WILBUR ZIMMERMAN. ROUGHWOOD SEED COLLECTION.

Crosnes **(Stachys affinis).** Generally harvested during the winter months when the tops are dead, the tubers are knobby and white. The plant resembles nettle and prefers moist, shady soil; thus, it is ideal for marginal ground. It is also extremely hardy, and has been cultivated as an important supplement crop in China and Japan for many centuries. The tubers are pickled or eaten in stir-fries. The plant was introduced into France in the 1880s and takes its European name from the village of Crosnes (Seine-et-Oise), the site of a large experimental farm where crosnes were first trialled. Crosnes are also grown in the United States and are now commonly seen in farm markets.

Devil's tongue **(Amorphophallus rivieri).** A native of Southeast Asia that is now very important in Japanese and Korean cooking, the tubers yield a starch that is solidified into a gel called *konnyaku* (yam cake). Noodles called *shirataki* are made from this. Yam cake is also commonly added to Korean hot-pot dishes.

Elephant's foot or telinga potato **(Amorphophallus campanulatus).** Mentioned in Sanskrit, this is one of the most ancient cultivated plants of tropical Asia. In India, the tuber (also called a corm) is prepared in curries, fried, added to stews, and cooked in syrup. It is also sold in cans and is imported in this form to the United States. The plant is now cultivated in East Africa, especially in areas where Indians have settled.

Giant swamp taro **(Cyrtosperma camissonis).** A native of the Pacific Islands and Indonesia. It grows well on the difficult soils of coral atolls, thus it is much favored by Polynesians. The tuber requires several years to mature, so cultivation is continuous, with some being dug while others are being planted.

Kembang Bangké **(Amorphophallus variabilis).** A near relative of devil's tongue mentioned above, this is also used to make the starchy gel known as *konnyaku.*

Korean bellflower root **(Platycodon grandiflorus).** This is the east Asian counterpart of the European rampion. Called *toraji* in Korean, is it employed in stir-fries and kimchee, or pickled like crosnes.

Kudzu **(Pueraria lobata).** Kudzu originates in China and Japan, and its common name is of Japanese origin.

It grows wild in the grasslands of the Pacific Islands, and because all parts of the plant are edible, it was formerly important in the agriculture of India, Malaysia, and Southeast Asia. Because the tubers, which can reach a length of three feet (1 meter) require several years to mature, the plant is slowly losing ground to sweet potatoes as a staple even though the tubers contain roughly 27 percent starch. The vines grow anywhere from 24 (8 meters) to 36 feet (12 meters) in one season and will overwhelm any plants nearby.

***Polynesian Arrowroot or Tacca* (Tacca leontopetaloides).** Grown mostly on the Pacific Islands, this is an ancient source of starch, which has long been sold under the name of pia flour. The plant is cultivated throughout Oceania as well as in India and Sri Lanka. Cultivation is now declining in favor of cassava, which is easier to grow.

***Rampion* (Campanula rapunculus).** The tubers resemble tiny potatoes and were once popular in salads and as a table vegetable. It is still cultivated to some extent in France, Germany, and Switzerland. Historically, it was grown as a garden vegetable even during Roman times, with the center of cultivation in the Rhine Valley. Its Latin name means little turnip, and it was evidently an important food among the Gauls and early Germans, perhaps with some now lost sacred connections. Numerous folk legends survive dealing with personifications of this tuber, including the famous Grimm fairy tale about Rapunzel, and the story of the first king and queen of ancient Poland—the queen's name was rampion.

***Soldier orchid* (Orchis militaris).** Found in temperate regions of Europe and Asia, this tuber was often gathered and prepared like a small potato. It was also used in medicine and in the preparation of *salep* (see adder's grass). Because the tubers resemble testicles, they were thought to enhance male sexuality. As the common name implies, the tuber was often employed as a forage food by armies on the move.

***Taro* (Colocasia *sp.*).** This group of tubers includes two cultivated species as well as the closely related genus *Alocasia*, all of which appear to originate in southern India. Some Indian historians claim that taro was brought under cultivation over 10,000 years ago, although this is not firmly established. Whatever the date, it is clear that taro is one of the most ancient of the cultivated Old World tubers. It spread to Egypt by the first century C.E. and then to many parts of the Mediterranean. The Spanish and Portuguese brought it to the New World. The history of taro and its many forms is taken up in further detail below.

***Yam* (Dioscorea *sp.*).** Yam is a loose term covering some 600 species, of which about ten are cultivated for food. Many member of this genus are poisonous or require processing to remove toxins in order to make them safe for consumption. The common name derives from a West African word nyami, but the botanical origin is thought to be Sri Lanka or Southeast Asia. Since this is such a large and economically important group, yams are treated separately below. Yams are now found in tropical regions throughout the world.

North America (United States and Canada)

In terms of naturally occurring and domesticated native tubers, North American biodiversity is relatively sparse. Most of the edible tuberous plants that exist here were employed by native populations prior to European contact. Very few of these plants were acculturated by Europeans except under frontier conditions or during times of scarcity. The introduction of the sweet potato in the South and the potato in cooler parts of the continent more or less preempted the domestication of potentially important native tuber crops that might offer nutritional alternatives better adapted to soil and climate. Only the Jerusalem artichoke (*Helianthus tuberosus*) has played a minor role doubtless because of its similarity to the potato when cooked. The following list is by no means complete, but it does list the primary tubers known to native peoples.

***Arrowhead* (Sagittaria sagittifolia).** Found all over continental United States and Canada, it is known by many Indian names, the most common being wapatoo. The tuber tastes like a potato and can be sun-dried for use in the winter. A closely related species, sessile-fruited arrowhead (*Sagittaria rigida*) is found only in the eastern North America. Both plants are aquatic. It is also important to note here that European and Asian arrowhead, formerly treated as separate species, are now grouped together, thus this plant is in fact found throughout the Northern Hemisphere.

***Bush morning glory* (Ipomoea leptophylla).** A native of the Great Plains, this was once collected for its tuber, which resembles a sweet potato. The tuber has also been classified as a root, although the distinction here is hazy. Some plants produce unpleasantly bitter or tough tubers, while others are starchy or even pleasantly sweet. These differences may be environmental. The tuber may be eaten raw or cooked and is excellent when sliced and sun-dried.

***Groundnut or bog potato* (Apios americana).** Sweet and starchy, these small tubers contain about 17 percent crude protein and are therefore among the most nutrient rich of all the New World tubers, more so even than the potato. They can be eaten raw or prepared like potatoes, or added to soups and stews like beans or peas. There is considerable breeding being undertaken to develop commercially feasible crops, with over ten named cultivars in circulation among experimental growers at the present time. The commercial advantage of this tuber is that it can be grown on marginal land and it is not subject to a large number of pests.

***Jerusalem artichoke* (Helianthus tuberosus).** First noted by Europeans about 1605, the Jerusalem artichoke has experienced numerous cycles in popularity over the ensuing centuries. It was promoted by French agricultural writers Antoine Parmentier (1789) and especially by Victor Yvart (1790) who wrote a treatise on the subject, and is even mentioned by American cookbook author Amelia Simmons in 1796. Rich in inulin, the Jerusalem artichoke was widely cultivated by native peoples in North America, especially in the Midwest where it is thought to have originated.

There are five basic tuber types and a wide range of skin colors, from pure white, to red, purple, even brown. There are also discernible differences in flavor, but nearly all of the known varieties share in common a strong resemblance to the flavor of cooked artichokes, hence the name: artichoke of New Jerusalem. Most native peoples referred to the plant as a "sun root," which is botanically more correct. The Jerusalem artichoke has been hybridized with the sunflower to yield the Sunchoke, which is high in sugar and may eventually serve as a commercial source for sugar.

A number of Jerusalem artichoke cultivars are considered improvements over the knobby, hard to pare wild sorts. These include Challenger, French Mammoth, Skorospelka (developed in Russia), Stampede (developed by Ontario Indians), and Fuseau, a tapered sort resembling a sweet potato in shape which was developed in Egypt about 1913.

***Maximilian's sunflower* (Helianthus maximilianii).** This is a near relative of the Jerusalem artichoke, which produces tubers or thick tuberous roots prepared and eaten in the same manner. It is native to the dry prairies of the Great Plains, where it was first identified by Prince Maximilian of Wied-Neuwied during a trip up the Missouri River between 1815 and 1817.

***Water parsley* (Oenanthe sarmentosa).** An aquatic tuber with black skin and starchy white flesh tasting of parsley. It was highly esteemed by the native peoples of the Pacific Northwest.

***Wild potato* (Solanum fendleri *and* Solanum jamesii).** These are small, marble-size potatoes found in the Southwest. They were gathered mostly by the Navajo, Hopi, and other native groups. The Fendler Wild Potato is said to taste like a chestnut when cooked. The Colorado Wild Potato (*Solanum jamesii*) was eaten raw, baked or boiled and can be stored for long periods of time. It was also dried and ground to make flour. Both species contain bitter toxins that can be neutralized when cooked with an alkaline substance.

***Wild sweet potato* (Ipomoea pandurata).** This is in most ways similar to the Bush Morning Glory, except that it has a vining habit and grows in the eastern regions of North America rather than on the Great Plains. It was considered an important food source by Eastern Woodlands peoples.

***Wood sunflower* (Helianthus strumosus).** A near relative of the Jerusalem artichoke, the tubers are less well formed, more elongated and knobby. The flavor is similar to a Jerusalem artichoke. The plant grows in forest clearings in eastern North America and has become relatively rare. It is cultivated on a very limited basis by specialists interested in heirloom crops.

South America (Including Central America and Mexico)

This region of the world possesses the richest natural diversity of tuberous species, yet nowhere is the literature more confusing than from this continent. As the late Sophie Coe pointed out "the treachery of common names" can transform comparative research into linguistic nightmares, especially when it comes to cookery. Local names for plants change not only across national borders, but from one region to the next, and even among neighboring native languages. All of these aliases show up in regional cookbooks, which must be read with great care. The *ocumo* of Venezuela is the *malanga* of Puerto Rico and the *quequisque* of Nicaragua. Not all of the multitudes of local names are listed below, just those that are most commonly mentioned in culinary literature. Nor are all of the South American tubers included, since many of the minor ones like swamp lily (*Thalia geniculata*) are consumed primarily or exclusively by indigenous ethnic groups. The tubers included here are those that play an important role in agriculture and kitchen gardens, and many of them are now commonly grown in other parts of the world.

***Arrowroot* (Maranta arundinacea).** Some botanists refer to the root of this plant as a tuber when it is round and as a rhizome when it is long, even though the genetic material is identical. This difference in shape is owing to physical changes as the plant matures, but for the purposes of cookery, it is treated here as a tuber. This is a plant that grows on boggy ground or along steams, and in the West Indies where it originates, it was grated, boiled, or baked in the manner of a potato by the native peoples. Because it is so rich in starch, arrowroot became an article of trade by the eighteenth century, the starch being an ideal thickener in sauces as well as a basis for soupy gruels in invalid cookery. It also became one of the base thickeners for *budín*, and a key ingredient in delicate *galletas*. Arrowroot is now grown mainly as a source of culinary starch, but its culture has spread to several parts of the world. In Asia, it is planted along the borders of rice fields, so it is an important secondary crop for small-scale farming. It is also employed in the manufacture of noodles.

***Cassava* (Manihot esculenta).** Also called manioc and yuca, cassava has become on of the most important food crops in the tropics, particularly in sub-Saharan Africa. The nutrient-rich leaves are boiled like spinach, the tuber cooked like potatoes, and the starch used for making tapioca. The genetic origin of the plant is tropical South

America, most likely northeastern Brazil. It was brought under cultivation about 3,000 B.C.E., but had spread to many areas of Central America, Mexico, and the Caribbean by the time Columbus first saw it in 1492. It became an important military ration for the conquistadors because it could be stored for a long period of time. Since the 1500s, cassava has been introduced and thoroughly integrated into the agricultures of Asia and Africa. In South America entire cookbooks, such as Enrique Tercero Hoyos's *Casabe* (Bogotá, 1996), are devoted to the preparation of this vegetable. A more complete discussion of cassava and its complex history are provided in a separate article.

***Cush-cush or Indian yam* (Dioscorea trifida).** Also called Mapuey. Compared with the more popular yams introduced from the Old World, this may be considered a minor crop limited to the northern coast of South America, parts of Central America, and the Caribbean. It has not received much attention in scientific literature, although it is the only New World yam raised for food. In Afro-Caribbean cookery, it is treated like the sweet potato and is superior in quality. The texture is very fine and creamy when mashed. There are several landraces, most with white flesh, others with rose or purple flesh.

***Dahlia* (Dahlia pinnata).** The common garden dahlia now grown as an ornamental was not noticed by European horticulturists until it was sent to Spain in 1787. Prior to that, its tubers were cultivated or gathered from the wild by the native peoples of southwest Mexico. The dahlia is still considered one of the native ingredients in the cookery of Oaxaca, and the petals make a colorful addition to salads. Today, there are several cultivars raised especially for their large, sweet potato-like tubers. There the similarity stops, since these tubers do not cook soft, but rather retain a certain celery-like crispness that is ideal for vegetable stir-fries. The flavor is complex, something akin to steamed pumpkin with overtones of sunflower seeds and a hint of spinach. Dacopa, an intensely sweet extract from the tubers, is used to flavor beverages in Central America. This extract tastes like strong mocha.

***Madeira vine* (Andredera cordifolia).** This fine ornamental vine, which was a popular verandah plant in Victorian America, is actually a very good garden vegetable with many overlooked qualities. Its succulent, fleshy leaves may be eaten raw or cooked, and its white, nutty tubers make excellent additions to a meal, especially because they retain their crispness if not cooked too long. Otherwise, when cooked soft, they resemble potatoes. This is a relative of Malabar spinach and ulluco, which is still commonly found in Central American markets. It originates in the tropical parts of South America, but outside the western hemisphere it is not widely dispersed as a food plant except for a few places in Asia, such as Japan and the Philippines.

***Malanga* (Xanthosoma *sp.*).** Christopher Columbus encountered this plant during his voyages to the New World but no one yet has established a universally accepted name. It was called *taia* in Carib, but goes by *yautia* or *malanga* in Spanish, *ocumo* in Venezulea, *chou caraibe* in the French West Indies, *tannia* and *calaloo* in the English-speaking islands, and *quequisque* in Nicaragua. The confusion is even greater since these names refer to specific species in some localities, while in others they are just general monikers to differentiate the plant from taro, which it resembles. The *yautia amarilla* of the Dominican Republic is *Xanthosoma atrovirens* and not any other yellow-tubered species, while the *yautia morada* of Puerto Rico is the same species as Nicaraguan *quequisque* (*Xanthosoma violaceum*). To get it right in the marketplace, it is almost necessary to bring a botanist along. Confusion arises from the fact that within each species there are numerous varieties and indeed many named cultivars. To the subsistence farmers of the Caribbean and South American tropics where this plant originates, all of this does not matter; it is only how it tastes that counts.

The most commonly grown species is the white tubered sort called *yautia blanca* or *malanga blanca* (*Xanthosoma saggittifolium*), a key ingredient in Cuban and Puerto Rican cookery. The differences between malanga and taro are very noticeable when subjected to comparative taste-testing. The malanga is finer textured, easier to digest, and contains more starch. The leaves, which are cooked like greens, are also richer in protein and minerals, and the Haitians believe they taste a bit like mild cabbage. The underground parts harvested are the lateral tubers, which means that by digging beside the plant, it is possible to remove tubers as needed without killing it. This low maintenance, perennial food supply is one reason that the vegetable is so popular among the rural poor in the tropics. It also grows in areas with less rainfall than required by taro and will even grow in well-drained uplands. For this reason, its cultivation has also spread to Hawaii, Malaysia, the Philippines, Indonesia, and much of Southeast Asia, where it is used like taro.

***Mashua* (Tropaeolum tuberosum).** Also known as Añu, this species of the garden nasturtium has been cultivated since ancient times in the Andes and has no known ancestral forms. It grows like a typical vining nasturtium and produces red and yellow flowers during the summer, but requires day lengths of twelve to nine hours for tuberization. The tubers are cone-shaped and thickened toward the bottom. There are two distinct varieties, a white skinned tuber flushed with violet, and a red-speckled one with pale yellow skin. Both are cooked before they are eaten and taste much like Jerusalem artichokes. Like oca and ulluco, the plants are highly productive and easy to harvest. Historically, Inca generals shipped large quantities of the tuber along with their armies under the belief that it would suppress venery so that the soldiers would forget their wives and devote themselves more energetically to fighting. It does not seem to have this effect on the Spanish.

***Oca* (Oxalis tuberosa).** Next to potatoes, oca was—and still remains—one of the most important tubers raised in the high Andes. It forms an historical triumvirate with the potato and ulluco, and speaks for the genius of the farmers who figured out how to coax prolific tuberization from plants that in the wild would never have supported the complex societies that later evolved in that part of the world. In fact, oca has been cultivated for so long that the ancestral plant is now lost.

Oca is rather hardy, with fleshy leaves and stems, and a multitude of colorful tubers that form very late in the season, when the days grow exceptionally short. In the Northern Hemisphere, this means that oca will not tuberize until late November; therefore, it must be grown in cold frames, polytunnels, or cool greenhouses in order to produce a crop. This is not a problem in the oca-growing regions of the Andes, where frosts come late, but it has hindered the spread of oca to other parts of the world. The French and English, for example, experimented with oca in the 1820s, but it remained a curiosity, more ornamental than culinary.

Ocas are sold by color in Andean markets, and there seem to be at least 60 variant forms, from snowy whites to bright, waxy reds, even black. In spite of this biodiversity, which certainly excites the eyes of experimental chefs, ocas are essentially of two sorts: the sweet ones that are eaten raw or sun-dried like figs to make *caui*; or the bitter ones that are boiled, and boiled again, then freeze-dried to make *ckaya*. Dried ocas are more nutritionally rich than freeze-dried potatoes (*chuño*), and therefore form an important supplement to the Andean diet. Fresh ocas resemble miniature potatoes, even to the "eyes," which can be planted like potato eyes in the early spring. Europeans find them bland-tasting, but when added to soups or raw to salads, they greatly enhance the visual appeal of the dish. Furthermore, the Indians of the Andes consider oca a potent aphrodisiac, so there may be unsung benefits to promoting oca beyond its old native borders.

***Potato* (Solanum tuberosum).** Known as papas in Quechua and in Spanish, potatoes have been cultivated in the Andes roughly since 3700 B.C.E. (there are scholars who argue for an even older date of domestication). Seven distinct species of potato are still cultivated in South America, although only *Solanum tuberosum* is presently grown worldwide. The long tubered species *Solanum ajanhuiri* was introduced to France from Peru about 1815. It is still cultivated by potato connoisseurs, especially the black variety called Negresse or Truffe de Chine, which has become popular with Parisian chefs because of its truffle-like flavor. A detailed discussion of the potato and its history and near relatives may be found in a separate article.

***Sweet potato* (Ipomoea batatas).** This tuber was brought under cultivation along the western coast of South America about 2800 B.C.E. It spread to nearly all parts of South and Central America, but never reached Mexico proper. The early Spanish likened its flavor to marzipan, and it was this potato, not the Peruvian potato, that was first sent to Europe. Sweet potatoes were grouped into two basic types by indigenous peoples: a mealy, starchy type used for bread making, and the fine-grained sweet types known today. Since the Spanish preferred only the sweet types, the starchy types have become extinct, except for a small pocket of "relic" cultivars found in parts of the Pacific and among the Maori of New Zealand.

The history of the sweet potato is complex, for it is one of the few New World plants that spread beyond the hemisphere prior to European contact. For a fuller treatment of the sweet potato, refer to the article by that name.

***Ulluco* (Ullucus tuberosa).** A relative of the tropical Malabar spinach, ulluco prefers growing conditions quite the opposite: short day length, high humidity, cool weather, ample rainfall. In the high Andes it has been interplanted with potatoes for thousands of years and is still grown in a region stretching from Bogotá, Colombia, into northern Argentina. It is one of the most frost-resistant of all the Andean tubers. Its native names are many, including *lisas*, *papa lisas*, *chuguas*, *rubra*, *timbos*, and *melloca*. The smooth-skinned tubers resemble miniature potatoes and are quite startling visually, coming in a rich array of yellows, purples or magentas, vibrant greens, and varieties that are speckled. There are six named cultivars which vary in sweetness or starch content. Some find the tubers bland when boiled, but when boiled and then fried, they taste like potatoes. They are also eaten raw with vinegar or dried in the sun to make *lingli*, an Andean snack food.

***Yacon* (Smallanthus sonchifolius).** A near relative of the sunflower, yacon (pronounced ha-KON) has been cultivated in the Andes for almost 2,000 years and perhaps much longer. The name is a Spanish combination of Quechua *yacu* and *unu*, both of which mean water in the language of the Incas. This refers to the fact that the tubers are juicy like apples and will yield a pleasant beverage when pressed. This juice is also cooked down until thick to make a type of molasses called *chancaca*. The plant itself is a handsome ornamental, with large palmate leaves resembling tithonia. The leaves are used in medicinal teas and are considered antidiabetic. The long, smooth, sweet-tasting tubers were treated as fruit by all Andean peoples and are still sold among fruits in the country markets of Peru, Bolivia, and Ecuador.

Images of yacon tubers and leaves dating from 500 C.E. have been found on cloth fragments at Nazca in Peru, direct evidence that the plant was already considered an important food source. Genetic evidence of long cultivation is also evident, since many strains have been reproduced from cuttings for such a long time that the flowers have become infertile. It is known from early Spanish accounts that yacon was mostly planted along the margins of fields and that its cultivation was spread over a wide area of the Andes by the Incas in the period immediately preceding Spanish conquest. Because yacon is day-length sensitive, many species cannot be grown outside their native habitats. There is some effort at present to breed out this sensitivity so that yacon can be grown more easily in North America and Europe. Since yacon's sugars can be tolerated by diabetics and it is nutritionally very low in calories, the plant offers a number of interesting possibilities for further development.

Aside from the yacon discussed here, there are at least 20 other species of yacon found in Mexico, Central and South America. Only a few of these have been brought under cultivation, although several types were treated as "managed" plants by native peoples. That is, they were maintained in the wild rather than cultivated in fields. Many of the Central American yacons produce edible seeds that resemble small, black sunflower seeds. They make excellent bird feed and would probably appeal to humans if they could be bred to grow larger. The seed also yields an oil which is highly valued for its medical properties.

***Yam bean* (Pachyrrhizus erosus).** Also known as *ahipa*, *xiquima*, and *jicama*, this is often described as a mono-tuberous root rather than a true tuber. Native peoples treated it as a tuber, and the Mayans included it in many of their food riddles, mentioning both yellow and white sorts. The plant is indeed a bean with a highly ornamental vine, but the beans themselves are toxic and narcotic. Only the tuber is eaten, and generally, if we are to judge by Aztec codices and early Spanish accounts, this meant eaten raw for its refreshing crispness.

The plant is native to tropical America, although its center of biodiversity appears to be Central America where other species are commonly found. The archeological record has not been helpful, but it is likely that the yam bean was domesticated in that part of the New World first, and then spread to other cultures. It was exported to the Philippines by the Spanish, and from there spread to other parts of Asia during the 1600s. It is now also grown in East Africa, where it has become quite common, although it is generally cooked.

It is also being marketed in the United States and Europe under the Mexican name *jicama* and plays an important role in Mexican and Central American cookery to this day.

See also **Africa**; **Aphrodisiacs**; **Cassava**; **Iberian Peninsula**; **Japan**; **Potato**; **South America**; **Sweet Potato**.

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William Woys Weaver

TURKEY. *See* **Poultry.**

TURKEY. *See* **Middle East.**

TWELFTH NIGHT. *See* **Epiphany.**

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UNITED KINGDOM. *See* **British Isles.**

UNITED STATES.

This entry includes twelve subentries:
African American Foodways
Cajun Cooking
California and the Far West
Ethnic Cuisines
Hawaii
The Middle Atlantic States
The Midwest
New England
Pennsylvania Dutch Food
Pioneer Food
The South
The Southwest

African American Foodways

A discussion of African American food must include the cultural patterns associated with how, where, when, with whom, and why certain foods are consumed and the patterns of food procurement, preparation, presentation, and dispensation. Studies of food as part of a cultural system should consider dietary behavior, the environmental conditions in which foods are grown, the meanings associated with food, the social structure and material culture affecting food, and the historical factors that contribute to the persistence or change in food behavior. Food meets a host of human needs—political, economic, communal, cognitive, and affective as well as nutritional—and it has a role in power relations, stereotypes, and assumptions.

Before discussing African American foodways, it is important to first clarify what is meant by the term "African American." *Webster's Encyclopedic Unabridged Dictionary of the English Language* (1996) defines "African American" as "a black American of African descent." This discussion narrows that definition to focus on black persons of African ancestry whose lineal relatives (parents, grandparents, great grandparents) have resided in the United States for several generations. The focus on lineal relatives for establishing African American foodways is based on the assumption that most children grow up in households with adult lineal relatives (parents and grandparents) and/or with adult collateral relatives (aunts, uncles, cousins), who in turn grew up in households with their lineal and/or collateral relatives. Where adults in the household grew up is important because they influence the initial foodways of children. Black parents who grew up in Africa or the Caribbean pass on preferences for foods from those cultural areas that are different from the preferences of black parents who grew up in the United States. Parents and close relatives also pass on many of the cultural patterns that surround dietary content. For the purposes of this discussion "foodways" are products of multigenerational historical process, reproduction, and change.

Soul Food: A Metaphor of Group Identity

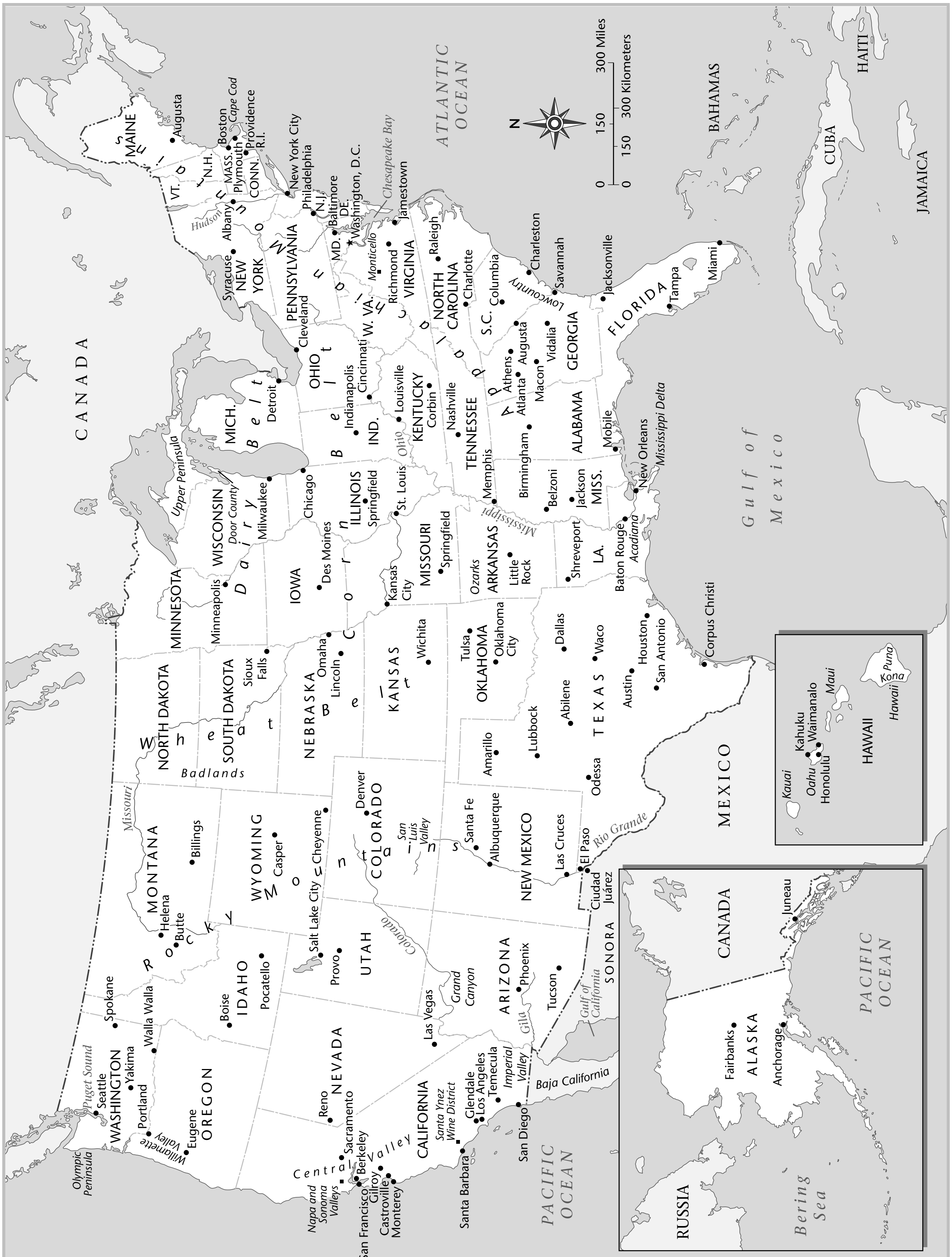
Linda Keller Brown and Kay Mussell, in *Ethnic and Regional Foodways in the United States: The Performance of Group Identity* (1984), discussed foodways as a metaphor of group identity and included contributions on Jewish Americans, Italian Americans, Russian Americans, Mexican Americans, Cajun Americans, Hindu Americans, and Florida Seminole Indians. However, no contribution focused on African American foodways even though during the 1960s soul food was adopted by millions of African Americans as a marker of ethnic identity, and soul food restaurants emerged wherever significant numbers of African Americans resided.

The concept of soul food emphasizes both content and preparation styles. Whitehead commented:

> Pork is a favorite soul food meat that must be fixed in a certain way. In addition, soul food requires the use of pork fat ("fat back," salt pork, streak-o-lean) as a seasoning in the cooking of vegetables in a slow stewing manner (vegetables such as collard and turnip greens, black-eyed and field peas, green and lima beans), and in the frying of other favorite foods such as chicken, fish, and [white] potatoes. (1992, p. 28)

William Wiggins has written that soul food restaurants include:

> down-home breads (cornbread, cracklin' bread, and biscuits), vegetables (collard, turnip, and mustard greens, candied yams, black-eyed peas, red beans and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Providence
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NEW YORK
New York City
Albany
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PENNSYLVANIA
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Washington, D.C.
Chesapeake Bay
Jamestown
VIRGINIA
Richmond
Monticello
W. VA.
NORTH CAROLINA
Raleigh
Charlotte
S.C.
Columbia
Charleston
Lowcountry
GEORGIA
Savannah
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Athens
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Vidalia
FLORIDA
Jacksonville
Tampa
Miami
OHIO
Cleveland
Cincinnati
MICH.
Detroit
Upper Peninsula
IND.
Indianapolis
KENTUCKY
Louisville
Corbin
Ohio
TENNESSEE
Nashville
Memphis
ALABAMA
Birmingham
Mobile
MISS.
Jackson
Belzoni
Mississippi Delta
New Orleans
LA.
Baton Rouge
Acadiana
Shreveport
ILLINOIS
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WISCONSIN
Door County
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Des Moines
MISSOURI
Kansas City
Springfield
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ARKANSAS
Ozarks
Little Rock
NORTH DAKOTA
SOUTH DAKOTA
Sioux Falls
Badlands
NEBRASKA
Omaha
Lincoln
KANSAS
Wichita
OKLAHOMA
Tulsa
Oklahoma City
TEXAS
Dallas
Waco
Houston
San Antonio
Austin
Abilene
Lubbock
Amarillo
Odessa
El Paso
Corpus Christi
Rio Grande
Ciudad Juárez
MONTANA
Missouri
Billings
Helena
Butte
WYOMING
Casper
Cheyenne
COLORADO
Denver
San Luis Valley
NEW MEXICO
Santa Fe
Albuquerque
Las Cruces
UTAH
Salt Lake City
Provo
Colorado
ARIZONA
Phoenix
Tucson
Grand Canyon
Gila
IDAHO
Boise
Pocatello
NEVADA
Reno
Las Vegas
WASHINGTON
Seattle
Spokane
Yakima
Walla Walla
Puget Sound
Olympic Peninsula
OREGON
Portland
Eugene
Willamette Valley
CALIFORNIA
Sacramento
Berkeley
San Francisco
Napa and Sonoma Valleys
Gilroy
Castroville
Monterey
Central Valley
Santa Ynez Wine District
Santa Barbara
Glendale
Los Angeles
Temecula
Imperial Valley
San Diego
Appalachian Mountains
Dairy Belt
Corn Belt
Wheat Belt
Rocky Mountains
HAWAII
Kauai
Oahu
Honolulu
Kahuku
Waimanalo
Maui
Hawaii
Kona
Puna
CANADA
Juneau
ALASKA
Fairbanks
Anchorage
PACIFIC OCEAN
RUSSIA
Bering Sea

> rice, fried okra, fried green tomatoes, green beans, pigeon peas, and squash), meats (fried chicken, shrimp, oysters, white buffalo, and catfish, neckbones, chitterlings, ham, gumbo, burgoo, and barbecue), and desserts (apple, peach, and cherry cobblers, sweet potato, transparent, pecan and apple pies). (1987, p. 81)

Some African Americans include rice on the soul food menu. Delilah Blanks (1984) found older African Americans in the South added wild animals, such as squirrels, rabbits, opossums, and deer. Flour-based gravies are a favorite with meats and rice. According to Wiggins, slaves began New Year's Day festivities as early as 27 or 28 December for ample celebration. They ate hoppin' John and attended watch night services to ward off family separations in the new year (Wiggins, 1987, p. 26). Many African Americans still eat hoppin' John or rice and black-eyed peas on New Year's Day for good luck in the upcoming year.

Among the soul food preparation styles are foods high in fat, salt, and sugar. Meats and other foods are fried, and most vegetables are stewed with pork fat. Whitehead reports that while dining with one of his study families in eastern North Carolina, at a single meal he was served fish, slices of country ham, corn bread, and white potatoes fried in pork fat and green vegetables stewed with salt pork as a seasoning. Country ham, preserved in a heavily salted brine, is a salt-laden favorite in the soul food menu (Whitehead, 1992, p. 98). Soul food is also spiced with red pepper (cayenne), malegueta peppers, hot pepper sauces, mace, allspice, cinnamon, cloves, sesame seed (benne), filé powder from sassafras leaves, thyme, and vinegar.

First-time patrons at soul food restaurants often find the drinks and desserts overly sweet. Heavily sweetened iced tea is the traditional drink, but unsweetened tea is often available. Whitehead observed that iced tea, lemonade, and Kool Aid, made with one cup of sugar to seven cups of water, were the favorite summer drinks of his study households. Fat (butter) and sugar are also used liberally in the preparation of favorite side dishes, such as candied "yams," a sweet potato dish, and desserts, such as apple or peach cobblers or pies; sweet potato pie and pudding; banana pudding; and chocolate, pineapple, coconut, lemon, and pound (plain) cakes.

With the increased awareness of heart disease, stroke, and diabetes, many African Americans have felt the need to reduce their consumption and preparation of these traditional soul foods, though they have not found it easy to change. Studies indicate that canned greens, frozen fried chicken, macaroni and cheese, corn or bread pudding, and sweetened tea are high in cholesterol, sodium, and saturated fat. Consequently public health agencies like the National Cancer Institute and cookbooks like *The New Soul Food Cook Book* (1996) by Wilbert Jones suggest ways to maintain flavors and diminish unhealthy habits.

The Southern Flavor of African American Culture and Foodways

The emergence of soul food was part of a cultural revitalization resulting from the black identity sentiments many blacks expressed in the 1960s. Most revitalization movements initiated by people of African ancestry in the Western Hemisphere, such as the Rastafarians of Jamaica, the Black Muslims in the United States, and Kwanzaa participants, seek to revive African cultural trends.

Evidence also suggests that various components of African American foodways have their origins in Africa. For example, the soul foods black-eyed peas, collard greens, okra, and benne or sesame seeds probably came from Africa. Archaeological discoveries indicate that "the meals the black women prepared for themselves and their families . . . readily could have used techniques and ingredients important in West African cookery" (Yentsch, 1994, p. 196). Anne Elizabeth Yentsch admits, however, that raising the point of African origins opens a Pandora's box because determining origins is "complex and tricky." The predominant cultural source of African American foodways is not Africa but the American South, involving a multiple-generation creolization process with contributions from Europeans and Native Americans as well as from Africans.

Pork and chicken are the dominant soul food meats, derived from animals the Europeans brought to the Americas. The Europeans, as maritime and colonial powers, were responsible for the movement of foods from continent to continent. For example, Europeans brought sugar cane to the Americas and thus contributed to the sweet foods in southern and soul food menus. Europeans brought foods from the Caribbean and Central and South America, "sometimes by circuitous routes through Europe and Africa and Asia," that became part of the southern and soul food diet, including "hot and sweet peppers, peanuts, tomatoes, lima beans, white potatoes, and sweet potatoes," chocolate, pineapples, lemons, and coconuts. (Egerton, 1987, p. 13). Europeans also brought rice to the lowlands of South Carolina and Georgia, from where it spread to Louisiana and Arkansas (Egerton, 1987, p. 307).

These foods Europeans brought to the American South became inextricably linked to the enslavement of Africans. For example, the slaves ate yams, peanuts, corn, and rice during the middle passage. Citrus fruits, like limes and lemons, hot malegueta peppers, herbs, and spices were provisioned during the middle passage for medicinal purposes. West African or Gold Coast slaves, who had centuries of experience, cultivated rice in the lowlands of South Carolina and Georgia (Egerton, 1987). Sugar cane traveled the circuitous route "North Africa to Spain and Portugal with the Moors; from Portugal to Madeira with the Portuguese; from Madeira to the Canary Islands with the Spaniards; and from the Canary Islands to Santo Domingo with Columbus . . . [and finally] to Louisiana in 1751" with the Atlantic slave trade (Mintz,

An upper-class African American family eating dinner in their home during the early 1900s. COURTESY OF THE LIBRARY OF CONGRESS.

1991, pp. 117–126). The Atlantic slave trade also introduced West African yams, which were replaced by sweet potatoes, millet, sorghum, rice, plantains, bananas, corn, cassavas, and palm oil.

Native Americans contributed maize or corn; a variety of peas and beans; fish, such as catfish and trout; and seafood, such as herring and shrimp, to southern diets. Indians taught white southern colonists and black slaves to hunt wild animals, such as opossums, deer, rabbits, and squirrels, which were still soul food items in the 1980s. Slaves quickly adopted bird hunting from Native Americans. European travelers' accounts noted that guinea fowl and other birds were a source of meat in West Africa. African Americans in the low country and Virginia were particularly shrewd "chicken merchants" (Yentsch, 1994, p. 203; Morgan, 1998, p. 367).

Archeological evidence suggests that African and Native American cultures were intertwined primarily in methods of consumption and in preparation of foods like rice and corn. During the colonial period, African meals consisted of a starchy main course accompanied by vegetables and a small serving of meat. Customarily the food was prepared in a large container and was eaten with hands or spoons (Ferguson, 1992, p. 97 *n*). Gourds were used as eating utensils and musical instruments. Leland Ferguson noted that the shards of cooking pots suggest commonalities among the foodways of Africans from several countries and Native Americans. Europeans influenced African and Native American food-related material culture, most notably in the adoption of such items as iron pots and wooden buckets. But Ferguson and others suggest that the manner of their use was adapted to African familiarity.

Given the contributions of Europeans and Native Americans, whites and Native Americans with cultural roots in the South could just as well view soul food as their own. Yet African contributions to southern foodways were considerable, as for centuries Africans and African Americans dominated the food scene through the preparation of these foods and thereby claimed the tradition. During the antebellum period, the slave cook was the primary food preparer for both the white plantation owner and the black slave families. For slaves

> the kitchen was one of the few places where their imagination and skill could have free rein and full expression, and there they often excelled . . . one of the few places where either blacks or women could let their guard down and be themselves. Almost everywhere else, they had to conform to binding roles that stifled expression and killed creativity; but in the kitchen, they could be extravagant, artistic, whimsical, assertive, even sensuous . . . . herein may lie the ultimate explanation for the natural superiority of Southern food. (Egerton, 1987, pp. 15, 17)

In its "natural superiority," southern food tends to be more spicy than foods from other regions of the United States. The slave cooks took advantage of the spices that came into North America from Africa, the Caribbean, and Central and South America. These spices not only stimulated the taste buds of the planter class but also made the lowly food items given to the slaves, such as the excess fat, snouts, tails, ears, and intestines of the pig and the bland and sometimes bitter greens, more tasty.

Of course the majority of African Americans with cultural roots in the South do not eat the same foods or prepare them the same way their ancestors did. However, the South has historically had the largest presence of African Americans. Even with the mass migration of blacks to the urban centers of the North and West during the first three-quarters of the twentieth century, the percentage of African Americans who remained in the South never dropped below 50 percent. As economic and political opportunities in the South improved, there came a reverse migration: a large number of African Americans returned, and by 2000 the South recorded a higher increase in African American population than in any other region in the United States. Consequently there has been a continual evolution of an African American culture in the South that includes African American foodways.

Even for the blacks who migrated out, the South retained its important cultural influence as ties continued with family members "back home," through holiday visits, attendance at church revivals and homecomings, and shared network functioning such as child and parental care (Stack, 1974). Migrants returned to get some of that "old down home cooking." Moreover, when African Americans moved to urban areas of the North and West, they took their food traditions with them along with their religions, which tended to perpetuate their foodways (Whitehead, 1992).

The foregoing should not be read as an argument for a synchronic view of southern or African American foodways—that is, one that ignores historical antecedents. Neither system has endured unchanged. Certain foods are consumed in all regions of the country and by members of most if not all ethnic groups. Consequently some argue that a truly "southern" diet and a truly African American diet do not exist (Fitzgerald, 1979). The notion that American food habits and preferences are national is based on supermarket and fast-food chains, mass media marketing, and the spread of ethnic groups and their traditional food preferences to all regions of the country. For example, Italian pastas, particularly spaghetti, and pizza have long been eaten in all regions, and Mexican and Chinese foods have become American favorites (Gabaccia, 1998).

A Cultural Ecological Approach to Foods and Foodways

The argument against specific southern and African American foodways parallels the argument that a southern culture does not exist because nationwide communication and transportation networks have incorporated southern components into a national, multiethnic American culture. However, these arguments focus narrowly on what people eat rather than on foodways as part of a larger biocultural system or what many foodways scholars refer to as a cultural ecological approach (Jerome et al., 1980). In this approach, the question is not to what extent other American foodways have permeated southern or African American food habits but rather to what extent southern and African American foodways have permeated the food habits of other Americans.

Thomas R. Ford described culture as a "historical production of environmental adaptation" (1977, p. 4). With regard to the study of food and foodways, five theoretical principles might be considered in a cultural ecological approach.

(1) Culture is a process of historical reproduction, and foodways as part of a cultural system are reproduced from generation to generation.

(2) Food is necessary for biological survival, thus the nutritional status of an individual or population is related to the availability and accessibility of food.

(3) The availability and accessibility of food is not only a function of the nutritional capacity of the physical environment but also a function of social and cultural influences.

(4) Social and cultural adaptations are made to factors related to the availability and accessibility of food.

(5) The persistence of factors related to the availability and accessibility of food contributes to the continuity of social and cultural adaptations developed in response to such factors.

Taste Preferences for Fats and Sweets: The U.S. South versus the French

Tony Whitehead spent the 1987–1988 academic year working with the noted French nutritional anthropologist Igor de Garine. Before Whitehead left for France, the owner of Dip's Country Kitchen, a soul food restaurant in Chapel Hill, North Carolina, implored him, "During your research in France, would you find out for me why is it that the French love fat foods and sweets as much as we [black people] do, but they don't seem to get as fat we do?" While Whitehead did not have the means to empirically explore this question, from his observations he concluded that fat, in particular butter and cream, was quite present in the French diet and preparation styles and that the French loved desserts. However, their desserts and drinks did not taste as sweet as the ones he was familiar with as a native and food researcher in the American South. And the French did not snack frequently on sweets, which were relegated to specific times of the day, the afternoon, equivalent to the English tea, and the evening. The French would just as likely have cheese for dessert. Even though the French have multiple courses at meals, they eat small quantities of each course. Finally, eating for the French seems to be a social event, with much talking and social interaction with wine, rather than an eating event.

The Historical Foundation of the African American Traditional Core Diet

The cultural roots of African Americans in the South were firmly established during more than two hundred years of slavery. Because slavery was a "total institution," it influenced the availability and accessibility of food and slaves' responses to these conditions (Stampp, 1956). Most of the foods available to slaves were passed on to them by their owners. African Americans in the South in the twenty-first century use preparation styles similar to those developed by slaves.

Plantation records, slave narratives, and archaeological examinations of slave quarters provide information on the diets of both blacks and whites. The planter class in the South consumed the "better" parts of hogs, chickens, and cattle; fresh milk; butter; and cheese. They passed to slaves the feet, necks, ears, and tails of hogs; hog chitterlings, kidneys, livers, and brains; chicken feet, livers, and gizzards; and buttermilk. Slaves were frequently allotted cornmeal, salt, pork, molasses, and herring, as these foods could be stored in bulk by the planters (Gibbs et al., 1980).

Many planters encouraged slaves to cultivate gardens for their own subsistence (Singleton, 1999, pp. 20–21). However, the foods slaves were allowed to produce for themselves varied. On some plantations slaves raised chickens and ducks and grew cabbage, collard and turnip greens, white potatoes, sweet potatoes, and a variety of beans and peas. Other planters prohibited slaves from producing such foods in fear that the slaves would sell them to earn money to buy their freedom or trade them for whiskey (Gibbs et al., 1980). According to Todd Lee Savitt (1975), planters often used slave produce to pay certain debts, and the slaves were allowed to keep the remaining produce for themselves.

Frequently slaves had to supplement their diets by gathering plants and wild berries; hunting small game, such as squirrels, rabbits, opossums, and raccoons; fishing; and stealing. Some scholars have placed these methods of food procurement within the context of plantation power dynamics and resistance, arguing that slaves in some instances exercised a modicum of autonomy by resisting planter attempts to control their diets. Fishing, hunting, and gathering gave slaves some sense of autonomy, but true acts of resistance involved theft of livestock and other foodstuffs, such as smoked meats, eggs, chickens, and vegetables (Yentsch, 1994).

Many of these food items are included in the African American traditional core diet that was characterized by Whitehead (1992) and Delilah Blanks (1984). In separate studies in North Carolina in the 1970s and 1980s, Whitehead and Blanks found that most were still regularly eaten in African American households. Presumably this traditional core diet has persisted over a number of generations.

Whitehead and Blanks found that other foods in the core diets of their study families were not a regular part of slave diets according to historical accounts. Among these foods are pork products, such as hams, ribs, chops, loins, and shoulders; whole chickens and chicken breasts, thighs, legs, and wings; beef products, such as ground beef, roasts, and steaks; fresh fruit; desserts, such as fruit pies, cobblers, cakes, and cookies; and beverages, such as sweet milk, coffee, tea, and lemonade. This does not mean that some slaves and some black free persons did not eat such foods, but according to historical accounts most African Americans did not eat them frequently during the slave period. It is likely that after emancipation more African Americans raised their own food and traded for or bought a wider variety of foods.

African Americans consumed other foods added to their diets by the twentieth-century mass food delivery and marketing systems. Whereas many African American traditional core foods were fresh produce, most of the foods were processed, canned, prepackaged, or frozen. Whitehead's research was motivated by the high fat and low fiber content of traditional core foods, which public health professionals blamed for the higher incidence of heart disease, hypertension, stroke and other cardiovascular conditions, diabetes, and rectal and colon cancers among blacks and whites in the southeastern United States. However, in a study published in 1996, Barry M. Popkin and Anna Maria Siega-Riz found that between 1965 and 1991 many traditional foods like sweet potatoes, greens, and black-eyed peas had decreased significantly in the diets of poorer blacks. The study noted that, among all socioeconomic classes, consumption of fast-food items, including "pizza, tacos and pasta dishes loaded with hidden fats" increased (Popkin and Siega-Riz, 1996, p. 718). These foods contribute to the fact that proportionately more African Americans, especially women, are overweight than white Americans (Kumanyika, 1997).

An Experiment to Test Southern Preference for Salt and Sugar

While Tony Whitehead's research in North Carolina was only exploratory, his findings were suggestive. Whitehead's original sample was the membership of 43 total households of 193 African Americans 10 years of age and above. A nutritionist on Whitehead's research team, Judith Katona Apte, created two simple instruments to explore sugar and salt preferences. The first was five water and sugar mixtures with the amount of water evenly calibrated between each. Mixture 1 had the least amount of sugar, and mixture 5 had the greatest. The second instrument was similar, consisting of broth-type mixtures with five different calibrated amounts of salt. These mixtures were first administered to ten graduate students at the University of North Carolina who were asked which mixture they preferred in their foods. Mixture 3 was selected by eight out of the ten students. The mixtures were then administered to the study participants. It was a methodological error to not pretest these instruments on research participants from the study community and adjust based on their preferred tastes. Nevertheless it was instructive that the most frequently stated preference of both salt (97 out of 141 cases) and sugar (111 out of 140 cases) concentrations was mixture 5. Even with the methodological error, the finding at least suggests that African Americans residing in this southern study community preferred higher concentrations of salt and sugar in their foods than did the ten graduate students, seven of whom were not originally from the southeastern United States. Whitehead observed that the favorite summer drinks among his study group had what might be considered higher concentrations of sugar (one cup) to water (seven cups) than what most Americans whose foodways are not southern would prefer. This also suggests that southerners and African Americans prefer foods higher in these ingredients.

Foods Accessible to Slaves: The African American Traditional Core Diet

Meats, Poultry, and Seafood

- Pork Extremities
- Chicken Extremities
    - wings, necks, backs, and feet
- Chicken Organs
    - livers and gizzards
- Wild Game
    - rabbits, squirrels, deer, and opossums
- Seafood
    - dried and salted herring; freshwater fish, such as trout, catfish, kingfish, croaker, black and red drum, and flounder; and shellfish, such as crabs, clams, and mussels

Vegetables, Legumes, Tubers, and Grains

- Green Vegetables
    - okra; collard, mustard, and turnip greens; poke salad, cabbages; and pumpkins
- Legumes
    - cowpeas and lima beans
- Tubers
    - white potatoes, sweet potatoes, onions, and turnips
- Grains
    - rice, corn, and wheat
- Wild Berries

Breads, Sweets, and Beverages

- Breads
    - cornbread and biscuits
- Desserts
    - sweet breads made with molasses or honey
- Beverages
    - buttermilk and teas made from roots and herbs, such as sassafras

The African American participants in a study by Psyche Williams-Forson (2001) complained that the grocery stores in their communities did not provide enough variety in fish, fruits, vegetables (all items in the African American traditional core diet), and soy products. Rather, the perception of all African Americans preferring primarily pork and beef products and low dietary fiber foods still exists.

Ecological Factors in the Post-emancipation Continuity of African American Traditional Core Foodways

The content of the African American traditional core diet became more entrenched after emancipation because the Civil War left the economy of the South devastated. Blacks and many whites resorted to the means of acquiring food that slaves and poor whites had learned during the slavery period, including gardening, hunting, fishing, gathering edibles, and for those who could afford it, raising chickens and pigs. However, lifestyle differences by race and class, including foodways, continued into the postslavery period.

Although slavery formally ended in 1864, the political economy of the plantation system did not. Sharecropping and tenant farming were the only forms of employment available to most blacks, and the economy maintained the marginal status of African Americans well into the twentieth century. African American foodways continued, particularly the modes of food acquisition. Gardening, hunting, and fishing remained significant forms of food procurement (Cussler and de Give, 1952). Blacks still got some food from "the white man," but now they had to pay cash or receive it on credit. For sharecroppers and small farmers, this frequently meant turning over a good portion of their pay from a good crop. The landlords who owned the farms allowed their tenants to garden and keep animals on these properties, similar to the pattern during slavery. Some foods and other goods could be purchased from stores in the nearest town or on the plantation, but usually with a credit line made out to the landlord. Thus workers saw little cash return for their labor as the landlords paid the accounts out of their wages.

Along with persistent poverty, the ecology of the region supported the continuity of the African American traditional core diet. The same foods grew wild or were cultivated, and African American families continued the food producing behaviors practiced during slavery with the exception of receiving rations from the planter (Gibbs et al., 1980). They raised many of the vegetables, legumes, and tubers they had consumed during slavery, and they continued to hunt and fish. Hogs and chickens were rather inexpensive to raise, partially because these animals ate pretty much anything the fertile area offered them.

These patterns of food acquisition continued in the twentieth century. Scholars of southern and African American foodways have noted that, although most foods were acquired from grocery and fast-food chains in the twentieth century, many African Americans in predominantly rural southern counties fished, hunted, and gardened; were involved in networks that killed hogs and shared pork products; and bought fresh produce from roadside stands and truck farmers who sold their produce in neighborhoods.

SOUTHERN "HOSPITALITY" IN BLACK AND WHITE

John Egerton noted that the concept of "southern hospitality" grew out of a "grand style . . . of gracious and elegant living" that was made possible because of the "platoon of black cooks and servants" that made the "elegant service and distinctive cookery" associated with the social events of the higher southern (white) classes possible (1987, pp. 14–15). He commented that while "white mistresses may have had favorite recipes they prepared themselves . . . one of the most fascinating and ironic indicators of the pervasiveness of this social pattern was the spate of post–Civil War cookbooks aimed at white women who found themselves quite literally helpless after the Civil War" (1987, p.16). Mary Titus has suggested that the concept and its ideological attachments are rooted in a complex cultural legacy of conflict. Two of the primary indicators of hierarchy and markers of separation coded in southern hospitality as practiced by southern whites were table manners and etiquette books, which emerged out of a social institution shaped by racial complexities. Thus for southern whites this notion of southern hospitality was also practiced as a symbolic gesture or code demonstrating the social distance between cook and consumer. Yet while the white practice of southern hospitality was a code for the elegance (or superiority) of southern (white) cuisine, it was also complicated by the adoption of the idea of southern hospitality by black southerners. However, during his North Carolina research, Tony Whitehead observed that the southern hospitality practiced by African Americans was not about southern manners that southern whites used to construct some sense of false superiority. The southern hospitality practiced by African Americans maintained the frequent practice of inviting acquaintances to social events in which food is a primary component. Whitehead (1988) also found that those who accepted such invitations were incorporated subtly into the social network of the person doing the inviting. Certain obligations and rights are associated with such network inclusions, which may then be functionally operational during times of need or may simply lie dormant if no need arises.

Taste Preferences and the Continuity of Foodways

One of the primary contributors to the persistence of foodways, in particular food content and preparation styles, is human taste preferences and how they evolve over time. Preferences for fat, salt, and sugar are widespread in human societies, but in the United States, especially in the South, the preferences for these ingredients are arguably the highest in the world. Methods of preserving and preparing foods have contributed greatly to taste preferences. For example, the preservation of pork in salt brine and the use of this salted pork and pork fat in the preparation of other meats and vegetables created a preference for salty, fatty foods.

Sweetened foods figure in the southern culinary tradition. Sugar was first brought to the West from the Orient, but it was only available to the well-to-do. Eventually sugar became the primary crop of West Indian plantations, production began in the American South, and sugar was available to the masses in colonial America. By that time the South had discovered other, less-expensive sweeteners, such as molasses; maple syrup, a technology borrowed from Native Americans; honey from bees brought by the Europeans; and sorghum syrup, also brought by the Europeans. Molasses was especially popular and was used in desserts, in drinks, and to flavor vegetable and meat dishes (Mintz, 1991, p. 125). Slaves worked in the sugar cane fields, where they sucked the cane and stole some for their own use. Sugar, a source of quick energy, may have contributed to the productivity of plantation labor, and fat and salt also may have been adapted for long hours of work in the hot fields.

Slave cooks influenced southern foodways and contributed to the southern preference for foods high in fat, salt, and sugar. Elizabeth Fox-Genovese commented:

> The talents deployed in the kitchens owed much to the slave women's special way with herbs and spices and to recipes developed and handed down among themselves. They brought similar skills and even greater ingenuity to the preparation of foods for their own families and friends. Regularly resisting the masters' preference for communal kitchens, slaves pressed for raw rations that they could prepare for themselves. On some plantations, one woman would cook for all the slaves in a kitchen built specifically for the purpose, but even then, the last meal of the day usually was prepared individually in the family cabins. (1988, pp. 160–161)

Most of the foods passed on to the slaves, such as pig and chicken feet, necks, and livers; pig fat, ears, chitterlings, and brains; and chicken hearts and gizzards, may not be considered "food" by many Americans. However, the tastes the slave cooks created made them delicacies to many.

Slave cooks prepared food for their families and other slave families, and they also prepared much of the food for the families of their white owners. Most plantation owners had at least one female slave who prepared the family meals, and on large plantations even the overseer had a female slave who prepared his meals. Consequently slave cooks shared their taste preferences with the whites (Gibbs et al., 1980). However, the whites on the plantation ate ham, biscuits, relishes, and pies, while the slaves ate fatback, greens, and corn bread (Walter, 1971). The availability of slave cooks allowed white masters to entertain frequently, giving rise to the concept of "southern hospitality." Poor whites outside the plantation most likely adopted the preparation styles of slave cooks because they consumed the same less-desirable foods (Hilliard, 1972). These tastes for salt, fat, and sugar contributed to the notion of the "natural superiority of southern food" mentioned earlier.

ROMANTICIZING SOUTHERN FOODWAYS

Some years ago Tony Whitehead heard a nationally known journalist state humorously in a speech at the University of North Carolina at Chapel Hill, "The worst thing about the North is that there is nothing good to eat up there." Whitehead found the comment interesting because it was similar to many sentiments he had heard from a number of his study participants during his five years of food-related research in the area. Southerners think northerners "mess up" food. One study participant (SP) told Whitehead about being invited to a barbecue by a transplanted northern friend who was going to cook pork ribs on a gas grill. The SP told his friend the total purpose of cooking ribs was to cook them slowly over charcoal. His friend said such a procedure was too slow. The SP responded that you have to cook them slow so you can drink a lot of beer while they are cooking: "A barbecue is no good without drinking a lot of beer." The SP had to go further into the analogies and metaphors that characterize the speech narratives of many southerners to convince his friend to cook the ribs properly. He finally won his case with an analogy between food and sex:

> The enjoyment of good food is similar to the enjoyment of good sex. You have a long period of foreplay to build your anticipation. This raises the actual act [eating or copulation] to the highest level of pleasure. Then afterwards, you fall into a nice pleasurable sleep—feeling very satisfied with the world and your place in it.

The superiority of southern or African American foods over those of the North may not be an exaggerated romantic notion, however. In fact southern foodways have permeated the foodways of Americans in other regions of the country. The diffusion of southern preferences may be attributable to the human preference for foods made more tasty with fat, salt, and sugar and their availability to early American colonists in the North as well as in the South.

John Egerton pointed out that many mass food delivery systems, including the supermarket chains Winn-Dixie and Piggly Wiggly and the fast-food outlet Krystal, originated in the South (1987, p. 39). These food delivery systems were successful in part because they responded to their clientele's taste preferences, including many items in the traditional African American core diet. Food outlets in other parts of the country emulated these pioneers in their high salt, high fat, and sweetened wares. Making foods more "tasty" makes them more attractive to consumers.While supermarket chains in other parts of the country did not initially stock popular southern items, such as pork fat, salt pork, ham hocks, and pig feet, eventually they discovered a market for those foods. Restaurants outside of the South added Creole and Cajun dishes and deep-fried catfish when they realized that southern tastes existed in their regions. Egerton stated, "Anyone who grew up on the [southern] food can attest, life without a little South in your mouth at least once in a while is a bland and dreary prospect" (1987, p. 49).

Social Networks, Festive Occasions, and the Persistence of African American Foodways

Even as the foodways of African Americans changed with upward mobility, broader ethnic diversity in all regions

JUNETEENTH

Juneteenth (19 June 1865) is one of the oldest-known celebrations to commemorate the end of enslavement. It is celebrated primarily in Texas as that was the day many enslaved Texans learned that they had been freed. Numerous tales attempt to explain the two-year delay between Abraham Lincoln's Executive Order of 1 January 1863 and the day the Texans heard the news. Many continue to make the annual pilgrimage to Galveston, the city where General Gordon Granger of the Union made the freedom announcement, to celebrate the day. While not as popular as Kwanzaa, Juneteenth is celebrated by African Americans throughout the United States with numerous cultural events. Because of its Texas roots, most menus for the event include barbecue spareribs or chicken. William Wiggins recorded that his first Juneteenth celebration included many foods familiar to African American southerners, "platters of barbecued chicken, long link sausages and brisket-sized chunks of beef, bowls of steaming brown beans seasoned with hunks of jowl bacon, a cold apple, lettuce, and mayonnaise salad, trays of white 'store-bought' bread, frosty pitchers of red lemonade, jugs of homemade blackberry wine, and a pan of peach cobbler" (1987, p. 3).

of the country, and greater concerns about health issues, the traditional core foods and foodways were preserved through festive occasions that bring members of a group together in celebration or recognition of some event of social significance. These occasions also reaffirm social ties crucial to the biological and psychological survival of the group and its members. This reaffirmation has been particularly crucial for African Americans. It was impossible for slaves to continue the social structures related to kinship, marriage, and family that they had known in Africa. However, slaves developed new social ties based on family and kinship systems, churches, and voluntary organizations that survived into the twenty-first century.

MALE FOOD PREPARERS

Tony Whitehead found that, in most of the households in his study, meals and the food served at church suppers were prepared primarily by the females. However, he found that, particularly among African Americans, men often did take to the kitchen. This was particularly true for some special meal. One of type of food at both small and grand feasts is the pig barbecue, which in North Carolina is referred to as a "pig picking." When a pig picking is "done right," it is a ritual in which males are responsible for preparing and cooking the pig, which begins the night before the feast. Males kill and clean the pig so it can be placed on the hot grill at midnight. It is grilled through the night, and the host and other males apply the barbecue sauce. Through the night the men carry out other important male activities, such as gossiping, telling tall tales, and drinking. Whitehead reported that in the historically racially segregated county of his research, an African American pig picking was one of the few places where he saw black and white males socialize, probably because of the absence of white women. Shortly before the feast the host may cut up portions of the pig, or the guests may "pick" pieces from the well-cooked animal until nothing is left but the carcass, thus the name "pig picking." Through the pig picking males become noted for their "special" barbecue sauces and their abilities to season the pig. As guests eat the pig they also applaud the cooks' abilities and extol their reputations among the best barbecue chefs in the state. The pig picking can become a male competition when a number of noted barbecue chefs (whether anointed by self or by others) are invited to cook the pig and to bring their own sauces. They are given a portion of the pig, to which they apply their respective sauces. At the feast the guests are told which male was responsible for which portion, and they give their opinions about which was the best.

Whitehead (1988) divided festive occasions into two types, impromptu and institutionalized. Impromptu occasions, such as a party or barbecue, are not related to any significant event. Institutionalized occasions are of three types, life cycle, calendrical, and communal, and correspond to three significant levels of social organization, the individual, the community, and the social network.

Life cycle occasions, such as births, initiations, weddings, and funerals, are celebrations of transitions or stages in the lives of individuals. Calendrical occasions are periodic celebrations recognized by the wider community, such as national holidays, like Independence Day, Memorial Day, Labor Day, or Presidents' Day, or annual religious events, like Easter, Christmas, and Thanksgiving Day. African Americans have created others, such as Kwanzaa and Juneteenth, which celebrates the termination of slavery. Communal occasions are celebrations of the social network, such as family reunions, church homecomings, and club or office celebrations.

Although life cycle occasions are celebrations of individual transitions, they are just as important for the network because they mark a change in status for both. For example, the network must adjust to the addition of a new member as a consequence of marriage or birth or to the loss of a member as a result of death. Similarly calendrical events are celebrated by the wider community, but networks take the opportunity to come together and reconfirm their ties. Food is central to festive occasions. In his North Carolina work (1992), Whitehead identified four types of African American food events: the meal, the petite feast, the small feast, and the grand feast.

Whitehead's study participants in a predominantly rural area defined a "meal" as a sit-down affair with others present. In other words, a meal is a communal occasion, not something one does alone. While meals are a day-to-day routine, the other three types of food events bring together household or network members into a festive occasion, and thus are referred to as "feasts." Feasts vary according to the number of network members present. A petite feast is best exemplified in the Sunday prechurch breakfast, which includes members of the household, and the Sunday postchurch dinner, which might include household and extended family members, the itinerant minister, and other guests. A small feast, such as a church or club dinner or an office picnic, includes network members from several local households. A grand feast, such as a family reunion or a church homecoming, includes extended network members, some from beyond the local setting.

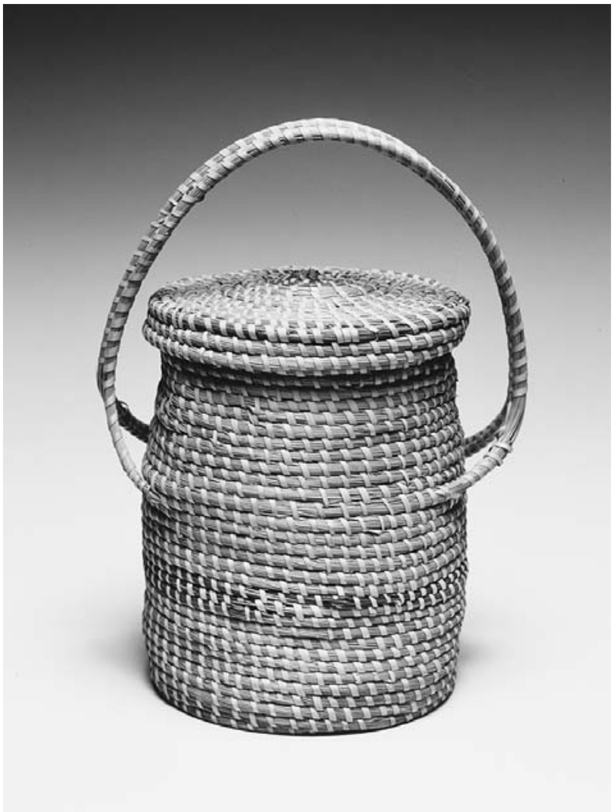
In rural southern counties African Americans eat traditional core foods at evening meals. For morning breakfast and midday lunch some, particularly the young, take advantage of prepared and fast foods. These households usually have traditional core foods on certain days of the week, such as for Friday or Saturday night dinner or for Sunday breakfasts, dinners, and suppers.

For African American families involved in church, Sunday breakfast and dinner are frequently petite feasts. The Sunday morning petit feast or big breakfast might be eggs; grits; sausage, bacon, country ham, fried chicken, or pork chops and rice smothered with gravy; and biscuits or rolls. The petite feast dinner, served after church at around 2:00 P.M., has similar foods in larger quantities with side dishes, such as macaroni and cheese and candied yams; drinks, such as lemonade, Kool Aid, and tea; and desserts, such as peach or apple cobbler or pie and pound, chocolate, pineapple, or coconut cake.

Traditional core foods are also served at small and grand feasts. Whitehead found that to be known as a "good cook" was important to the women of the church, who display their cooking skills at church dinners on Friday nights, Sunday afternoons, or Sunday evenings. Whitehead observed a functional aspect to the concept of "southern hospitality." He suggested that a cook invites a new acquaintance to a food event, usually a petite or small feast, in part to broaden the affirmation of her or his status as a good cook.

African Americans raised in the South but living outside southern rural counties do not eat traditional core foods often, but many include them in feasts. African Americans with southern cultural roots gather on holidays for cookouts, picnics, or barbecues and share foods similar to those from home. In Washington, D.C., the staffs of representatives of some southern states have small feasts at which foods from their states are served. Sometimes a favorite restaurant from the home state caters the food, for example, North Carolina barbecue.

African Americans outside the South go "back home" on other holidays to have petite feasts with their relatives there, and they are expected to come home for family reunions and church homecomings. Family reunions usually last two or three days and involve several feasts. Subfamily units may hold petite or small feasts in addition to the grand feast or banquet dinner for all who attend the reunion. A church homecoming invites members who have moved away back for a celebration. Church members invite their ministers to their family reunions, but Whitehead found that some churches organized homecomings around the family reunions of several church members to broaden the occasion for those returning and to lessen concerns about making too many trips. Feasts are central to all of these occasions, and African American traditional core foods are the primary fare. Whitehead (1989) observed that the greatest incentive for traveling a long distance is to get one's fill of that "good old down home cooking." The more feasts during these visits, the better the time. Moreover, family members in the South know that food is an incentive and prepare enough so visitors can take a little back North with them.



Gulla basket for storing dried okra. Made of long needle pine and reed grass in South Carolina, circa 1880. The hooplike handle was designed so that the basket could hang from a hook in the kitchen ceiling. This style of basket weaving was brought to South Carolina from West Africa. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

As mass food delivery and marketing systems change the diets of all Americans, the feasts that bring together African Americans, particularly those with cultural roots in the South, provide continuity in African American traditional core foods. As long as festive occasions and the rituals that accompany them continue, those foods will continue as well.

See also **Barbecue; Fats; Feasts, Festivals, and Fasts; Kwanzaa; Pig; Poultry; Salt; Sugar and Sweeteners; Sugar Crops and Natural Sweeteners; Tea; Thanksgiving.**

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Tony L. Whitehead
Psyche Williams-Forson

CAJUN COOKING

Cajun cooking is a regional cuisine native to South Louisiana. Traditional Cajun cooking developed in a diverse and abundant natural environment and a multiethnic though predominantly French Catholic social environment. In the narrowest sense the word "Cajun" refers to descendants of eighteenth-century Acadian settlers expelled from Canada who eventually settled in South Louisiana among a multiethnic French-speaking population, including people of French, African, Spanish, German, Native American, and other descent. Eventually the Cajuns (short for Acadians) dominated twenty-two parishes of South Louisiana, now called Acadiana. They lived in relative isolation until the twentieth century, when the outside world came to Cajuns in the form of compulsory English education, the oil industry, World War II, mass media, and an influx of outsiders bearing a standard American mass culture. Like immigrants from foreign shores, Cajuns found themselves in a new world of change. Cajun culture was a source of scorn by outsiders and an embarrassment for many insiders, and French speaking declined.

However, a revival of Cajun culture gained steam in the 1970s with the creation of French programs in the schools, a general attention to cultural expressions (music, food, and so forth), and a rise in pride in being Cajun. Part of this pride of identity is as a people who are highly sociable, who know how to enjoy life (joie de vivre), including the enjoyment of food, and who know how to prepare food that is exceptionally good. It is fitting that Cajun cooking has become a major cultural export and Cajun chefs have become high-profile media personalities.

Ingredients

In the past, small farms produced pork and poultry, while beef was more common in the southwestern part of the region. People raised corn, greens, okra, peppers, mirliton (chayote), seasoning vegetables (onions, peppers, garlic), and more. Rice, the preferred grain, was raised in some areas and imported in others. Native Americans taught the use of filé powder, made from sassafras trees, for gumbo. Hunting, fishing and gathering in the bayous, swamps, and Gulf waters provided ingredients such as crawfish, crab, shrimp, finfish, turtle, alligator, venison, squirrel, and other game.

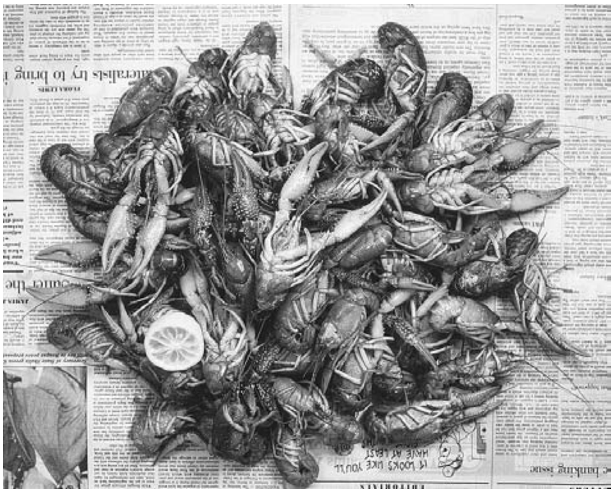
Jambalaya is the great classic of Cajun cooking. Its main ingredients are rice, sausage, and chicken. © OWEN FRANKEN/CORBIS.

In the past it was necessary for Cajuns to be competent in the various environments to acquire food, and it was necessary to know how to process it for cooking. Today, most food is purchased at grocery stores, yet the traditional subsistence skills are symbolically valued and often practiced as recreation (hunting, fishing, gardening) or shown off at festivals (skinning furs, opening oysters, butchering a hog).

Cooking Aesthetics

The aesthetics of traditional Cajun cooking demand that foods have strong, intense flavors. Strong flavoring comes from the use of seasoning vegetables (onion, bell pepper, garlic, celery) and from the careful browning of ingredients. Gumbo and other sauce-based dishes begin with a flour-based roux that is slowly browned to a dark color. Seasoning vegetables are browned. Coffee is dark-roasted. The use of cayenne and other hot peppers intensifies flavor. The proportion of hot pepper varies throughout the region and among cooks.

Cajuns say good food takes time, and many dishes require long simmering that follows slow browning. For example, gumbo, a soup, or stew that will be served over



Cooked crayfish, known locally as crawfish (or sometimes "crawdads"), are a Louisiana bayou specialty. They are traditionally served on newspaper. © NATHAN BENN/CORBIS.

rice, is simmered for hours until the ingredients soften and break down.

Major dishes reflect the practice of combining a flavorful multi-ingredient item with a bland staple, usually rice. Gumbo (of many varieties), étouffée, sauce piquant, and fricassee are served over rice. Jambalaya and rice dressing contain rice. The pattern occurs in less obvious forms, such as rice-containing boudin sausage (the "Cajun fast food"), corn bread dressing, boulettes (rice and meat or seafood balls), vegetables stuffed with seasoned meat and corn bread, and crawfish bisque, which contains cleaned crawfish heads stuffed with a dressing mixture.

Community Food Events

Community food events include boucheries, cochon de laits, rural Mardi Gras, and festivals dedicated to certain foods. At old-fashioned boucheries families took turns butchering a hog, then cooking or distributing the perishable meat for quick use. A modern family boucherie is a party at which a hog is butchered, cleaned, and converted to various dishes, including boudin sausage, cracklings, hogshead cheese, backbone stew, chaudin (stuffed stomach), rice dressing, and cuts for the freezer. A party called a cochon de lait is a pig roast, a scaled-down version of a boucherie. Rural Mardi Gras involves gathering the ingredients for gumbo, including live chickens, by riding horses or trucks from house to house, begging for ingredients, and performing antics. Women cook the gumbo for the night's dance at a community kitchen. Throughout Acadiana festivals are dedicated to food as prepared dishes or major ingredients, such as crawfish, gumbo, sauce picquant, boudin, shrimp, rice, and so forth. Festivals usually include eating contests and food preparation demonstrations.

In both traditional and modern Cajun culture, food is a center of attention, something to brag about, something to enjoy, and something to center social events around. Both men and women cook, and men are often the star cooks at larger social events. A man's outdoor kitchen is as elaborate and well equipped as the owner can afford.

Crawfish Boils

The quintessential Cajun food event is the backyard crawfish boil. In spring people catch or buy live crawfish and boil them outdoors with cayenne pepper and vegetables (corn on the cob, potatoes, carrots). The hot crawfish and vegetables are poured onto newspaper-covered tables. People peel the crawfish by hand to extract the tail meat and often suck the heads for additional flavored juices. Crawfish boils are extended family events but also events that outsiders to the region are likely to be invited to. At a crawfish boil food is a boundary marker that positively shows that Cajuns are competent and sociable. Outsiders often have difficulty peeling the crawfish or tolerating the hot pepper, and many are squeamish about boiling live animals or about eating what looks like an insect. The outsider (in the past often the more powerful or wealthier immigrant from the dominant American culture) is the novice, and the Cajun is the skilled one, a friendly yet superior host teaching how to peel and eat crawfish. Once a poor people's food, scorned by outsiders, the crawfish has become a symbol of Cajuns as well as a relatively high-priced ingredient sometimes used in nontraditional dishes such as crawfish Newburg or crawfish pizza.

Cajun Cooking Gains Fame

In the 1980s trained chefs raised on Cajun cooking, such as Paul Prudhomme and Alex Patout, brought their food to the nation though restaurants, cookbooks, television, and public appearances. Cajun cooking became famous, even faddish. Cajun dishes appeared on menus far from Louisiana with varying quality. Fast food chains featured "Cajun" items. The number of food manufacturers in Louisiana multiplied, as did the number of restaurants catering to tourists. Internet sites sell Cajun ingredients and prepared dishes for overnight shipment. The non-Cajun Emeril Lagasse promotes Cajun dishes on television and in cookbooks, and tourism advertising focuses on Cajun cooking as a major reason to visit Louisiana.

See also **Crustaceans and Shellfish; Fish; Game.**

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C. Paige Gutierrez

CALIFORNIA AND THE FAR WEST

California mirrors the history and culture of many states in the Far West. Like the states in the Southwest, California was first settled by the Spanish from what is now Mexico, but it received many of its subsequent settlers from the eastern United States during the Gold Rush of 1849. California's population includes descendants of Russian settlers, as do the states of Oregon and Washington. Like Idaho, Nevada, Colorado, Wyoming, and Montana, California is home to Basque families, many of them sheepherders, whose ancestors came from the Pyrenees Mountains of northeast Spain and southwest France. Chinese laborers who came to the West to build railroads settled in many small towns and founded businesses, eventually creating the great California Chinatowns of San Francisco and Los Angeles. California also encompasses many of the agricultural activities of other Western states, including citrus growing, also found in Arizona, and wine making, a prominent industry in Oregon and Washington. Fruits and vegetables that are grown in the Imperial Valley of California in winter hit their peak growing seasons somewhat later farther north in the San Joaquin and Sacramento valleys; Oregon and Washington follow even later. The American West could be said to begin where the Great Plains meet the mountains of the Continental Divide. From that point west, all streams flow in the general direction of the Pacific Ocean. From there ranges of mountains separated by broad, fertile valleys or deserts stretch across the land until, after the final range, the land, moist from winter storms and fog and rich from the great river bottoms, drops gently to the Pacific Ocean.

The great majority of the population in the West is concentrated along the Pacific Coast, yet cities like Denver, Salt Lake City, and Las Vegas grow each year, as the population of the United States moves into the Sun Belt in ever-greater numbers. The states of the West adjacent to California and the Pacific Northwest contribute greatly to the character of the Far Western states, because it is through them that many of the settlers migrated from the East on their way to the Pacific's shores. This region is also home to its first settlers, the Native American nations, whose ancestors, in prehistoric times, are thought to have crossed the land bridge from Asia into what is now Alaska. These nations and tribes have made a significant contribution not only to the development of foods in the region, but also to its artistic and spiritual elements.

It is misleading to categorize the food and culture of the Far West by state lines or even by cities or small communities. Cultures rarely start and stop at administrative boundaries. Traditions and tastes spread with far greater subtlety as groups move from one community to another, not only taking with them food that has always been a part of their lives but also adopting foods and flavors along the way. The largest cities of the West are cosmopolitan places where many ethnic groups practice a broad variety of food traditions. Most towns and villages have food and culture practices similar to those of larger cities. In addition, many families of specific ethnic descent do not eat the foods of their own tradition every day, but enjoy exploring the foods of other cultures or foods generally considered "American." It is most often at various festival times that ethnic groups celebrate their heritage, whether it is the festivals of individual pueblos in northern New Mexico or a Greek Orthodox festival held for the entire community on a specific saint's day. The Far West can be grouped into four general areas for the purposes of discussing food and culture: The Mountains, the Great Southwest, California, and the Pacific Northwest. (The Southwest is also covered in more detail in a separate article by that title.)

The Mountains

The states of Montana, Wyoming, Idaho, Nevada, Utah, and Colorado are punctuated by broad expanses of plains at the easternmost extent, leading to ranges of mountains separated by broad expanses of farming or ranch country. The food of the region is reflected in the activities that once took place there or in current lifestyles. After the Native Americans, the first settlers were trappers seeking furs. They were followed by settlers who came west in the mid-1800s following the Lewis and Clark Expedition (1804–1806). Mining exploration took place throughout the region in the nineteenth century. At the height of mining activity, larger mining towns possessed hotels and restaurants with menus to rival those in long-established cities, and the finest performers played in the local opera houses.

Large ranches, which raised cattle and sheep, were established in the nineteenth century followed by the smaller farms of homesteaders. Food in the ranch house or farmhouse was simple, reflecting both the Yankee origins of the settlers and the distance consumers lived from the sources of supplies. Early settlers subsisted on salt pork and beans, supplementing their diets with fresh foods if they could find them. Quick breads were made either using a kind of baking powder called *saleratus* or from a sourdough starter. When a steer or sheep was slaughtered, every part of the animal was put to good use. The huge extent of large ranches dictated the use of portable, compact camp kitchens called chuck wagons, which could be moved from one place to another to feed cowboys while they were working away from the main ranch buildings. The Dutch oven played a versatile role both in the home and in chuck wagon cooking. Over the coals of a fire it was an excellent vessel for making all kinds of stews. Buried in the coals, the Dutch oven served literally as an oven capable of producing biscuits, cobblers, and other shortbreads.

What marks the region today are foods that can be enjoyed in the outdoors while hiking, fishing, river rafting, skiing, or camping. Freshwater fish, especially trout, and game are plentiful. While camp food tends to be the simple fare like beef stew inherited from the English, Welsh, and Yankee settlers, it is sometimes enhanced by experienced camp cooks, who produce creative dishes like lasagna made with dried spfoglia pasta sheets and reconstituted dried shitake mushrooms in Dutch ovens over their campfires. Restaurants in major cities of the Mountain region offer many different kinds of cuisine to sophisticated diners.

The Southwest

The Southwest encompasses New Mexico, Southwest Texas, Arizona, and the southern part of Colorado settled by the Spanish. The distribution of what is considered "traditional food" of the Southwest (a combination of Native American food and food adapted from Old Mexico) is not uniform, but instead is reflected in the areas that have been settled the longest. For greater detail on this area, see the separate article on the Southwest.

One aspect in the history of the Southwest that affected the growth of food culture throughout the West by introducing refinement in menu offerings and service was the Harvey House restaurant chain established along the line of the Santa Fe Railroad. Here entrepreneur Fred Harvey established restaurants that served train passengers at scheduled stops. A sophisticated menu was offered, and passengers made their choices en route. The orders were forwarded by telegraph to the restaurant so that the food was ready to be served when the train arrived. Passengers were served in the restaurant dining rooms by uniformed young women who had been recruited from respectable eastern families. This effort led to greater expectations for quality food and service throughout the West. In addition, many of the young women stayed and married business and professional men, contributing to the character of many of the cities in the area.

California

Contemporary California is a land of dramatic contrasts, from the richly populated coastline to the sparsely settled inland deserts; from the highest point of land in the contiguous United States (Mount Whitney) to the lowest (Death Valley); from the hot dry interior to the cool, moist, and sometimes foggy seacoast. In the San Joaquin and Imperial valleys, where fields are irrigated, vast amounts of produce are grown for markets throughout the United States. Lettuces with names like red leaf, oak leaf, and curly leaf grow near other table greens with names like radicchio, trevise, and arugula, reflecting their French and Italian ancestry.

Table corn and table grapes are grown in California's Central Valley for consumption in several western states. In the microclimates near the coast, delicate produce is raised for sale at local farmers' markets. Some communities are known for specialized crops: Gilroy claims the title of Garlic Capital of the World, and Castroville, near the coast above Monterey Bay, boasts proudly of its artichokes. Ingredients indigenous to California's land and seacoasts include soft fruit, stone fruit, nuts, grain, game, cattle, poultry, fish, shellfish, and olives. Also grown are avocados, figs, pomegranates, persimmons, citrus, almonds, asparagus, strawberries, and dates.

The settlement of California. Spanish settlement in California began in the sixteenth century with military and missionary expeditions from what is now Mexico. Spanish missionaries often resettled Native Americans near their new missions, sometimes giving a tribe a new name to match the name of the mission. Civilians came with these expeditions and established the great land-grant ranches of early California, bringing with them food traditions of Spain, tempered by years in Mexico.

Some settlers came by sea. Russian families settled in Northern California and farther north in Oregon and Washington. Basques from the Pyrenees mountains of northwestern Spain and Southwestern France settled to grow sheep in eastern mountains of the state, bringing with them their special versions of sheepherder's bread and oxtail stew. With the discovery of gold in 1849, people of all backgrounds moved west, many staying to take up some activity other than mining. Many Chinese provided labor for the construction of the railroads.

In the twentieth century, California's population grew tremendously, and cities like Los Angeles, San Francisco, and, somewhat later, San Diego expanded to accommodate larger numbers of people and their needs. Today the state is home to a considerable portion of the aeronautical industry, film and television production, some large military installations and a great diversity of technical development, especially in the field of computing. New residents came from Asia, eastern Europe and the Middle East. Chinatown in San Francisco is one of the largest in the United States, bringing with it much excellent food and sources for ingredients. Los Angeles has its own Chinese community as well as a well-established Vietnamese community. The Los Angeles suburb of Glendale is host to a large Armenian enclave with its own supermarkets and its own hospital.

California foods. Food availability in California makes cooking at home and dining out a pleasure. The broad, year-round availability of good fruits and vegetables, seafood, poultry, locally grown rice (including exotic types), and many other products gives cooks and chefs enormous inspiration. Fine fresh ingredients have always been appreciated in California, as is evident from California cookbooks published in the late nineteenth and early twentieth centuries. In the last quarter of the twentieth century, a champion of these products, Alice Waters of the restaurant Chez Panisse in Berkeley, launched a renewed appreciation of locally grown ingredients acquired directly from producers, a move that ultimately inspired the growth of local green markets across the entire United States. The emphasis on freshness and proximity to the buyer is reflected in the cuisine of many of California's restaurants, now emphasizing the uncomplicated flavors of ingredients in season.

Some traditional dishes in California reveal the origins of its inhabitants. *Cioppino* (a tomato-based seafood soup) is the child of Italian immigrants who became fishermen in San Francisco and the Monterey Peninsula. Another dish, a product of nineteenth-century San Francisco in gold-rush days, is hangtown fry (a combination of fried oysters, crisp bacon, and scrambled eggs often served as a special breakfast). Mexico's influence, both old and new, can be seen in the Mexican food of Southern California, where flavors and textures of the food of the Mexican state of Baja California are reflected in such simple but excellent fare as shrimp or fish tacos wrapped in soft, warm tortillas and garnished with shredded cabbage.

Despite a frequent focus on the coastal cities of California because of their large populations, there is much to California that is neither coastal nor urban. The deserts along the borders of Arizona and Nevada are dry and desolate. Where water is available, ranches like those in the Mountain States and in the Southwest continue to flourish, raising cattle and sheep. Where Basque families have settled, they have established restaurants featuring the traditional foods of their culture. Food is served in many courses, family-style, and includes hearty stews with sweet peppers and Basque sheepherder's bread. Major inland agricultural centers are large farm-oriented operations. Others, catering to the demand for organically grown produce or specialty items, employ methods imported from Asia and other countries and do much of their work by hand.

In the northwestern part of California, where giant redwoods populate the forests, the rainfall may exceed one hundred inches a year, too wet for most farming but an exceptional climate for fresh wild mushrooms, which are gathered by experts who have their own special spots that only they know. The mushrooms are then passed on to produce brokers to sell.

Wine. The California wine industry produces wines to complement the breadth of California food. Although the wine industry in California burgeoned after World War II, it actually was begun in the early twentieth century, surviving the effects of Prohibition. The state's many hills and valleys are home to microclimates that give unique character to the many varieties of wine grapes grown locally. Best known of the regions are the Napa, Sonoma, and Russian River valleys of California north of San Francisco, and the Santa Ynez Valley north and east of Santa Barbara, but other vineyards abound in Monterey County and even as far south as Temecula, near San Diego. Wines made in the state have won many awards in "blind" tastings against some of the finest wines in the world.

California should be called the Salad State, for it has created a whole health cuisine based on fresh greens and vegetables. Its most famous salad is Caesar Salad, which is now found on menus throughout the United States. When properly made, Caesar Salad is prepared with great flourish by a waiter at tableside. PHOTO BY ANDRÉ BARANOWSKI.

The Pacific Northwest: Oregon and Washington

Like California, both Oregon and Washington are dry in the eastern portion and more humid in the west and along the seacoast. And, as with California, these states are rich in fresh fruits and vegetables, excellent fish and shellfish, quality meats and poultry, and outstanding wines. Each state has its own special character, dictated by the climate and latitude.

Oregon was founded at the end of the Oregon Trail, a two-thousand-mile route from Missouri that was followed by thousands of emigrants, primarily from the 1840s to the 1860s. From the mouth of the trail poured settlers from the Midwest and the East, bringing with them architecture and foods of their previous homes. Foods learned along the way also became a part of the culinary repertoire, with desserts like cobblers, popular because of the ease of producing them and the abundance of berries in the area. Cherries, blackberries, loganberries, raspberries, and blueberries appear as summer progresses. Occasionally, blueberries and quail are raised together, the berries providing some of the food for the quail while also enhancing the taste of the flesh of the bird as well. Oregon's eastern farms and orchards produce extraordinary pears and other cool-weather fruit.

Some prominent restaurants in Oregon have chosen to celebrate local foods and wines on their menus, featuring the excellent oysters that are harvested in the area, or farmstead cheeses and local wines.

Aquaculture plays a large role in the production of oysters, mussels, and Atlantic salmon in the Pacific Northwest. Restaurants and stands offering shellfish may have four or five varieties of oysters available for tasting.

Oregon's and Washington's wines are almost as well known to many Americans as the wines of California. Many of the smaller productions rarely leave the state or are eagerly purchased by knowledgeable wine shop proprietors and sommeliers (restaurant wine stewards). Oregon wines include exceptional ones made largely from the pinot noir grape and the cabernet sauvignon grape, both of which develop well in cooler climates.

Like Oregon, Washington's coastal area is home to growers of all kinds of crops, including a rich supply of soft fruit, that require a mild climate. The eastern part of the state is famous for its apples. Washington is also well known for its salmon production and nearly as well known for its smoked salmon as its fresh fish. The Ballard area of Seattle is home to many Scandinavians, whose emigrant parents brought with them the skills for both hot and cold smoking.

While New England Yankees, Scandinavians, and Russians were some of Oregon and Washington's first settlers, the Asian population has contributed greatly to the area in terms of food culture. One historian referred to the region as less a melting pot than a stir-fry. New residents to the region have come from Southeast Asia and also from Hong Kong during the period when it was becoming a Special Administrative Region (status conferred in 1997) of China.

Native American food traditions have considerable influence in Washington and Oregon, where salmon is split open, stretched on wood racks, and roasted before an open fire. The salmon plays a similar sacred role in the Pacific Northwest as corn does for the Native Americans of the American Southwest.

Also a part of the tradition of Native Americans in the Pacific Northwest is the "potlatch" gathering, celebrating wealth sharing, prosperity, and overabundance. The word "potlatch" comes from the Nootka-Chinook *patshal* ("gift"). The largesse demonstrated at these gatherings is a demonstration of success as well as an attempt to outdo the host of the previous potlatch feast.

While permanent and temporary markets abound in the coastal regions of Washington and Oregon, no place represents the bounty of the area quite like the Pike Place Market in Seattle. This open market is active every day, featuring the freshest of fish and shellfish, vegetables and fruits in season, and other ingredients, as well as flowers and crafts. Permanent indoor shops in the complex sell many items other than those related to food, and shops around the market have expanded into blocks to the east, but the array of ingredients for the dishes of many cultures remains a main attraction and represents a microcosm of the food culture of the region.

See also **Crustaceans and Shellfish; Farmers' Markets; Fish; Fish, Smoked; Fruit; Herding; High-Technology Farming; Organic Agriculture; Organic Food; Vegetables; Wine**.

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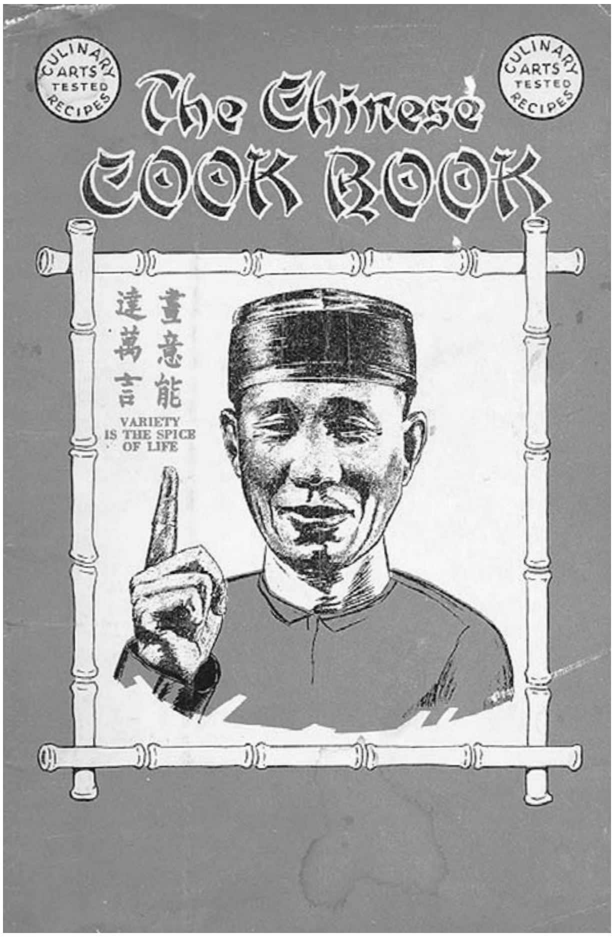
Madge Griswold

ETHNIC CUISINES

"Ethnic food" has been used colloquially for a wide variety of foodstuffs, virtually any that can be identified in the public mind with a foreign source or a American minority group. In the narrower ethnographic meaning, which will be employed here, however, it pertains only to food prepared or consumed by members of an ethnic group as a manifestation of its ethnicity. Thus it would not be an appropriate term for most foreign food eaten in a foreign land, fusion food as prepared by some innovative chef, Italian food as prepared by Greek restaurateurs, sushi prepared by a non-Japanese American housewife, or food purchased from Taco Bell or Pizza Hut, though it is sometimes extended to all these. Unfortunately, there is no clear cut universally accepted definition. In the end ethnic food is food that members of an ethnic group consider their own and that others attribute to them.

Most social scientists agree that the ethnic group is a social category defined by any one of a variety of criteria, including country of origin, physical features such as skin color, ancestoral language, religion, or some combination of these. Ultimately ethnicity is a matter of identity—recognition of the social distinction by both members of the group and outsiders. Although ethnicity has to do with social not cultural categories, members of each group inevitably participate in a subculture that is more or less different from that of those outside the group. Food and foodways (by which is meant that entire complex of ideas and behaviors associated with food) is a particularly important component of these cultural differences.


CULINARY ARTS TESTED RECIPES
CULINARY ARTS TESTED RECIPES
The Chinese
COOK BOOK
畫意能達萬言
VARIETY IS THE SPICE OF LIFE

Foreign cuisines are often altered once they are transplanted to the United States. This Chinese-American cookbook by M. Sing Au published in 1936 features many dishes unknown in China, such as Lantern Party Salad and Chop Suey Soup. ROUGHWOOD COLLECTION.

Cultural Adaptations

Ethnic foodways, like other American foodways, are in constant flux. Changes in immigrant foodways are part of a larger process of social and cultural change.

The process by which immigrants become ethnic Americans is long, gradual, and complex. One can think of this as ethnogenesis or the creation of a new social group. Along with the development of a new ethnic group is a parallel development of a new subculture, including new foodways, that both symbolizes the group's uniqueness to its members and marks off its social boundaries. The new subculture is created in the American context, altered to a greater or lesser degree from what was known in the homeland. Polish Americans (and any other ethnic group can be substituted here) are not the same as Polish in Poland, and Polish American culture is different from the culture(s) found in Poland. Neither do Polish Americans belong to some culture somewhere between American and Polish, as might be surmised from the overly simplistic models of acculturation that have so often dominated thinking on the subject. Ethnicity exists only in specific contexts where one sort of people (Us) is brought into regular and intimate contact with people of other sorts (Them).

It is impossible to re-create exactly in America the foods of one's homeland, no matter where that might have been. Ingredients as basic as flour are different in the United States, yielding different results. Many ingredients are unobtainable here. The white cheese *(beli sir)* of Bosnia that Bosnian refugees require for one of their most common dishes, *sirnjaca* (a sort of cheese pie), is not available in the United States. Many Bosnians say *sirnjaca* is the food they miss most. They cannot even make cheese or the many other milk products that were an important part of their diet in Bosnia, because unpasteurized milk is unobtainable in the United States.

The same is true of the equipment and implements of cooking. The national dish of Bosnia, *Bosanski lonac*, is a stew of combined meats and vegetables slow cooked in a special earthenware pot. The special pot is so much a part of the dish that it is named after it; *lonac* means pot in Serbo-Croatian. These are used for no other purpose and are often treasured heirlooms. One Bosnian American housewife related that hers was a gift from her father, who had given each of his daughters one he had brought back from a distant market where they were sold. She had been forced to abandon hers when she fled Bosnia. One might cook a similar combination of meats and vegetables in an aluminum stew pot, but it is not the same.

But these sorts of problems get worked out, just as they do for other aspects of life. Adjustments are made. Substitutions are found. One accepts that some favorite foods of one's homeland can now exist only as fond memories. It is this process of adjustment, the culinary dimension of an immigrant becoming an ethnic American, that is of significance here.

The process by which immigrants become ethnic begins as soon as they board the boats and planes that carry them to the New World. The incentives are somewhat different for refugees than for willing immigrants, but the process remains pretty much the same. No group of emigrants from any country represents a cross section of that country's population. They are always drawn from some regions more than others, some social strata more than others, and some communities more than others. Since each of these groups possesses a recognizable subculture (including distinctive foods and foodways), it is logical that immigrant communities cannot replicate exactly their old national culture in the New World. If most of the Italians who settle in a particular community are from Calabria, then Italian cooking in that community will surely reflect the regional cuisine of Calabria, at least in the earlier phases.

Out of immigrant culture develops an ethnic culture that differs from it in significant ways. There are several primary sources on which this developing subculture draws. The first is the culture of the homeland. One aspect of the process is an amalgamation of the local, regional, and class-related subcultures that are represented in the new community. These processes have both a public and a private face, and it may well be that they work faster in the public. In the Detroit area, Lebanese, Yemeni, and Chaldean restaurants are rapidly developing a common Arab-American menu at the same time that housewives of these same groups continue to cook distinctive national cuisines. Even though the proprietors and cooks of many Mexican restaurants have come directly from Mexico, their menus feature the same standardized combination plates of the stereotypic "Mexican" restaurant derived primarily from Texas-Mexican cuisine. This is so even when a significant proportion of their customers are also recent arrivals from Mexico. Some regional recipes or cooking techniques may be preserved as family traditions, but in general the community will reach some consensus.

A second source in the creation of an ethnic culture is the culture of mainstream America, such as it is experienced by immigrants and ethnics. An important part of the accommodation process is finding ingredients in the United States to substitute for those from the homeland that are no longer available. Hmong find aluminum foil an acceptable substitute for banana leaf when wrapping food. Serbian American cooks, like other Balkan immigrants, attempt to replicate the white cheese so important in their cuisine with some combination of cottage cheese, feta, sour cream, or cream cheese. Different combinations may be used for different purposes, but nothing tastes quite right. Other substitutions are for the sake of convenience. Norwegian Americans making *lefse* may replace freshly peeled potatoes with dried potato flakes, especially when cooking in quantity. Many Asian Indians quickly replace labor-intensive flatbreads with store-bought white bread. Still other changes have to do with higher standards of living. Dark flour may be replaced by white flour, considered desirable but less affordable in the Old Country. Meat becomes much more prevalent in the diet of most immigrant groups.

Creolization

The third source—too often overlooked—is the cultures of other immigrant and ethnic groups encountered in the United States. Most often immigrants settling in multiethnic environments will move into neighborhoods and will work in occupations associated with earlier immigrant groups. Finns, Croatians, and Italians who went to northern Michigan to work in the iron and copper mines replaced Cornishmen, some of whom became their foremen and bosses. These earlier immigrants from Cornwall became their model for American culture, and the Cornish national dish, pasty, was soon adopted by all. New Yemeni immigrants in Detroit, Michigan, moved into houses vacated by Poles, Romanians, and Lebanese who were ready to move uptown or to the suburbs. Their foreman at the auto plant is likely to have been hired from one of these previous waves of immigrants. These people of different ethnic cultures establish models of American life for the new immigrant. The Mexican immigrant who is hired to work in the kitchen of an Italian restaurant is surely affected by that experience. And when he or she takes home extra food to share with members of his or her family, they too will be affected.

The creation of ethnic culture from these various sources takes place within the particular constraints of minority life: the homesickness, the prejudice, the sense of being different, the urge to assimilate or to resist assimilation, the need to recreate the Old World in the New or to reject all possible reminders of the life that was. All these factors shape the specific form taken by the new culture. Many have come to call this process "creolization" after the term for a similar linguistic process, both of which refer to the creation of a new cultural configuration out of parts of several other preexisting cultures. Creolization may be regarded as the defining characteristic of ethnic food.

One can observe creolization in any aspect of ethnic culture, but it is particularly significant in food and foodways. There are a number of reasons for this. First, cooking and eating are expressive behaviors relatively easy to observe and, most important, heavily laden with symbolic meaning. A particular dish can evoke memories of home, family, better times, one's own place in the world. Familiar food is very much the natural way of things. In a sense, for an immigrant all the food of one's homeland is "comfort food." African Americans outside the South may pointedly eat soul food as an expression of who they are. A single dish may become the most important expression of ethnic identity, symbolizing the group and signaling to other members this common bond and by extention others, thereby reinforcing an individual's own sense of belonging. Crawfish among Cajuns and kielbasa among Polish Americans of pre–World War II immigration serve as examples. Because cuisine is especially responsive to new environments, where some ingredients are unavailable, and because new social settings bring new ways of eating and cooking, foodways are especially quick to adapt and change. At the same time, however, perhaps no aspect of culture is so resistant to change, so tenaciously held. After all, eating is a daily reaffirmation of who you are. Generations after the loss of their mother tongues, ethnic Americans are still likely to be cooking and eating some version of the family's "mother cuisine," even though it may be significantly changed from food in their homelands.

The social structure of an American ethnic group is often reflected in its foodways. Some groups were ethnic minorities in the nations from which they came to the United States. Examples include Jews and Roma from eastern Europe, Hmong from Vietnam, Germans from Russia. Such groups usually develop distinct communities in the United States with foodways that are distinctive, albeit usually closely related to those of others who came from the same country. Ethnic groups are often nested, one identity subsumed within another. A person might be Sephardi in the company of Ashkenazim and Jewish when with a group of Gentiles. A Hmong might be so categorized when with other Vietnamese and Vietnamese when with other Americans. All such social differences are replicated by differences in cuisine, and these take on great symbolic importance.

Foodways serve to demonstrate ethnic community in more instrumental ways as well. Eating together at an ethnic picnic or banquet is a manifestation of group solidarity. Borrowing a start of yogurt in the Armenian-American community or for *viili* (another soured milk product) among Finnish Americans is an expression of the network of relationships that constitutes community. Receiving needed ingredients from relatives or friends still living in one's homeland demonstrates the link to homeland that is another aspect of the ethnic community. These might be foodstuffs unavailable here, at least in the locale where the recipient resides. Similar social relationships may be enacted when foodstuffs are sent between different American communities, as when Arab Americans in Detroit's large community send basic ingredients to relatives living in northern Michigan, where the Arab-American community is small and even the basics are unavailable.

Often foodstuffs are sent from abroad, not because the item is unavailable in the United States but because the item from one's homeland is thought to be superior in quality. Most Lebanese Americans, for example, prefer spices and *kishik* (dried yogurt) from Lebanon. In some cases the item sent from abroad is not even considered superior but is laden with symbolic meaning. An Austrian American who receives annually a box of walnuts from home knows that they do not taste better than American walnuts and that sending them costs more then buying them in the United States. But they come from the tree in the family homestead where he or she grew up, and no American walnut really suffices.

Diffusion

Diffusion is rarely a one-way street. Just as members of an ethnic group are influenced in their foodways by those they live among, members of the majority population (including members of other ethnic groups) adopt ethnic foods, usually changing them in the process. Most often this involves commercialization, often initiated by ethnic entrepreneurs from within the community itself. As the process proceeds, changes in the foodstuff often transform it into something far different from the original; pizza, yogurt, and bagels come to mind.

Ethnic food has existed in America since colonists first encountered the exotic foods of local Native Americans and vice versa. But as a field of study, ethnic food attracted little interest until just prior to World War II. Most earlier commentary on ethnic food had to do with hastening its demise in the interest of assimilation. Some of the earliest work on the subject was done by Margaret Mead and her colleagues at the National Research Council's Committee on Food Habits during the early 1940s. Their goal was to develop profiles of cultural food preferences in the United States in an attempt to better shape national policy to fit particular local situations. At first they planned to exclude ethnic food from their studies, but soon, most likely under impetus of the new world war, they began to include study of what was then called "the food habits" of "foreign background groups in the U.S." By the time the committee was disbanded in 1942, it had produced a series of mimeographed memoranda on ethnic food.

The Federal Writers Project (1935–1943) generated further study of ethnic foodways as one part of its studies of regional cultures. America Eats, more specifically devoted to foodways, was a spinoff. The goal was to publish a book by that title comprising a comprehensive account of the history and ethnography of culinary traditions in the United States. Although it was to be regionally organized, research inevitably included ethnic foodways. A tentative table of contents included such items as Minnesota's lutefisk dinners, Mexican backyard barbecues, and North Dakota's Scandinavian picnics. Due to increasing concern with the war effort, the project was abandoned in 1942, and little of the research was ever published.

Nearly all of the work on ethnic cuisines up to this period was descriptive in nature and applied in purpose. One of the first analytic papers on the intersection of food and ethnicity was by John Bennett, Harvey Smith, and Herbert Passin in 1942, "Food and Culture in Southern Illinois," in which they demonstrate how diet is shaped by culture in a region shared by Germans, African Americans, and old-stock Americans.

The revitalization of ethnicity in the United States initiated by the African-American civil rights movement and further stimulated by activities surrounding the bicentennial brought ethnicity to the fore of American consciousness, both within and outside ethnic communities. As a multicultural model of America developed and ethnic pride was manifested, retention of traditional foodways came to be regarded as a positive rather than a negative attribute. Ethnic food was further popularized during the explosion of interest in food during the 1960s, 1970s, and 1980s and the general search for new and exotic foods. This surge of interest was felt at both the popular and scholarly levels. Ethnic food continues to be a frequent and important research topic for folklorists, cultural anthropologists, and culinary historians.

See also **Combination of Proteins; Foodways; Icon Foods; National Cuisines, Idea of.**

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William G. Lockwood

HAWAII

Located almost dead center in the North Pacific Ocean—2,500 miles west of California—Hawaii consists of a string of 132 coral and volcanic islands extending some one thousand miles from the Big Island to Wake Island. Centuries of volcanic activity have deposited layers of ash that have enriched the soil. Strong sun combined with moderate temperatures and plenty of rain have produced a long growing season in the midst of a tropical paradise—a paradise that lured nineteenth-century European and American merchants and adventurers interested in exploiting Hawaii's natural resources. One result was an economy dominated by King Sugar, which employed waves of immigrants to do the backbreaking work refused by native Hawaiians.

This successive importation of workers left Hawaii with a thriving mélange of cultures, each of which made its own contribution to the twentieth-century phenomenon known as Local Food. A Creole mixture of different cuisines (including Polynesian, Japanese, Chinese, Portuguese, Korean, and American), Local Food is centered on carbohydrates—an ancient Hawaiian quest.

The First Polynesian Immigration

When human beings originally landed on Hawaiian shores between 300 and 500 C.E., having probably sailed roughly two thousand miles from Samoa, they encountered over a hundred species of birds, including large fowl, abundant fish and shellfish in shoreline reefs and lagoons, a few fruit trees at high altitude, ferns, several kinds of *limu* (seaweed), and nearly a thousand flowering plants. These species had arrived gradually on trade winds or sea currents and had evolved in isolation over hundreds of thousands of years.

But the same geologic conditions—deep canyons, high cliffs, forests, bogs, and a wide variation in barometric pressure, rainfall, temperature, and wind—that produced Hawaii's unique flora and fauna had also lim-

Taro is one of the most important food plants in traditional Hawaiian cookery. The root is used in making *poi,* while the stems (shown here) can be cooked as a green vegetable. © DOUGLAS PEEBLES/CORBIS.

ited its native foods. Hawaii's astonishing diversity included almost no edible vegetation and no source of edible carbohydrates. Luckily, the early Hawaiians brought at least twenty-seven kinds of foodstuffs, including the coconut, breadfruit, sweet potato, banana, sugarcane, arrowroot, wild ginger, mountain apple, and taro—much revered by the ancient Hawaiians, who pounded the roots into a paste, *poi*, that remains a starchy staple today. In addition, they imported pigs, chickens, and dogs. By mistake, they brought along rats.

They lived well on their isolated islands. They ate many foods raw, including some fish. Other food was cooked in *imus*, earthen pits lined with *kiawe* wood and lava rock. They prepared for bad weather by drying and salting fish. While they had no distilled liquors, they used the roots of *awa* (kava) and ti (a lily relative) to brew narcotic drinks.

The Second Polynesian Immigration

The early Hawaiians were legendary seafarers who had sailed thousands of miles using the stars, sun, winds and currents, shifting cloud masses, and bird flights. There is some evidence that they continued to sail their hundred-foot-long outrigger canoes to distant islands in the Pacific, bringing back food, plants, and spouses.

Between the eleventh and thirteenth centuries, aggressive, roaming Polynesians from Samoa and Tahiti settled in Hawaii and established a feudal regime overseen by their nobles and priests. The new feudal lords protected the ancient stonewalled fishponds, which yielded five thousand pounds of fish daily, and they enhanced traditional irrigation systems by building elaborate rock terraces.

They allocated property rights fairly widely, enabling most Hawaiians to eat well. The new rulers also enforced many complex *kapus*, or taboos, some of which helped manage scarce resources. Their system of land division is cited by biologists for its habitat protection. The huge freshwater and seawater fishponds were integrated with agriculture, and river valleys were managed as unified systems. The upland forest, left uncut by taboo, helped supply rivers with nutrients for downstream fields and fishponds. Seasons for gathering or catching scarce food or game were strictly enforced. Some taboos were exclusionary, particularly toward women, who were barred from preparing food for or eating with men. They were not allowed to eat the best foods, such as coconuts, shark meat, and pork. Breaking the taboos was punishable by death.

The Arrival of Westerners

By the time Captain James Cook landed on Kauai in 1778, Hawaiians had developed a comfortable economic system overseen by a feudal government. The Westerners would soon change all that.

Cook was the first of many seamen to use Hawaii as a way station to refuel and resupply ships in the middle of the ocean. He was renowned for having solved the

The warm waters off the Hawaiian islands offer a large variety of colorful tropical fish that are prized in local cookery. © DOUGLAS PEEBLES/CORBIS.

immense problem of scurvy among sailors, which he concluded was due to a lack of fresh fruits and vegetables. At every port he sought out fruit (particularly citrus), vegetables (including onions and new potatoes), fish, and meat.

The lush islands had much to offer Cook, who ruthlessly took immense amounts of food on his first trip, exploiting Hawaiian generosity. While Hawaiians had welcomed him with a lavish feast on his first visit, they knifed him to death when he returned in 1779.

Cook gave Hawaiians the first specimens of Western flora and fauna—goats, English pigs, and melon, pumpkin, and onion seeds. Close behind him came whalers and traders at the end of the eighteenth century, then the American missionaries, mainly Congregationalists, in 1820.

The missionaries introduced the church, school, printed word, woolen clothes, wood houses, and many foods. They sought to clean, clothe, and feed Hawaiians according to Christian standards to make them more responsive to the gospel. Beef was already available because cattle had been imported in 1793 by Captain George Vancouver, who had convinced King Kamehameha to permit women as well as men to eat it, as long as they ate from different cows.

The Congregationalists brought their prized New England foods—potatoes, apples, salted cod, corned beef, butter, and cheese. Food became a vital tool in Christianizing Hawaiians and turning them away from their traditional practices. When Queen Regent Kaahumanu converted to Christianity in 1824, she held a service at the edge of the Halemaumau fire pit sacred to the goddess Pele. Declaring her allegiance to Jehovah, she ate ohelo berries, which were both sacred to Pele and taboo to women. Not a murmur was heard from the volcano goddess.

Dominance by Plantations

Meanwhile, Westerners had also introduced their diseases, which reduced the native Hawaiian population from an estimated 300,000 at Cook's arrival to 60,000 by the mid-1800s and 40,000 by the end of the century. The rapidly expanding sugar industry—many plantations were owned by missionaries and their descendants—imported thousands of Chinese and then Japanese laborers to replace the Hawaiians. Just as the arrival of Westerners nearly wiped out native Hawaiians, the domination of agriculture first by sugar and later by pineapples wiped out the Hawaiian system of small farming overseen by religious laws, which regulated both hunting and farming.

Although wealthy whites received important administrative posts in the Hawaiian government, thereby governing indirectly, they became increasingly unhappy with the monarchy, which they deemed corrupt and inefficient. They wanted secure property rights to build their plantations and they wanted no restrictions on their importation of labor. They overthrew the monarchy in 1893. (Hawaii became a U.S. territory in 1900 and the fiftieth state in 1959.)

Between 1852 and 1930, Chinese, then Japanese, Okinawans, Norwegians, Germans, Koreans, Puerto Ricans, Portuguese, and Filipinos were imported by the immensely powerful factors that supplied plantations with all their needs, including workers. The workers wanted their own food, and the plantation stores procured it from abroad if it could not be grown locally. What could be grown was. Thus rice became Hawaii's third most important crop, after sugar and pineapples. Most immigrants brought seeds with them, though they could not always get them to grow. Manufacturers sprang up to produce tofu, noodles, kimchi, and sake.

Into this diversity came yet another set of missionaries—home economists, most trained by Columbia University's Teachers College. Convinced of the legitimacy of their field, the home economists taught at the newly established University of Hawaii, a land-grant university. Working with the electric and gas companies in the 1920s, they developed recipes that required the new appliances—stoves, ovens, and refrigerators. They promulgated the nutritional messages and agricultural advice of the Extension Services. They catalogued locally grown tropical foodstuffs and analyzed the nutritive values of the Hawaiian diet. They encouraged the consumption of American food, including milk, which many adult Hawaiians were unable to digest properly. They trained school cafeteria managers to produce Salisbury steak, mashed potatoes, and creamed corn. And they wrote the first cookbooks on Local Food.

The Development of Local Food

Hawaii's sad story of colonial exploitation is tempered by its exuberant ethnic diversity, nowhere to be found more clearly than in food. Calling themselves "locals," Hawaiians call the food they eat "Local Food," a term that most food writers now capitalize. Identified in the 1920s as a distinct phenomenon, Local Food mixes dishes from each of Hawaii's ethnic groups into unique forms, most famously the plate lunch served at diners and lunch wagons. This includes two scoops of sticky rice, meat cooked Asian style, and macaroni or potato salad—all eaten with chopsticks. Local Food includes shaved ice, SPAM wonton, *malasadas* (Portuguese donuts), saimin (noodle soup), crack seed (Chinese preserved plum), and butter *mochi* (a rice confection).

Except for indigenous coconut and banana trees, most foods associated with Hawaii are imported. The first immigrants, the Canoe People, brought with them twenty-four different plants. Since about 1800, a large number of additional plants, including pineapples, papaya, avocado, guava, sugar cane, coffee, and macadamia nuts, were introduced. Even the Kiawe tree—a variety of the family that includes mesquite, and is now rampant throughout the islands—was introduced.

Hawaii's premier agricultural product in modern times, the pineapple, is a native of Paraguay. Although introduced in the early 1800s, it was not commercially successful until the early twentieth century, when it was canned and sold to U.S. markets. By the early 1950s, almost 75 percent of pineapple on the world market was Hawaiian, thanks to inspired advertising. Hawaii has no canneries left today. Its entire crop is distributed fresh, accounting for about one million tons of fruit, or one-third of the world's consumption.

The highly prized Kona coffee, imported by Don Francisco de Paulay Marin in 1828, thrived in Hawaii's volcanic soil, enhanced by local altitude and climate. Simultaneously mellow and robust, Kona beans became renowned worldwide after the market crash of 1899, when the large plantations began leasing their lands to families of workers, who greatly improved the methods and quality of production. Many of those families are now in their fifth generation, producing some two million pounds a year. In the 1990s, coffee began to supplant the sugar cane plantings on several other islands, including Kaua'i, Maui, Moloka'i, and O'ahu—which now surpass Kona in total production. Most Hawaiian beans are sold for blends. Coffee marketed as a Kona blend must be at least 10 percent Kona.

Theobroma cacao, a variety of criollo, was able to take advantage of the same volcanic soil and climate and thrive. Though originally equatorial, Hawaiian cross-breed cacao, which has a nutty flavor and low acidity, grows quickly in open sun. (Its equatorial competitors need shade.) Its pods are harvested early—in two years rather than five—and its trees are more productive than elsewhere, averaging a hundred pods each, or five times the world's average. The chocolate is premium grade.

While macadamia nuts were brought to Hawaii as ornamentals in the nineteenth century, they did not become a commercial crop until the 1920s. Because the nut is very hard to crack, it is normally sold shelled. And because its production is labor intensive—one hundred pounds of harvested nuts yield only ten to fifteen lbs of edible meats—macadamias garner a premium price. Hawaii has some twenty thousand acres planted with macadamia trees today. The trees have a fifty-year lifespan.

Sugar cane, now displaced as a commercial crop, was introduced by the Polynesians. In the nineteenth century it became the islands' most significant commercial crop; it was for sugar cane that the Western economic interests eventually overthrew the monarchy.

Bananas were both indigenous and imported. With seventy varieties now grown on the island—and prestige accorded to some—Jean-Marie Jossellin likens the Hawaiians' distinctions among bananas to the Eskimos' distinctions of the varieties of snow.

Making Sense of Tourism

Since Hawaii's resident population of 1 million serves some 6 million tourists annually, the influence of outsiders on Hawaiian food can hardly be overstated. Until the late twentieth century that influence was baleful, with Honolulu having perhaps the worst restaurants of any major Western city. Even once elegant hotels like the Royal Hawaiian serve wretchedly bad meals in the name of traditional luaus—originally religious feasts of genuine importance degraded to farce by commercial exploitation.

But it is also true that many foods thought to be Hawaiian are not. Much of the so-called Hawaiian food served at Polynesian restaurants on the American mainland was invented in California and promulgated by Trader Vic's and other restaurateurs. Fried rice, satays, curries with coconut milk, rum-based drinks garnished with flowers and paper parasols, and dishes named after the goddess Pele or King Kamehameha have no real connection with Hawaii.

Since the early 1990s, however, a genuine Pacific Rim cuisine emphasizing cross-cultural influences but using local ingredients has developed. This has benefited small farmers, giving them outlets for superb fruits and vegetables—Maui onions (comparable to Vidalias), Manoa lettuce, Kahuku watermelon, Waimanalo corn, Kona oranges (a Valencia competitor) and avocados, Puna papayas, and an amazing range of seaweeds and ferns.

Meanwhile, native Hawaiians have reversed their population decline—about one-fourth of Hawaii's resident population of one million at the start of the twenty-first century claims some Hawaiian ancestry. Who is a native? One definition is that a native Hawaiian is someone who eats *palu*, a condiment made of chopped bits of fish head and stomach mixed with tiny amounts of *kukui* (candlenut) relish, chili peppers, and garlic. Not many fraudulent Hawaiians are likely to come forward to win this credential.

See also **Coffee; Fruit; Pacific Ocean Societies; Sugar and Sweeteners; Sugar Crops and Natural Sweeteners**.

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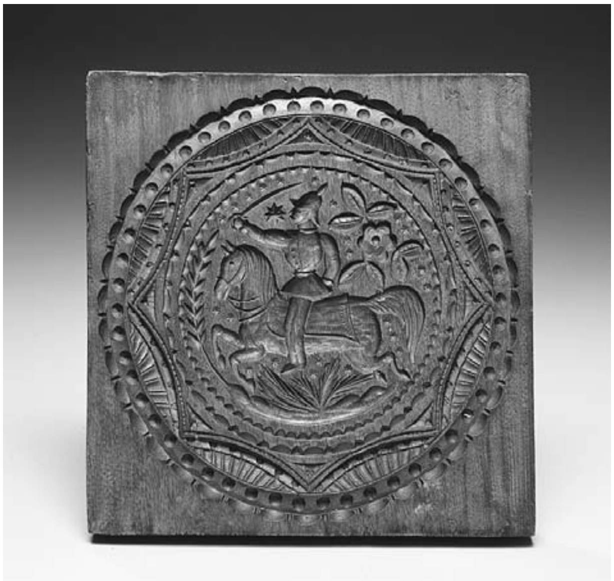
Julia Vitullo-Martin

THE MIDDLE ATLANTIC STATES

The waves of European ethnic settlement in the mid-Atlantic colonies in the United States prior to the Revolution produced regional culinary patterns that have influenced American cookery down to the present day. These areas of settlement have been described as "culture hearths" by folklore scholar Henry Glassie because they created a continuous emanation of influences. The cumulative effect of these culture hearths has been twofold: an evolution of distinctive mid-Atlantic foods and foodways, and a spread of this coastal culinary identity into the interior of the country, especially into the Midwest.

The succession of settlement begins with the Holland Dutch, who in 1624 carved New Netherlands out of the Hudson Valley of New York and adjoining parts of New Jersey, with significant settlements in Delaware (direct from Holland), and in Pennsylvania in the form of migrations from New York and New Jersey. The Swedes and Finns settled among the Dutch in the Delaware Valley beginning in 1638 with the foundation of New Sweden (over Dutch legal objections). All of this initial settlement, which was represented by relatively small numbers of people, was later numerically overwhelmed by large immigrations from the British Isles, headed principally by the English Quakers who founded New Jersey, Pennsylvania, and Delaware.

The Quakers themselves represented a mixture of English, Welsh, Scots, Irish, and Ulster Scotch-Irish elements, and each of these groups brought Old World foods and foodways to the region. The Quaker policy of extending settlement opportunities to continental Europeans suffering from religious persecution virtually threw the entire region open to a vast mélange of new settlers from Germany, Switzerland, Alsace, Austria, and France. These non-English-speaking settlers created in the Middle Colonies a cultural diversity that has come to represent American food culture as a whole. Yet each group has left its legacy, the most important perhaps being the German-speaking element, which gave rise to the present-day Pennsylvania Dutch. In terms of area, the so-called Pennsylvania Dutch settlement region was about the same size as modern Switzerland and just about as varied. Close behind the Pennsylvania Dutch were the Scotch-Irish who settled the hill country of Appalachia and who created a regional culinary culture known as Cohee.



New Year's cake print issued by Thomas Y. Watkins of New York to commemorate a dinner given at the Waldorf-Astoria Hotel by the Pilgrims of the United States in honor of Field Marshal Viscount Kitchener of Khartoum on April 18, 1910. The field marshal is depicted on horseback. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

From a historical standpoint, the most recent treatment of the foods and foodways of the New Netherlands Dutch is Peter G. Rose's translation of *The Sensible Cook* (1989), which explores Hudson Valley Dutch foodways via an old Holland Dutch cookbook. The original *Sensible Cook (De Verstandige Koek)* appeared in 1667, at a time when Dutch gardening was undergoing a horticultural revolution. The Dutch infatuation with exotic plants and kitchen gardening was transplanted to the New World, especially through the medium of Dutch Mennonite seed and plant merchants, who controlled much of the trade with New Netherlands and the Quaker colonies to the South.

The Dutch Cuisine

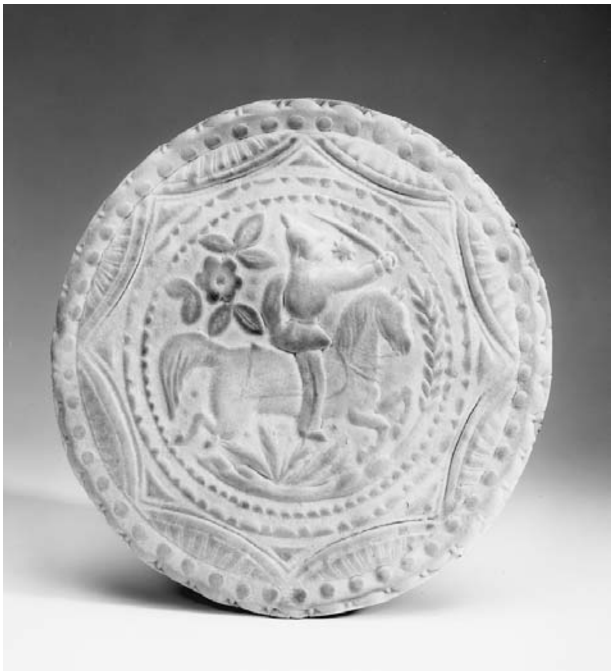
In spite of persistent Old World contacts, New Netherlands Dutch evolved into a dialect of its own with a large array of food concepts fully unknown to the Old World Dutch. These dishes would include *suppawn* (a type of cornmeal mush) and pumpkin pancakes, but intermingled with such Old World dishes as *olie-koecken* (a type of fat cake), soft or yeast-raised waffles, and *kool sla* (cabbage salad), served hot or at room temperature. Modern American coleslaw is probably the best known legacy of this old Dutch cooking tradition. However, the small Dutch New Year's cake called a *kookjie* has also entered standard American English under the more generic form of cookie (small cake). The true New Netherlands *kookjie* was in fact the so-called New Year's Cake, which evolved into a high art form in New York and Philadelphia. Many elaborately carved molds survive as a silent testimony to this lost art of ornamental pastry. The New York atelier of baker and mold maker John Conger produced some of the most elaborately carved molds to survive from the 1830s and 1840s.

The English Cuisine

By contrast, the English cuisine in the Middle States, as illustrated by the Quakers of Philadelphia and Baltimore, was basically a British Isles cookery adjusted to New World ingredients and climate. Nineteenth-century Quaker cookbook authors such as Elizabeth Ellicott Lea (Sandy Spring, Maryland), Elizabeth Nicholson (Philadelphia), and Hannah Widdifield (Philadelphia) mention a number of dishes associated not only with their religious group, but with the general population at large: white sweet potato pie (Quarterly Meeting Pie to Quakers), lemon butter and rusks, and the ubiquitous dried beef gravy. This last dish, which was served over toast, was often known as "Quaker gravy" throughout the region. Its chopped beef and onion version has survived to this day under the rubric of the Philadelphia cheese-steak sandwich.

The Quaker element was especially well known for its dairy culture in the form of substantial spring houses for the production of high quality butter and cheese. Philadelphia cream cheese (a soft cheese resembling French brie) was famous in the nineteenth century, although today it lives on in name only in the form of a processed cheese spread. The rich milk and cream that produced the popular cheeses and butters of the region also served as a major ingredient in Philadelphia ice cream, at one time a highly sought-after food on the American luxury market.

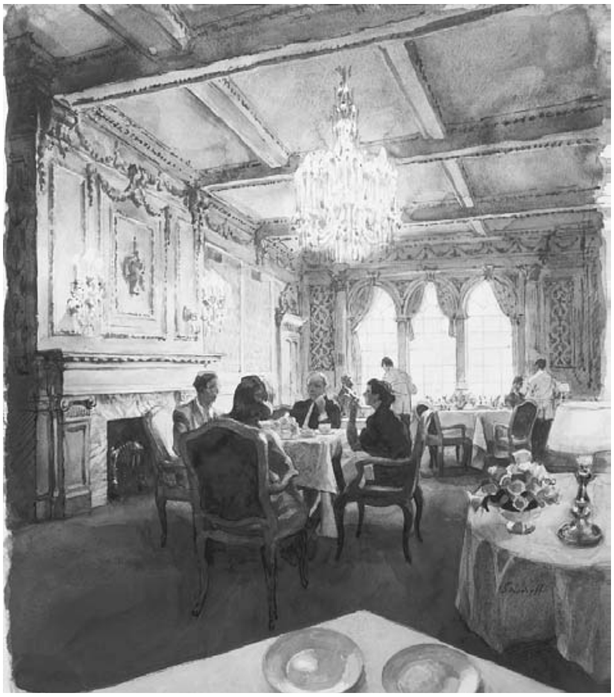
Quaker farmers were also skilled gardeners and orchardists, and some, like the Bartrams of Philadelphia, Humphrey Marshall, and William Darlington, studied native plants and trees and exchanged seeds with their European contacts. The Quakers also kept up an English preference for tea-drinking over coffee. Among the urban Friends of the nineteenth century, Quaker Tea Parties were synonymous with catered balls, a menu heavy with rich cakes and fancy side dishes, and a beverage selection awash with the best wines and champagne. In total opposition to this show of opulence, were Friends who promoted vegetarianism and abstinence from alcohol long before these themes became commonplace in American culture. In fact, the first health food stores were opened in Philadelphia by the Quaker Martindale family during the 1860s.



A New Year's cake made from the Thomas Y. Watkins print (facing page). The cake would have been further ornamented with colored icings and gilding. PHOTO WILLIAM WOYS WEAVER.

The Pennsylvania Dutch element introduced food concepts found in the traditional peasant cookeries of southwest Germany, Switzerland, and Alsace-Lorraine. The pioneer generation ate simple, one-pot meals like sauerkraut and pork or *Schnitz-un-Gnepp* (dried apples and dumplings with ham and ham stock) reproduced from the homeland. They consumed more soups than their English-speaking neighbors, as well as numerous flour-based preparations like noodles and filled dumplings. Since the Pennsylvania Dutch farmers settled in what soon became the colonial wheat belt, a vast array of pies, cakes, breads, and festive cookies were added to the immigrant menu. Outdoor bake ovens were once a common feature on nearly every farmstead in the region, and travelers through the area never fail to mention the popularity of *Lotwarrick* (apple butter), salads with hot dressings, and *Schmierkees* (cottage cheese), especially *Schmierkees* flavored with chives.

In spite of the culinary quiltwork that once represented the region, most ethnic groups did not initially like or adopt the cuisines of their neighbors, except out of necessity. Thomas Hill, a New Jersey Quaker passing through eastern Pennsylvania on his way to settle along



Watercolor of the interior of La Panetière, a 1980s Philadelphia restaurant that employed the setting of an elegant turn-of-the-century townhouse to create an intimate atmosphere. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

the west branch of the Susquehanna River, remarked in reference to the Germans: "My breakfast this morning, two cups of coffee without sugar, and three eggs; bread baked hard, and crust wet." For another meal: "Salad with milk, oil, vinegar, bonny clabber and bread; good God! How can they work so hard on such food!" A melting-pot effect did eventually overtake such aversions, especially in urban areas and in families in which intermarriage between ethnic groups occurred. This kind of hybrid mixing resulted in such regional specialties as pop-robin pudding (grated dough baked with cinnamon and butter), mush muffins (cornmeal Welsh muffins), and chicken salad served with fried oysters—to name a few.

Due to religious tolerance, this part of the United States was the first to witness many charitable food-related events, such as the church supper, fund-raising cookbooks, camp meeting dinners, and Sunday school picnics. The spread of these blue-collar social institutions was due in part to the publishing industry that once characterized Philadelphia's literary scene. Writers like Eliza Leslie and Sarah Josepha Hale gained national prominence through *Godey's Lady's Book*, a prominence the city maintained into the early 1900s with *The Confectioners' Journal*, Wilmer Atkinson's *Farm Journal*, Sarah Tyson Rorer's *Table Talk*, as well as Curtis Publishing's *Ladies' Home Journal* and *Country Gentleman*. Every one of these publications is chock-full of recipes reflecting trends in American cookery during this period. Sarah Tyson Rorer in particular managed to take her culinary agendas well beyond the walls of her once-famous Philadelphia Cooking School. Her crossover into product promotional literature and specialized recipe books for everything from ice cream to vegetables made her a household name by 1900.

From a historical standpoint, colonial New York and southeastern Pennsylvania have left a lasting impression on American cookery via such foods as coleslaw, crullers, shoofly pie, soft pretzels, and rye whisky, not to omit New Jersey's once famous apple brandy known affectionately as "Jersey Lightning." Much of this emphasis on regionalisms has been revitalized through the efforts of the Kutztown Folk Festival, founded in the early 1950s and considered the first of its kind in the country. While the festival may attract New Yorkers in search of rural roots, the movie *The Age of Innocence* has recaptured the sumptuousness of the culinary scene during New York's Gilded Age. This was an era when American food as social display by the robber barons reached its ultimate apotheosis, since the grand dinners were also social events staged as much for the participants as for a spectacle-hungry public. In this exchange the seeds of many mythologies were sown.

The Origin of Current Trends

It is often forgotten today that the cowboy in American mythology and the "chow" cookery now associated with cowboy fare were not created from scratch on the Great Plains, but in the townhouse study of blue-blood Philadelphia author Owen Wister. His romantic novel *The Virginian* (1902) was a launching point for this very pervasive image in American culture. Immigration has also contributed to an ongoing evolution of more recent icon foods, such as New York's bagels and Reuben sandwich and Philadelphia's hoagies (known elsewhere as grinders or submarines).

New York has evolved into a truly international metropolis with a fascinating food story that would consume all the pages of this encyclopedia. Its position on the international scene was firmly fixed after World War II with the establishment of the United Nations headquarters in Manhattan. But it was New York's role in the American culinary revolution that has had its most lasting effect on our food. The transformation of the classic French cookery of such restaurants as Le Pavillon (which opened in 1941) into the likes of The Four Seasons and the celebrated Windows on the World in the World Trade Center is the story of an Americanization process in *haute cuisine* that emanated primarily from New York City. Added to this were the TV personalities of James Beard and Julia Child, whose impact on American cookery has been fundamental. The James Beard Foundation, with its annual awards for chefs and food writers, has continued to focus on New York's leadership in many branches of American food and culture.

As a counterpoint to this, Philadelphia and Baltimore have managed to retain a regional American character, especially in terms of culinary identity. Philadelphia established itself as the American culinary capital in the early nineteenth century, with roughly one-fourth of its immigrant population either European or Caribbean French. This contributed to a Caribbean accent in its urban cookery, hence the turtle soup and pepperpot vendors. It was also the cultural mecca where the Old South wintered. Pre–Civil War Philadelphia was indeed a city whose lifeblood was derived from Southern money and shipping, which brought to its larders vast quantities of foodstuffs from Asia, the Caribbean, and South America. Its economic rival was sister-city Baltimore, which today has preserved much of its Federalist Era culinary culture as defined by the Chesapeake Bay.

Both Philadelphia and Baltimore became centers of manufacturing after the Civil War, which changed elegant streets of stately row houses into smoke-congested corridors of noise, shuffling foreign labor, and crime. The rich left for the suburbs; thus, in both cities, dining culture retreated to country houses or into the hands of dining club managers and African-American caterers. In Philadelphia, the Augustin family (originally from Haiti) became the most important catering family on the East Coast and prided itself on such specialties as oyster fritters, creamed terrapin, and rasped rolls. At one time the Augustins owned railroad cars with kitchens so that elegant meals could be served as far away as Boston, Chicago, and Washington.

It was the Chesapeake Bay that eventually saved Baltimore, because the city has revived its culinary identity within the last thirty years on such local Bay specialties as soft-shell crab, beaten biscuits, stuffed ham, sweet potato pie, and Lady Baltimore Cake (another Owen Wister invention). With the restoration of historic Society Hill, Philadelphia culinary culture was revived in the 1970s by La Panetière, the haute-cuisine launchpad for what has become a culinary renaissance in that city. Philadelphia's annual spring food festival called Book and the Cook (created by White Dog Café owner Judy Wicks) has done much to bring national attention to the City of Brotherly Love. Unlike New Orleans, which depends primarily on tourism for its restaurant business, Philadelphia's success story has been the result of a grassroots appreciation of good food paired with its old loyalty to farm markets and regional produce.

The anomaly for the entire region is Washington, D.C., which for its first century was largely an artificial city carved out of Maryland farmland. Aside from the White House, where lavish dinners were *de rigueur*—but not under every administration—Washington was a boardinghouse town for congressmen and not noted for its good food. By the early 1900s, the city evolved into a more cosmopolitan place, yet retained a provincial Southern character well into the 1960s, when the Kennedys brought a new kind of flair to the capital, and Georgetown and northwest Washington underwent a cultural revitalization. However, there were always a few popular restaurants, such as Marjorie Hendrick's Watergate Inn, which served regional American specialties, even a respectable Pennsylvania Dutch menu. More recently, the influx of Vietnamese immigrants and the renovation of numerous downtown buildings have led to an exciting new mix of culinary choices.

See also **Foodways; Germany, Austria, Switzerland; Low Countries; Restaurants**.

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Don Yoder

THE MIDWEST

The term "Midwest" first appeared in print in 1880 to describe the Kansas-Nebraska region and was enlarged by 1910 to include all twelve of what are now considered the midwestern states: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Geographic features of what are now considered the midwestern states include wide and fertile river valleys, limestone bluffs overlooking rivers and lakes, broad expanses of grasslands, the Great Lakes, the dry and rocky Badlands of the Dakotas, the deciduous woodlands of the northern Midwest and southern Missouri, the sandhills of Nebraska, and wetlands.

According to the geographer James R. Shortridge, "midwestern" connotes pastoralism, small town life, hospitality and friendliness, traditional values, farmers, yeoman society, and the Jeffersonian ideal. "The Midwest is America's pastoral face," he says, "etched into our consciousness as a permanent physical location, despite the presence of industrial cities" (Fertig, 1999, p. 30).

The most prominent geographic feature of the Midwest is rolling grassland or prairie. But of the 400,000 square miles of prairie that once stretched from central Ohio westward to the foothills of the Colorado Rockies and from Alberta, Manitoba, and Saskatchewan in Canada south to central Texas, less than 1 percent has remained natural prairie (Fertig, 1999, p. 166).

Native Foods

Before European settlement of the Midwest, Native American tribes gathered wild foods, such as native persimmons, papaws, berries, nuts of all kinds, and prairie turnips (Wilson, 1987, p. 119). Wild rice, really an aquatic grass, not a true rice, is the only grain native to North America, and it was a staple food of the Sioux and Chippewa tribes. Wild rice grows in the lakes and rivers of Minnesota, upper Michigan, northern Wisconsin, and lower Canada (Fertig, 1999, p. 223).

Wild game included venison, rabbit, elk, antelope, quail, migrating geese and ducks, prairie chickens, wild turkeys, and the American buffalo (bison). Certain tribes also planted many different varieties of corn, beans, squash, and sunflowers (Wilson, 1987, pp. 16, 58, 68, 82–84). Dakota Sioux Indians pounded buffalo fat, dried meat, parched cornmeal, and dried berries together to make "wasna," a high-calorie trail food (Episcopal Church Women, 1991, vol. 2, p. 21). Native Americans also fished for walleyed pike, bass, and perch from the lakes and catfish and trout from the rivers and streams.

Most of the prairie ultimately became productive farmland, small towns, cities, and suburbs. It is rangeland to the American cattle industry and is recognized as the nation's breadbasket. The eastern or short-grass prairie in Ohio, Indiana, Illinois, and Iowa has become the corn belt. The western or tall-grass prairie in Kansas, Nebraska, the Dakotas, and Canada has become the wheat belt. The central mixed-grass prairie in the hilly grasslands of southern Indiana, Illinois, and southwestern Wisconsin has become the dairy belt (Fertig, 1999, p. xi).

Midwestern Cooking

Midwestern cooking reflects both the bounty of the land and the ethnic diversity of the population. Favorites include wheat and honey buns, kolaches (fruit-filled sweet yeast dough pastries, originally *koláče*), traditional breads of all kinds, steaks, hamburgers, fried chicken, and pot roast. Locally brewed wheat beers are enlivened with a squeeze of lemon and accompany a bowl of chuck wagon chili zipped with the heat of peppers. Crisply roasted pheasant and other game delicacies are autumn treats. A piece of homemade pie and a cup of coffee welcome a newcomer, provide a warm and homey occasion for catching up with all the gossip, or bring a sweet ending to a family dinner.

City dwellers start the day with a cup of coffee and a bagel or a piece of toast. For farm families a hearty breakfast of bacon or sausage, eggs, biscuits or toast, and hash browns is more common. Lunch is a sandwich or salad and soup, perhaps a favorite bean soup. For dinner farm families might enjoy a slow-simmered pot roast or stew that has cooked all day. Midwesterners are also fond of casseroles, known as "hot dishes" in Minnesota, that can be assembled early in the day and baked later on. City households might have pasta, grilled chicken, or steak.

From barbecue competitions in the warmer months to ethnic food festivals throughout the year, midwesterners proudly affirm their culinary traditions. Residents of Milwaukee, Wisconsin, enjoy traditional Friday night fish fries at restaurants and churches. Catholic churches in rural parts of eastern Indiana and western Ohio offer chicken dinners throughout the summer and fall months,

Main Dining Room looking west, as seen from the balcony of Private Dining Room "B." Avenue of Palms is to the left; the windows to the right overlook Lake Shore Drive and Lake Michigan.

The main dining room of the Drake Hotel on Lake Shore Drive, Chicago in 1928. During its heyday, the Drake and its famous menus represented the ultimate in fine dining in the Midwest. Roughwood Collection.

featuring chicken fried in lard, garden vegetables, and homemade pies and cakes. The Door County Fish Boil is an ongoing summer ritual in Wisconsin in which whitefish, potatoes, and onions are boiled to overflowing in an outdoor cauldron.

Culinary Traditions

During the late 1700s and early 1800s settlers from the original thirteen American colonies began to move westward into Ohio, Indiana, Illinois, and Michigan. French settlers had already established villages along the Mississippi River in what is now Illinois, Missouri, and Iowa, and along the Missouri River in what is now Missouri and Kansas. These small settlements began to grow as the Louisiana Purchase, acquired by President Thomas Jefferson in 1803, opened up vast tracts of land for settlement. Between 1865 and 1880 Kansas attracted more immigrants than any other place in the nation. The promise of virtually free land and a chance to start over drew thousands to the rolling prairie. The first Homestead Act, passed by Congress in 1862, enabled the head of a family to claim 160 acres of land in Kansas for only a small filing fee and a residency requirement of five years (Fertig, 1999, p. 29).

As the Homestead Acts continued to be revised, new land was opened up in North and South Dakota, Iowa, and Nebraska that attracted new groups of immigrants, including Poles, Irish, Czechs or Bohemians, and Austrians. Each adult in the family could claim 160 acres, up to 480 acres per family, on the prairie. For a small filing fee the families could farm the land providing they built a homestead and lived there for a certain number of months a year. Women as well as men filed claims and lived on the land until it was theirs after the residency requirement had been completed (Fertig, 1999, p. 29). Each ethnic group brought its own unique culinary traditions to the melting pot of the Midwest.

Czech. Immigrants from what became Czechoslovakia brought their love of sweet and sour flavors, dumplings of all kinds, dried fruits and mushrooms, and kolache. Wild duck or jackrabbit was marinated in a vinegar and spice mixture, then roasted in the oven. The gravy was thickened with sour cream. Dumplings made from flour, bread crumbs, or potatoes were cooked on top of simmering stews or soups. Dried fruits and mushrooms were plumped in liquid and made into sweet or savory soups. Barley filled out stuffed cabbages or added depth to wild

The Midwest is home to numerous ethnic communities. One of the largest is the Polish community in Chicago and around Detroit. Polish foods are available in many parts of the Midwest, and the best known are pirogi. PHOTO BYANDRÉ BARANOWSKI.

mushrooms in a baked dish. Cold weather vegetables like cabbage, carrots, potatoes, and parsnips also feature in Czech cooking. Kolache, tiny individual coffeecakes made of buttery yeast dough and filled with fruit butters or preserves, are a favorite fresh and hot in Nebraska, South Dakota, and Kansas kitchens.

German. The Heartland welcomed Germans from many different culinary traditions, and each group brought a different cooking style. The Volga Germans enjoyed a tradition of bierocks, verenicke, and other dishes similar to those of the Russian Mennonites. The "border people" from Bavaria loved homemade noodles and sweet-sour dishes, such as sweet-sour heart, liver, and tongue. Most of their cuisine was centered around cabbage and pork of all kinds. Smoky flavors combined with sweet and sour flavors, and onions and herbs. Homemade sauerkraut simmered with pork, potato pancakes, tortes, braised cabbage, sausage cooked in beer, honey, and spice cookies entered mainstream American cuisine thanks to German immigrants.

Russian Mennonite. Wheat-farming Russian Mennonites, who brought the first Turkey red winter wheat seeds to Kansas in 1875, are credited with transforming this part of the prairie into the nation's breadbasket (Fertig, 1998, pp. 47–57). Their foodways were influenced by sojourns in the Netherlands, Germany, and the Ukraine. A Protestant sect advocating a simple life and a firm commitment to the ideas of the church, much like the Amish, the Mennonites kept searching for a place where they could work and worship in peace. Fleeing religious persecution for their pacifist views, the Mennonites brought their favorite foodways with them to each new homeland. One specialty, a fruit soup or *moos* (pronounced "mose"), is thickened with flour. Verenicke, a ravioli-like pasta filled with dry-curd cheese, is served with sour cream ham gravy, jelly, or syrup. Homemade bread is a staple in most households, but the traditional favorite is zwieback, a brioche-type sweet yeast bread often served on Sundays. When sliced and toasted in the oven, it takes on a nutty, delicious flavor and keeps for weeks. Immigrant families often brought baskets of toasted zwieback to last until they reached the prairie.

Swedish. Pure, clean flavors combine with rich, buttery baked goods and creamy, mild tastes to form the constellation of Swedish foods of the Midwest. The flavors and colors of sillsalat, pickled herring, and pickled beets offer a taste counterpoint to the mild flavors of Swedish potato sausage, baked brown beans, and Swedish yellow pea soup. Fresh dill turns up in potato dishes and pickles of all kinds. But the highlight of a meal is always the baked goods: hard and crispy knackebrod with soup, almond-flavored kringler or saffron-flavored Lucia buns (for Saint Lucia Day on 14 December) and tea rings with breakfast, mellow limpa rye bread with dinner. Mellow and milky desserts like ostakaka and rice pudding are often served with a red fruit sauce as much for a color contrast as for a taste complement. Indeed deep red is a favorite punctuation mark in Swedish meals, whether is appears in the spiced gluhwein on special occasions, beet dishes and sillsalat, or lingonberry and red currant sauces for everything from lacy Swedish pancakes to roast goose.

Polish. Without the traditional "seven sours" of pickled vegetables, no deluxe Polish meal would be complete. Centered around hearty peasant food, the cooking of Poland is full of thick soups, dried mushrooms, sauerkraut, potatoes, ground and spiced meats, fish with horseradish sauce, sour rye bread, and buttery baked goods. The Easter tradition of "breakfast all day long" and the Christmas tradition of the multicourse Vigilia hold firm in Polish families. Sour cream, vinegar, plums, horseradish, beets, cabbage, potatoes, poppy seeds, caraway seeds, and allspice configure and reconfigure in countless recipes. Buttery baked goods flavored with almonds and poppy seeds, smoked sausages of all kinds, poached pike with horseradish sauce, marzipan baked apples, and herring in sour cream reflect the diversity of this cuisine.

Italian. Italians, mainly from Sicily, were one of the last immigrant groups to arrive in the Midwest, in the early 1900s. Many Italian immigrants became market gardeners or opened restaurants or produce businesses in places like Des Moines, Chicago, St. Louis, Cincinnati, and Kansas City. Varieties of Italian cookies, some made with pine nuts or fig preserves, star in Italian bakeries and festivals throughout the Heartland. *Amogio*, a marinade of white wine, garlic, and herbs, flavors chicken and beef, which is then rolled in *modiga* or flavored breadcrumbs and grilled. Zesty tomato sauce tops pasta dishes and baked eggplant.

Barbecue. Traveling up from South America, the barbeque tradition is rooted in the foodways of rain-forest Indians, who smoked meats over green wood to preserve them for later use. Over time this technique spread to the American South and from there to Missouri, where black residents used pit barbeques to smoke lesser and cheaper cuts of meat like spareribs and brisket. In 1916 the Kansas City resident Henry Perry began selling barbequed turkey, duck, pig, and goose, and by 1929 he had three separate barbeque stands. His fame spread, and he taught others, including Charlie Bryant, the secrets of slow smoking. Bryant and his brother Arthur Bryant eventually took over Perry's business, calling it Charlie Bryant's. When Charlie died in 1952, it became Arthur Bryant's, whose barbeque rose to fame when Calvin Trillin extolled it. By the early twenty-first century Kansas City had over one hundred barbeque joints, from the basic shack to the high-style restaurant (Stein and Davis, 1985, pp. 11–20).

State Fairs

The region's agricultural roots are celebrated every year in state fairs held in late summer and early fall. During the 1850s, when the region was predominately agricultural, state fairs were established throughout the Midwest. The first was the Ohio State Fair, held in Cincinnati in 1850. Even though most state economies changed from mainly agricultural to businesses of other kinds, the tradition continued into the twenty-first century. They usually include the butter cow or other object or person sculpted from butter, a traditional attraction that began at the Ohio State Fair in 1903. Concessions offer unique state fair food, such as pork chop dinners in Iowa, barbecued rib dinners in Missouri, fried chicken dinners in Ohio, Indian tacos in Nebraska, and anything you want on a stick, including cheese, bamboo beef, smoked turkey legs, roasted corn, and corn dogs (Fertig, 1999, p. 60).

See also **Barbecue; Beer; Bread; Dairy Products; Maize.**

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Judith M. Fertig

NEW ENGLAND

New England's early foodways set a pattern for the common, everyday cookery that would be carried across the American continent and endure through time to the present. Many dishes considered today particularly American—pumpkin pie, johnnycake, pork and baked beans, apple pie, among others—evolved in New England from the yeoman English cookery of the seventeenth century colonist who came to the region.

Early Preferences

English settlers arrived in New England with a decided preference for beef and beer, wheat bread, peas and root vegetables, tree fruits, particularly apple, and well-developed dairying practices. Their seasoning habits were close to the rich and complex flavorings of the late medieval era. They ate fish on fast days, regarded it appropriately as light fare, but often associated it, especially salted fish, with poverty. Venison hunting and consumption was, for these people, restricted in Old England as sport and fare for the gentry. Within a few decades, settlers had considerably altered some of these habits to accommodate the climate and growing conditions of their new home, the variable supplies of still-developing trade networks, and economic realities of a colony as a joint stock company.

Climate and Cash Flow

New England's weather was much colder, particularly in winter, than the English were accustomed to in the Gulf Stream–moderated British Isles. The colonial period and early nineteenth century were, as well, affected by what weather historians have characterized as a mini ice age. Still summers were shorter, hotter, and more humid than English growing seasons, conditions that adversely affected wheat and pea growing in particular. A recurring mildew attacked wheat, gradually impelling a switch from wheat flour bread to one made with rye and the Native American's cornmeal, which settlers named "Indian" to produce a loaf called "rye and Indian." New England's climate favored the native beans that ultimately fared better than peas as a field crop and helped urge the shift to the beans pottage that would evolve into baked beans.

New England's climate limited natural abundance. Compared to other colonies in North America, settlers in the north were limited to gathering greens in early spring,

The icon food of New England is baked beans—one of Boston's nicknames is "Beantown"—and many families pride themselves on heirloom recipes, some tracing to the 1600s. Baked beans were originally prepared in earthenware cookpots. Slow simmering is one of the cooking secrets for a successful recipe. © Becky Luigart-Stayner/CORBIS.

and wild fruits and nuts in two to three months of summer and early fall. Deer, moose, and small animals were most toothsome in the fall before they had spent cold months grazing on evergreens and mosses. Settlers near water could hunt wild fowl, as well as catch fish. But cold weather hunting and fishing was often strenuous and yielded uncertain results with at least as great an expenditure of energy finding food as would be gained from eating it. Besides the issue of dubious food value, early settlers viewed hunting and gathering as the sport of the gentry and idle, and, more to the point, they faced economic realties which mitigated against that activity.

Of first importance was establishing an economic base for the colonies settled all through southern New England. As joint stock companies, they owed money, and much effort was expended to raise it and to create some business that would yield profit. From the start, this impulse created a market economy that skewed settlers' activity toward lumbering, fishing, and producing the most merchantable crops and agricultural products, and away from growing experimental foodstuffs or from indulging in hunting and gathering with potentially unreliable results. New England's gentry farmers in later years took up the gentlemanly farming found earlier in the South and the Middle Atlantic colonies, growing experimental crops, vegetables, conducting animal husbandry, and cultivating fruit trees—quince, pears, cherries, apricots, and even peaches, but chiefly apples. By the later nineteenth century even middle-class professionals spent their leisure growing everything from strawberries to pumpkins in gentile competition, but for the first century and anywhere on New England's frontiers, Yankees preferred the tried, true, and reliably abundant. This conservatism in taste and preference for reliability endured through the centuries.

Food from the Native Americans

New England's settlers adopted a limited range of food stuff and agricultural practice from the Native Americans. As most cultures do when encountering new foods, the English accepted those that most resembled the familiar and preferred. Practicality drove the adoption of what the Native Americans called the Three Sisters: corn, squash and pumpkins, and beans.

Corn grew and yielded well. Cornmeal behaved culinarily like the familiar oatmeal and was handled as oatmeal had been in England in the unleavened bread bannock. Bannock was also known in the North of England as jonniken. The corruption of the term jonniken accounts for the name johnnycake, best seen in the Rhode Island spelling of jonnycake, which is to this day an unleavened mixture of cornmeal, salt, water, sometimes thinned with milk, and baked over fire on a flat pan in traditional bannock fashion. Cornmeal was also cooked as a mush or hasty pudding, as had been oatmeal. Similarly, Indian meal was used in place of the customary coarse oatmeal to make the milk-based, molasses-sweetened Indian pudding, ultimately named for the cornmeal used to make it.

Squash and pumpkins worked in recipes like apples did, so they were stewed as a sauce or sliced in pie form as apples were in the seventeenth century. Later, in the eighteenth century, they would be used like the similarly textured sweet potato in the sweet puddings often baked in pastry shells, and thus gradually evolved into pumpkin pie.

For many centuries, the most commonly used bean in Europe was a large flat bean of which the modern fava is a kind. Settlers encountered the smaller, rounder, kidney-shaped beans of North America that could be used as peas had always been used in potages and soups, often with salted meat, or even sometimes ground to be combined with grains for a coarse bread. Most of the early potages were stewed dishes, but toward the end of the eighteenth century, New Englanders took advantage of still warm brick bake ovens to bake slowly a pot full of beans with salt pork. Baked beans were barely sweetened in the early era, the most usual proportion being one large spoonful of molasses to a quart of dried beans. Industrially produced beans of the later nineteenth and early twentieth centuries were notoriously and popularly sweet, and many homemakers followed the example to create the sweet baked beans we know today.

Reform and Beer and Bread

Uncertainty with grain crops together with the relative ease of apple growing gradually brought about a slight shift from beer and ale to apple cider drinking. Still for the first two centuries of New England's history, housewives continued the paired activities of baking and brewing, both of which used and generated yeast. The advent of the Temperance movement, the earliest of the foodways-related reforms to take hold of New England, gradually eliminated brewed beverages from widespread daily and family consumption and replaced them with tea and coffee, and eventually for festive occasions, lemonade. Some people continued to drink wine, and beer and cider, but the Temperance influence was widespread in New England, and broke the bread-making and brewing connection, opening the way for commercial yeast-making and the wider acceptance and manufacture of chemical leavenings such as pearlash, later saleratus, and eventually baking soda and cream of tartar, and baking powder.

New Englanders reverted to making bread with wheat after the Eire Canal opened in the 1820s, and lower cost wheat flour came on the market. The old rye-and-Indian gradually disappeared, but in the mid-nineteenth century the combination could be found in Boston brown bread, which continued to use rye, cornmeal, and sometimes wheat flour as well, mixed with chemical leavenings, milk, sweetened with molasses, and steamed—more pudding than bread, but eaten as bread would be, often accompanying baked pork and beans. This combination continues even to our time, and was carried across the country anywhere New Englanders settled.

Fish, Molasses, and Industry

New England was the earliest region to industrialize. In the late eighteenth and early nineteenth centuries, Boston and Providence capitalists converted money from trade and shipping into textile manufacture. Some of this wealth had been originally generated by the salt cod trade with Europe and the West Indies, where it formed a leg of the well-known triangle trade that included molasses and slaves. Settlers engaged in cod fishing early, utilizing one of the regions natural resources, in order to produce an income for repayment of investments in colonies. The codfish that hangs in the Massachusetts State House has little to do with gastronomic preferences of New Englanders, but honors instead the source of much wealth.

New Englanders certainly did consume salt codfish, often on Saturday, often in the form of a boiled dinner with root vegetables, and a sauce of fried salt pork or butter and chopped boiled eggs. This dish gained the derisive nickname Cape Cod Turkey, variously Block Island Turkey. Chowder, another dish with strong New England associations, came ashore from the fishing fleets. Earliest versions of it were comprised of fishermen's provisions, salt pork and hardtack, to which fish was added. When Yankees added potatoes to their everyday diet, they were used in the chowder, too, eventually replacing hardtack as a thickener.

The molasses was made into rum, and provided an inexpensive sweetening characteristic of many of New England's early dishes. Wherever saltwater access made shipping possible molasses, brown sugar, and refined white sugar were available to cooks, even in the hinterlands. Two other sweeteners, commonplace in interior New England, were a thick, molasses-like syrup made from boiled down sweet apple cider, and maple sugar. Produced mostly as a commodity, partly for home consumption, sugar-making from maple tree sap became a widespread activity in the middle to late eighteenth century, and grew steadily through the nineteenth. The goal was sugar production, though in more recent times, the syrup has become more desirable.

The Maine lobster dinner is one of New England's most popular tourist attractions. The menu may vary from restaurant to restaurant, but the basics are universal: boiled lobster, corn on the cob, cornbread, and coleslaw. Many menus include oysters or quahogs (a type of clam) for starters. © BOB KRIST/CORBIS.

The industrialization of New England promoted urban growth and transformed many New Englanders from food producers to food consumers only. Urbanization created a stronger market for dairy products—cheese, milk, and butter—and changed many New England farms from producing varied crops to focusing on a specialty such as dairying, orchards, or raising poultry for meat and eggs. By the mid-nineteenth century, grain and even beef and pork were brought into New England's cities from the West by way of railroads and artificial refrigeration.

New England has many distinctive cookeries, from the shipboard fare of the old whaling ships to the rustic cookery of Maine logging camps. This cook in the Fletcher Field Logging Camp (Washington County, Maine) is shown preparing bread in a 1948 photograph taken by Leland J. Prater. © CORBIS.

Factory work also changed the daily patterns of meals for many New Englanders. The old rural pattern of a morning breakfast, noon dinner, and a smaller meal called tea or supper in the evening gave way to breakfast, a lunch carried to work, and a supper or dinner in the evening at the end of the work day. For many laboring families, however, dinner became a Sunday phenomenon, placed in the middle of the day. People in farming communities would continue the old pattern well into the twentieth century.

Immigration

Industrialization encouraged immigration from the French Canadian north and Europe and gradually introduced ethnic flavors to the region. The same reformist impulse that gave Temperance such a strong footing in New England also worked toward mainstreaming the newcomers' diets. Scientific cooking and cooking schools, such as the well-known Boston Cooking School, made as their missions both to educate middle-class women in healthful and aesthetically pleasing cookery, but also to uplift the poor, often immigrant, populations caught in the economic vicissitudes of industrialization. This combined readily with many immigrants desire to meld into American life, which they accomplished by giving up some of their traditional dishes to eat more meat. Many ethnic groups living in neighborhoods nevertheless managed to continue many familiar foodways and supported local groceries, butchers, fish markets, and green grocers. In the twentieth century, with the culmination of nearly a century of exposure to Italians, Portuguese, Eastern Europeans, French, and Asians, Yankee cooks ate in ethnic restaurants and experimented with foreign dishes at home.

Thanksgiving

The national holiday Thanksgiving owes it origins to the sustained custom of autumn harvest festivals brought to and continued in New England. Originally a moveable feast that could occur almost anytime at the conclusion of the growing season, early New Englanders preferred to conclude butchering season before celebrating the harvest, usually at the end of November or beginning of December. Individual colonial, later state, governors declared what day, usually a Thursday, the holiday would be observed. A holiday of family reunion, feasting, and recreation, Thanksgiving's menu has been much mythologized, starting with the event considered the first Thanksgiving, described by Edward Winslow in *Mourt's Relation*: "so we might after a special manner rejoice together after we had gathered the fruit of our Labors." Winslow reported that they had wild fowl and venison, and William Bradford writing in *Of Pilmoth Plantation* about the same event, referred to fish, turkeys, and Indian meal.

In the nineteenth century when the story of founding settlers of Plymouth was romanticized, the association of turkeys and the so-called Pilgrims at Thanksgiving assured that dish would appear on the table along with roast pork, chicken pies, fall-harvested vegetables such as squash, potatoes, and turnips. Cranberry sauce and pickles and other preserves accompanied the meal, and pies followed made of pumpkin, apple, and mincemeat. This menu, with very few substantial changes, spread across the country with settlers, and has continued to the present along with the habit of observing the day. While nearly every state in the nation observed Thanksgiving in some form, the day became a nationally declared holiday when Abraham Lincoln, at the urging of Sarah Josepha Hale, set the holiday at the last Thursday in November. Franklin Roosevelt changed the date to the fourth Thursday, where it rests today.

See also **Fish: Sea Fish**; **Foodways**; **Maize: Maize as a Food**; **Squash and Gourds**; **Sugar Crops and Natural Sweeteners**; **Thanksgiving**; **Wheat: Wheat as a Food**.

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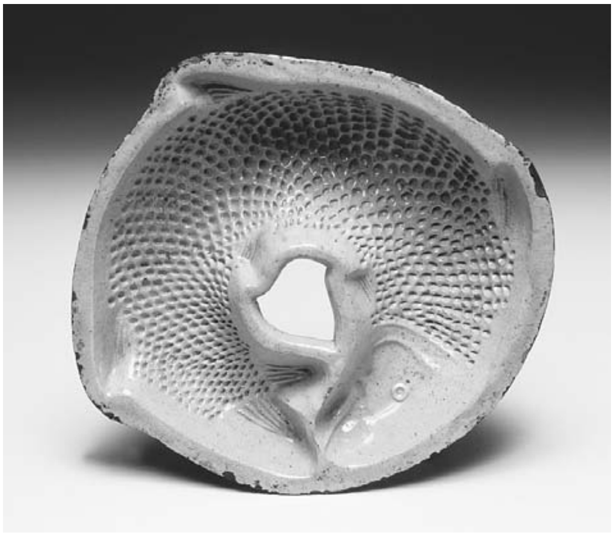
Sandra L. Oliver

PENNSYLVANIA DUTCH FOOD

Also referred to as Pennsylvania German and incorrectly as Amish, this rural style of regional American cookery underwent its greatest flowering during the nineteenth century. It became one of the primary regional cookeries of the Middle Atlantic and Midwestern states, encompassing communities scattered throughout Pennsylvania, Maryland, Virginia, North Carolina, Ohio, Indiana, Illinois, Iowa, and Wisconsin, and of Ontario, Canada. Each area of settlement developed its own regional specialties or regional interpretation of shared culinary themes. The heartland of the cookery, however, is southeastern Pennsylvania, where it first evolved in the eighteenth and early nineteenth centuries. Because they represent a composite of several German-speaking cultures that settled in colonial America, Pennsylvania Dutch foods and foodways are remarkably diverse, incorporating elements of Swiss, Southwest German, and North German cuisines but transformed into something essentially American.

If a unifying thread once existed, it was in characteristics shared with the regional cookery of Alsace, France, as exemplified by the cookery books of George Girardey (1842) and William Vollmer (1856). The differences between Alsatian and Pennsylvania Dutch cuisines are much more acute, since a large number of the Pennsylvania Dutch shifted from daily wine consumption before the Civil War to near total abstinence. Wine was replaced by sugar, especially in the tourist fare styled as Amish or Pennsylvania Dutch. Also opinions vary over what to call this ethnic cookery, reflecting an evolution both of the group's self-perceptions and how it is seen by outsiders.

The term "Pennsylvania Dutch," the oldest label, derived from the colloquial English use of "Dutch" to designate anyone from the Rhine Valley, be they Hollanders, Germans, or Swiss. Even William Shakespeare used the word in this sense. The term was given popular currency by the travel writer Phebe Earle Gibbons in *Pennsylvania Dutch and Other Essays* (1872). One body of American scholars who study this culture prefers the term "Pennsylvania Dutch" since it implies a native hybrid that



Fish mold for the New Year. Berks County, Pennsylvania, circa 1810. Yellow glaze on pale earthenware. This ancient symbol of the New Year traces to the sacred salmon of the Rhineland Celts, which swam into the Rhine in vast numbers in early March (old New Year). By chasing its tail, the fish is symbolically chasing the old year, since its head represents the new. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

evolved in North America as opposed to German American cuisine. An opposing body prefers to use the term "Pennsylvania German," a label that came into vogue during the 1890s among a group of scholars, mostly Germanophiles, who viewed the culture as a pure, uncreolized European transplant. These two opposing points of view, an American-centered definition and cultural vision defined by Europe, remained in tension into the twenty-first century.

With the ascendancy of Adolf Hitler in the 1930s, the term "Pennsylvania German" fell into disfavor due to anti-German sentiments in the United States. This shift was exemplified by J. George Frederick's *Pennsylvania Dutch and Their Cookery* (1935), which struck a patriotic note by highlighting famous individuals from the culture and the very Americanness of the cuisine. At the same time the Amish Mennonites, whose agrarian lifestyle represents a co-mingling of Old and New World themes and whose pacifist beliefs were fully opposite to those espoused by Hitler, provided a new and convenient symbol for the culture as a whole. Numerically, at the end of the twentieth century the Amish represented less than 5 percent of the total Pennsylvania Dutch population, yet tourism after the late 1940s exploited them to such an extent that "Amish" became a muddied synonym for both "Pennsylvania Dutch" and "Pennsylvania German."

A stylized and highly limited menu format created by the Pennsylvania Dutch Folk Festival at Kutztown, Pennsylvania, and its many spin-offs during the early 1950s led to a canonized cuisine, including chow-chow pickles, whoopie pies, chicken corn soup, and red velvet cake, that most restaurants claim is Dutch. The foods on this limited menu neglect the wide range of cooking styles prevalent in the community, emphasizing only peasant roots or once-popular Victorian farm fare, cracker pudding for example, at the expense of the more sophisticated ethnic dishes. The term "Amish" is also commonly misapplied to this menu and serves as an advertising gimmick for such dubious products as Amish Polish pickles, Amish tortillas, or Amish friendship bread. The implication is that, since the Amish live close to the land, foods associated with them convey values of purity, integrity, simplicity, and homemade goodness, commercial connotations formerly associated with the term "Quaker" in the nineteenth century. Thus the Amish theme has given rise not only to a type of interior decoration (the Amish are forbidden to decorate their homes) but also to a spate of Amish-style cookbooks promoting those values.

Historically, the best Pennsylvania Dutch cooks and cookbook authors, like Mrs. J. A. Keller, Edith Bertels Thomas, Ruth Hutchison, Ann Hark, John Levan, and Preston Barba, came from the ranks of the mainstream groups, such as the Lutherans, Reformed, or Moravian.

GINGERKRAUT (*IMBERGRAUT*)

This is a Christmas dish generally eaten with turkey or roast goose. It is also served at New Year's.

Yield: 6 to 8 servings

¼ cup (60 ml) walnut oil (olive oil may be substituted)
2 Tablespoons (15 g) white mustard seed
2 medium onions (300 g), sliced
2 cups (500 ml) turkey or chicken stock
2 pounds (1 kg) sauerkraut, drained of liquid
3 Tablespoons (50 g) coarsely shredded fresh ginger root
15 juniper berries
3 Tablespoons (15 g) chopped red bell pepper

Heat the oil in a deep nonreactive saucepan. Add the mustard seed and sizzle until they pop and begin to turn gray (about 1 minute). Add the sliced onions and cover. Let the onions sweat for 10 minutes, then add the turkey or chicken stock, sauerkraut, ginger, and juniper berries. Cover and simmer over a low heat for 1 hour. Add the chopped pepper as a garnish and serve immediately.

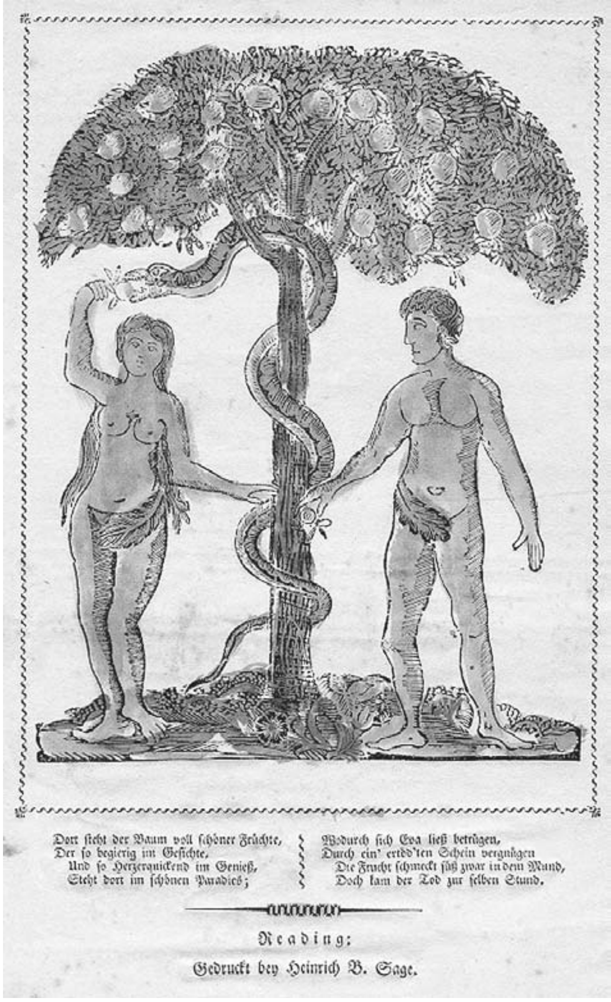
SOURCE: Weaver, *Pennsylvania Dutch Country Cooking,* p. 174

Professionals from that segment of the community operated the inns, the once-numerous wineries, the hotels, the bakeries, and the confectionery shops. The plain sects, like the Amish, were the farmers who provided the cuisine with high-quality, fresh materials, keeping alive a system of farm markets that survived into the twenty-first century. But due to their religious restrictions, they could not indulge in fine cookery, such as goose liver pie or wine noodles, of the sort taught in Moravian girls' schools. This dichotomy of cuisines based on differences in income and religion is perhaps best exemplified by Moravian sugar cake, a rich pastry served with coffee, and the various kinds of *Botboi* (potpie) eaten by farmers for Sunday dinner. Both dishes are of medieval origin.

Moravian sugar cake is a festive bread sweetened with brown sugar and cinnamon. It originally was baked in large, round loaves that were broken apart and served during Moravian love feasts, a congregational celebration. The *Botboi* (pronounced BOT-boy), originally an English colonial one-pot meal boiled in an iron pot lined with dough, gradually evolved a Pennsylvania Dutch identity by replacing the dough, which the English made with suet, with flat egg noodles. The concept of layering ingredients between noodles, similar to lasagna, traces to classical antiquity and may represent a technique preserved in the medieval cookeries of southern Germany and Alsace. In any case, *Botboi* further evolved among the Pennsylvania Dutch so that each Pennsylvania region could claim its own identifying dish, such as the chicken-and-saffron *Botboi* of Lancaster and Lebanon Counties, the pea *Botboi* of the Cumberland Valley, and the peach *Botboi* of Somerset County.

Other types of Pennsylvania Dutch dishes include the *Schales* (pronounced SHAH-less), a species of baked casserole normally made with legumes and shredded vegetables; the *Gumbis* (pronounced GOOM-biss), a deep-dish casserole consisting of layered ingredients; and various distinctive types of meat dishes and sausages. The most popular form of *Gumbis* is a dish called *Schnitz-un-Gnepp* (pronounced SHNITS-oon-NEPP), a baked or stewed mixture of dried apples, ham, and dumplings. Among the meat dishes, *Panhas* (pronounced PAN-haas), a word derived from ancient Belgic *pannas*, is sold in most farm markets as a breakfast dish. The word "scrapple" is replacing the dialect name *Panhas*. Of Lower Rhineland origin, *Panhas* was eaten as a porridge on butchering day but became a pot pudding, made with the leftovers of pork butchering, that is sliced, fried, and eaten with a variety of condiments. The primary thickeners are buckwheat and cornmeal.

Among the Pennsylvania Dutch, *Seimawe* (pronounced ZEI-maa-eh) is considered a "national" dish. A pork stomach is stuffed with potatoes, sausage, bread, and various herbs, poached, then baked. Served with great fanfare, the best are those that can be sliced like sausage. The origin of this dish is quite ancient and probably traces to pre-Germanic cultures in the Rhineland. Other signature foods are sauerkraut, de rigueur for New Year's dinner; summer sausage, also called Lebanon bologna; and shoofly pie, a molasses crumb cake baked in a pie shell that was first introduced commercially at the U.S. centennial in 1876. Of all the Pennsylvania Dutch contributions to American culture at large, the most lasting have been the Christmas panoply of gingerbreads, candies, and pastries; pretzels of all kinds; and vegetable gardening, which has persisted as a symbol of biodiversity and small-scale sustainable agriculture.



Dort ſteht der Baum voll ſchöner Früchte,
Der ſo begierig im Geſichte,
Und ſo Herzerquickend im Genieß,
Steht dort im ſchönen Paradies;

Wodurch ſich Eva ließ betrügen,
Durch ein' ertöd'ten Schein vergnügen
Die Frucht ſchmeckt ſüß zwar in dem Mund,
Doch kam der Tod zur ſelben Stund.

Reading:
Gedruckt bey Heinrich B. Sage.

Broadside print for Adam and Eve Day (December 24), an old Pennsylvania Dutch folk observance that associated the Tree of Knowledge with the Christmas tree. Printed by Heinrich Sage, Reading, Pennsylvania, circa 1820. ROUGHWOOD COLLECTION.

See also **Christmas; Germany, Austria, Switzerland; Sustainable Agriculture.**

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William Woys Weaver

PIONEER FOOD

Pioneer foods can be defined as the emergency foods and the makeshift methods of food preparation employed by European settlers in the Americas, Africa, Australia, and other parts of the world to which European culture was transplanted en masse. While work has been done on such scattered themes as the Australian Germans (Heuzenroeder, 2001), the German settlers on the Russian steppes (Kloberdanz and Kloberdanz, 1993), and the Portuguese experience in Brazil (Camara Cascudo, 1967), research on pioneer cultures has largely concentrated on particular ethnic groups rather than looking at overall patterns and themes. This essay attempts to outline some general observations on the pioneer food culture of the continental United States. These foods have played an important role as symbols in traditional culture and as continuing images in modern mass culture. The Fort restaurant outside of Denver has become a national symbol of this genre of cookery, and its owner, Samuel Arnold, has been a keen supporter of research on this subject. Jacqueline Williams's *Wagon Wheel Kitchens* (1993) is especially noteworthy for its treatment of pioneer foods along the Oregon Trail.

Faced with the double problem of establishing new economic and social communities to replace the ones left behind, early American settlers were forced to make compromises on what they served on their tables. The primitive, log-cabin-in-the-clearing style of life was indeed rugged and different from later stages of more settled food production and consumption. In wooded areas fields had to be cleared before farming and gardening could commence. European methods of slash-and-burn agriculture were employed to make new ground amid the stumps of trees later removed. On the Great Plains the log cabin became the sod house, but on all frontiers the initial dependence was significantly on wild foods to supplement the diet. This included game, such as wild turkey, jackrabbit, quail, pigeon, venison, squirrel, groundhog, bear, and, of course, buffalo.

County histories are rich in stories of pioneer foodways, especially in noting wild plant foods that are no longer consumed. Cattail flapjacks, the wapatoo or swamp potato *(Sagittaria latifolia)*, prairie breadroot *(Psoralea esculenta)*, the pond apple *(Annona glabra)* of Florida, the buffalo pea *(Astragalus crassicarpus)*, the cabbage palm *(Sabal palmetto)* of the coastal South, and the miner's lettuce *(Montia perfoliata)* of the West Coast all carry names that allude to their substitute uses in settlers' diets. Some native plants, like miner's lettuce and Mormon tea (*Ephedra viridis*), are still widely consumed in the twenty-first century, while others, like the mayhaw (*Crataegus aestivalis*) of the Deep South, have become symbols of regional cooking (mayhaw jelly). Many wild food plants, like camass (*Comassia quamash)* of the Northwest, are grown mostly as garden ornamentals.

Aside from wild plants, the principal food source derived from the Native Americans was corn (maize), which became the primary grain raised by backwoods farmers, taking precedence over wheat and other cash crops. Corn products eaten at the pioneer table were many. Corn on the cob was a favorite summer dish once corn attained the milk stage in midsummer. It was commonly roasted in ashes downhearth rather than boiled. In fact, in the twenty-first century is still called "roasting ears" in many parts of Appalachia.

Cornmeal mush or suppawn was a common winter dish normally eaten with milk or syrup. The solidified residue was sliced and fried the next day for breakfast. Dried corn was also a winter dish, along with hominy or samp. The latter was of two kinds: large hominy hulled in lye water, then boiled and served whole; or small hominy (grits), which was ground to create several grades of texture, depending in part on the type of corn used. Small hominy is a popular dish in the South, although it was once widely eaten in other parts of the country.

Another pioneer grain, this one brought from Europe, was buckwheat, which could thrive in poor soils on hilly or mountainous land and provided bees with a local source for buckwheat honey. An English traveler through early America once referred to the ubiquitous buckwheat cake as a popular American breakfast preparation. Buckwheat was also combined with cornmeal to make various types of pork or venison scrapple known by such regional names as panhas (Pennsylvania and Ohio), poor-do (Upper South), and liver mush (Appalachia). Because of its dark color, buckwheat dishes fell out of fashion during the late nineteenth century in favor of foods made with wheat.

The prevalent method of cooking in pioneer settlements was in open fireplaces, where primitive breads, such as johnnycakes and corn dodgers, could be baked on hanging griddles or in Dutch ovens. The Dutch oven, a straight-sided iron bake kettle with a tight-fitting lid, became a symbol of frontier one-pot cooking because it could be used for baking, frying, boiling, and braising. Among the Mormon settlers of Utah, the Dutch oven represented their religious trek through the wilderness, and in the twenty-first century Dutch oven cooking remains a central feature of Mormon outdoor gatherings.

Undoubtedly the frontier diet was monotonous by any standard, especially during the winter, when greens were few. Such was the observation of the Methodist circuit rider Marmaduke Pearce, who traveled through the thinly settled areas of western New York in 1811: "O the cold houses, the snow, the mud, the sage tea, the baked beans!" (Peck, 1860).

See also **Cake and Pancake; Game; Hearth Cookery; Maize.**

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Don Yoder

THE SOUTH

One of the most popular books written about the American South, Margaret Mitchell's *Gone with the Wind* (1936), begins with a barbecue. To the 80 million people who live in the region, it would seem only appropriate. Food, like music or a syrupy drawl, has always been one of the cultural touchstones that sets the South apart.

Some of the best-known regional dishes in American cookery come from the great crescent that stretches from Virginia to eastern Texas. The South is home to a groaning table of famously down-home foods, like fried chicken, skillet cornbread, pork barbecue, pecan pie, catfish and hushpuppies, bourbon whiskey, and greens and pot likker (which refers not to real liquor but to the aromatic juices of boiled greens).

When Americans speak of the South, they usually mean the eleven states of the old Confederacy (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia) plus parts of border states, like Kentucky and Maryland, that lean toward Dixie culturally. It is a varied landscape that takes in multiple mountain ranges, a spacious swath of hill country, broad coastal plains, vast alluvial flatlands, and three thousand miles of shoreline. Historians have called it the closest thing to a nation within a nation in the United States, and it has spawned a collection of foods and foodways as varied as the landscape.

ALL THE KING'S PONE

Back in the 1930s Huey Long, the pot-bellied potentate of Louisiana, tried to show his common touch by talking up the health benefits of cornbread and pot likker, a modest dish enjoyed by southerners everywhere. "The Kingfish" decreed that it was classier to dunk the bread into the likker, the savory juice left behind by boiled greens, instead of crumbling it. Julian Harris, the editor of the *Atlanta Constitution,* disagreed. Thus started the Great Corn Pone Debate of 1931.

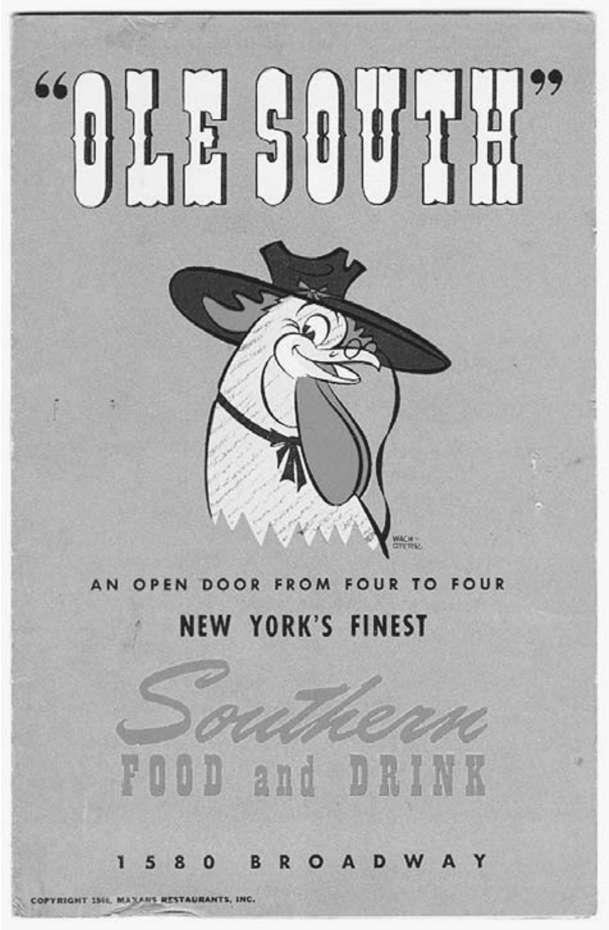
For weeks the mock controversy raged in newspapers, as Harris accused Long of closet crumbling and Long charged Harris with yellow-corn journalism in telegrams fired off to the *Constitution*'s Pot Likker and Corn Pone Department. Long even offered a jesting recipe called Pot Likker à le Dictator.

The future president Franklin D. Roosevelt eventually weighed in, proposing that the important question be referred to the 1932 Democratic National Convention. "I must admit that I crumble mine," he wrote, perhaps belying a bias from all the time he spent at the spa in Warm Springs, Georgia.

The First Southerners

When Europeans began to arrive during the 1500s, they found the land well populated by American Indians whose ancestors had dwelled there for thousands of years. The natives fished, hunted game, gathered berries and nuts (like the indigenous pecan), and cultivated crops, especially beans, squash, and maize (corn). Early European settlers were struck by the bounty. Captain John Smith, who helped found the first permanent English colony at Jamestown, Virginia, in 1607, wrote of "an abundance of fish, lying so thicke with their heads above the water, as for want of nets . . . we attempted to catch them with a frying-pan" (quoted in Ketchum, 1964). The place-names spoke of plenty; for example, Chesapeake is an Indian word meaning "great shellfish bay."

At least one of the cornerstones of southern food was already in place when the Europeans came, that is, corn. The Powhatan tribe of Virginia showed the English how



Not the actual South, but the nostalgic South brought north and served forth in this New York club menu featuring "stimulating" Southern Comfort, fried chicken dinners ($2.00), mint juleps, and a place to party until 4 A.M. Menu cover, 1946. ROUGHWOOD COLLECTION.

to plant, harvest, soak, and hull the native grain, which they ground into a gritty meal called rockahominy. They also made a bread of it, *appone.* Both names stuck, and southerners have enjoyed corn pone and hominy grits ever since.

Many of the foods that came to be associated with the South are not native. The Spanish, who explored the region during the 1500s and colonized Florida, introduced oranges, peaches, sugar cane, pigs, and chickens. The French, who planted their tricolor along the Gulf Coast from Mobile to New Orleans, brought their cooking techniques and used local ingredients to create new dishes like gumbo and jambalaya. The Scotch-Irish, who poured into the southern Appalachian mountains, squeezed a new distilled spirit out of corn. According to legend, a Baptist preacher by the name of Elijiah Craig was the first to make bourbon whiskey in the 1780s in Bourbon County, Kentucky.

But the dominant strains of southern cooking, as of southern life, are English and African. The English who settled the region brought their own livestock and fruits (apples chief among them), a direct, earnest style of cooking, and a taste for stews, puddings, and pies.

The African slaves who were imported to work the fields starting in the 1620s brought some of the most quintessentially southern foods with them, including okra, peanuts, watermelons, and black-eyed peas. Some of these foods, peanuts, for instance, actually originated in South America but did not take root in North America until they were taken to Africa and brought back across the Atlantic in the slave trade. Slave cooks also enlivened the southern kitchen by using peppers and spices they had either known in Africa or picked up in the Caribbean, the first stop in the New World for many of them. This forced collaboration between black and white newcomers laid the foundation for the region's cooking.

Southern Hospitality

By the time of the American Revolution in the 1770s, the southern Atlantic colonies were developing an economic system dominated by the large-scale cultivation of single cash crops, such as tobacco and rice. The plantation system spread west after independence, as cotton bolls blanketed the region and sugar cane sprouted through the lower Mississippi River valley.

The plantations developed a reputation for lavish entertaining that led to one of the enduring legends of the young country, southern hospitality. In 1746 a correspondent for *London* magazine compared the Virginia planters' lifestyle to that of English country squires: "All over the Colony, a universal Hospitality reigns; full Tables and open Doors, the kind Salute, the generous Detention, speak somewhat like the old Roast-beef Ages of our Forefathers. . . . Strangers are sought after with Greediness, as they pass the Country, to be invited."

Company was so routine at Mount Vernon, George Washington's estate, that the first president once complained in a letter that he and Martha had not dined by themselves in twenty years. The first lady evidently made a custom of large meals. The recipe for Martha Washington's Great Cake in the files at Mount Vernon begins "Take 40 eggs."

The apotheosis of this grand spirit was Thomas Jefferson, the third president and first epicure, who brought vanilla, macaroni, and wine making to the hills of the Virginia Piedmont. Jefferson loved to entertain at the White House and at his neoclassical mansion Monticello. His lavish entertaining was largely responsible for his dying $40,000 in debt.

Hard Times

Few southerners could afford to set a table like Jefferson or Washington. Before the Civil War the great majority were slaves or yeoman farmers. After the war ended slavery and bankrupted the plantation system, millions became tenant farmers or sharecroppers, working fields they rented by giving landlords a large portion of what they grew.

These new American peasants were fueled by a monotonous diet of salt pork, cornbread, molasses, and whatever vegetables they were able to grow or gather. The most commonly eaten vegetables were green beans, black-eyed peas, and leafy greens (turnips in the Upper South, collards in the Lower South), usually boiled for at least an hour with ham hocks or some other pork flavoring. Sweet potatoes joined the plate in late summer, when they were harvested and stored in earthen mounds for consumption through the winter.

Humble though these foods may have been, they could summon powerful emotions among those raised on them. In Ralph Ellison's novel *Invisible Man* (1952) the narrator, a young man from the South, practically bursts into homesick tears when he smells Carolina sweet potatoes roasting at a vendor's stand on the sidewalks of New York.

Decades after the devastation of the Civil War, hunger and malnutrition lingered in the South. In the early 1900s federal doctors investigated the widespread listlessness—some called it laziness—that many had noticed among the region's poor. Much of it was blamed on pellagra, a disease of vitamin deficiency caused by a grossly unbalanced diet. Pellagra did not recede until a nutritional campaign was launched during the 1930s and cornmeal, the bulk of so many diets, was enriched with vitamin B_{12}.

Many southern foods have long been linked with poverty. Mark Twain makes the connection in his masterpiece *The Adventures of Huckleberry Finn* (1884), when Huck tells Jim he would rather eat wheat bread because that's "what the quality eat—none of your low-down corn pone."

Indeed, southerners used to regard wheat bread as somehow elevated, calling it "light bread" to distinguish it from run-of-the-mill cornmeal. Baking with wheat did not catch on until commercially milled flour and baking powder became widely available in the late 1800s. Then southern cooks made up for lost time, making light, fluffy biscuits part of their daily routines, especially at breakfast. Kinky Friedman, a country musician from Texas, once wrote a song titled "Get Your Biscuits in the Oven and Your Buns in Bed." Most of his listeners no doubt approved of his priorities. In the South, hot bread always comes first.

Some Special Foods

Many distinctively southern dishes are associated with special events, including holidays, family reunions, community fundraisers, and the like. On New Year's Day, for example, a peas and rice dish called hoppin' John is eaten for good luck, often with a side serving of greens to foretell money. Reunions bring out cauldrons of Brunswick stew, Frogmore stew, burgoo, or muddle—hearty concoctions made in particular areas of the South with vegetables and pork, seafood, mutton, or fish respectively. Churches and athletic leagues raise money with plates of catfish and hushpuppies, fried dollops of cornmeal whose name probably derives from the way cooks used to keep dogs at bay by tossing them some batter. Funerals and homecomings produce an amazing variety of pies and cakes, a reflection of the region's pronounced sweet tooth. And some people think it would not be Christmas without ambrosia, a dessert made of grated coconut and orange sections that is virtually unseen the rest of the year.

No matter what the occasion or month, it is considered perfectly normal to accompany any meal with iced tea. Given its hot, humid climate, the South has a powerful thirst for cold beverages. Among the many soft drinks that originated in the region are the world's two most popular, Coca-Cola and Pepsi, both created by pharmacists (the first in Georgia, the latter in North Carolina) in the late 1800s.

Fried chicken, perhaps the most renowned of southern dishes, may have begun as a seasonal specialty. Its genealogy is uncertain. Among the settlers of the South, both Africans and Scots have a tradition of frying poultry. However it got there, fried chicken was already established by 1828, when Mary Randolph included a recipe for it in one of the earliest American cookbooks, *The Virginia House-wife.* She specified all the essentials, chicken parts dredged in flour, seasoned, and fried in hot fat.

In the nineteenth century fried chicken was usually eaten during the warm months, when hens hatched the chicks that grew into tender young fryers. By the mid-1900s a huge poultry industry that could supply fryers year-round had developed in Georgia, Arkansas, and the Carolinas. Poultry consumption rose throughout the calendar.

Traditionally fried chicken was a Sunday treat reserved for after-church dinners and special company, like the preacher or the in-laws. The dish gradually spread into other days of the week, spurred on by the rise of fast-food franchising after World War II. The first and largest of the chicken chains, Kentucky Fried Chicken, once advertised "Sunday dinner seven days a week." Harland Sanders, who went by the honorary title "colonel," started the business in the 1930s at a roadside cafe in Corbin, Kentucky. By the end of the twentieth century the empire that bears his goateed image was selling a taste of Dixie at nearly eleven thousand outposts around the world.

An Enduring Love Affair

Another food that strongly evokes the South is barbecue. While much of the rest of the United States uses the term to refer to a backyard cookout, southerners use it quite particularly to mean the slow smoking of meat over hardwood coals. The meat is almost always pork.

Green glaze collards were introduced in South Carolina by Philadelphia seedsman David Landreth in 1820. Landreth developed this unique variety of worm-resistant cabbage so that southern gardeners would enjoy larger yields. Boiled collard greens and the pot broth are one of the cornerstones of southern cooking. PHOTOGRAPH BY L. WILBUR ZIMMERMAN. ROUGHWOOD SEED COLLECTION.

Southerners have long had a thing about swine. William Byrd, a Virginia planter, observed in the early 1700s that his neighbors were eating so much pig flesh that they "seem to grunt rather than speak." Before refrigeration became common, pigs were usually slaughtered when the weather turned cold in late autumn—"hog-killing time"—and the meat was preserved as bacon, sausage, salt pork, or hams rubbed in spices and allowed to cure for months in a smokehouse. Little of the hog was wasted. The small intestines were breaded and fried or boiled as chitlins, and the fat was rendered into cracklins that flavored cracklin cornbread.

Of all the uses of pork, barbecue is probably the most popular. In the beginning the dish was usually served at political rallies and other community get-togethers. By the end of the twentieth century it was more commonly served at casual restaurants, universally known as barbecue joints, where everyone from blue-collar laborers to white-collar professionals sit cheek by jowl mopping barbecue sauce from their lips.

Southerners love to argue the merits of different barbecue styles. Two areas are particularly known for their expertise. In the Carolinas pit masters smoke whole hogs at gatherings called "pig pickin's" and serve the meat pulled from the bone with a spiced vinegar sauce that, unlike most barbecue dressings, contains no tomatoes or ketchup. In parts of South Carolina the sauce is mustard-based. Meanwhile in Memphis, Tennessee, the self-described "pork barbecue capital of the world," pork ribs or chopped pork shoulders are served in sandwiches with creamy coleslaw. People in Memphis love barbecue so much that some restaurants serve barbeque-topped pizza and barbecue spaghetti, pasta tossed with barbecue sauce.

Changing Tastes

The last half of the twentieth century brought rapid change to the South. The civil rights movement engineered a revolution in race relations, business and government invested heavily in the region, and air conditioning made it more comfortable to live there. Millions of outsiders moved south for jobs or retirement, bringing their tastes and customs with them. In fast-growing areas like Atlanta, Georgia, or Charlotte, North Carolina, it is almost as easy to find a bagel as a biscuit.

In the midst of this evolution southern cooking enjoyed something of a revival, as natives and newcomers alike came to regard it as another ethnic cuisine to be discovered or rediscovered. Native sons and daughters like Craig Claiborne, Edna Lewis, and Nathalie Dupree celebrated the region's foods in cookbooks and television cooking shows. A new generation of chefs lavished their talents on the old cuisine at high-end restaurants from Arkansas to Virginia. Popular road-food guides told travelers where to find the best barbecue joints, seafood shacks, produce stands, ladies' tea rooms, and meat-and-three-plate lunch emporiums.

Even so, traditional southern home cooking seemed to be fading. Fewer people had time to make messy, demanding dishes like fried chicken. Some avoided them altogether out of concern for fat and cholesterol. Old-fashioned southern food was increasingly left to restaurant kitchens or rolled out only on special occasions.

Yet southerners remain deeply attached to their foods and rituals. In a nation that relentlessly wears down regional distinctions, their shared foodways are one of the few things that knits them together and reminds them who they are. How else to explain the enduring appeal of grits, the unremarkable cornmeal porridge that is one of the region's most joked about icons?

Shelby Foote, the Mississippi-born novelist and historian, takes his culinary heritage seriously. Once, when he was staying in a hotel, he hung a breakfast order on his doorknob asking for grits. Room service brought him hash browns instead. Yankees eat hash browns with breakfast. He put out the card again, this time with a note: "This morning you brought me potatoes. Do not commit this outrage again."

See also **Barbecue**; **Biscuits**; **Chitlins (Chitterlings)**; **Maize**; **Pig**; **Sensation and the Senses**.

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Jim Auchmutey

THE SOUTHWEST

The Southwest encompasses New Mexico, southwestern Texas, Arizona and the southern part of Colorado that was settled by the Spanish. Although all of Texas is sometimes considered part of the Southwest, much of east Texas is more closely related to the Southeast and much of north Texas is more related to the Midwest and the West.

Southwestern foods in the United States are a product of the foods of the Native Americans and the foods of Spanish and Spanish-Indian settlers from Mexico. This tradition appears in the areas that have been settled the longest. Its distribution follows a roughly north–south line starting in southern Colorado, especially along the San Luis Valley, and proceeding southeast along the Rio Grande River, including the cities of Santa Fe, Albuquerque, and Las Cruces, New Mexico. In Arizona, the line is roughly an east–west one, marked by the Gila River, below which are long-established Spanish-Mexican settlements. In Texas the Southwest can be described as being south and west of San Antonio. Traditional food is also found in other communities in the region, as individual families have moved to establish new homes.

Outside of the traditional areas, communities of the Southwest reflect a food tradition that is more Eastern or Midwestern than Southwestern. In some cases it may also represent the simple ranch cooking of the Mountain States of Colorado and Utah. Inhabitants of larger cities in the Southwest represent many different cultures, as is the case with cities elsewhere in the United States. Asians, Africans, Europeans, Latin Americans, and people from many countries in the Middle East and the Indian subcontinent all have their own enclaves, giving rise to a broad variety of markets and restaurants. Tucson, Arizona, far from the largest of the cities in the Southwest, boasts a cultural and food festival each October that regularly has more than fifty different ethnic food booths. While some families cling to their ethnic food traditions, especially in isolated communities, others are more likely to celebrate their inherited food culture on special holidays. It is not unusual in the Southwest to find a family enjoying its own native cooking one evening, while exploring flavors from another on the next.

Traditional Foods in the Southwest

Traditional Southwestern food is commonly viewed by persons living outside the Southwest as consisting of tamales, tacos, enchiladas, tostadas, and burritos. While these dishes are extremely popular in many restaurants, they are referred to in the culinary repertoire as *antojitos* (snacks).

Traditional to the old Southwest are slow-cooked stews and slow-grilled foods, served with beans, rice, and corn tortillas. Vegetables used include squashes, *nopales* (pared and trimmed pads from the prickly pear cactus), jicamas (spherical tubers that, when pared, have a crisp texture and a faint taste of apple or water chestnut), purslane, and tomatillos (tart fruit that resemble tomatoes with husks but are related to the cape gooseberry). Avocados are used to make guacamole (a thick sauce of crushed avocado with seasonings). Fresh cilantro (also known as coriander), is used frequently to season fresh, quick-cooked dishes. Many of these foods existed in the diet of the Native American before the arrival of the Spanish. Opinions differ on whether chilies were grown in the Southwest before the arrival of the Spanish from Mexico, but the variety of spices that create the chili-based dishes today, both within the Native American culture and outside, arrived with the Spanish.

Food specialties of the Southwest differ from region to region. The burrito (a soft flour tortilla wrapped around a hot, savory filling) originated in the area north of the state of Sonora, where the flour tortilla originated. Stacked enchiladas (corn tortillas prepared as for rolled enchiladas but layered flat with savory fillings) are a specialty of New Mexico, although their popularity has spread throughout the region. *Salpicon* (a shredded-beef salad with vegetables) is a hallmark of southwest Texas.

Elements of Traditional Southwestern Cooking

Tortillas, beans, rice, vegetables, and some meat and cheese are the mainstays of traditional Southwestern cooking. In areas within driving distance of the Gulf of California, fish and shellfish increase the choices. Apart from the well-known *antijitos* mentioned earlier lie the true gems of Southwestern cuisine: red chili con carne (chili with meat) made with meat simmered in a sauce of reconstituted dried red chilies, cumin, dried coriander and oregano; and green chili con carne made from meat simmered in fresh green chilies, onions, garlic, and tomatoes. Beef, pork, lamb, and goat are all used, although beef is the most common in restaurants. Chicken is also cooked with sauces made from either red chilies or green chilies. These dishes vary from town to town and family to family. Beans are usually served separately, not as a part of the chili stews. While chili stews are slow-cooked, fish and shellfish may be quickly grilled. Chicken is marinated in a mixture of orange juice and spices before being grilled, and steak is often marinated, then grilled for *carne asada* (literally translated as "roasted meat"). The cheese used in many popular Southwestern restaurants is either Longhorn cheddar or Monterey Jack, with sour cream used as a garnish. In the barrios (the Hispanic-Mexican neighborhoods) and in the homes of serious Southwestern cooks, Mexican *queso fresco* (literally "fresh cheese") and commercially made Mexican *crema* (similar to sour cream) are used instead.

Chili. The dish known as "chili," much beloved in the region, is a creation of U.S. cooks. True aficionados eschew tomatoes or beans in their chili, preferring to have their meat, either cubed or coarsely ground, simmered only in a sauce made from reconstituted dried red chilies, spices, and other flavorings. Contests are held throughout the region to determine the best chili. Private cooks and restaurants often take liberties with this tradition, producing their own variations.

Tortillas. Tortillas in the Southwest were traditionally made with either yellow or white corn, and sometimes with the more exotic red or blue corn. These corn tortillas are made from corn that has been soaked in slaked lime and then ground. They require no fat of any kind and are cooked on an ungreased *comal* (griddle). The tortilla acts as a wrapper or as bread. Occasionally, wedges of tortilla are crisped as a snack. Nachos (crisp wedges of corn tortilla topped with cheese and other garnishes) are a recent invention. While crisp, folded corn tortillas are served with fillings as tacos, the more authentic style for a taco is simply a soft, warm tortilla.

The flour tortilla native to the Mexican state of Sonora, sometimes as much as eighteen inches in diameter, is a more recent addition to traditional foods. The traditional flour tortilla of northern Sonora is a thin disc made from flour, water, and lard patted into shape by hand, than cooked quickly on a large hot griddle. These large tortillas are used to wrap foods, but they also are spread with butter and crisped before cheese and occasionally other toppings are added to form a crisp snack that resembles pizza. Flour tortillas are also made into quesadillas (tortillas folded over cheese and other fillings and grilled or fried). Small flour tortillas used in place of corn tortillas are an addition of the twentieth century, as is the inclusion of baking powder in the dough to give the flour tortilla a puffy quality.

Tamales. A *tamal* (plural, *tamales*) is a packet of corn-based dough that is stuffed, wrapped in softened corn husks, and steamed. The corn husks are removed at the table before the tamales are eaten. While tamales are served throughout the year in restaurants in the Southwest, beef and red chili tamales are traditional for Christmas when families and friends gather to assemble dozens of tamales. A traditional Christmas *tamal* is made from *masa* (a dough of corn treated with slaked lime, which is whipped with lard or shortening to make it fluffy), with a filling of shredded beef that has been stewed with red chilies and spices. Fillings used throughout the year may be made from slow-cooked chicken, beef, pork, lamb, or goat, which have been seasoned with reconstituted dried chilies and with spices.

The green corn *tamal* is a specialty of midsummer and best known in southern Arizona, although green corn tamales are also made in New Mexico. Although the green corn *tamal* is now available frozen year round, it is best fresh when corn is in season. The best green corn *tamales* are made from field corn, the kind given to animals for fodder. The fresh corn dough is filled with cooked green chilies and cheese, and the *tamales* are traditionally prepared as above.

Chilies. Many chilies, both red (which is the ripe form) and green, are grown in the Southwest, but the variety of chilies available, however, is not as diverse as it is in Mexico. Each variety of chili has its own special use, alone or in combination. Green chilies appear in fresh salsas (sauces) but also appear in stewed dishes, depending on the flavor desired. Red chilies are dried for use throughout the year and are reconstituted for use in cooked salsas and slow-cooked dishes. The combination of different red chilies with spices and herbs such as ground coriander seed, ground cumin seed, and oregano or fresh coriander leaves (cilantro) gives each dish its special character. Chilies, even those from the same plant, can vary in piquancy. Traditionally, the piquancy has been rated in Scoville units, where higher readings indicate a higher degree of piquancy. Some experts now question the value of that practice as different humans react somewhat differently to levels of piquancy.

Beans. Simmered dried beans, the mainstay of traditional Southwestern cooking, are usually *charro* beans (cowboy beans), but beans may be simmered or baked with various flavorings. "Refried" beans are not fried twice but are cooked beans mashed into shortening and seasoned with onion, garlic, and other seasonings.

Barbacoa and grilled foods. While not as widespread as the ubiquitous red or green chili-flavored stews, pit-cooked meats and grilled meats, chicken, and fish are also elements of Southwestern cooking. Slow pit barbecuing traditionally was done using the head of the animal, although today other cuts are used. Grilled meats include *carne asada* and chicken marinated in orange juice and spices and then grilled.

Fried breads and sweets. *Sopaipillas* (made from quick dough of wheat flour and baking powder, rolled out, cut, and deep-fried so that they puff up) are served as a savory bread with meals in parts of New Mexico. In Arizona, these are occasionally served with savory seasonings, but are more likely to be served as a dessert with honey. Southwestern desserts are fairly simple, serving as a soothing and cooling finish to a meal. A favorite is flan (a molded baked custard). Another is *almendrado* (an almond-seasoned mixture of egg white and gelatin served with a custard sauce). *Bizcochitos* (anise cookies) and *buñuelos* (deep-fried wheat-flour pastries) are popular as well.

Drinks. While the Margarita (a mixture of Tequila, lime juice, and orange liqueur) is popular in Southwestern restaurants, Mexican beers are more often drunk with foods in the Southwest if an alcoholic beverage is desired. Many nonalcoholic drinks are available in Hispanic-Mexican neighborhoods shops and restaurants, including *tamarinda* (a sweetened drink made from tamarind pulp), *horchata* (sweetened rice drink), and *aguas frescas* (literally "fresh waters") made from various fresh fruits.

The Food and Culture of the Southwestern Native American

The importance of corn in the food life of Native Americans cannot be overemphasized. Corn is essential and sacred; corn is life itself. In many pueblos the day begins with a sacrifice of corn. Corn originated in Mexico in about 2500 B.C.E., but required hybridization before it was useful as a food. Contemporary Pueblo Indians plant corn with great ceremony and care. Corn appears in the Native-American diet today in the form of tortillas. It also appears as hominy and *posole* (corn kernels that have been treated with slaked lime so that they swell and release nutrients bound inside). *Posole*, sold dried and made of yellow, white, red, or blue corn, refers to a soupy stew that is made with simple ingredients, including seasoning of chilies for everyday fare and with meat for festival occasions. Another significant part of the diet of the Southwestern Native American, beans are planted with the same kinds of sacred observances as corn. While the most common bean in the Southwest today is the pinto bean, a wide variety of beans, some extremely flavorful, were a part of the Native American diet in the past. As seed savers work to isolate some of these "heirloom" beans and grow them, some of the old varieties are again becoming available not only to the Native American but also to the general public.

The meeting of Mexican and Navajo Indian come together in this southwest invention, the fry-bread taco. PHOTOGRAPHED AT CANYON DE CHELLY NATIONAL MONUMENT, ARIZONA.

While the hunting, gathering, or growing of food take on a sacred aspect, the act of preparing food is an important and time-consuming activity. Among the Pueblo Indians and other nations, the act of stringing red chilies to dry each autumn takes on a special significance, for there must be a string of chilies equal to the height of each person in a family to sustain the demand for the coming year.

The popularity of foods such as Indian fry bread, (dough cooked on a hot stone) came with the increased availability of refined flour and commercially prepared shortening or lard. From a culinary standpoint, fry bread and *sopaipillas*, mentioned earlier, are essentially the same. The "Navajo taco" employs fry bread rather than a tortilla as its wrapper. While this increased used of fat and flour has provided flavorful alternatives to the corn tortilla, the consumption of significant quantities of these ingredients has altered the diet of the Southwestern Native American to the extent that obesity and diabetes are rampant. Efforts of such organizations as Native Seeds Search to preserve the original foods of these peoples are intended to at least partially encourage a return to a more healthy diet.

See also **American Indians; Central America; Chili Peppers; Combination of Foods; Legumes; Maize; Mexico; Squash and Gourds; Stew**.

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Madge Griswold

UTENSILS, COOKING. Among professional cooks, cooking implements in the kitchen are referred to collectively by the French term *batterie de cuisine*. This includes all utensils involved in the preparation of food regardless of specific function or type of material (ceramic, metal, glass, wood). The range of utensils in any given kitchen speaks volumes about the elaborateness of the cooking that takes place there as well as the type of food prepared. There are also large cultural differences in the implements deemed necessary for food preparation, so the *batterie de cuisine* of a Chinese kitchen is quite different from that of of a kitchen of medieval Syria, ancient Rome, or a modern American hotel. From the standpoint of culinary history, the study of cooking utensils falls under two broad categories: archaeology for the ancient and medieval utensils, and material culture for objects of more recent date. Because of their beautiful design, cooking implements are also of interest to certain branches of decorative arts and antique collecting.

Archaeologists rely almost exclusively on utensils in their attempt to reconstruct cuisines of the past, especially when there are no written records to provide working recipes. It is known that the Roman cookery book of Apicius was originally illustrated with pictures of utensils because there are a few scattered references to these pictures in the surviving text. Medieval scribes did not bother to copy those pictures. If they had, modern food historians would have a better idea of what some of the mysterious implements mentioned in Apicius looked like. But the fact that the original cookbook contained pictures of unusual utensils is evidence in itself that certain recipes in Apicius were not familiar even to most educated Romans.

The Austrian food ethnographer Anni Gamerith revolutionized the study of cooking utensils during the 1970s when she published her studies about the relationship among food types, utensils, and heat source (open hearth or enclosed cook stove). Heat source determined the design of the utensils, and this functional reality determined the range of dishes that could be accomplished with that technology. To be certain, the *batterie de cuisine* of a typical farm kitchen or even of a well-equipped kitchen in an urban townhouse not only reflected the type of dishes made there but also inventoried the economic level of the household, where it fit into the larger social picture. The kitchen and its implements thus become critical keys in understanding the foods of the past.

Cooking utensils can be organized into several categories depending on their function and the kind of cooking that is done. The categories include preparation equipment; pots, pans, frying pans, and cauldrons; griddles and equipment for roasting and baking; utensils for tabletop cooking; and utensils used for charcuterie.

Preparation Equipment

Preparation equipment includes spoons, spatulas, meat forks, knives, cutting boards, scissors, and shears. Grinding, crushing, straining, sifting, and sieving implements are also part of this group, as are whisks and beating devices that range from the most primitive handful of twigs bound together with string to the most powerful food processors and blenders. Ceramic, glass, and stainless steel bowls fit into this category as well. Measuring devices vary from country to country, depending on the weight system used. Most countries use a metric system for measurement of both liquids and solids, although the actual number of units to the measure may vary. Home cooks in the United States use a system developed in the late nineteenth century that employs measuring spoons and measuring cups (different kinds for dry or liquid measuring), but the body of measurements used in American cookery (pounds, ounces, quarts, and so forth) dates to Elizabethan England and represents a system of measure that is both archaic and at odds with that of the rest of the world.

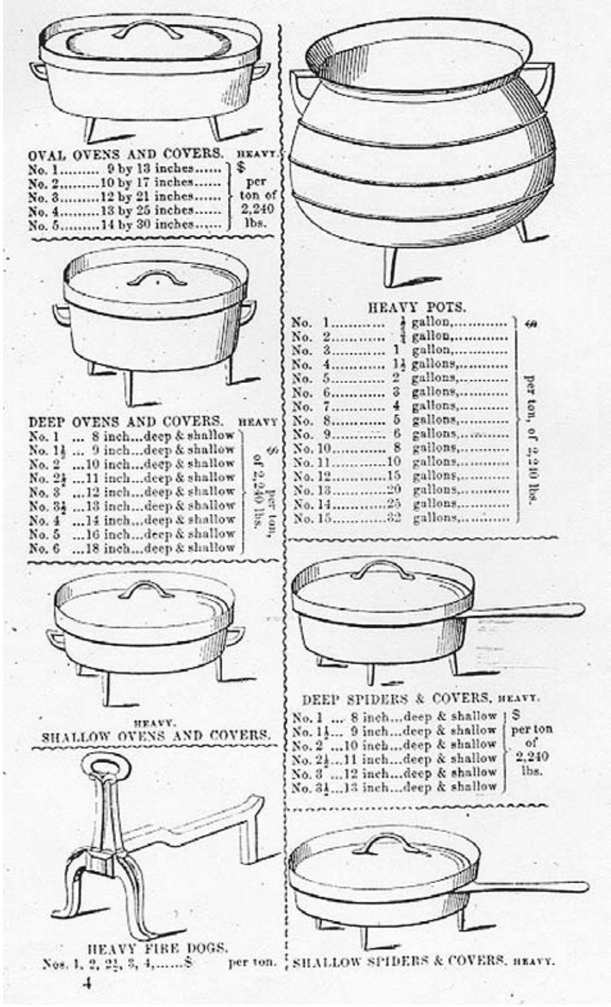
Pots, Pans, Frying Pans, and Cauldrons

Pots, pans, kettles, skillets, cauldrons, and frying pans are included among items that are placed on an open flame or directly over a heat source. These utensils have the longest history of use, as they were first used over open fires. There were also critical differences in their designs. A kettle, for example, was characterized by straight or outwardly splayed sides. It was generally used uncovered for boiling foods or reducing them to another consistency, as in the case of large copper apple butter kettles. On the other hand, a traditional pot bulged on the sides and featured a neck below the rim. It was often used for cooking several things at once and invariably included a wooden or tin lid. Pot lids were normally sold separately from the pot itself but were usually numbered to match the number on the pot, such as "5" for five gallons, or "10" for ten gallons. Cookpots (one word in colloquial American usage) were generally small and made of ceramic. They were employed in cooking foods that would be spoiled in color or flavor if they came in contact with an iron pot or kettle. Classic New England baked beans were originally baked in ceramic cookpots set on a trivet among the hot coals.

Frying pans were known in ancient Greek and Roman kitchens: *téganon* to the Greeks, *patella* to the Romans. The Roman *patella* survived in modern Spanish as *paella* and in modern Italian as *padella*. Frying pans were probably also used to prepare grain dishes, the antecedents of paella made with rice. Skillets were originally deep, much like modern sauce pans, but the term is used interchangeably with frying pan. It is common practice among American cookbook writers to forego the use of "frying pan" altogether in favor of "skillet," as in the phrase, "brown lightly in a skillet" rather than "brown lightly in hot fat in a frying pan." This word manipulation is an attempt to make the recipe sound more appealing and less fatty although the ingredients remain the same. Frying pans with legs, once common in open hearth cookery, were generally called spiders both in England and in America.

"Pan" is a term of truly ancient origin, deriving from Celtic *panna*. The feature that distinguished it from other utensils was its flat bottom. This is why sauce pans and sauté pans, while very different in shape, are nonetheless called "pans." A versatile pan that combines the best of both the sauté pan and the frying pan has higher, sloping sides that are often slightly curved. This pan is called a *sauteuse* (literally a sauté pan in the female gender), an *evasée* (denoting a pan with sloping sides), or a *fait-tout* (literally "does everything"). Most professional kitchens have several of these utensils in varying sizes.

The cauldron evokes a vision of a huge pot boiling fiercely over an open fire. Actually the traditional cauldron was used in much more diverse ways, sometimes containing several different foods in smaller, sealed containers or wrapped in cloth. It is far more likely that the cauldron gently simmered than rapidly boiled. The word itself is of Celtic origin, and this one hearth utensil was universal throughout Celtic-speaking Europe. It was the symbol of hospitality, was used in religious rituals, and was often mentioned in Irish myths. Judging from archaeological evidence, the most ancient cauldrons were shaped like bowls. The Belgic Celts used cauldrons in the preparation of fish stews, which they made on board their fishing boats. These stews, called "chowders," were adopted by the Roman navy, survived through the Middle Ages, and have many counterparts. One unifying feature of all chowders prepared in a cauldron was the lining of cabbage leaves (later coarse dough) that separated the food from the metal, thus preventing it from taking on the taste of the pot.



OVAL OVENS AND COVERS. HEAVY.
No. 1......... 9 by 13 inches...... $ per ton of 2,240 lbs.
No. 2.........10 by 17 inches......
No. 3.........12 by 21 inches......
No. 4.........13 by 25 inches......
No. 5.........14 by 30 inches......

DEEP OVENS AND COVERS. HEAVY
No. 1 ... 8 inch...deep & shallow $ per ton, of 2,240 lbs.
No. 1½ ... 9 inch...deep & shallow
No. 2 ...10 inch...deep & shallow
No. 2½ ...11 inch...deep & shallow
No. 3 ...12 inch...deep & shallow
No. 3½ ...13 inch...deep & shallow
No. 4 ...14 inch...deep & shallow
No. 5 ...16 inch...deep & shallow
No. 6 ...18 inch...deep & shallow

HEAVY.
SHALLOW OVENS AND COVERS.

HEAVY FIRE DOGS.
Nos. 1, 2, 2½, 3, 4,......$ per ton.

HEAVY POTS.
No. 1............ ½ gallon,............ $ per ton, of 2,240 lbs.
No. 2............ ¾ gallon,............
No. 3............ 1 gallon,............
No. 4............ 1½ gallons,............
No. 5............ 2 gallons,............
No. 6............ 3 gallons,............
No. 7............ 4 gallons,............
No. 8............ 5 gallons,............
No. 9............ 6 gallons,............
No. 10............ 8 gallons,............
No. 11............10 gallons,............
No. 12............15 gallons,............
No. 13............20 gallons,............
No. 14............25 gallons,............
No. 15............32 gallons,............

DEEP SPIDERS & COVERS. HEAVY.
No. 1 ... 8 inch...deep & shallow $ per ton of 2,240 lbs.
No. 1½... 9 inch...deep & shallow
No. 2 ...10 inch...deep & shallow
No. 2½...11 inch...deep & shallow
No. 3 ...12 inch...deep & shallow
No. 3½...13 inch...deep & shallow

SHALLOW SPIDERS & COVERS. HEAVY.

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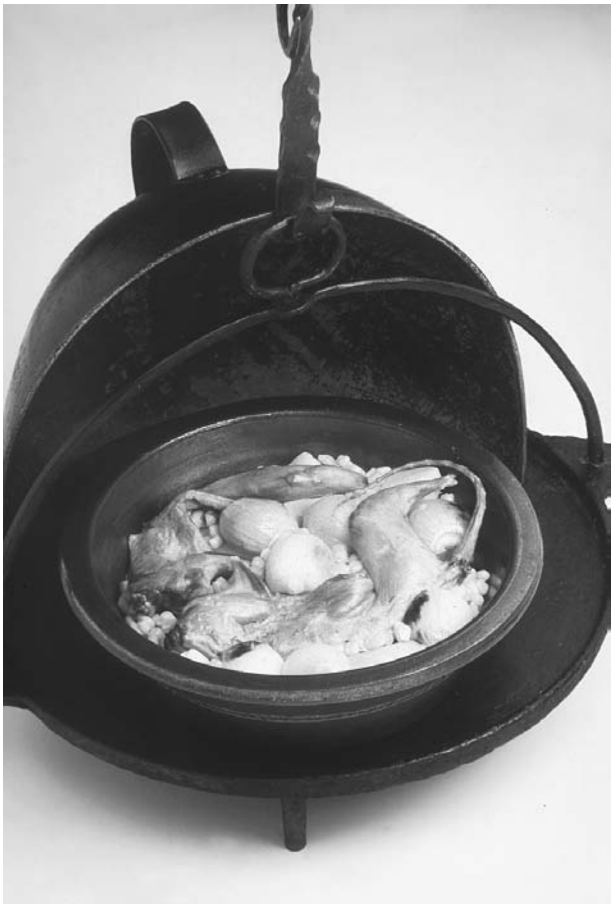
Detail of a page from the 1857–1858 catalogue of cast-iron utensils manufactured by Savery & Company of Philadelphia. Note the careful terminology given to each of the different shapes: oval oven (top left), deep spider and shallow spider (bottom right), and pot (top right). Pot is synonymous with cauldron and by strict definition must have a bulging body and neck or rim as shown in the catalog. Pots were sold with or without lids. ROUGHWOOD COLLECTION.

Griddles and Equipment for Roasting and Baking

Griddles, grill pans, and irons for baking and toasting fall into another category of cooking utensil that also includes open outdoor and indoor grills and rotisseries. In one of the most effective rotisseries, the flame is arranged vertically, and the food is arranged on rods before the fire. These are most often used in commercial environments, including permanent food stalls in some countries. Griddles are used for pan grilling and for hearthside baking in much of the world, from the crumpets of England to the tortillas of Mexico, and the Hopi Indians used a special stone griddle to make *piki* bread. Irons are used for forming special cookies, but they also include hinged



An assemblage of utensils showing how an Appalachian dish of squirrel, potatoes, and maize would be baked on the hearth in the 1830s. A brown stoneware baking dish has been placed on a hanging griddle. The tin bonnet reflects heat from the hearth back towards the food so that it cooks evenly. ROUGHWOOD COLLECTION.

irons for making waffles, hinged and ridged irons for producing *panini* (a grilled sandwich that originated in Milan), and the characteristic shell design of the iron to form the French *croque monsieur* (a grilled ham and cheese sandwich).

Roasting pans and equipment include spits, dripping pans, and roasting pans for use in ovens. Skewers also fall into this category, as when they are used in a tandoor oven, although they may also be used for grilling.

Baking and pastry work calls for yet another set of equipment. Such items include plaques (baking sheets) and pans and dishes especially designed for this use. This category includes frozen and chilled desserts as well, bringing into play molds of various kinds. Bread baking often employs flat baking stones that permit the retention of heat and, in combination with steam, produce a crisp crust. Loaf pans are also employed in bread baking and dessert making.

Utensils for Tabletop Cooking

One classification that crosses over into table service is equipment for tabletop cooking. This includes fuel sources, such as spirit lamps, alcohol burners, Sterno (a commercial fuel), or butane. Tabletop or tableside cookware includes the chafing dish, in which a sauté pan is set over simmering water over a heat source, the oval skillet for finishing dishes over a flame at table side, and the Mongolian firepot. The latter is a device, frequently made from brass, in which a central chimney is set above a heat source. Liquid, usually broth of some kind, is heated and added to the pan that surrounds the chimney. Guests then cook their own food, such as a variety of meats, poultry, and vegetables, in the simmering liquid. Fondue pots, pottery for cheese fondue and metal for meat or fish fondues, are also used to cook at the table.

Utensils Used for Charcuterie

A final category of cooking utensils is those used for making charcuterie (pâtés, terrines, galantines, and sausages). These include grinding and stuffing equipment for sausages and specialized baking dishes for various kinds of charcuterie loaves. A terrine, as a utensil for baking the dish of the same name, may be pottery or enameled cast iron. Forms for *pâté en croûte* (loaves baked in pastry of some kind) often have designs in the sides to make the pastry case more attractive when baked.

Materials Used in Cooking Utensils

While fired clay, bronze, and iron pots were used for many centuries, copper pots were also found in the Middle East, Europe, and North Africa. In addition, porcelain, aluminum, stainless steel, and glass have become common, and newer materials develop as stove technologies change.

As hearths evolved, so did the designs for various kinds of utensils. As a wider variety of materials became available, some were judged better for specific kinds of cooking. Thus, although cooking utensils are sold in sets of different shapes and sizes but all made of the same material, some usually are better fitted to a specific cooking function than others. The function also depends on how well the metal conducts heat. Sometimes a great deal of heat is required, as in sautéing or searing meats. In some cases, slower heating but fine heat retention is needed. Utensils made of certain metals are preferred by expert cooks for the superior results they produce. For example, where it is important to conduct heat quickly and remove it just as quickly, as in sautéing to just the right degree of doneness, copper lined with tin, stainless steel, or nickel is excellent, and aluminum is a close second. That is not to say that utensils of other metals cannot be used for those purposes; they simply are not as effective.

For long, slow cooking, heavy cast iron holds heat evenly and permits simmering at relatively low temperatures, as does clay (although, except in the case of the Japanese *donabe* cooking pot, clay utensils cannot be used over a direct flame). Steel, on the other hand, has low conducting properties and is useful for foods to be cooked in a large amount of boiling water, for example blanching vegetables. Ceramic and glass materials may be used for baking and are also used in tempered-glass double boilers.

Some metals, notably copper, aluminum, and iron, interact with foods cooked in them and must be lined with another metal to be used safely with food. Copper can be used unlined for boiling water, melting sugar, and beating egg whites. Since acid and eggs interact with copper, pans used to cook them are generally lined with tin, nickel, or stainless steel.

Iron and aluminum, like copper, interact with some foods. Unlined cast iron or aluminum interacts with eggs and acidic foods like tomatoes. Cast iron is often enameled to reduce this problem. Aluminum can be lined with stainless steel, which is nonreactive. Some aluminum is treated to make its surface nonreactive.

One of the finest materials for slow simmering in ovens remains low-fired clay. It holds heat well and even imparts a flavor or quality that metals cannot provide to a dish. For higher-heat work, such as soufflés, highly fired porcelain is preferred by some cooks, although others use glass or tinned steel.

The thickness of the material used in a utensil also affects the quality of the results. Thin metal utensils tend to warp easily over heat. Thin pottery, porcelain, or glass breaks easily and does not hold heat. Thickness, however, also implies weight. Professional-weight copper utensils are heavy, especially in larger sizes, as are cast iron ones. This is one of the reasons lined or anodized aluminum is preferred by some cooks.

Form and Function in Cooking Utensils

Function determines the shape of a pot or pan nearly as much as the material from which it is manufactured. In sautéing, for example, a wide pan with three-inch straight sides and a long handle permits the food to be shaken and tossed easily without falling from the pan. Moisture evaporates quickly, preventing food from being steamed rather than sautéed. Pots used for long braisings, on the other hand, have higher sides to concentrate the contents and prevent evaporation. Such vessels have closely fitting lids as well. Stockpots are traditionally tall in proportion to the diameter to minimize evaporation during the long, slow simmering process. Some stockpots in professional use for restaurant work, however, are wider than they are tall to allow evaporation of a large amount of liquid and concentration of flavor.

Professional kitchens also have the challenge of handling large amounts of food that make enlarged utensils heavy and awkward. Giant stockpots either turn on gimbals for easy pouring or have spigots at the bottom to draw off liquid. Braising devices for banquet work are often large, rectangular devices, four feet long and two feet wide or more, and are arranged on gimbals so the pan can be tilted easily. Overall, the utensils and cooking equipment of the large, professional kitchen have a far more industrial appearance than cooking utensils used in a home.

Differentiation of Use in Forms of Cooking and Cooking Utensils

The anthropologist Claude Lévi-Strauss notes, in both *The Raw and the Cooked* (1969) and *The Origin of Table Manners* (1968), that in certain tribes, some cooking functions were reserved for men and others for women. In his example, the roasting function (representing something that was somewhere between raw and cooked) was reserved in certain tribes to men, while boiling (which represented something that was well cooked and was even associated with the start of decay) was reserved to women. Lévi-Strauss also mentions that roasts are more often served to guests or at feasts, while boiled or simmered foods are considered everyday food. In the Middle East, cooking methods associated with hunting, roasting, or grilling over a campfire were reserved for men. The tradition has become common among Americans, where many men handle outside grilling at home.

Cooking utensils sometimes are reserved for special functions related to religion. The Jewish laws of kashruth dictate that separate utensils be used for dairy meals and for meat meals. They further direct that either a completely different set of utensils be used for the feast of Passover or the utensils be ritually prepared for Passover by a special boiling process. This grouping of utensils by food type was also practiced by many peasant societies in Europe, especially in areas where ceramic utensils predominated. Since pottery absorbs food flavors (onions and fats in particular), many households maintained separate utensils for fish, meat, and milk preparations.

See also **Ancient Kitchen; Apicius; Cooking; Cuisine, Evolution of; Etiquette and Eating Habits; Gamerith, Anni; Greece, Ancient; Hearth Cookery; Iron Cookstove; Kitchen Gadgets; Preparation of Food; Rome and the Roman Empire**.

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Madge Griswold

V

VEAL. *See* **Cattle; Mammals; Meat.**

VEGETABLES. Vegetables are plants considered fit for human consumption, although they may also double as fodder crops for domesticated animals. As cultural metaphors, they are firmly embedded in all languages and emerge in such expressions as "hot tomato" for an attractive woman, "cabbage head" for someone who is not too bright, or "cool as a cucumber" in reference to extremely calm nerves. However, from a scientific standpoint, the use of the term "vegetable" is highly subjective and is a term of convenience rather than one based on a neatly ordered scientific classification. This ambiguity evolved out of horticultural practice and to some extent out of cultural bias hinging on the key question: what is fit to eat? The vegetable of one culture may be repulsive to another, as, for example, the cannibal's tomato *(Solanum uporo Dunal)* of Melanesia and Polynesia, which was formerly used in salsas for human flesh. On Fiji, the berry was actually cultivated near sites designated for human sacrifice.

Vegetable classification as defined by Western culture derives in part from prescientific attitudes about the mythic world to which those plants belonged in antiquity. Both the Greeks and Romans—and most other ancient Mediterranean peoples—differentiated between two types of edible plants, *holera* or *olera* (cultivated plants) and *horta* (wild plants gathered as food). This dichotomy was presided over by different sets of deities who represented fundamental attitudes about human society and its relationship to nature. We have inherited this structural framework insofar as vegetables are now exclusively defined as oleraceous or esculent herbs, as cultivated in the *hortus oleritus* (kitchen garden). Thus the formal botanical term for growing vegetables is "olericulture."

The idea that certain vegetables were suitable for boiling (or conversely that only boiling plants were "vegetables") was highly developed even in ancient Greece. The implication arising from this was that these plants were also worthy of domestication. The ancient Greek physician Diocles of Carystus even went so far as to note that, among the *horta*, beet greens, mallows, sorrel, nettle, orach, iris corms, truffles, and mushrooms were the most suitable for boiling. His beet greens were the ones found growing near the sea, not those cultivated in gardens, presumably the wild ancestor *(Beta vulgaris* L. spp. *maritima)* of the present-day cultivated sorts.

In most romance languages this association with boiling or poaching is further reinforced by such cognates of *oleritus* as Spanish olla (a cook pot or stewing pot), implying that the kitchen garden is designed to produce plants mostly earmarked for treatment in hot water. This connotation is clear in the word *Gemüse*, the German term for vegetables that derives from the medieval German *Gemüsz*, a mush or porridge. The idea of cooking or boiling the plants is preeminently expressed in the French term *jardin potager*, literally 'a garden for pot dishes: soups and stews.'

The French have also provided English with the word "vegetable." Its most literal meaning is plain: edible vegetation. The accepted origin of the word is that it derives from Medieval Latin *vegetare* via Old French *vegeter* (to vegetate). The classical Latin root is generally given as *vegetus* (lively or active), although this line of linguistic evolution may be subject to revision as more research on French links to Gaulish comes to light. In any case, the old meaning of "vegetate" did not imply something in decline, a common modern connotation, but rather something that was springing to life, a profusion, a natural bounty expanding from seed almost to the extent that it could be heard rustling as it grew—the complete opposite of the gardens of Adonis discussed later in this essay. This concept of vegetal fecundity is quite in line with Celtic ideas about food and nature and is especially characteristic in the obvious lack of definition between the cultivated and uncultivated worlds. Thus, in its root meaning, the English word is more all-inclusive than the Mediterranean concepts of *holera* and *horta.*

This ambiguity is best exemplified by the vast range of plants that are called vegetables in the English language. Tomatoes are berries, yet they are called vegetables. Garlic is considered a vegetable, yet one does not eat the leaves. And what about rhubarb stems, which are treated like a fruit (the leafy part is poisonous), or the sunflower, which is consumed as a seed or as oil? Where does edible vegetation fit in? Most garden books define

Ceramic vegetable steamer with deep red glaze by Virginia potter David Norton. The concept is based on the Yunnan pot of China, which features a cone in the center and holes for admitting steam. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

vegetables as annuals because they are grown to crop for one season only, yet many of these plants are true biennials (celery, carrots, cabbage, leeks, turnips), and some are even perennial (rhubarb, horseradish, sweet potatoes, asparagus, sorrel, peppers).

Another method for defining vegetables was based on the part of the plant considered most esculent for consumption. Here we have the rather simplistic division of the plant world into root vegetables (such as parsnips), pod vegetables (cowpeas, for example), and leaf vegetables (spinach and chard to name two). Again, while it is easy to imagine carrots as root vegetables, lima beans as pod vegetables, and collards as leaf vegetables, the unending discovery of edible plants from exotic locales such as Africa and South America has challenged all Old World definitions of this classification.

In this category is the East African oyster nut *(Telfairia pedata)*, a rampantly vining cucurbit that is normally planted at the base of trees large enough to support the heavy fruit. In fact, several vines—both male and female—are grown on the same tree and will produce large squash-like fruit for up to twenty years. But it is the seed, not the fruit itself, that is eaten. Once established, the vines are not given much attention. While oyster nuts are intentionally planted around trees conveniently located near dwellings, this is a vegetable crop based more on passive intervention than on formal horticultural practice. This is a pattern once common in hunter-gatherer societies, where certain patches or stands of useful wild plants were periodically tended and encouraged through selective weeding to produce higher yields.

The yacon *(Smallanthus sonchifolius)* of South America is similarly outside the norm, for it produces crunchy, sweet-tasting tubers that are eaten like fruit. It has been cultivated in the High Andes for so many centuries and reproduced by root division for such a long time that many varieties can no longer produce fertile seeds. They are utterly dependent on humans for survival. Since it is low in calories, the tuber has been recently reevaluated as a possible diet food.

This continuing botanical revelation has also altered dietary schematics. Old peasant foraged foods like dock have been rediscovered as biodynamic or macrobiotic, synonyms for well-being, longevity, and psychological balance. In this way the vegetable has repeatedly inserted itself into the most radical of lifestyle movements—but this is hardly new, since vegetarianism and the dietary signification of plants has played a key role in philosophical approaches to nutrition since the days of Pythagoras or even since Adam and Eve, the original vegetarians.

Vegetables in the Fertile Crescent

Eden was said to be somewhere in ancient Mesopotamia. About the original garden we know little, but the Mesopotamian peoples left vast heaps of cuneiform tablets that reveal detailed information about the vegetable plants they once cultivated. As the climate grew hotter and drier many thousands of years ago, a vivid visual distinction evolved between cultivated and uncultivated ground. In fact, the vegetable gardens of that era were enclosed by walls both as protection from wandering livestock and as a means to contain and define the area where precious water would be distributed. Furthermore, it is clear from most of the records, whether Assyrian, Babylonian, or of any of the other cultures sharing the Fertile Crescent, that vegetables were commonly grown around date palms or fruit trees. The palms filtered the blasting sunlight and gave the garden the appearance of a welcoming grove. Thus the garden was also a place where socialization took place and indeed became a place sanctified by its own gods and protective forces.

Archaeological remains (mostly seeds) from this region also support what is documented in clay tablets. The range of vegetables included many still familiar: cucumbers, chards, gourds, onions, garlics, leeks, melons, chickpeas, lentils, cress, kales, and sesame—both for the seeds and for the oil. Colocynth melons, which resemble small watermelons, were grown primarily for medical applications. Some modern Arabic words, such as *kurrat* for a type of leek, can be traced to ancient texts from this period, proof of the long continuity of many of these vegetables. Indeed, even the Arab word for vegetables, *baql*, traces to ancient Aramaic *buqul.*

Tablet inscriptions also point to another feature of vegetable culture that suggests highly developed horticultural practices: specialization. There are numerous references to the "cucumber place" or to the "garlic place," which implies that entire beds were devoted to one type of vegetable and that in many cases this was the sole crop raised by the grower. Garlic was especially valued in this respect and even was used as collateral in financial agreements. In texts where a year-to-year continuity can be reconstructed, it is evident that a garlic place may change into a chard place, so some system of crop rotation must have been in effect. This concept of agricultural specialization was thought to have been perfected by the Phoenicians and codified by Mago, whose great work on agriculture (lost in the original Punic) was highly respected by the Romans.

The Phoenicians were also great middlemen in trading vegetables and seeds throughout the Mediterranean. They are thought to have spread the culture of shallots and artichokes well beyond the eastern Mediterranean, and are known to have introduced the intensive cultivation of saffron into North Africa and southern Spain—saffron was primarily a dyestuff and secondarily a ritual herb. Many Punic words for specific vegetable varieties reflected this plant exchange, as, for example, in *koussimezar* (the Mezar melon or Egyptian "cucumber"), an egg-shaped melon, one of the earliest types to come out of Africa.

Vegetables in Egypt

There is a large body of published material on the history of gardening in ancient and pre-Islamic Egypt, but there are no books per se devoted exclusively to vegetables. Orchards, trees, flora, landscape gardening, and even aquatic plants have received thorough coverage, yet the vegetable stands alone in this curious neglect. Vegetables in general have been viewed as poverty food by most cultures, especially when they form a large portion of peasant diet. Egypt was no different in this regard.

The fine gardens of ancient Egypt were enclosed like those of Mesopotamia and contained trees, flowers, even ponds for fish and ducks. The gardens of the peasants were mostly simple agricultural plots devoted to a specific mix of vegetable crops associated with the local economy, as, for example, lentil or onion growing for absentee landlords in large urban centers like Alexandria. On the other hand, vegetable gardens within temple precincts were often quite elaborate and were intended to supply the priesthood with a full range of food as well as offerings for the deity. Lettuce, for example, was important to the cult of Amun-Min, thus its cultivation held both culinary and religious significance. Indeed, temple gardens were considered to be part of heaven, like the temple itself, so vegetables from those gardens achieved a purity unlike those from the common world.

Papyri and tomb paintings have provided a rich array of material dealing with the common vegetables of the day, although not much is known about their actual preparation as food. The most commonly mentioned vegetables were lentils, leeks, lotus, melons, gourds, garlic, asphodel (grown for its bulb), fava beans, chickpeas, fenugreek (ground as flour), garland chrysanthemum (now popular in Asian cooking), cucumbers, onions, lettuce, and mallow. Egypt also served as a conduit for the introduction of watermelons from tropical Africa and, during the late Ptolemaic Period, for the introduction of rice, taro, and sugar cane from Trapobane (ancient Sri Lanka). Due to their dependence on specialized irrigation and cultivation techniques, none of the last three plants spread beyond the eastern Mediterranean until after Arab conquest.

The Greek occupation of Egypt under the Ptolemys radically altered the Egyptian vegetable garden, both with new introductions and in lasting terminologies. *Molókhe* or mallow *(Malva parviflora)*, which was once so important to Greek cookery both as a green sauce and as an ingredient in complex recipes, also supplied leaves used like grape leaves for making dolmas. The Egyptians transferred the Greek name to a native wild plant now known as Jews mallow *(Corchorus olitorus)*, which was similarly used in green sauces. It is still called *molkhia* in Egyptian Arabic. The use of the same name for plants of a different genus or species is one of the lasting ambiguities inherited from the ancients, who were more apt to lump vegetables together according to how they were used, as in the case of the Roman propensity for treating carrots, parsnips, and parsley root as *pastinaca.*

The Vegetables of Ancient Greece and Rome

There are few surviving writings from the Greeks and Romans that do not mention food and vegetables in some manner. It is known from quotes and citations in works like the *Deipnosophists* of Athenaeus that many books on gardening and agriculture once existed but are now lost. Athenaeus himself lavished considerable attention on foodstuffs, none the least being vegetables. His interests ranged from toasted chickpeas (still a snack food in the Mediterranean) to the medical applications of beets and carrots as vermifuges or a good dish of cabbage to treat a hangover. He even cited the known varieties of lettuce, garlic, fava beans, and many other garden plants in an effort to differentiate which were the best from a connoisseur's point of view.

The surviving Roman work most easily accessible to the general reader is also by another connoisseur, an eccentric called Apicius, whose detailed recipes give specific hints about the role vegetables played in the haute cuisine of imperial Rome. For example, asparagus was baked in eggy casseroles called *patinae*, mallow was commonly added to barley soup, celery made a good stuffing for suckling pig, and turnips marry well with baked duck. There is also scattered advice on when to harvest certain vegetables, as in the case of stinging nettles, which only loose their prickly character when cooked or dried.

Many other works could be cited, such as Columella's *On Agriculture* and especially Pliny's monumental *Natural History*, but the medical writings of the imperial physician Galen are perhaps the richest in detail, since there is considerable commentary on the diet of peasants and farmers and the sorts of vegetables they ate. The aristocratic tone and intended readership of most of the writings that have survived from this period do not provide the kind of firsthand observations one might expect from a true master gardener, although Pliny's eye was in fact well nuanced to such details—yet some of his botanical "facts" are obviously scrambled and secondhand. And while it is true Columella certainly knew how to run an estate, he was not the vegetable gardener.

Furthermore, aside from comments about asparagus and cabbage, Cato's treatise *On Agriculture* makes only passing reference to vegetables—be certain to grow them near cities. While this allusion does confirm the existence of well-organized market gardening, Cato's treatise is so loaded with ideology about salty Romanness *(Romanitas)* and the purity of certain rigorous lifestyles that any conclusions drawn from him must be done so with definite reservations. However, it is fairly clear from these and other ancient authors that quite a few cities had developed market gardening to a high degree and even specialized in the cultivation and export of vegetable produce to Rome and other large urban centers.

For example, Cyrene in present-day Libya was well-known in ancient times for its silphium, fragrant saffron, and a mild-tasting tuber now generally identified as taro. It was also the center for the export of the so-called wild artichoke (*Cynara cornigera* Lindl.), whose domestication was introduced early into Cyprus, Libya, and Carthage from the Levant. This handsome plant is depicted on surviving mosaics in the House of Dionysios at Paphos, Cyprus, and in a mosaic in the Bardo Museum at Tunis. The Roman farmers of Spain and Italy evidently adapted the novel idea of harvesting the flower bud as a delicacy to their local wild cardoons because the artichoke of the western Mediterranean is a subspecies derived genetically from the cardoon (*Cynara cardunculus* L.), not from a wild artichoke ancestor. Buds of the milk thistle, blessed thistle, and safflower were also similarly harvested and eaten.

The dissemination of the artichoke, or at least of the horticultural technology required to cultivate it for food, brings up the larger question of plant exchange during the height of the Roman Empire. Commerce flowed to and from the far-flung provinces in a manner only replicated by the European Union. Archaeology has indeed confirmed that foodstuffs moved quite easily from one place to another, with such exotics as rice turning up in sites in Germany and England. There is also indisputable evidence that, among the aristocracy at least, country life on the great estates attempted to imitate the court life of imperial Rome. Gardens excavated from villa sites have confirmed this.

On the local level, however, Mediterranean cuisine and Mediterranean vegetables were not readily assimilated among the general populace. Joan Alcock's study of food in Roman Britain (2001), based on overwhelming archaeological evidence, reached the conclusion that assimilation was selective, and it was this selectivity that gave rise to the regional cookeries that eventually provided a link of continuity with the regional cookeries of the Middle Ages. This is also the growing consensus of archaeologists in other parts of Europe. Thus, the old saw that "the Romans introduced it" must be requalified, especially since quite a number of vegetables were cultivated in some regions long before the Romans arrived. Cabbage, especially the kales, originated in northern Europe, and in fact, the English words for kale and cabbage are Celtic in origin, as are the German words *Kabbis* and *Kohl*, not to mention the Latin *brassica* and *caulis.* This is evidence in itself that the vegetable exchange during Roman times was complex and two-way, with the Romans themselves learning new things from conquered peoples.

A broader look at Roman literature of all types is especially useful in drawing general conclusions about the state of vegetable gardening from that time. For example, Pliny parodied "gastronomic prodigies," monster vegetables and fruits valued for their size alone. This would suggest that some market gardeners were well acquainted with horticultural practices based on careful seed selection, cold frame techniques, and the manuring of plants at critical periods of growth, much like the modern-day cult of the monster pumpkin or watermelon. There is also a great deal of information concerning value judgments about the role of vegetables in the diet and their cultural significance. Many Roman satires mention garlic as a food only fit for galley slaves and peasants or as something eaten only by soldiers going off to war (garlic heats up the body and therefore creates a warlike spirit). The general drift is that anything flavored with garlic is therefore rustic and unrefined and as much an antidote to poison as it is to the consuming flames of love (what sweet kiss is not withered by the scorpion sting of garlic breath?). Likewise, fava beans are eaten by jurymen in order to stay awake during trials, their noisy flatulency providing an echoing thunder of divine approval or of legal derision.

The most commonly mentioned vegetables in Roman literary sources include many still known, although in shape and habit they probably did not resemble modern varieties. The list includes turnips, radishes, rocket (arugula to American grocers), leeks, lentils, lettuce, orach, Old World gourds (eaten young like zucchinis), cabbage, onion, peas, chickpeas, fava beans, cucumbers, asparagus, cowpeas, beets, beet chards, sprouting broccoli, watermelon, garlic, mallow, dock, chickling vetch, and blite—otherwise known as purple amaranth *(Amaranthus lividus).*

A number of scholars have taken the liberty of translating *blitum* (blite) as spinach (Gowers, 1996), and this has greatly added to the confusion about the culinary history of spinach because *blitum* is not true spinach. However, something called *barbaricum bliteum* (barbarian blite) also surfaces in Roman literature. This is either true spinach as cultivated by the Armenians and Persians or else good-king-henry, so important to the ritual cookery of the ancient Gauls—the leaves of both plants are similarly shaped. In any case, this mystery vegetable was considered insipid eating and was equated with crudeness and stupidity (insipid people were people who lacked "flavor").

Some of these vegetables also carried a great deal of symbolic baggage, especially in connection with religious cults. Mallow *(molóche)* was considered one of the purest sacrifices for Apollo Genétor at Delos, and Pythagoras himself was said to have lived on it as part of his vegetarian dietary regime because it "washes" the stomach.

Lettuce was associated with the gruesome death of Adonis, the prepubescent lover of Aphrodite, who hid among lettuce before he was gored to death by a wild boar. Thus lettuce was associated with male sterility, effeminacy, and cowardice, and generally was viewed as a suppressant of sexual performance (Detienne, 2000). Gardens of Adonis were planted in pots or baskets during the heat of summer and then allowed to die prematurely on the roofs of houses during the feast of Adonia (19 July during the Roman Empire) as symbolic evidence of the boy's sexual prowess, which produced no "seed" or fruit. Significantly, these little gardens consisted of barley, wheat, lettuce, and fennel, each plant highly symbolic of some aspect of fertility yet a total inversion of what was understood to be garden abundance.

Interestingly, a distinctive lettuce dedicated to Gauas (the Cypriot Adonis), and later known as "Cyprian" during the Byzantine period, was discovered in a Serbian monastery by the U.S. Department of Agriculture in the early twentieth century and is preserved in several American seed banks. It is physically similar to the pointed-leaf lettuce depicted in the medieval *Tacuinum Sanitatis* (Arano, 1976) of the eleventh-century Syrian Christian physician Ibn Botlân. By virtue of this continuity, at least in form and appearance, Cyprian lettuce is a true heirloom variety, a category of vegetable that will be dealt with later in this discussion.

Vegetables in the Early Christian Period

The early Middle Ages is a murky period for the study of vegetables, but a copy (in the Austrian State Library at Vienna) of the *Codex of Dioskorides* dating from 500 to 511 C.E. is illuminated with pictures of plants. The drawings are fairly accurate and convey the important physical characteristics of the vegetables and herbs shown. Thus it is possible to determine that a leek on folio 278 belongs to the Kurrat Group, an ancient type of salad leek mentioned earlier and still grown in the Near East.

The *Codex of Dioskorides* is medical in nature, dealing with the health and dietary aspects of the plants discussed. For a horticultural companion, the *Gheoponika* of Kassianos Bassos, a tenth-century reworking of several older agricultural treatises, provides rules for the cultivation of garden vegetables, thus offering some insights into the seasonal food cycle, both horticultural and culinary, in the old Byzantine East. More specifically, the role of the *Gheoponika* in the provisioning of Constantinople with fresh vegetables has been studied by several historians, most importantly by Johannes Koder (1993). When taken together with the *Book of the Eparch* (prefect of Constantinople) regulating merchants and guilds during the reign of Leo VI (886–912), a relatively detailed picture of market gardening falls into place. It is perhaps significant to note that by the 1100s many villages in Bulgaria were given imperial privileges that freed them of military duty in exchange for producing food for the court. It is for this reason that the Bulgarians have long been called the gardeners of the Balkans, a status they maintained even under later Ottoman rule.

In the West, the eighth century *Capitulare de villis* of the Holy Roman Emperor Charlemagne is quite valuable for its references to gardens. For example, the *ravocaulos* of that document is believed to refer to a variety of kohlrabi. However, the most priceless garden record is a parchment drawing of the garden plan of the Cloister of St. Gall in Switzerland surviving from the early 800s. It provides a detailed look at how the Roman kitchen garden became transmogrified into a source of both food and medical plants. Sixteen plants are discernible on the plan, including cucumbers, melons, cowpeas, bottle gourds, and smallage (celery resembling parsley). Most important, they are organized into rectangular raised beds. This is one of the earliest references extant to this common garden practice, but it was not unique.

The *Hortulus* of Walahfrid Strabo, abbot (from 838 to 849) of the Cloister of Reichenau on an island in Lake Constance, makes reference to a similar number of plants, again arranged in raised rectangular beds. Strabo's Latin poems about his garden discuss the uses of both herbs and vegetables and is the oldest surviving source on gardening written in Europe during the Middle Ages. Most interesting of all, archaeological exploration of the abbey site has revealed that it was constructed from the recycled ruins of an abandoned Roman villa and that the layout of the garden more or less followed the outlines of the ancient one. The implication is that the Roman gardening tradition maintained by the wealthy during imperial times did not fully disappear at the outset of the Middle Ages. Many estate gardens disappeared completely due to wars and pillaging, but in some regions they simply became fewer in number and passed into non-Roman hands (Percival, 1976). Château Ausone near Saint-Emilion in Bordeaux is a famous example of this continuity, although its fame rests on wine not gardens.

The archaeological link is not as clear when it comes to the vegetables themselves, since botanical residues, especially seeds, impose certain limitations on what can be retrieved for science. A carrot seed is indistinguishable from a wild carrot seed and will not tell how the root was shaped or even its color. Unfortunately, seeds are mostly what one has to work with from medieval sites, although some inferences can be revealing. Cucumber seeds show up in Polish sites in the 900s, thus establishing a bottom line for a vegetable much associated with Polish national cookery. Carbonized fava bean plants from North Germany from the same period reveal that, after the beans were harvested (as winter fare), the plants were used as straw in barns. Seeds, however, do help untangle dates of introduction, and one thing that scholars have learned from medieval archaeology is that the vegetable world was not static, as historians have led us to believe in the past.

The broad, flat fava bean, which is the preferred sort for modern cookery, did not appear until the 800s in Spain. This is only one example of vegetable breeding (probably through highly controlled selection) that took place during the Middle Ages, although innovation was indeed slow by present-day standards. Some agricultural historians have suggested that it was the Arabs who created these new types of vegetables—the cauliflower, for example. What can be documented from surviving Arab literary sources is rapid dissemination, but the westward movement of plants in general and vegetables in particular was far more complex than hitherto presumed and remains an area of research ripe for future exploration.

Vegetables and the Arab Diaspora

The agricultural historian Andrew Watson has long promoted the idea that an agricultural revolution took place under early Islamic rule in the eastern Mediterranean, a revolution that was carried westward into North Africa and Spain (Watson, 1983). This has important implications for the movement of vegetable plants. However, other scholarship has questioned this thesis. There is growing evidence that the revolution was already taking place during the late Byzantine period and that it consisted of newer ways of irrigating land and reclaiming marshes so more intensive forms of agriculture could be undertaken. Without entering the question of who invented what, two critical points are undeniable: the technology came out of Persia and South India (the vast irrigation systems in Sri Lanka were well known even to the Greeks), and its spread westward was made possible by the political stability that Arab conquest brought to the regions under its control. It is easy to point to the concentration of wealth in bright spots such as Syria (Damascus and Baghdad in particular), Egypt, and al-Andalus in Spain, but there was an economic implosion in other parts of the newly formed empire. The family papers of the Ibn'Awkal merchants of eleventh-century Egypt reveal a great deal about industrial crops like Egyptian flax or high-profit goods like black pepper, indigo, and sal ammoniac, but information on common garden vegetables is rather limited. That is, unless one looks at medical literature and cookery books.

The most heavily used culinary source is also one of the oldest: the *Kitab al-tabikh*, otherwise known as the Baghdad cookery book. It was written down in 1226, although internal evidence clearly indicates that the material was compiled from several much earlier sources, some of which were not Arabic. This ambiguity is one of the difficulties in using cookbooks to pinpoint the introduction of new vegetables. But that said, there are other Arabic cookery manuscripts equally rich in detail surviving from the Middle Ages, such as the *Manuscrito Anónimo* of Moorish Spain, and all of the recipes no matter what the source are fairly clear about the role vegetables played in the diet of the times.

There is certainly no ambiguity in the Baghdad cookery book about the use of eggplants and no doubt at all that the sort discussed had dark black skin (there are directions for removing it). The book also makes ample reference to fava beans, cardoons, rhubarb, leeks, the ridged cucumber (Armenian snake melon), carrots, gourds, taro, cultivated purslane, turnips, sweet fennel, and spinach. There are also references to a form of cabbage commonly translated into English as cauliflower. Without a picture, one cannot be sure (it could be a type of broccoli), but since true cauliflower evidently evolved in the Dead Cities region of northwestern Syria, it is quite likely that this luxury vegetable migrated during the early 800s with its growers when they resettled elsewhere—a small group of those Syrian Christians emigrated to the Karpasia district of Cyprus, where cauliflower was first observed by pilgrims to the Holy Land later in the Middle Ages. The cauliflower is not mentioned in European scientific works until specimens are discussed by Dodonaeus in 1560. By that time Cypriot seed was being exported to northern Europe via Venice.

One is also treated with a rich array of vegetables in another work called *Kitab Wasf al-At'ima al-Mu'tada* (Description of Familiar Foods) written in 1373. Of particular interest is the differentiation of several types of leeks, indicating not only distinct varieties but also distinct culinary uses at different stages of development—indirect evidence of a highly evolved sense of market gardening. Four sorts of leek are mentioned: the vegetable leek *(kurrath baql)*, the Nabatean leek, the table leek, and the Syrian leek. The first is not a variety but rather a spring leek, young greens similar in character to Chinese garlic chives. The Nabatean leek may be equated with the modern salad leek of Iraq, a member of the Kurrat Group, short in height and rather deep-rooted. The table leek is a blanched leek similar to the Catalan Calçot onion, and indeed the cultural technique of burying them in deep trenches may be the same. The Syrian leek is the *kephalotón* of medieval Cyprus, a Greek word derived from Syrian *quaflot*, a leek with an unusually large bulb. This plant is the genetic ancestor of the modern elephant garlic. Under the name *Porrum Syriacum*, it was first illustrated in European botanical literature by Tabernaemontanus in 1588.

Arab books dealing with cookery exhibit an undeniable passion for elegant preparations, even with simple vegetables. But such food was the privilege of the aristocratic few, and the wealth that sustained that lifestyle was soon to fade with the economic upheavals caused by the

Crusades. Until the late twentieth century, historians have greatly underestimated the exchanges that took place after the establishment of Latin footholds in the Levant and Byzantium or the role of large Christian minorities that persisted in Egypt and Syria during the early Muslim period.

The Nestorian or East Syrian Church, which spread into Persia, established strong trading communities in China and Malabar as well as in Cyprus, where the Nestorian Lakhan family became extremely powerful based on trade in medical aloes. One line of trade and plant exchange went through Tabriz in Persia overland to the Caucasian kingdom of Georgia and the Greek Empire of Trebizond on the north coast of modern Turkey, all to circumvent the Arabs. That this Black Sea entry was an important route for the movement of Asian food plants westward may be inferred from an eleventh-century Byzantine reference to the "citrons" of Anatolia, a variety of lemon introduced via Georgia and Armenia and still preserved in Georgian botanical collections. Eggplants also followed this route.

European contact with foods of the Arab world was not limited to the crusading troops that went to the Holy Land and returned. The Latin Kingdom of Jerusalem (1099–1291), the Principality of Achaea (1205–1430), a French feudal state established in Greece with its capital at Mistra, a Catalan principality centered on Athens, various Venetian and Genovese ports, and the sister kingdoms of Cilicia (1080–1375) in Asia Minor and on Cyprus (1192–1489) were all characterized by colonial aristocracies with highly orientalized foodways.

The last kingdoms, especially that of Cyprus due to a Papal Bull, served as conduits for the spice trade with the Muslim world. In the case of Cyprus, the kingdom lent its name to an international style of cookery mentioned in numerous medieval cookbooks. More important, the intermarriage of wealthy Latins in the Levant with European nobility, particularly with families in Aragon and in northern Italy, brought to Europe a constant influx of personal cooks, gardeners, and retainers schooled in eastern Mediterranean ways. It is not surprising that some of the earliest references to exotic vegetables like eggplants, cauliflowers, okra, and numerous sorts of Near Eastern melons show up in late medieval Italy.

Vegetables in the Renaissance

The *Carrara Herbal* (British Library, Egerton MS 2020), created sometime before 1403, was one of the first late medieval herbals to depict plants and vegetables accurately, although it may have been based on a now lost Byzantine prototype. Such illustrated handbooks of health, as well as numerous herbals, offer a rich visual record of the sorts of vegetables deemed worthy for the table in that period. The beautiful gardens witnessed by travelers through the Latin East were now replicated in Italy but with the goal for reattaining a glorious Roman past. The Italian pleasure gardens of this period so impressed Casimir the Great of Poland that he installed one in Cracow during the 1360s, complete with cold frames for forcing Mediterranean vegetables. In short, the vegetable garden once again becomes an object of status.

Hands holding a variety of vegetables: beet chards, carrots, turnips, spring onions, and radishes. © CRAIG LOVELL/CORBIS.

The discovery of printing, followed quickly by the discovery of the New World and the heady harvest of its vegetable riches, only accelerated a quest for new and exotic things to ornament the gardens of the rich and powerful. Tomatoes, peppers, potatoes, sunflowers, beans, sweet potatoes, new sorts of pumpkins, and a new kind of wheat called maize fill the pages of botanical treatises and plant books of the period. The 1500s may be characterized as a century during which botanists attempted to organize the vegetable world into some type of scientific order, although that "order" by modern standards was quite chaotic. For example, a confusing observation is that the Jerusalem artichoke from North America (not from Jerusalem and not an artichoke) is known as *Flos solis Farnesianus* (Farnese sunflower) in reference to the fact that the gardens at the Villa Farnese in Rome provided several botanists with the first known specimens. Sorting out such conflicting nomenclature has plagued garden historians ever since.

However, botanical gardens were established in this century, the first in 1545 at the University of Padua, and some of the greatest botanical works of the Renaissance were issued during this era, especially those devoted to cataloging the gardens of such important plantsmen as Conrad Gesner in Switzerland (1561), Georg Fabricius in Meissen, Germany (1569), and Camerarius in Nürnberg (1588). All of these books contain valuable woodcuts depicting vegetables, and many medieval favorites like skirret *(Sium sisarum)* and monk's rhubarb *(Rumex patientia)* are shown for the first time. Vegetables also figured prominently in Renaissance art and paintings, especially the still life genre. Among the most whimsical vegetable compositions are those by the court painter Giuseppe Arcimboldo (c. 1527–1593), who used vegetables and fruits to create faces and other conceits.

The most significant body of literature, however, was the garden guides that discussed not only specific vegetable varieties but also how to grow them. The French work known as *L'agriculture ou la maison rustique*, first published in Latin (1535) by the Paris printer Charles Estienne, was soon translated into most major European languages. Marco Bussato's *Giardino di agricultura* (Venice, 1592) was also extremely influential, as was Johann Coler's *Oeconomica ruralis et domestica* (Wittenberg, 1597). The great classic, however, was Oliver de Serre's *Théatre d'agriculture* (Rouen, 1600), which became a standard garden book for much of the next century. This great outpouring of garden knowledge was capped in many ways by the lavishly illustrated *Hortus Eystettensis* assembled by Basilius Besler in 1613 for his patron plant collector, the bishop of Eichstätt in Bavaria. Not only did the good bishop own prize specimens of rare eggplants, balsam apple *(Momordica balsamina)*, tomatoes, and domesticated asparagus, his potted prickly pear cactus from the New World required a wooden superstructure to hold the monster plant in place.

Vegetables in the Baroque Period

The seventeenth century witnessed a revolution in botanical science and the proliferation of books devoted to illustrating plants and vegetables from many parts of the world, including new introductions from Asia and the Americas. Francisco Hernandez's *Nova Plantarum* (Rome, 1651) was devoted almost exclusively to the foods of Mexico and included native names for the plants. His woodcut illustrations offer a priceless look at the characteristics of common vegetables then grown in New Spain, including the lowly miltomatl or tomatillo *(Physalis ixocarpa)* now popular in Southwest American cooking. Other books containing strange designations like *Pomum amoris majus fructu luteo* (large yellow fruited love apple or, more simply, yellow tomato) remind one how much lack of order prevailed in the scientific naming of newly discovered vegetables and how much has changed since Linneaus imposed order on the world of plants in the eighteenth century. Names like *bamia Aegypitiaca* (Egyptian okra—*bamya* is actually a Syrian word) of one author might become "ladies' fingers" of the next. Likewise the *lactuca hispanica* (Spanish lettuce) of one author was the *Cos* or Roman lettuce of another, the names more often than not reflecting the source of seed rather than the true origin and history of the vegetable. One of the most fashionable cabbages of the period was the so-called *Brassica tophosa*, better known as black Tuscan palm tree kale, "rediscovered" by American seedspeople under the new moniker "dinosaur kale." The penchant for fanciful names has not changed.

If a generalization can be made about the seventeenth century, it is that the rare and exotic vegetable of the previous century gradually became the daily fare of the urban middle class by 1700. Plant breeding, especially in Holland, brought many new sorts of vegetables onto the market. Named varieties of potatoes, carrots, celery, chicory, peas, and turnips soon proliferated in kinds and colors. Added to this roster were newly discovered Asian foods, like Malabar spinach *(Basella alba)*, introduced from Java in 1688. Handbooks on plant breeding were even published, one of the earliest in English being Walter Sharrock's *History of the Propagation and Improvement of Vegetables* (1660). From this time on, the vegetable undergoes a steady refinement with emphasis on greater delicacy of flavor, more beautiful shape, and increasing tenderness.

Much of this was directly connected with shifts taking place in cookery, especially the use of vegetables in sauces and elaborately prepared dishes. Vegetables were also given ornamental value with paring knives, so turnips feathered out into birds, carrots unwound into golden fish, and the cookbooks of the day are full of illustrations showing how to do this. Most notably, however, the vegetable became a prized market commodity; growing of vegetables, a respectable line of work for the honest laborer; and period depictions of market scenes never fail to convey the impression that only the best has been laid before the eye.

Aside from shifts in cookery, the virtues of country life and the pursuit of its simple pleasures helped elevate vegetable gardening as a worthy and genteel pastime. Jan van der Groen's *Den Nederlandtsen Hovenier* (Amsterdam, 1669) was extremely influential in this respect, as were Nicolas de Bonnefon's *Les delices de la campagne* and *Le jardinier françois* in France. All of these works were translated into several languages and included specific discussions of vegetable varieties and cooking tips. Under fava beans, for example, Bonnefon recommended several different methods of preparation, including fricassees like peas or boiled plain with slices of bacon, noting that fresh green savory went "marvelously well" with any fava bean dish.

Not the least important, from the standpoint of vegetables, was John Evelyn's *Acetaria: A Discourse on Sallets* (London, 1699), which discussed most of the popular types of vegetables of the day, especially ways to employ them raw or semicooked in salads. Of earth chestnuts *(Bunium bulbocastanum)* he remarked: "the Rind par'd off, [they] are eaten crude by Rustics, with a little Pepper; but are best when boil'd like other Roots, or in Pottage rather, and are sweet and nourishing."

Vegetables in the Enlightenment

The idea that vegetables recaptured the original wholesomeness of Eden became an underlying theme for many of the more offbeat cookbooks of the eighteenth century, with *Adam's Luxury and Eve's Cookery* (London, 1744) considered one of the most typical. The underlying philosophies expressed in these books may be said to represent the intellectual forerunners of true vegetarianism, which was indeed practiced in colonial North America by the so-called White Friends, a group of Quakers who wore clothing of unbleached cloth. The most highly organized vegetarians in early North America, however, were the Bible Christians, who expanded from England in 1816. Martha Brotherton's *Vegetable Cookery* (London, 1833) became the dietary handbook for this group.

The European penchant for country life was quickly transferred to England during the 1600s and from there to colonial America. Doubtless it achieved its American apotheosis in such famous estates as William Penn's "Pennsbury Manor" along the Delaware River, Thomas Jefferson's "Monticello" in Virginia, William Hamilton's "Woodlands" near Philadelphia, and Charles Carroll's "Mount Clare" in Baltimore. Jefferson's personal garden account book, published by the American Philosophical Society in 1944, remains a lasting testimony to the central role that kitchen gardens—and vegetables in particular—played in this manorial lifestyle.

It was on such estates as these that many of the Old World exotics were first introduced to North America. Charles Norris of Philadelphia, for example, is known to have raised black-skinned eggplants, since a letter survives from 1763 imploring him for seed. Many of the most popular vegetables of this period can be found in Philip Miller's *Gardener's and Botanist's Dictionary* (London, 1759), and remarkable as it may seem, some of Miller's vegetables are extant, among them red celery, Spotted Aleppo and Silesia lettuces, spinach beets, and domesticated sea kale.

The Vegetable in the Nineteenth Century

The Industrial Revolution in England and Europe created the need for a new type of gardener and, indeed, new sorts of vegetable varieties. Market gardening had always existed to some extent in and around urban centers, but the huge new concentration of landless workers packed into the cities meant someone else would have to act as a surrogate kitchen gardener to supply their tables. Thus vegetable horticulture underwent rapid specialization with growers focusing on such basic food crops as cabbages and onions, or turnips and potatoes.

New demands were placed on vegetable breeders for vegetables that would travel well and that gave a good appearance even after rough handling. The old-time requirements of the country kitchen gardener for vegetables that dried or pickled well were overthrown by cold frame and hot-house horticulture that could deliver such tender things as fresh peas and lettuce all winter. Furthermore, most of the old medieval vegetables like skirrets, rampion, orach, sow thistle, and nettles dropped out of mainstream diet and by the mid-nineteenth century were largely associated with rural poverty, those "rustics" mentioned by Evelyn in his treatise on salads. So thorough has industrialization distanced the consumer from the *horta* of old traditional northern European diet that the wild greens of Mediterranean culture, indeed any unusual food plants from Asia or Africa, are embraced as an antidote to a diet adrift of its "natural soul."

The two bibles of nineteenth-century American kitchen gardening are arguably Bernard M'Mahon's *American Gardener's Calendar* (Philadelphia, 1806) and Fearing Burr's *Field and Garden Vegetables of America* (Boston, 1863). Both of these works were reprinted in the twentieth century because they contain long, valuable lists and detailed descriptions of many nineteenth-century vegetables. Burr even included small woodcut illustrations. M'Mahon's book is a cultural bridge with the past, for it contains much on the old types of vegetables still eaten by traditionalists of his day. His is also a book written for the person who gardens, in particular a person who employs a staff, thus his vegetables fall into that category of food destined for genteel tables. Fearing Burr's book was quite another sort.

Burr's primary interest was to catalog the best commercially available vegetable varieties so gentlemen farmers and market gardeners would be guided in their selection of the best seed for the best investment. The book was arranged like a scholarly encyclopedia, and it was not cheap, two points against it from a farmer's standpoint. Its New England stodginess was quickly overtaken by Peter Henderson's *Gardening for Profit* (New York, 1865), an inexpensive handbook that became a best seller and the blueprint for true truck farming. Henderson was a seedsman, and he was not blind to the fact that small-scale farming for urban markets would require yet another type of vegetable; indeed, his book marks the birth of the so-called commercial vegetable grower.

Henderson's effect on vegetable breeding was immediate, and nowhere in the United States did it manifest itself more than in the explosion of newfangled high-profit tomatoes. The Paragon tomato was introduced in 1870 along with the canning jar of the same name—the connection was not coincidental. The leading tomato breeder of the time was Alexander Livingston (1822–1898) of Ohio. His Acme tomato (1875), Golden Queen (1882), Beauty (1885), and Stone (1891) are still grown and are considered among the classics of American commercial garden vegetables. But Livingston was only one of a number of seedspeople actively engaged in creating newer and better vegetables for the market. Perhaps the dean of them all was W. Atlee Burpee of Philadelphia, who even went so far as to offer large monetary rewards for backyard discoveries worthy of commercialization. Many of Burpee's best vegetable introductions came from housewives and farmers who happened to have an eye for the unusual, of which the Montreal Market Melon is a prime example. Burpee's sense of marketing was also shrewdly sophisticated, because he hired Sarah Tyson Rohrer, owner of the Philadelphia Cooking School, to create a cookbook called *How to Cook Vegetables* (Philadelphia, 1891), thus insuring that even the most helpless beginner would feel confident in buying his seeds. After all, they received the cookbook as a bonus.

The second half of the nineteenth century witnessed a large increase in the number of vegetables developed solely for manufacturing purposes not only in the United States but in Europe as well. In France, the tiny cornichon pickles were introduced in the 1880s. In England, the Marrowfat pea became the ubiquitous pea of the canneries, both as a canned vegetable and as pea soup. Whole communities grew up around the production of one vegetable. In Germany, Zittau became famous for its monster onions and Tetlow for its dwarf turnips; Poitou in France became famous for its golden leeks. In the Austro-Hungarian Empire, at Znaim in what is now the Czech Republic, a pickling industry was established in 1852 based entirely on the Znaim cucumber, a mutation of a cucumber brought from Asia in 1802. This pickle capital of central Europe remained in business until 1945, when it collapsed under ethnic cleansing. Today the Znaim cucumber is extinct.

The need for fresh breeding stock to supply growers with newer and better varieties of plants lay behind the establishment of several experimental gardens in the late 1800s. The most famous was at Crosnes (Seine-et-Oise) in France, a place-name now attached to a tuberous vegetable *(Stachys affinis)* from China first trialed there in the 1880s. The heads of that garden were Auguste Paillieux (1812–1898) and his assistant Désiré Bois. The two of them coauthored a garden classic known as *Le Potager d'un curieux* (Paris, 1885), and Bois later published his own masterwork, *Les Plantes alimentaires* (Paris, 1927). These men were responsible for a large number of new vegetable introductions, and they were interested as well in their histories. They valued the research of such botanists as Emilii Bretschneider, whose history of plant exploration in China (1898) remains one of the milestones of nineteenth-century horticultural writing. They were also keenly aware of the value of biodiversity.

The greatest collector of vegetables and edible plants in general specifically for their genetic interest was Nikolai Vavilov (1887–1943) of Russia. The Vavilov Institute, founded at St. Petersburg in 1905, became a model for similar gene banks established in other countries, including the United States. Vavilov's collections gathered from all parts of the world are considered priceless, and they have taken on much greater importance since the development of hybrids and genetically engineered foods.

In the past the hybrid vegetable was viewed as a worthless mule, and most growers disdained them because they were not fixed in their characteristics, thus they would not grow true from seed. A revolution took place in this thinking during the 1940s as seed companies began to promote the benefits of controlled crosses to yield vegetables with specific traits. Such plants are known as F1 hybrids, the label standing for "first generation." This concept has further evolved with the idea that the precise genetic mix to create that plant may be patented and thus owned in perpetuity. Genetic engineering has added one more element to the mix: traits borrowed from near species or from other life-forms to create vegetables that would not have occurred in nature. This type of vegetable dominates agribusiness, but it has also come under attack from many quarters under the moniker of "Frankenfood" (a word combination of "Frankenstein" and "food").

The primary argument against the hybrids is that, since seed cannot be saved, growers are forced to purchase new seed each year. For large-scale farmers, this increases the debt side of the ledger at the cost of seed-saving convenience. Another argument is that hybrids on the whole lack the same vigor as open-pollinated plants, that there is some long-term genetic decline at play. The patented vegetable has been criticized on moral grounds (who owns Nature?) and because it is easy to circumvent the patent by creating renegade varieties with slightly different genetic compositions. Furthermore, the ownership issue resembles the sort of complex economics of old tithes and quitrents that eventually changed medieval agriculture from a tenant system to serfdom. This New Feudalism is based not on class privilege but on farms mortgaged to banks, fertilizer companies, and seed suppliers.

While the pros and cons of these arguments are primarily limited to the farming side of the equation, it is an issue that ultimately affects the consumer and the price of vegetables on the shelf. These issues are also more polarized in developed countries like the United States than in Africa, Asia, or Latin America, where small-scale farming is the norm, and the economics of farming are different and are not necessarily based on cash flow or cash crops. However, the financial success of hybrids, patented varieties, and genetically engineered food is predicated on cheap oil for transportation, not to mention the chemical by-products of oil translated into herbicides and pesticides required to maintain these specialized vegetable crops. Oil, not politics or environmentalism, may ultimately determine the future of such vegetables. But there is also another revolution taking place. It is known as artisanal agriculture, its technology is increasingly organic, and it is based on open-pollinated vegetables, many of which are also heirloom varieties.

The Heirloom Vegetable and the Ten-Acre Farm

The discovery of vitamins and the role they play in human nutrition raised the status of the vegetable from an adjunct to the meal to a much more centralized role. When it became clear that legumes could deliver much of the same nutritional value as meat, a new look at all sorts of vegetables seemed to be in order. On hindsight, the appearance of Eleanour Sinclair Rohde's *Uncommon Vegetables* (London, 1946) and John Organ's *Rare Vegetables* (London, 1960) should have served as warnings that a shift was taking place in the food world and that this shift was the harbinger of something new. Several elements appear to have converged and to have begun working in conjunction with one another.

The first was a general setting of rapid economic growth, especially in the 1980s, and the flow of some of this new-made wealth into dining out. The second was the mainstreaming of vegetarianism and more broadly of healthy lifestyles, which placed new demands on the market (and on restaurants) to come up with a more challenging and nutritionally satisfying range of vegetable choices, although not necessarily inexpensive choices. The third was the American Bicentennial in 1976, which spawned a renewed look at historical foods and foodways and which gave rise to a number of grassroots organizations devoted to studying and preserving foods of the past. The most important plant organization, and one with enormous continuing influence, is Seed Savers Exchange in Decorah, Iowa, the high temple of what is known as the heirloom vegetable.

The fourth and perhaps the most significant development was the growth of small or artisanal farms devoted to supplying high-end urban markets with the vegetables demanded for a new American cuisine variously styled California cuisine and championed by such activist restaurants as Chez Panisse in Berkeley, California, and the White Dog Café in Philadelphia. The core concept of California cuisine was the use of locally grown food products with an emphasis on freshness, originality, and organic horticultural methods. This type of model could be replicated anywhere in the country, and thus a real interest in heirloom vegetables was born.

The heirloom vegetable is a variety that has been handed down from the past. It may be an old commercial variety like Conover's Colossal Asparagus (1863), a garden classic like Victoria Rhubarb (1837), or a symbol of American gardening genius like the Brandywine tomato (1889). Whatever their role, these are plants that have been preserved more or less intact since they were developed. Their historical and cultural genealogies may be impressive, and this alone appeals to many people who sense a loss of cultural identity and who are looking for a means to recover their "natural souls." Native American heirlooms are extremely potent in this regard.

From an economic standpoint, the heirloom vegetable is free of the ownership issues inherent in hybrid, patented, and genetically engineered food. The heirloom belongs to the community, and an exchange of this food (as well as its seeds) is viewed as a strong link in the commensality of people and a link with nature, especially since the plants are pollinated by natural means out under the sky. On a less philosophical level, heirloom vegetables were developed to meet the agricultural needs of specific soils and environments and therefore do not require the same economic investment in fertilizers and insecticides as hybrid varieties. They are also strengthened by an inherent genetic diversity lacking in hybrid sorts—a built-in mechanism to prevent massive crop failure. This appeals to organic growers, and the surprisingly rich flavors of plants raised in this manner have gained many converts in the food community at large. Politically, the heirloom vegetable represents an alternative to the type of market control and genetic expropriation associated with agribusiness. In developing countries, this means local control of local food resources, a theme championed by the Food and Agriculture Organization of the United Nations.

When the astronauts first set foot on the moon, they looked back to behold a blue orb in the darkness of space. That view changed humanity, because it said as no words could express that Earth is indeed an Eden and perhaps, for all its vicissitudes, our only reward. The philosophies that have guided us in the past are seriously challenged. While it is true that vegetables are not perceived by humans to react to pain, fear, or anxiety and while they do not have red blood, who is to say they are not our protectors?

See also **Cannibalism; Gardening and Kitchen Gardens; Genetic Engineering; Legumes; Maize; Onions and Other *Allium* Plants; Organic Farming and Gardening; Peas; Pythagoras; Tubers; Vegetarianism; Vitamins.**

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William Woys Weaver

VEGETARIANISM. The dietary practice and philosophy of vegetarianism dates back to the views of Pythagoras in the fifth century B.C.E., as well as to religious practices associated with Hinduism, Janism, Zoroastrianism, and Buddhism. Historically, support for a vegetarian lifestyle has been grounded in both health and ethical and moral arguments. However, in the United States and Canada health arguments have dominated, and ethical and moral arguments typically have taken a lesser role. While many people become vegetarians because of concern for the treatment of animals raised in factory-like conditions, North Americans more commonly become vegetarians because they believe that it will help them lose weight, have more energy, or ameliorate such health conditions as high blood pressure or heart disease.

While the percentage of North Americans practicing vegetarianism has remained rather consistent at about one percent of the total population (and about 5 to 6 percent in the United Kingdom), social acceptance of this lifestyle increased dramatically in the late twentieth century. In large part, recognition by medical and nutritional authorities that vegetarian diets can be healthful and even desirable when appropriately planned has led to the legitimacy of vegetarian diets and to fewer fears regarding nutritional deficiencies. While the increasing scientific and cultural acceptance of vegetarian diets has not led to a greater percentage of the population adhering to vegetarian diets, more people are experimenting with "semi-vegetarianism," adding more meatless meals to their weekly menus.

Varieties of Vegetarianism

A wide range of dietary practices falls under the rubric of "vegetarianism." People who practice the strictest version, veganism, do not use any animal products or by-products. They do not eat meat, poultry, or seafood, nor do they wear leather or wool. They avoid foods that contain such animal by-products as whey and gelatin and do not use products that have been tested on animals.

Other vegetarians limit their avoidances to food. For example, ovo-lacto vegetarians consume eggs and dairy products but not meat, poultry, and seafood. Ovo vegetarians do not consume dairy products, and lacto vegetarians consume dairy products but not eggs. Semivegetarians occasionally consume some or all animal products and may or may not consider themselves vegetarians. Studies suggest that semivegetarians outnumber "true" vegetarians by about four to one.

These terms define the various types of vegetarians by what they do not consume. Consequently, many vegetarians are concerned that nonvegetarians view vegetarian diets as primarily prohibitive and restrictive. They emphasize that following a vegetarian diet often leads people to consume a wider variety of foods than many meat eaters do, as vegetarians often include a wider range of fruits, vegetables, grains, and legumes in their diets.

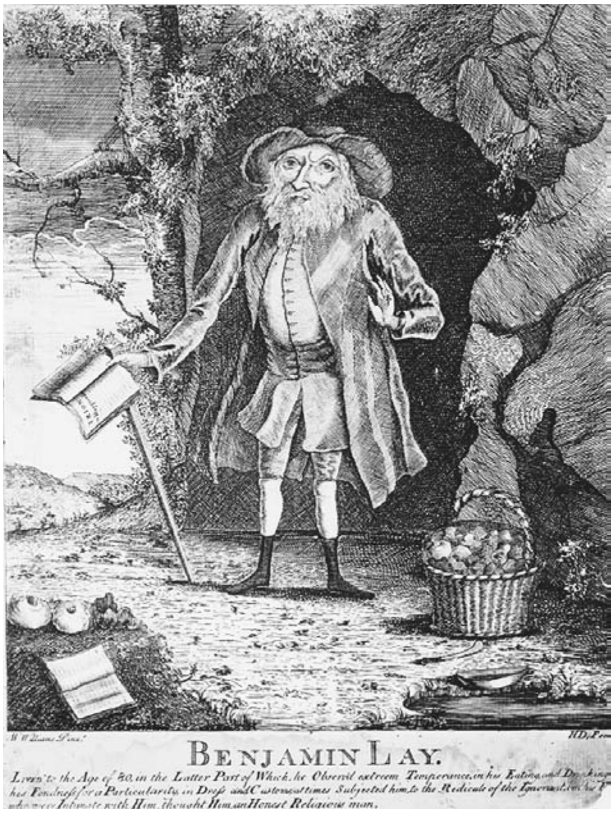
A Brief Historical Perspective

Vegetarianism arrived in the United States in the early 1800s as primarily a religious practice associated with the Bible Christian Church of Philadelphia. The church's leader, William Metcalfe, advocated abstinence from meat as a form of spiritual temperance. In 1830 the Bible Christian Church hired Sylvester Graham, who had been studying medicine in Philadelphia, as a temperance lecturer. Graham soon branched out on his own, turning elements of a religious philosophy into a more secular set of practices in which he advocated abstinence from alcohol, sex, coffee, tea, spices, and of course meat.

Graham's philosophy was rooted in a deep distrust of the emerging industrial revolution of the 1830s and 1840s. He expressed concern that the marketplace was supplanting the role of "hearth and home" in developing moral character and stressed the importance of individual efforts to restore a moral balance in an increasingly chaotic social world. With Metcalfe and such vegetarian advocates as William Alcott and Russell Trall, Graham helped form the American Vegetarian Society in 1850. Many early suffragists and abolitionists, such as Susan B. Anthony, Lucy Stone, and Horace Greeley, attended the early meetings of this organization.

The vegetarian legacy continued with the efforts of John Harvey Kellogg, who developed cornflakes in 1894. The Seventh Day Adventist Church hired Kellogg in the 1870s to run its Battle Creek Sanatorium, where popular treatments included exercise, hydropathy (water cure), and a vegetarian diet. The Seventh Day Adventist Church continued to endorse and promote vegetarian diets in the twenty-first century, although it did not require its members to adopt them.

Interestingly, although early vegetarianism was strongly associated with religion (first with the Bible Christian Church and then with Seventh Day Adventism), vegetarianism has been primarily a secular rather than a spiritual practice in North America. Even the early vegetarians were encouraged to adopt vegetarianism as a means to good health that would enhance their individual capacities, including their capacity to experience the Divine, and vegetarianism has rarely been promoted as a spiritual path in and of itself. Consequently, despite its historically religious underpinnings, the health aspect of vegetarianism has predominated in the United States and Canada.


BENJAMIN LAY.
Lived to the Age of 80. in the Latter Part of Which he Observ'd extreem Temperance in his Eating and Drinking
his Fondness for a Particularity in Dress and Customs at times Subjected him to the Redicule of the Ignorant
who were Intimate with Him thought Him an Honest Religious man.

Early eighteenth-century engraving of Benjamin Lay, a Quaker vegetarian and hermit in Pennsylvania. Lay and other Quaker vegetarians known as "White Friends" (they wore only undyed cloth) were heavily influenced by Thomas Tryon's *The Way to Health* (London, 1683). Tryon's discourse contained material on Pythagoras and his vegetarian philosophies. Later editions were expanded with recipes for seventy-five "noble dishes" prepared without "eating flesh and blood." Lay is shown holding Tryon's book in his hand. ROUGHWOOD COLLECTION.

Characteristics of Contemporary Vegetarians

While vegetarians probably exhibit more differences than similarities, researchers have discerned several patterns regarding their social backgrounds and statuses. Vegetarians tend to come from predominantly middle-class backgrounds, and a substantially smaller percentage comes from lower social classes. This can be explained by the fact that people who have less money view meat as desirable and associate it with upward social mobility. Therefore, when they have discretionary income, they are likely to use it to purchase meat products. In North America meat is often associated with success and social status. People are only likely to reject meat once they have the opportunity to consume as much as they want.

Gender is another patterned feature of vegetarians in North America. Studies have consistently found that about 70 percent of all vegetarians are female. Several explanations are possible. First, the foods embraced by vegetarian diets are those already symbolically linked with feminine attributes, that is, foods that are light, low-fat, and not bloody (as people often equate blood with strength). For many people meat and masculinity are inextricably linked; therefore it is easier for women than for men to escape cultural expectations. In addition, women tend to be more concerned with weight loss, and many pursue a vegetarian diet as the means to that end. Finally, some researchers hold that women are more likely than men to hold a compassionate attitude toward animals, leading them to have more concern about killing animals for food. All of these factors contribute to the reality that women are more likely than men to become vegetarians.

Studies have suggested that vegetarians may share a variety of other characteristics as well. For example, while vegetarians are less likely than the general population to follow a conventional religion, they are more likely to describe themselves as spiritual and to practice some form of yoga or meditation. They are more likely to describe themselves as "liberal" and less likely to adhere to traditional values that embrace upholding the existing social order. They are also less likely than the general population to smoke cigarettes and drink alcohol. Yet it is important to point out that vegetarians are more different than similar in their social backgrounds, political beliefs, and health practices.

Reasons for Vegetarianism

People become vegetarians for a variety of reasons, including personal health, a concern for the treatment of farm animals and the environment, spiritual beliefs, and sometimes simply a physical disgust toward meat. Most commonly North Americans follow a gradual path toward vegetarianism that starts with a health motivation. They perceive that a vegetarian diet will give them more energy, will help them lose weight, or will assuage a health condition, such as heart disease or cancer. Other people become vegetarians out of a concern for the rights of animals or a belief that meat production causes devastating effects to the environment. Some grew up with or adopted a religion (for example, Hinduism, Jainism, Seventh Day Adventism) that encourages or requires a vegetarian diet. Still others are concerned with world hunger and take the view that many more people can be fed on a vegetarian diet than on a meat-based one.

People tend to first stop eating the foods they view as the most offensive or unhealthy. For most gradual vegetarians this is red meat. The typical path for a new vegetarian is to stop eating red meat first, then poultry, and then fish. Some move to further prohibitions by adopting a vegan lifestyle as they eliminate eggs, dairy products, and other animal by-products. As people progress along the vegetarian "path," they tend to adopt new reasons to support their lifestyle practices. Most commonly people begin with a health motivation and gradually become concerned with the humane treatment of animals and protecting the environment, and many develop a disgust response to meat products.

Scientific Controversy and Gradual Acceptance

After the mid-1800s, the medical establishment responded to advocates' claims that vegetarian diets are healthful and desirable. In the 1800s vegetarians were primarily labeled as "quacks" and were characterized in the popular press as weak, sallow, and emaciated. The notion that vegetarians are weak and lack energy persisted throughout the twentieth century.

In the 1970s dietitians and nutritional scientists focused much attention on vegetarian diets, and many considered them a medical problem. These nutritionists were particularly concerned that vegetarians did not consume adequate protein. During the 1970s and 1980s many articles in nutrition journals debated whether or not vegetarian diets were desirable and gave advice about how to deal with obstinate vegetarian clients. Over time, however, dietitians accepted the idea that vegetable protein derived primarily from grains and legumes is not of lesser quality than protein from meat and other animal-based foods. Eventually dietitians accepted their clients' vegetarian lifestyles and began to help them improve those diets instead of trying to convert them to meat eating.

By the early twenty-first century the American Dietetic Association and the U.S. Department of Agriculture both endorsed the healthfulness of vegetarian diets when they are appropriately planned (just as any diet should be). However, new controversies have arisen, particularly regarding the necessity and desirability of consuming milk and other dairy products. This controversy was spurred in the late 1990s in large part by the view of the renowned pediatrician Benjamin Spock that children should be fed a vegan diet after age two. This stance has generated much debate, as it challenges the deep-seated cultural notion that milk is necessary to build strong bones and to foster physical development.

The Vegetarian Movement

Most people adopt vegetarian diets at least in part as a result of interactions with other practicing vegetarians. People rarely become vegetarians in isolation. Through social interactions, people learn the reasons for adopting vegetarian diets and how to successfully follow them. For example, they learn how to cook vegetarian meals and where to buy foods that will ensure that their new diets are both nutritionally sound and personally satisfying. Consequently, vegetarianism is typically much more of a social experience than an individual experience.

Numerous vegetarian organizations facilitate this social learning. Although they are largely distinct from animal rights and environmental organizations, they sometimes share leadership and other resources. At the national level the American Vegan Society, the North American Vegetarian Society, and EarthSave hold conferences, distribute literature on vegetarian diets, and help form local vegetarian societies. In these local groups people interact, share potluck meals, listen to speakers, and sometimes distribute vegetarian literature to the public at local events.

Other national vegetarian organizations, such as FARM, Vegan Action, and Vegan Outreach, encourage vegetarians to take a more activist stance. The Vegetarian Resource Group distributes well-documented, scientifically oriented literature to the public and works with governmental and professional organizations to advance the movement's goals. All of these groups primarily promote vegetarianism through education and embrace the varied reasons for adopting vegetarian diets.

See also **Kellogg, John Harvey**; **Organic Food**; **Pythagoras**; **Vegetables**.

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Donna Maurer

VITAMIN C. Vitamin C is also known as ascorbic acid, because it is the "anti-scorbutus" vitamin (*scorbutus* being the Latin name for the disease of scurvy). Unlike other vitamins, it is only required by a few species, particularly humans, but also guinea pigs and bats. Others, such as dogs and cats, make it for themselves by oxidizing glucose. Species that require the vitamin have lost the key enzyme that manufactures vitamin C because of a genetic mutation during evolution, in a period when the natural diet was vitamin C–rich, resulting in no disadvantage. The empirical formula of the vitamin is $C_6H_8O_6$; it is a white crystalline powder, freely soluble in water and pleasant tasting, but easily destroyed by heat and oxidation. A daily intake of as little as 7 milligrams (mg) has been found to be sufficient to prevent the development of signs of scurvy, but the usual recommendation is that adults should aim to take some 70 mg per day, partly as a safety factor. One school of thought recommends much higher intakes, of perhaps 1,000 mg, on the grounds that its antioxidant properties will increase resistance to infections, aging, and cancer. This assertion remains controversial, however. The Institute of Medicine recommends 2,000 mg/day as the tolerable upper intake level for adults. High levels may have a laxative effect, but this is welcomed by many people. The main natural sources of the vitamin are fresh fruits and vegetables. One of the first fruits valued for its antiscorbutic activity was the orange—each one containing some 50 to 75 mg of the vitamin. In contrast, an apple of similar size has only 7 mg. Potatoes have been an important source of the vitamin in some cultures, not because they are particularly rich, but because they have been consumed in large amounts.

The value of potatoes as a source of vitamin C is influenced by the way in which they are prepared. Thus, one large potato cooked in its skin in a microwave oven may supply 30 mg of the vitamin, but the same quantity may supply only a third of that or even less when boiled, mashed, and reheated on a buffet table. One problem has been to understand how Eskimos, in their traditional lifestyle, managed to obtain enough vitamin C when they had no access to fruits or vegetables. Although fully cooked meats have lost essentially all their vitamin C, the scarcity of fuel meant that the Eskimos could only bring a piece of meat just to the boil in water. They then drank the vitamin-rich broth and ate the meat, thus meeting their need for vitamin C. Liver cooked in this way is richer than muscle meats in vitamin C. Cows' milk too loses most of its vitamin C when heat-sterilized or "condensed," and infantile scurvy has been a problem where mothers have economized by using canned milk as a complete food for their infant.

See also **Beriberi; Niacin Deficiency (Pellagra); Nutrient Bioavailability; Nutrients; Nutrition; Scurvy; Vitamins**.

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Kenneth John Carpenter

VITAMINS.

Overview

The word "vitamin" came from the term *vita mines* (vital amines), which was introduced by Casimir Funk, who, in 1912, isolated a growth factor from rice polishings that contained an amine (a compound incorporating a nitrogen atom with two hydrogen atoms) and could cure the disease beriberi. Several other growth factors were identified early in the twentieth century as well, and these substances were also called vitamins even though they did not contain an amine. Vitamins are classified into two major groups: fat-soluble and water-soluble. (See the Appendix for a complete chart of vitamins.)

Fat-Soluble Vitamins

Vitamin A. In the early 1900s, Sir Frederick Hopkins demonstrated that animals would not grow if lard was provided as a sole dietary lipid. When a small quantity of milk containing fat was added to the diet, the animals thrived. The fat-soluble factor was isolated and designated as vitamin A, later called retinol or retinal; these and similar compounds are referred to as retinoids. Carotenoids, which are essentially two retinoids joined tail to tail, are inactive forms of vitamin A and are called provitamin A. They are converted to vitamin A in the intestine and liver. Vitamin A and carotenoids are absorbed in the chylomicron (a lipoprotein particle that transports lipids from the intestine) fraction and stored in the liver. Some foods such as milk are fortified with vitamin A. Rich sources of carotenoids include carrots, leafy green vegetables, and pink grapefruit.

Vitamin A is, chemically, a subgroup of retinoids, which are defined as a class of compounds that consist of a six-membered ring and a side chain with four conjugated double bonds (four isoprenoid units). The term vitamin A is used to describe retinoids exhibiting qualitatively the biologic activity of the retinoid, retinol.

Vitamin A binds to a retinol-binding protein that transports the light-sensitive vitamin to various target tissues, including the eyes, skin, and gastrointestinal track. The major functions of vitamin A include vision and regulation of cellular proliferation and differentiation. Vitamin A functions on vision by interacting with the rod and cone cells in the retina. It is responsible for absorbing light. The 11-*cis* form of vitamin A (retinal) combines with the protein opsin to form rhodopsin in the rod cells and iodopsins in the cone cells. The rhodopsin and iodopsins absorb light at various wavelengths and trigger a nerve impulse to the visual cortex in the brain that is ultimately perceived as black-and-white and color vision, respectively.

Vitamin A's other major physiologic function is to maintain the health of skin and mucous-secreting cells by regulating their cellular activity and maturation. The dietary requirements depend on age.

The major consequence of vitamin A deficiency, which continues to be a serious nutritional problem among millions of schoolchildren in southern and southeastern Asia and parts of Africa and South America, is night blindness. Vitamin A deficiency can lead to complete blindness and severe damage to the outer covering of the eye (the cornea), often causing it to perforate, with loss of the fluid from inside the eye (keratomalacia). Vitamin A deficiency also produces changes in the skin that are related to the inability of the skin cells to mature and produce keratin properly. This leads to follicular hyperkeratosis and phrynoderma (a condition characterized by rough, dry skin). Vitamin A deficiency has also been linked to increased mortality in early childhood.

Acute and chronic ingestion of excessive amounts of vitamin A can cause a multitude of symptoms and consequences. The most serious is that it can cause severe birth defects, spontaneous abortions and learning defects, and skin and epithelial-cell exfoliation. Inexperienced white explorers of the Arctic who ate polar-bear liver in excess developed severe vitamin A intoxication that caused a total sloughing of their skin and mucous-secreting cells in the upper airway and esophagus, bringing on painful death. (This is in contrast to the indigenous Inuit, who specifically avoid eating polar-bear liver.)

Vitamin D. One of the consequences of the industrial revolution was the high incidence of the bone-deforming disease rickets. It was estimated, at the turn of the twentieth century, that more than ninety percent of children living in the industrialized cities of northern Europe and the northeastern United States had rickets. It had been known that cod-liver oil possessed a factor that had antirachitic activity. Originally, it was thought that the antirachitic factor was vitamin A. However, Hopkins heated cod-liver oil to destroy the vitamin A activity and demonstrated that it still possessed antirachitic activity. This new fat-soluble vitamin was labeled vitamin D. It was also recognized that exposure of food, animals, and humans to ultraviolet radiation also prevented and cured rickets.

There are two principal forms of vitamin D: Vitamin D_2 comes from the precursor ergosterol found in yeast and plants, and vitamin D_3 comes from the cholesterol precursor 7-dehydrocholesterol that is found in the skin of reptiles, birds, mammals, and humans. Vitamin D_2 and vitamin D_3 are essentially equally active in most birds and in most mammals, including humans. Chickens and New World monkeys, however, cannot utilize vitamin D_2. There are very few foods that naturally contain vitamin D. Fatty fish, such as salmon and mackerel, and fish-liver oils, such as cod-liver oil are good sources of vitamin D. Cow's milk and human milk have very little vitamin D. However, in the United States and Canada, milk and some breads and cereals are fortified with vitamin D. In Europe, fortification of foods with vitamin D was outlawed when sporadic cases of vitamin D intoxication were observed in children in the 1950s. Today some margarine and cereals are fortified with vitamin D in Europe, but milk is not.

Vitamin D_3 is made by the action of sunlight on the skin. Provitamin D_3 (7-Dehydrocholesterol) absorbs solar ultraviolet B radiation (wavelengths 290–315 nm) and is transformed into previtamin D_3. Previtamin D_3 is unstable at body temperature and isomerizes (rotates its double bonds) to vitamin D_3. Once formed, vitamin D_3 leaves the skin and enters the circulation, bound to the vitamin D binding protein. It travels to the liver where it is activated to 25-hydroxyvitamin D [25(OH)D]. This form, however, is biologically inert at physiologic concentrations and is the major circulating form of vitamin D. It is, nevertheless, the form that is measured to determine the vitamin D status of an individual, because it represents a summation of dietary and skin sources of vitamin D. 25(OH)D is transported on the vitamin D binding protein to the kidney, where it undergoes its final activation on carbon 1 to form 1,25-dihydroxyvitamin D [1,25$(OH)_2$D], the biologically active form of vitamin D.

The principal function of vitamin D is to maintain blood calcium and phosphorus in the normal range in order to promote neuromuscular function and to maintain metabolic activities. It accomplishes this by enhancing the efficiency of intestinal calcium transport in the small intestine and by stimulating precursor cells of osteoclasts to become mature osteoclasts. Among the functions of osteoclasts is to remove calcium from bone. Serum calcium and phosphorus are in the form of $Ca_x(PO_4)$. When these compounds are in the normal range, they are in a supersaturated state that can thus be deposited in the skeletal matrix as calcium hydroxyapatite.

1,25$(OH)_2$D interacts with a receptor in the nucleus of cells, known as the VDR (vitamin D receptor). It also complexes with the "retinoic acid x" receptor in that cellular structure. These receptor-activated vitamin D complexes find their way to genes that have responsive elements known as the vitamin D-responsive element. These elements in turn unlock genetic information that is responsible for various biologic functions in intestine and bone. It is recognized that a wide variety of tissues including the brain, parathyroid glands, breast, pro state, stomach, and skin also have VDR. Although the exact physiologic function of 1,25$(OH)_2$D in these non-calcium-regulating tissues is not well understood, 1,25$(OH)_2$D inhibits cellular proliferation and induces terminal differentiation of a wide variety of cells, including bone, skin, skeletal muscle, breast, and prostate. The dietary requirement depends on age.

Vitamin D deficiency results in a decrease in the efficiency of intestinal calcium absorption that in turn leads to a decrease in unbound or free calcium concentrations in the circulation. This is recognized by the parathyroid gland and results in an increase in the production and secretion of parathyroid hormone (PTH). PTH enhances calcium reabsorption by the kidney and causes increased output of phosphate in the urine. PTH also stimulates the kidney to produce more 1,25$(OH)_2$D. The net effect of vitamin D deficiency is a low-normal serum calcium and a low serum phosphorus (due to the PTH-induced phosphate wasting in the kidney). Thus calcium and phosphorus concentrations fall below supersaturating levels, thereby resulting in poorly mineralized bone. In children, this causes rickets and, in adults, osteomalacia. In addition, vitamin D deficiency in adults can precipitate and exacerbate osteoporosis. In winter, little if any vitamin D can be made in the skin of people who live above 40° north or below 40° south of the equator. An increase in the zenith angle of the sun due to latitude, time of day, and season of the year will dramatically reduce the production of vitamin D_3 in the skin. Moreover, aging and sunscreen use can markedly reduce the production of vitamin D by more than 60 percent and 99 percent, respectively. Rickets due to vitamin D deficiency in children may include bowlegs or knock-knees, widening of the ends of the long bones, growth retardation, and muscle weakness. In adults, in addition to osteomalacia and increased risk of osteoporosis, it causes bone pain, muscle weakness, and fractures.

The safe upper limit for Vitamin D is 2,000 units a day. Although it is difficult to ingest enough to cause vitamin D intoxication, it can occur. Usually, oral ingestion of 10,000 units a day and greater will cause vitamin D intoxication. This intoxication causes an elevation in the blood levels of calcium and phosphorus, which results in the calcification of soft tissues, including the kidney and major blood vessels, and may also cause the formation of kidney stones.

Vitamin E. The discovery of vitamin E (tocopherols—from *toc-* meaning 'childbirth', *phero-* meaning 'bringing forth', and *-ol* representing the alcohol portion of the molecule) was due to the observation that supplementation of the diet with vitamin E prevented fetal death in animals that were fed a diet containing rancid lard. There are eight naturally occurring vitamin E compounds. Four of them are known as tocopherols and four are known as tocotrienols. The most abundant form of vitamin E is alpha-tocopherol. One of the major functions of vitamin E is to act as a biologic antioxidant to protect the sensitive cellular membranes from oxidative destruction. The major sources of vitamin E consumed by Americans are vegetables and seed oils, such as corn oil, soybean oil, and safflower oil. Wheat germ is a rich source of vitamin E. Although butter contains very little vitamin E, American margarine contains a significant amount of this antioxidant vitamin.

Vitamin E, like the other fat-soluble vitamins, is absorbed in the chylomicron fraction into the lymphatic system and is transported into the venous blood. The dietary requirements depend on age.

There have been difficulties in defining a clinical syndrome that correlates with vitamin E deficiency in humans. Vitamin E deficiency is associated with anemia in newborns.

Toxicity from excess vitamin E has been associated with increased bleeding tendency in adults and impaired immune function, decreased levels of vitamin K-dependent clotting factors, and impairment of leukocyte function.

Vitamin K. Vitamin K was discovered by Henrik Dam in Copenhagen in 1929. He observed that chicks fed a fat-free diet developed severe bleeding under the skin and in the muscle and other tissues. He named this new fat-soluble vitamin, vitamin K (for "Koagulation vitamin"). Vitamin K is distributed widely in both animal and vegetable foods as well as in milk. It comes in several forms: vitamin K_1 comes from plants and is known as phylloquinone, and vitamin K_2, first isolated from fish meal and in animal foods, comprises a group of compounds known as menaquinones. In addition, bacterial flora in the intestine synthesize menaquinones that are bioavailable.

Vitamin K, like other fat-soluble vitamins, is absorbed in the chylomicron fraction and then appears in the lymph and subsequently in the venous circulation. The major physiologic function of vitamin K is to activate blood-clotting proteins. This is accomplished by the modification of a substance, glutamate, found in several precoagulant factors, including factors II, VII, VIIII, and X, that are produced in the liver. Vitamin K is also responsible for the modification of other proteins, including the major noncollagenous protein in bone. The dietary requirements depend on age.

Vitamin K deficiency is rare because of the widespread distribution of the vitamin in plant and animal foods and because microbiotic flora in the normal gut synthesize menaquinones. However, vitamin K deficiency in breast-fed newborns remains a major worldwide cause of infant morbidity and mortality. Infants have very little stored vitamin K at birth, and the gut is nearly sterile during the first few days of life. As a result, infants can develop a severe bleeding condition known as hemorrhagic disease of the newborn if they do not obtain vitamin K during the first few days of life from an exogenous source, particularly since mother's milk contains little vitamin K and few bacteria other than those it picks up from maternal skin as an infant suckles. Adults who have intestinal malabsorption syndrome and who are taking antibiotics can become severely vitamin K-deficient. This can lead to generalized bleeding from all orifices.

There are no reported cases of intoxication due to excessive ingestion of phylloquinone. Ingestion of excessive amounts of menadione, a vitamin K precursor, can cause anemia secondary to the destruction of red blood cells, and an alteration in bilirubin metabolism causing hyperbilirubinemia in infants (kernicterus).

Water-Soluble Vitamins

Thiamine (vitamin B_1). Beriberi is a disease with a constellation of systems affecting the nervous and cardiovascular systems. It was first described by the Chinese in 2697 B.C.E. In 1926, B. C. P. Jansen and W. F. Donath identified a factor from rice-bran extracts that prevented beriberi. The antiberiberi factor was identified chemically and called thiamine (vitamin B_1). Thiamine is found in yeast, lean pork, and legumes. It serves as a receptor for high-energy pyrophosphate. It is this form of the vitamin that provides its chemical function. Pyrophosphate is extremely important for the generation of energy in the cell. However, it cannot enter the cell unless it is attached to thiamine. Thiamine is absorbed by the small intestine and transported to the liver. The major biochemical function of thiamine is to act as a coenzyme (that is, to provide a transfer site) in the alpha-keto acid carboxylation pathway. The dietary requirements depend on age.

Thiamine deficiency causes beriberi. Anorexia, neuritis, gastrointestinal dysfunction, cardiac irregularities, and muscle atrophy are present. There are three types of this disorder: wet, dry, and infantile. Wet beriberi is associated with body fluid retention (edema). Dry beriberi is related to neurologic abnormalities. It is recognized that alcoholics who have poor nutrition and thiamine deficiency, when receiving intravenous fluids, for example in the emergency room of a hospital, can develop severe altered mental states known Wernicke's and Korsakoff's syndromes. Wet beriberi is associated with heart abnormalities; dry beriberi is associated with neurological abnormalities that can cause permanent confusion if not treated in a timely manner.

Excessive ingestion of thiamine is cleared by the kidneys. There is no evidence that ingesting excessive amounts causes toxicity.

Riboflavin. In the 1920s, another water-soluble vitamin was discovered; it exhibited antipellagra activity and was termed vitamin B_2. The substance was found to be yellow in color and was identified as a coenzyme, riboflavin 5'-phosphate (flavin mononucleotide or FMN).

The more abundant form of this vitamin is a complex flavin-adenine dinucleotide (FAD) that also participates as a coenzyme. Usually, the FMN and FAD are associated loosely with proteins and are released in the acidic gastrointestinal juices. The vitamin is absorbed by the proximal small intestine. Sources of riboflavin include eggs, lean meats, milk, broccoli, and enriched breads and cereals.

The physiologic function of riboflavin is to participate in oxidation-reduction reactions in numerous metabolic pathways and in energy production via the respiratory chain in the mitochondria. The dietary requirements depend on age.

Riboflavin is distributed widely in foodstuffs, and therefore deficiency is not common. However, there are reported cases of deficiency that are characterized by sore throat, hyperemia and edema of the pharyngeal and oral mucosal membranes, cheilosis (abnormal scaling and fissuring of the lips), angular stomatitis (surface inflammation of the mouth), glossitis (inflammation of the tongue), seborrheic dermatitis (an inflammation of the skin involving oversecretion by the oil-producing cutaneous glands), and anemia. Severe riboflavin deficiency can affect the conversion of vitamin B_6 to its coenzyme and reduce the conversion of tryptophan, an amino acid found in proteins of animal and plant origin, to niacin (see next section). Deficiency is principally due to abnormal digestion, abnormal absorption, or both. People who are lactose-intolerant—a condition that is most common among blacks and Asians—often limit consumption of milk (as noted above, an excellent source of riboflavin); they may therefore be at increased risk for riboflavin deficiency. Intestinal malabsorption syndromes, including tropical sprue celiac disease, small bowel resection, and gastrointestinal and biliary obstruction can lead to riboflavin deficiency.

There is no evidence that toxicity can occur as a result of excessive ingestion of riboflavin. The most likely reason for this is that riboflavin is cleared rapidly by the kidney and is not stored in the body.

Niacin. In the mid-1700s, a Spanish physician, Gaspar Casal, recognized a disease known as pellagra that caused diarrhea, dementia, and dermatitis in maize-eating (corn-eating) populations throughout the world. In 1937, Conrad Elvehjem and his colleagues observed that nicotinic acid was an effective treatment for pellagra. Nicotinic acid is synonymous with both niacin and nicotinamide. It is associated with ribose lyphosphate to form nicotinamide adenine dinucleotide (NAD) and NAD phosphate. Most niacin in food is present as a component of NAD or NADP and is relatively stable to cooking and storage. Good sources of niacin include meats (especially liver), fish, legumes such as peanuts, some nuts, and some cereals. Both coffee and tea also contain reasonable amounts of this vitamin. Niacin is unique among the B vitamins because its precursor amino acid, tryptophan, can help meet the daily niacin requirement.

Niacin has a multitude of physiologic functions in a wide variety of metabolic pathways that are related to energy production and biosynthetic processes. At least two hundred enzymes are dependent on NAD and NADP. Both of these substances act as electron acceptors or hydrogen donors. Most NAD-dependent enzymes are involved in catabolic reactions, whereas NADP is used more commonly for reductive biosyntheses of fatty acids and steroids, for example. The dietary requirements depend on age.

Niacin deficiency causes pellagra. This condition is associated with diarrhea, dementia, and dermatitis. It is endemic in India and in parts of China and Africa. The classic appearance of pellagra is a pigmented rash that develops symmetrically in areas of the skin exposed to sunlight. The tongue can become bright red and there is often vomiting and diarrhea. Patients can also exhibit anxiety or sleeplessness, and can become disoriented and delusional.

Nicotinic acid is now used to treat hypercholesterolemia. Side effects of large amounts of nicotinic acid include flushing of the skin, abnormalities in liver function, and hyperglycemia. At extremely high ingestion levels, nicotinamide causes death in rats.

Pyridoxine (vitamin B_6). Vitamin B_6 was identified in the 1930s. Like many of the water-soluble B vitamins, vitamin B_6 includes a group of compounds that act as a coenzyme phosphate donor. These include pyridoxal 5′-phosphate (PLP), and pyridoxamine 5′-phosphate (PMP). Plants foods contain predominantly pyridoxine, whereas animal products contain primarily pyridoxal and pyridoxamine. Vitamin B_6 is absorbed mainly by the lower small intestine (jejunum).

Like many of the other coenzyme B vitamins, vitamin B_6 has numerous biologic functions that are related to metabolism. B_6 is critically important for the production of glucose. PLP is also necessary for the conversion of tryptophan to niacin, which is why the two are often associated. The dietary requirements depend on age.

As with many of the other B vitamins, there are a wide variety of clinical symptoms associated with vitamin B_6 deficiency including an abnormal electroencephalogram, convulsions, stomatitis, cheilosis, glossitis, irritability, depression, and confusion.

High doses of pyridoxine have been used to treat premenstrual syndrome and other neurological diseases. Such uses have resulted in neurotoxicity and photosensitivity.

Pantothenic acid. Pantothenic acid was one of the more difficult vitamins to isolate and separate from the other water-soluble B vitamins. Finally in the 1940s, it was synthesized and was found to be associated with coenzyme A (CoA). CoA is an essential cofactor for biologic acetylation reactions and participates in the respiratory tricarboxcylic acid cycle, fatty-acid synthesis and degradation, and a wide variety of other metabolic and regulatory processes. The dietary requirements depend on age.

Pantothenic acid deficiency affects the adrenal gland, nervous system, skin, and hair adversely. Pantothenic acid deficiency in humans is rare, but has been associated with fatigue and depression.

High doses of calcium pantothenate have not been found to be toxic in humans.

Folic acid and cobalamin (vitamin B_{12}). In the mid-1800s, several physicians recognized that a severe form of anemia was associated with disorders of the digestive system. In 1934, William Castle and his associates observed that normal human gastric juice contained an intrinsic factor (IF) that combines with an extrinsic factor in animal-protein food, resulting in the absorption of a vitamin that prevents anemia. Vitamin B_{12} was isolated in 1948 and was shown to be the extrinsic antianemia factor.

Vitamin B_{12} absorption is unique among the B vitamins, in requiring an IF to help its absorption. Folate, on the other hand, is absorbed directly by the upper (proximal) small intestine.

Whereas vitamin B_{12} is found only in animal protein, folates are common in nature and present in nearly all natural foods. The dietary requirements depend on age.

Vitamin B_{12} deficiency can occur either because of inadequate vitamin B_{12} ingestion or because of the loss or inadequacy of production of intrinsic factor in the stomach. The two most notable clinical signs of vitamin B_{12} deficiency include megaloblastic anemia and neurological deficits. Vitamin B_{12} deficiency can cause paresthesia (especially numbness and tingling in the hands and feet); the diminution of vibration and position sense; unsteadiness; poor muscular coordination with ataxia (loss of muscular coordination); moodiness; mental slowness; poor memory; confusion; agitation; depression; and central visual loss. Delusions, overt psychosis, and paranoid ideas may occur in severe deficiency.

Folate deficiency also causes megaloblastic anemia and can cause neurological abnormalities as well, including irritability, forgetfulness, and hostile and paranoid behavior. For adults, ingestion of ten thousand times the minimum requirement for B_{12} and several hundred times that for folic acid has not been associated with toxicity.

Biotin. Biotin was identified in the 1940s. It, like many of the other B vitamins, acts as a coenzyme. Biotin is plentiful in foods such as liver, egg yolk, soybeans, yeast, cereals, legumes, and nuts. With the exception of cauliflower and mushrooms, vegetables, fruits, and meats, however, are poor sources of biotin. Biotin is also present in human and cow's milk. The major physiologic functions of biotin are related to carbohydrate and lipid metabolism. The dietary requirements depend on age.

Biotin deficiency causes mental-status changes, myalgia (muscle pain), hyperesthesia (abnormal sensitivity to pain, touch, cold, etc.), localized paresthesia, and anorexia with nausea. Dermatitis can also be associated with deficiency. The immune system is impaired in biotin-deficient animals. Neurological disorders including seizures and developmental delays have been reported in children. There have been no reports of intoxication due to excessive biotin ingestion.

Vitamin C. Scurvy is recognized as a deficiency disease that has taken a high toll in human suffering and death. The disease, which is caused by vitamin C deficiency, was recognized in ancient times by the Egyptians, Greeks, and Romans. It was especially prevalent among sea explorers of the sixteenth to eighteenth centuries. Typically, sailors developed bleeding and rotting gums, swollen and inflamed joints, dark blotches on the skin, and muscle weakness that occurred within months when at sea. It was the loss of 1,051 sailors in 1774 that prompted the British Admiralty to seek a cure for this devastating disease. They found that lemon or lime juice could prevent the disease. In the late 1920s, Albert Szent-Györgyi and Glenn King isolated vitamin C and identified it as hexuronic acid. Vitamin C is water-soluble and is absorbed efficiently by the small intestine. Its major physiologic function is to provide reducing activity for a wide variety of metabolic steps. It is important for the modification of lysine and proline—two amino acids that are common components of collagen. These modifications result in the cross-linking of collagen strands providing structural support for this essential component of bone and fibrous tissues. The dietary requirements depend on age.

As noted, vitamin C deficiency causes scurvy, which is associated with a wide variety of abnormalities, including hemorrhages under the skin, black-and-blue marks, hyperkeratosis, joint discomfort, edema, weakness, fatigue, lassitude, depression, and hysteria.

It was suggested by the Nobel Prize Laureate Linus Pauling that extremely high doses of vitamin C could prevent cancer. With the exception of excessive amounts of vitamin C causing bowel impaction via a large number of vitamin C tablets ingested, there are very few serious consequences from an overingestion of vitamin C, though it can increase the risk of kidney stones and other renal diseases.

Other nutrients. Other nutrients that are essential could be considered vitamins. These include choline, carnitine, inositol, and taurine.

See also **Beriberi; Choline, Inositol, and Related Nutrients; Inuit; Maize; Niacin Deficiency (Pellagra); Nutrients; Vitamin C; Vitamins: Water-soluble and Fat-soluble Vitamins; Appendix: Dietary Reference Intakes.**

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VITAMINS.

WATER-SOLUBLE AND FAT-SOLUBLE VITAMINS

Vitamins are among the nutrients found to be essential for life. Unlike other classes of nutrients, vitamins serve no structural function nor do they provide significant energy. Their various uses tend to be highly specific. Common food forms of most vitamins require some metabolic activation into a functional (active) form. Although vitamins share these general characteristics, they show few close chemical or functional similarities. For example, some vitamins function as coenzymes, others function as antioxidants, and two vitamins, A and D, function as hormones.

Fourteen substances are now generally recognized as vitamins. Vitamins are frequently described according to their solubility; they may be either fat-soluble or water-soluble. This method of classification dates back to the history of their discovery as labeled by McCollum as "fat-soluble A" and "water-soluble B."

Other sections in this encyclopedia describe the chemistry, biochemistry, and physiology of the vitamins. This article provides additional information that is focused on dietary requirements, upper levels (to avoid toxicity from supplementation), and food sources. (See sidebar for definition of terms, and see Appendix for a complete chart of vitamins.)

DIETARY REFERENCE INTAKES

See Appendix for full chart of Dietary Reference Intakes.

Recommended Dietary Allowance (RDA)—the dietary intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in a particular life stage and gender group.

Adequate Intake (AI)—a recommended intake value based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of healthy people that are assumed to be adequate—used when an RDA cannot be determined.

Tolerable Upper Intake Level (UL)—the highest level of nutrient intake that is likely to pose no risk of adverse health effects for almost all individuals in the general population. As intake increases above the UL, the risk of adverse effects increases.

SOURCE: Food and Nutrition Board, Institute of Medicine. *Dietary Reference Intakes* (FNB, 2000, p. 3).

Water-Soluble Vitamins

Thiamin. Thiamin was the first vitamin to be identified. In modern times, thiamin deficiency is seen most commonly in association with chronic alcoholism. Only a small percentage of large doses are absorbed, and elevated serum levels result in its active urinary excretion. After an oral dose of the vitamin, peak excretion occurs in about two hours (Davis et al., 1984). Total body thiamin content in adults is approximately 30 milligrams with a half-life of 9 to 18 days (Ariaey-Nejad et al., 1970).

The recommended dietary allowance (RDA) for thiamin in adult women is 1.1 mg/day and in adult men it is 1.2 mg/day. The RDA for pregnancy and lactation is 1.4 mg/day (FNB, 1998). It should be noted that increased needs exist in persons being treated with hemodialysis or peritoneal dialysis, individuals with malabsorption syndrome, women carrying more than one fetus, and women nursing more than one infant.

There are no reports of adverse effects from the consumption of excess thiamin consumed in food or supplements. No upper level (UL) can be set due to the lack of reported findings associated with adverse effects. Supplements that contain up to 50 mg/day are available over-the-counter with no reported problems.

Food sources from which most of thiamin in the United States is derived include enriched, fortified, or whole-grain products, such as bread, bread products, mixed foods that contain grain, and ready-to-eat cereals. Foods that are especially rich in thiamin include yeast, lean pork, and legumes. Thiamin is absent from fats, oils, and refined sugars. Milk, milk products, seafood, fruits, and vegetables are not good sources.

Riboflavin. The second vitamin discovered was named vitamin B_2 or riboflavin. Most dietary riboflavin is consumed as a complex of food protein. Signs of riboflavin deficiency are sore throat, redness, and edema of the throat and oral mucous membranes, cheilosis (cracking of the skin around the mouth), and glossitis (red tongue). Vitamin B_2 deficiency most often occurs in combination with other nutrient deficiencies. The B vitamins are quite interrelated; for example, niacin requires riboflavin for its formation from the amino acid tryptophan, and vitamin B_6 requires riboflavin for conversion to the active coenzyme form (McCormick, 1989).

The RDA for riboflavin has been set at 1.3 mg/day for men and 1.1 mg/day for women through age seventy years and older. For pregnancy, the RDA for riboflavin is set at 1.4 mg/day and it is 1.6 mg/day for lactation (FNB, 1998).

When riboflavin is absorbed in excess, very little is stored in the body tissues. Excess is excreted via the urine, and the amount varies with intake, metabolic events, and age (McCormick and Greene, 1994). No adverse effects associated with riboflavin consumption from food or supplements have been reported. No adverse effects were reported from a single dose of up to 60 milligrams and 11.6 milligrams of riboflavin given as a single intravenous (IV) dose (Zempleni et al., 1996).

The greatest contribution of riboflavin from the diet comes from milk and milk drinks, followed by bread products and fortified cereals. Especially good food sources of riboflavin are eggs, lean meats, milk, broccoli, and enriched breads and cereals. Recall that riboflavin loss occurs when it is exposed to light, so store milk in opaque containers or away from the light.

Niacin. The term "niacin" refers to nicotinamide and nicotinic acid. The coenzymes, the active form of niacin in the body, are synthesized in all tissues of the body. The amount of niacin in the body is the result of absorbed nicotinic acid and nicotinamide, as well as conversion of the amino acid tryptophan (60 milligrams of tryptophan = 1 milligram of niacin; Horwitt et al., 1981). Excess niacin is excreted through the urine.

Pellagra is the classical manifestation of niacin deficiency. Pellagra has been seen in areas where corn (low in niacin and tryptophan) is the dietary staple. Enrichment and fortification of grain has virtually eliminated pellagra from the United States and Europe.

The RDA for adult men is 16 mg/day of niacin equivalents, and the RDA for women aged nineteen to over seventy is 14 mg/day. In pregnant women the RDA is 18 mg/day of niacin equivalents and in lactating women it is 17 mg/day (FNB, 1998).

Niacin, given as nicotinic acid in doses from 4 to 6 g/day, is one of the oldest drugs used in the treatment of hyperlipidemia, which consists of elevated blood levels of triglycerides and cholesterol. Niacin lowers low-density lipoprotein (LDL) cholesterol and triglyceride concentration. This therapeutic effect is not seen with nicotinamide. Nicotinic acid in therapeutic doses can cause flushing and headache in some people. These side effects are not harmful.

An upper limit for niacin was set at 35 mg/day for adults, if the niacin is obtained from supplements, not foods. Individuals who take over-the-counter niacin to "self-medicate" may exceed the UL on a chronic basis. The UL is not intended to apply to those receiving niacin under medical supervision.

Dietary intake of niacin comes mainly from mixed dishes containing meat, poultry, or fish, followed by enriched and whole-grain breads, and fortified cereals. Significant amounts of niacin are found in red meat, liver, legumes, milk, eggs, alfalfa, cereal grains, yeast, and fish.

Vitamin B_6. Vitamin B_6 is a coenzyme for more than 100 enzymes involved in the metabolism of amino acids, glycogen, and nerve tissues (FNB, 1998). Microcytic anemia, reflecting decreased hemoglobin synthesis, can be seen in deficiency states. The interaction of vitamin B_6 and folate (another B vitamin discussed below) has been shown to reduce the plasma concentrations of homocysteine and decrease the incidence of cardiovascular disease (CVD) risk (Rimm et al., 1998). Subjects with the highest intake of folate and vitamin B_6 had a twofold reduction in CVD as compared to the group with the lowest intake.

In the 1970s there was quite a bit of discussion about the status of vitamin B_6 in women using oral contraceptives. This was probably an artifact of hormonal stimulation of tryptophan catabolism rather than vitamin B_6 deficiency. At the time these studies were conducted, estrogen concentrations were three to five times higher in contraceptive agents than they are today.

The RDA for vitamin B_6 is 1.3 mg/day for adult men and women up to age fifty years. The RDA for people over fifty years of age is 1.7 mg/day for men and 1.5 mg/day for women. For pregnant women the RDA is set at 1.9 mg/day and for lactating women, 2.0 mg/day (FNB, 1998).

No adverse effects have been associated with intakes of vitamin B_6 from food. However, large doses of pyridoxine used to treat carpal tunnel syndrome and premenstrual syndrome have been associated with sensory neuropathy (Schaumburg and Berger, 1988). These findings were noted with dosages from 2 to 6 g/day. It appears that the risk of developing sensory neuropathy decreases quite rapidly at dosages below 1 g/day. Thus, the UL for adults is set at 100 mg/day of vitamin B_6 as pyridoxine.

Food sources of vitamin B_6 include fortified, ready-to-eat cereals; mixed foods with meat, fish, or poultry as the main ingredient: white potatoes, starchy vegetables, and noncitrus fruits. Vitamin B_6 is widely distributed in foods; good sources are meats, whole-grain products, vegetables, and nuts.

Folate. Folate is a B vitamin that exists in many chemical forms (Wagner, 1996). Folic acid, the most stable form of folate, occurs rarely in food, but is the form used in supplements and fortified food products. Folate coenzymes are involved in numerous reactions that involve DNA synthesis, purine synthesis, and amino acid metabolism. The most well known is the conversion of homocysteine to methionine. It is this reaction that reduces the concentration of homocysteine in the plasma, and may lower the risk of cardiovascular disease (Rasmussen et al., 1996).

The metabolic interrelationship between folate and vitamin B_{12} may explain why a single deficiency of either vitamin leads to the same hematological changes. In either folate or vitamin B_{12} deficiency, megaloblastic changes occur in the bone marrow and other replicating cells.

Pregnant women are at risk for developing folate deficiency because of the heightened demands imposed by increased synthesis of DNA. Low folate status is associated with poor pregnancy outcome, low birth weight, and fetal growth retardation (Scholl and Johnson, 2000). Because of the possible incidence of neural tube defects (NTDs) during the preconception period (that is, just before and during the first 28 days of conception), the Food and Nutrition Board recommends that women who are capable of becoming pregnant should consume 400 μg/day of synthetic folic acid, derived from dietary supplements or fortified food, in addition to their usual dietary intake (FNB, 1998). NTDs are the most common major congenital malformations of the central nervous system.

Recommendations for intake of folate are dependent on variation in bioavailability. Supplemental folate is nearly 100 percent absorbed, while absorption of folate found in foods is only about 50 percent. Fortified foods approach the level of bioavailability of folate found in supplements. This has led to the term Dietary Folate Equivalents or DFEs. Thus, dietary recommendations for folate intake are based on "folate equivalents." One μg of folate equivalents = 1 μg of food folate = 0.5 μg of folic acid taken on an empty stomach or = 0.6 μg folic acid with meals. The RDA for women is 320 μg dietary folate equivalents and for men it is 400 μg. During pregnancy 600 μg/day of folate is recommended and 500 μg/day is recommended during lactation (FNB, 1998).

No adverse effects have been associated with the consumption of normal folate-fortified foods. However, the risk of neurological effects that result from vitamin B_{12} deficiency that are masked with high doses of folate caused the FNB to set a UL. The UL for adults, nineteen years and older, is set at 1,000 μg/day of folate from fortified food or supplements.

Folates are found in nearly all natural foods. Protracted cooking or processing may destroy folate. Foods with the highest folate content include yeast, liver, other organ meats, fresh green vegetables, and some fruits (oranges, for example). Most of the dietary intake of folate in the United States comes from fortified ready-to-eat breakfast cereals followed by a variety of beans and peas, fresh and dried. As of 1 January 1998, all enriched cereal grains, pasta, flour, and rice are required to be fortified with folate at 1.4 mg/kg of grain.

Vitamin B_{12}. Cyanocobalamin is the compound we call vitamin B_{12}. This is the only vitamin B_{12} preparation used in supplements. An adequate supply of vitamin B_{12} is essential for normal blood formation and neurological function. The absorption of vitamin B_{12} is dependent on several physiological steps. In the stomach, food-bound vitamin B_{12} is dissociated from proteins in the presence of stomach acid. Vitamin B_{12} then binds with protein and in the intestine the vitamin B_{12} binds with intrinsic factor for absorption. If there is a lack of sufficient acid in the stomach or intrinsic factor in the intestine, malabsorption occurs and the resulting condition caused is pernicious anemia.

The anemia of vitamin B_{12} deficiency (completely reversed by addition of B_{12}) is indistinguishable from that seen with folate deficiency. Because up to 30 percent of people older than fifty are estimated to have atrophic gastritis with low stomach acid secretion, older adults may have decreased absorption of B_{12} from foods. Thus, it is recommended that most of the vitamin B_{12} consumed by adults greater than fifty-one years of age be obtained from fortified foods or supplements.

The RDA of vitamin B_{12} for men and women is 2.4 μg/day, most of that amount coming from fortified foods or supplements in those over fifty years of age. During pregnancy, the RDA is 2.6 μg/day and it is 2.8 μg/day during lactation (FNB, 1998). No adverse effects have been associated with excess B_{12} intake from food or supplements. After reviewing the literature, the FNB found insufficient evidence for determining a UL.

Vitamin B_{12} is present in all forms of animal tissues. It is not present in plants and thus does not occur in fruits or vegetables. Because a generous intake of animal foods is customary in the United States, B_{12} intake from foods is usually adequate. People who avoid eating animal products may obtain most of their requirement through fortified foods.

Vitamin C. Ascorbic acid (the chemical name for vitamin C) is a potent antioxidant in animals and plants. Vitamin C is important in the synthesis of collagen. Some evidence indicates that vitamin C reduces virus activity by inhibiting viral replication (Johnston, 2001). Many anecdotal reports support a role for vitamin C supplementation to reduce the severity of cold symptoms.

Some epidemiological evidence indicates that supplemental vitamin C protects against risk for myocardial infarction. However, large-scale epidemiological studies do not suggest a benefit of vitamin C supplementation on cardiovascular health risks (Kushi et al., 1996).

Non-heme iron absorption from food is enhanced two- to threefold in the presence of 25 to 75 mg of vitamin C, presumably because of the ascorbate-induced reduction of ferric iron to ferrous iron, which is less likely to form insoluble complexes in the intestine. However, vitamin C has no effect on increasing iron absorption from heme iron (Johnston, 2001). Unlike most animal species, humans lack the ability to synthesize ascorbic acid; thus, the diet is the sole source for this vitamin.

The current requirement of vitamin C is 90 mg/day for adult men and 75 mg/day for adult women. During pregnancy the RDA is 85 mg/day, and 120 mg/day during lactation. The UL for vitamin C was set at 2 g/day (FNB, 2000). This level was set as a guideline for people using dietary supplements and was based on reports of gastrointestinal symptoms reported when too much vitamin C was taken.

Almost 90 percent of vitamin C in the diet comes from fruits and vegetables, with citrus fruits, tomatoes, tomato juice, and potatoes being the major contributors. It is also added to some processed foods as an antioxidant.

Pantothenic acid. Pantothenic acid was named after the Greek, meaning "from everywhere," because it is so widespread in foods. Pantothenic acid is essential in the diet because of the inability of animals and humans to synthesize the pantoic acid moiety of the vitamin. Pantothenic acid plays a primary role in many metabolic processes, such as oxidative metabolism, cell membrane formation, cholesterol and bile salt production, energy storage, and activation of some hormones (Miller et al., 2001).

Pantothenic acid deficiency in humans is rare because of its ubiquitous distribution in foods. Many health claims are made regarding the role of pantothenic acid in ameliorating rheumatoid arthritis, lowering cholesterol, enhancing athletic performance, and preventing graying of hair (Miller et al., 2001). However, sufficient information is lacking at this time and so firm recommendations may not be made. No reports of adverse effects of oral pantothenic acid in humans have been reported.

The Food and Nutrition Board (1998) established an adequate intake level (AI) for pantothenic acid of 5.0 mg/day for adult men and women, 6.0 mg/day during pregnancy, and 7.0 mg/day during lactation. As mentioned above, pantothenic acid is found in a wide variety of both plant and animal foods. Because of its thermal lability and susceptibility to oxidation, significant amounts are lost during processing. Rich food sources include chicken, beef, liver, and other organ meats, whole grains, potatoes, and tomato products.

Biotin. In mammals, biotin serves as a coenzyme for reactions that control such important functions as fatty acid metabolism and gluconeogenesis. Biotin is recycled upon degradation of enzymes to which it is bound. Biotin from pharmaceutical sources is 100 percent bioavailable. Deficiency is rare but has been seen in patients on parenteral nutrition without biotin supplementation (Zempleni and Mock, 1999). Lipoic acid and biotin have structural similarities, thus competition potentially exists for intestinal or cellular uptake. This may be of concern in settings where large doses of lipoic acid are administered or taken as supplements (Zempleni et al., 1997).

The Food and Nutrition Board established an AI for biotin due to insufficient data to set an RDA. Adult men and women have an AI of 30 μg/day (FNB, 1998). It is the same for pregnancy and increases to 35 μg/day during lactation. No adverse effects of biotin have been reported. Toxicity has not been reported in patients receiving up to 200 mg orally daily or up to 20 mg intravenously.

Biotin is distributed widely in natural foods. Those rich in biotin include egg yolk, liver, and some vegetables. It is estimated that individuals in the United States consume between 35 and 70 μg/day.

Choline. Choline has been considered a nonessential nutrient because humans can synthesize sufficient quantities. However, when hepatic function is compromised, hepatic choline synthesis is decreased and thus choline is now considered "conditionally" essential. In a 1998 report from the Food and Nutrition Board, choline is considered an essential nutrient (FNB, 1998). The Food and Nutrition Board noted that additional studies on the essentiality for human nutrition are needed. Specifically, the 1998 Food and Nutrition Board study suggested that graded doses of choline intake be studied regarding their effects on organ function, plasma cholesterol, and homocysteine levels.

Choline functions as a precursor for phospholipids and acetylcholine, and betaine. The AI for adult men was set at 550 mg/day and for women at 425 mg/day. For pregnancy, the AI was increased to 450 mg/day and during lactation, to 550 mg/day (FNB, 1998). Due to reports of hypotension (low blood pressure) from excess intake, a UL was set at 3.5 g/day for persons nineteen years and older. Choline and choline-containing lipids, mainly phosphatidylcholine, are abundant in foods of both plant and animal origin. Rich sources include muscle and organ meats and eggs. To date there are no nationally representative estimates of choline intake from food or supplements.

Fat-Soluble Vitamins

Vitamin A. The active forms of vitamin A participate in three essential functions: visual perception, cellular differentiation, and immune function. A number of food sources are available for vitamin A. Preformed vitamin A is abundant in animal foods and provitamin A carotenoids are abundant in dark-colored fruits and vegetables. With a 2001 report from the Food and Nutrition Board (FNB 2001), there has been recognition of a change in equivalency values of various carotenoids to vitamin A. Retinol activity equivalents (RAEs) for dietary provitamin A carotenoids—beta-carotene, alpha-carotene, and beta-cryptoxanthin—have been set at 12, 24, and 24 μg, respectively (see Table 1, below). This decision is based on an extensive review of studies, which are summarized in the FNB report (2001) (see Table 1).

A number of factors affect the bioavailability of carotenoids (Castenmiller and West, 1998). Percent ab-

TABLE 1

Dietary forms of vitamin A and provitamin A carotenoids

Consumed	Absorbed	Bioconverted
Dietary or supplemental Vitamin A (1 μg)	Retinol	Retinol (1 μg)
Supplemental beta-carotene (2 μg)	beta-carotene	Retinol (1 μg)
Dietary beta-carotene (12 μg)	beta-carotene	Retinol (1 μg)
Dietary alpha-carotene or beta-cryptoxanthin (24 μg)	alpha-carotene or beta-cryptoxanthin	Retinol (1 μg)

SOURCE: Adapted from FNB 2001

sorption decreases as the amount of dietary carotenoids increases, and the relative carotene concentration absorbed increases when consumed with oil or associated with plant matrix material. That is part of the plant vitamin source, not separated out as a supplement. The presence of dietary fat stimulates the secretion of bile acids and improves the absorption of carotenoids.

Recommended dietary allowance for men is 900 μg/day of vitamin A and for women 700 μg/day. During pregnancy, RDA is set at 770 μg/day and 1,300 μg/day during lactation. Human infants consume about 400 μg/day of vitamin A in the first six months of life (FNB, 2001).

Based on the literature review, the FNB used liver abnormalities as the critical adverse effect for setting the UL for adults. Issues of carcinogenicity were considered for women of childbearing age. The UL varies slightly with age between 2,800 and 3,000 μg/day of preformed vitamin A in food or supplements for adolescents and adults. Note that alcohol intake enhances the toxicity of vitamin A.

The richest sources of vitamin A are fish oils, liver, and other organ meats. Whole milk, butter, and fortified margarine and low-fat milks are also rich in the vitamin. In the United States carrots, fortified spreads, and dairy products are the leading contributors of vitamin A to the diet.

Vitamin D. Vitamin D is essential for life in higher animals. It is one of the most important regulators of calcium homeostasis and was historically considered the "anitrachitic" factor. The biological effects of vitamin D are achieved only by its hormonal metabolites, including two key kidney-produced metabolites: $1,25(\mathrm{OH})_2$ vitamin D and 24,25(OH) vitamin D. In addition to its role in calcium metabolism, research has identified that vitamin D plays an important role in cell differentiation and growth of keratinocytes and cancer cells and has shown that it participates in the process of parathyroid hormone and insulin secretion (Bouillon et al. 1995).

Vitamin D_3, the naturally occurring form of the vitamin, is produced from the provitamin, 7-dehydrocholesterol, found in the skin under the stimulation of ultraviolet (UV) irradiation or UV light. Vitamin D_2 is a synthetic form of vitamin D that is produced by irradiation of the plant steroid ergosterol. A requirement for vitamin D has never been precisely defined because vitamin D is produced in the skin after exposure to sunlight. Therefore, humans do not have a requirement for vitamin D when sufficient sunlight is available. The fact that humans wear clothes, live in cities where tall buildings block the sunlight, use synthetic sunscreens that block UV rays, and live in geographical regions of the world that do not receive adequate sunlight contributes to the inability of the skin to synthesize sufficient vitamin D (Holick, 1995). Exposure to the sun sufficient for humans to obtain enough UV radiation to synthesize adequate vitamin D can be as little as three weekly exposures of the face and hands to ambient sunlight for 20 minutes (Adams et al., 1982).

A substantial proportion of the U.S. population is exposed to suboptimal levels of sunlight during the winter months. Under these conditions, vitamin D becomes a true vitamin and must be supplied regularly in the diet. The Food and Nutrition Board recommend an AI or adequate intake of vitamin D at 200 IU/day (5 μg) for adults up to fifty years of age (FNB, 1997). For adults over fifty-one, the AI is set at 400 IU/day (10 μg).

To prevent life-threatening hypercalcemia, an upper level (UL) for vitamin D has been set at 2,000 IU/day (50 μg) for adults over age eighteen. The use of $1,25(\mathrm{OH})_2$ vitamin D for treatment of hypoparathyroidism, vitamin D–resistant rickets, renal osteodystrophy, osteoporosis, and psoriasis opens the door for potential toxicity because this form of the vitamin is much more toxic and the body's metabolic controls are bypassed. When this medication is being used, careful monitoring of plasma calcium concentrations is required.

Salt-water fish are good unfortified sources of vitamin D. Small quantities are derived from eggs, beef, butter, and vegetable oils. Fortification of milk, butter, margarine, cereals, and chocolate mixes help in meeting the dietary requirements. Excessive amounts of vitamin D are not available in usual dietary sources. However, excessive amounts can be obtained through supplements that result in high plasma levels of 25(OH) vitamin D.

Vitamin E. Vitamin E (also called tocopherol) is found in cell membranes and fat depots. Because of their chemical structure, there are eight stereoisomers of each of the tocopherols. In addition to each of the stereoisomers, each occur in alpha, beta, gamma, and delta forms (FNB, 2000).

Its most recognized function is to protect polyunsaturated fatty acids (PUFA) from oxidation. PUFAs are particularly sensitive to oxidative damage, and the protective role of vitamin E is supported by a similar antioxidant protection from vitamin C and selenium. One tocopherol molecule can protect 100 or more PUFA molecules from autoxidative damage (Pryor, 2001).

The various forms of vitamin E have different biological activity, with the natural source isomer—*R*,*R*,*R*,-alpha-tocopherol—being the most active. In supplements you may see this isomer called by its former name, *d*-alpha-tocopherol. Synthetic vitamin E is called *all-rac*-alpha-tocopherol or *dl*-alpha-tocopherol in supplements. Biological activities of vitamin E are given in the older international units (IU) or alpha-tocopherol equivalents (alpha-TE). Because of the many forms of vitamin E in plants and available synthetically, the relative activities of each form is complex. Current evidence indicates that vitamin E from natural sources has approximately twice the bioactivity in humans that the *all-rac* (synthetic) vitamin does (Burton et al., 1998).

Based on the literature review, FNB used hemorrhagic (bleeding) effects for the criteria to set the UL. For adults nineteen years and older the UL is 1,000 mg (2,326 mol)/day of any form of supplementary alpha-tocopherol. There is no evidence of adverse effects from intake of vitamin E naturally occurring in foods.

The RDA for vitamin E is 15 mg/day of naturally occurring alpha-tocopherol for adults above nineteen years of age (FNB, 2000). During pregnancy 15 mg/day is recommended and 19 mg/day for lactation.

The tocopherol content of foods varies widely depending on storage, processing, and preparation. The best sources of vitamin E are the common vegetable oils and products made from them. However, most of the tocopherols may be removed in processing. Wheat germ and walnuts also have high amounts of tocopherols.

Vitamin K. Vitamin K was named after the first letter of the German word *Koagulation*. For many years blood coagulation was assumed to be the sole physiological role for vitamin K. We now know that vitamin K plays an essential role in the synthesis of proteins including prothrombin and the bone-forming protein, osteocalcin (Vermeer et. al., 1995).

Dietary vitamin K absorption is enhanced by dietary fat and is dependent on bile and pancreatic enzymes. The human gut contains large amount of bacterially produced vitamin K, but its contribution to the maintenance of vitamin K status has been difficult to assess (Suttie, 1995). The vitamin K produced by bacteria in the gut is less biologically active even though it is stored in the liver and present in blood. Current understanding supports the view that this vitamin K source may partially satisfy the human requirement but that the contribution is much less than previously thought.

The drug warfarin, widely prescribed as an anticoagulant, functions through inhibition of vitamin K. As a result, alterations in vitamin K intake can influence the efficacy of warfarin. The effective dose of warfarin varies from individual to individual, as does the dietary intake of vitamin K. The best solution appears to be to establish the necessary dose of warfarin and urge patients to maintain a constant intake of foods high in vitamin K in their diets. Only a small number of food items contribute substantially to the dietary vitamin K.

The recommended intake is based on an AI or adequate intake of 120 μg/day for men, 90 μg/day for women, and 90 μg/day during pregnancy and lactation (FNB, 2001). No adverse effects have been associated with vitamin K intake in humans from food or supplements. Thus, no UL is set for vitamin K.

Collards, spinach, and salad greens are high in vitamin K. Broccoli, Brussels sprouts, cabbage, and Bib lettuce contain about two-thirds as much, and other green vegetables contain even less. Vitamin K is also found in plant oils and margarine, with soybean and canola oils having the highest amounts. U.S. food intake surveys indicate that spinach, collards, broccoli, and iceberg lettuce are the major contributors of vitamin K in the diet.

See also **Additives; Assessment of Nutritional Status; Dietary Guidelines; Immune System Regulation and Nutrients; Microbiology; Nutrient Bioavailability; Nutrient–Drug Interactions; Nutritional Biochemistry; Appendix: Dietary Reference Intakes.**

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VITICULTURE. *See* **Grapes and Grape Juice; Wine.**

W-Z

WAFFLES AND WAFERS. Waffles and wafers are like many other foods of ancient origin in that the name and the food described have separate histories that eventually merge into one. The wafer traces its origin to ancient Egypt, but the descriptive terms applied to it are generally of medieval origin. In Latin, *oblatao* and *oblatum* were used to denote cakes made with unleavened flour and water worked into a thin flat round or square sheet of pastry and baked until crisp. This Latin root meaning is still employed in many European languages, but with varied interpretations. In modern German, *Oblaten* are both communion wafers and sheets of paper-like material laid under gingerbreads or baked meringues to keep them from sticking to the baking sheet. In Polish, *oplatki* are communion wafers or any wafers resembling them in shape and texture.

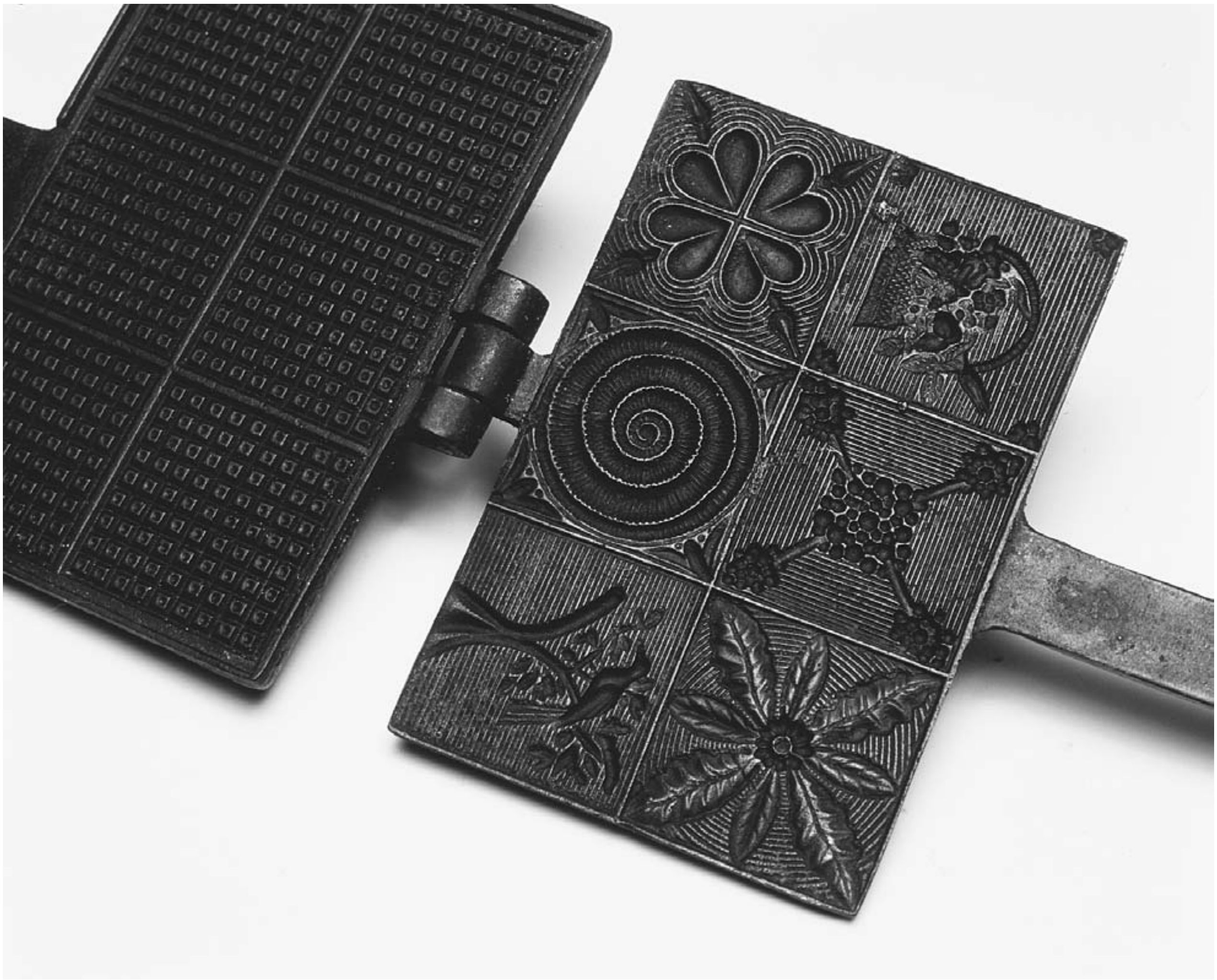
In English, however, the root word stems from medieval German and Anglo-Saxon: *weben*, "to weave," in reference to the crisscrossed pattern on the surface of the wafer. It appears in medieval Frankish as *wafel* and later in medieval French as *waufre*, now written *gaufre*, with the diminutive *gaufrette*. *Gaufre* can also be a honeycomb and in that sense may refer to an ancient pattern imprinted on certain wafers. This same honeycomb design is found on Coptic ritual breads in Egypt and may relate to an extinct votive wafer or flat bread sweetened with honey. Its modern survival may be the Swiss *Tirggel*, a type of honey wafer imprinted with a wide variety of ornamental images.

The wafers of ancient Egypt were prepared from only the finest wheat flour (actually the flour of emmer, a species of primitive wheat). Athenaeus of Naukratis attributed the origin of the wafer's name (*obelias*) to the fact that it cost one *obel* (a thin Greek coin). Since this "fact" was drawn from a literary source, it may well be pure folk etymology. As Otto Meinardus has pointed out repeatedly in his seminal work on early Coptic Christianity, there is a far more fundamental dimension to the wafer since the grain from which it was made was treated as the actual "body of Osiris" (Meinardus 1964 and 1999); thus those who partook of the ritual wafers were said to live by the body of their god. This concept was carried over into Christianity in two forms: in the *oblata hosta* employed as the bread of communion in the Latin church (due perhaps to its similarity in shape and function to ritual bannocks), and in the *fetir* (leavened flat bread), *duhn* (unleavened flat bread), and *qurban* (communion loaf) of the Coptic church. All three Coptic breads may be stamped, although it is mainly the *qurban* that serves as the ritual link to pre-Christian Egypt by virtue of its employment as communion bread. This bread, prepared only by monks from the finest wheat flour, is stamped with a wooden form to create the honey-comb pattern also found on wafers. This pattern is sometimes described by art historians as interlocking crosses.

In addition to the New Testament associations of the communion bread, the Copts also believe that Adam received grains of wheat from the Archangel Michael and therefore must honor god with bread offerings. The Feast of St. Michael on 12 Hatur (21 November) is one of the major Coptic feasts for which a large number of ritual breads are prepared. Thus, some of the earliest depictions of both wafers and round loaves stamped with wafer patterns can be found in Coptic art honoring this saint.

The introduction of the ritual wafer into the West cannot be accurately dated, although in the form taken over by Christians, it may have arrived in connection with the cult of Osiris once found throughout the Roman Empire. It survived solely as a key element of the Latin Eucharist and remained a point of contention with Eastern Orthodoxy, which claimed that the Christ intended leavened bread for the Eucharist. Jacobite Christians even claim to preserve the original sourdough starter.

During the Middle Ages, communion wafers were made by monasteries, which also sold them as a form of fasting food, since they contained no animal fats, eggs, or dairy products. It is evident, however, that the composition of wafers could be elaborated with expensive ingredients like saffron, sugar, and various spices for the benefit of the nobility and other classes of society willing to pay a higher price for a more pleasurable form of self-denial. By the 1200s wafers were well integrated into courtly cuisine and form one of the standard dessert foods served at banquets. One of the earliest references to this appears in the 1285 Anglo-Norman "Treatise of Walter of Bibbesworth," which includes dinner menus set to verse. In one menu, the meal ends with "plenty of wafers" (*oubleie a fuissun*). These were probably sweetened with



Wafer iron for stove-top baking. Made by the Werle Iron Foundry, Ottweiler (Saarland), Germany, ca. 1840–1870. Cast iron. The underside of the wafer depicts the traditional *waben* or "woven" texture while the topside is ornamented with snails, flowers, and hearts. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

sugar from Cyprus and flavored with saffron, since sweet saffron wafers are mentioned many times in medieval manuscript cookery books.

Wafers also played a significant role in localized religious observances in many parts of Europe. In Franconia (a subdivision of modern Bavaria), wafers were especially important on Ascension Day and Pentecost. On Ascension, for example, the Auswerfung des Himmelbrots (showering the manna) was practiced, whereby priests threw wafers and other treats down from the "sky" painted on the church ceiling in imitation of manna falling from heaven—this after a figure of Christ was hoisted up through a trap door as though rising into the clouds. In Alsace, communion wafers were purchased from monasteries and used to ornament the earliest known Christmas trees. In most cases, these wafers were ornamented with religious pictures, Christian symbols, or a simple cross.

Since wafers could be consumed as fasting fare, there was considerable demand for them in towns and cities. This demand led to the secularization of wafer manufacture as a specialized craft organized into guilds. Wafer makers also altered the pictorial imagery employed on wafers, introducing scenes from fables, classical antiquity, coats-of-arms, or symbols of love. Thus the wafer moved from a purely religious context to a middle-class form of dessert, especially for festive occasions. By the 1600s, the irons used to make wafers were commonly found in the homes of well-off burghers, and many Dutch, French, German, Spanish, and Italian still life paintings show wafers, especially those rolled into tubes, scattered among the foods on richly appointed tables. These festive wafers acquired numerous names all over Europe, such as *pizzelle* in Italy, *Eiserkuchen* (iron cakes) in some parts of Germany, or in Holland *Nijarskouk* (New Year's cake). Elsewhere they were called Twelfth Night wafers and were even stamped with fantastic masks or printed with molds to resemble playing cards—this latter motif popular in Switzerland.

Wafers rolled into tubes were not an invention of the Renaissance even though they became popular at that time. The concept is said to trace to the Christians of Syria who were especially well known for their filled pastries during the Byzantine period. One type of wafer was first wrapped around sticks of sugar cane to dry, then removed, filled with various rich mixes of mashed fruit or cheese, and fried or baked. These confections were taken to India by the Syrian Christians who settled there and were continued by the exiled Syrians living in Cyprus during the de Lusignan dynasty (1291–1489). Wafers filled with jelly or used sandwich style for fruits cooked in wine and mashed, continued to be popular as Christmas confections in Europe well into the nineteenth century. Bent into cones, they were used to hold various sweets, and this idea was the basis for the now ubiquitous ice-cream cone commercialized at the U.S. Centennial in 1876.

The waffle is a later offshoot of the basic wafer idea, but taking it to an opposite extreme. Where the wafer served as a metaphor for fasting and self-denial, the waffle became the Protestant symbol of festive luxury. Made with eggs, cream, and other rich ingredients originally forbidden during fast days, the waffle evolved as a type of fat cake baked between irons in imitation of *pain perdu* or French toast. It first appeared in the Low Countries in connection with Christmas, New Year's, Twelfth Night, and Carnival, employing the distinctive honeycomb pattern to render it crispier than a deep-fried slice of toast. Like wafer irons, waffle irons were often given as wedding gifts, and it was the Dutch who settled in New York who brought the waffle custom to North America, for it was otherwise not well known to the English.

In the United States, waffle irons appeared in many eighteenth-century household inventories, especially those of well-to-do families. The popularity of waffles as a special occasion dish (for Sunday breakfast, for example) or as Christmas and New Year's confections gradually spread so that by the Civil War, waffles were available in most hotels, especially as a breakfast or supper food served plain or in combination with various meat fricassees. Ham gravy, chicken gravy, waffles made with a sweet potato batter, all of these and many more permutations appeared on hotel menus. By the early 1900s, once the automobile and the Sunday drive came into fashion, such main course waffle dishes were integrated into the menu of local tourist destinations catering to the Sunday clientele. Waffle dinners of the 1920s and 1930s even become a form of fund-raising for churches and fire companies.

Hot coffee and waffles are popular high-energy breakfast fare in both Europe and America, especially at ski resorts. PHOTO TAKEN AT A FARM KITCHEN OPEN TO SKIERS IN HAFJELLET, NORWAY. © ADAM WOOLFITT/CORBIS.

The electric waffle iron, which first appeared in the 1890s, became a popular tool of the home economics movement, and a popular wedding gift by the end of World War I. It brought the eat-out experience full circle into the home not just for its convenience, but by lowering the perceived cost through boxed waffle mixes, canned gravy preparations, and the like. The processed waffle, entirely pre-made and frozen so that can be cooked in toasters or the microwave oven, is now the supermarket descendant of the rich confection of former times. The fat-free waffle with its New Age ingredients and designer flavors may not evoke a breakfast fit for kings. On the other hand, the costly honey drizzled over it, now imported from the Amazon jungle, can only provoke wonder from the gods of old, whose honeycombed cakes were once a metaphor for eternal life.

See also **Bread**; **Breakfast**; **Christianity**; **Christmas**; **Epiphany**; **Fasting and Abstinence**; **Wheat: Wheat as a Food**.

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William Woys Weaver

WAITERS AND WAITRESSES. The career of the waiter and waitress begins with the industrialization of food. Prior to that, women dominated food preparation and serving in most cultures, and this may have reinforced the suspicions of them as dangerous. Polluted or poisoned foods have been a style of murder favored by women. A notorious poisoner was the Marquise de Brinvilliers (1630–1676) who claimed that half the French court of Louis XIV was engaged in attempted murder. Before her, there was Agrippina (15–59 C.E.), Lucrezia Borgia (1480–1519), and Catherine de’ Medici (1519–1589), who have each been associated with such acts.

The Trusted Sex

In court societies, before the regulations introduced by the modern bureaucratic state, chefs, waiters, and food handlers were appointed by the monarch, and this served as an endorsement of trust. In the modern era, with refrigeration and scientific forensics, the incidence of food pollution and poisoning has dramatically dropped. At the same time, men have entered the food business and become celebrated chefs and restaurateurs. This is not to imply a causal relationship, but an interesting association of gender and status, borne out with examples from the formal restaurants of the late nineteenth century, where respectable women were not allowed as guests but could work—in lowly positions—and where only males were trusted with the job of waiter. They were required to justify that trust by wearing white gloves while serving to demonstrate that their fingers had not slipped into the sauce and then been licked clean.

Waiters and Power

Many pleasures of dining out relate to service and luxury. In the formal restaurant, diners have temporary possession of elegant silverware, crystal and tableware, and the command of others. George Orwell (1933) declares that one should never feel sorry for the waiter who stands by, watching and attending to the pleasures of diners. The waiter is a snob and thoroughly understands the attractions of the experience and wishes only for the opportunity to act exactly as the diner is doing.

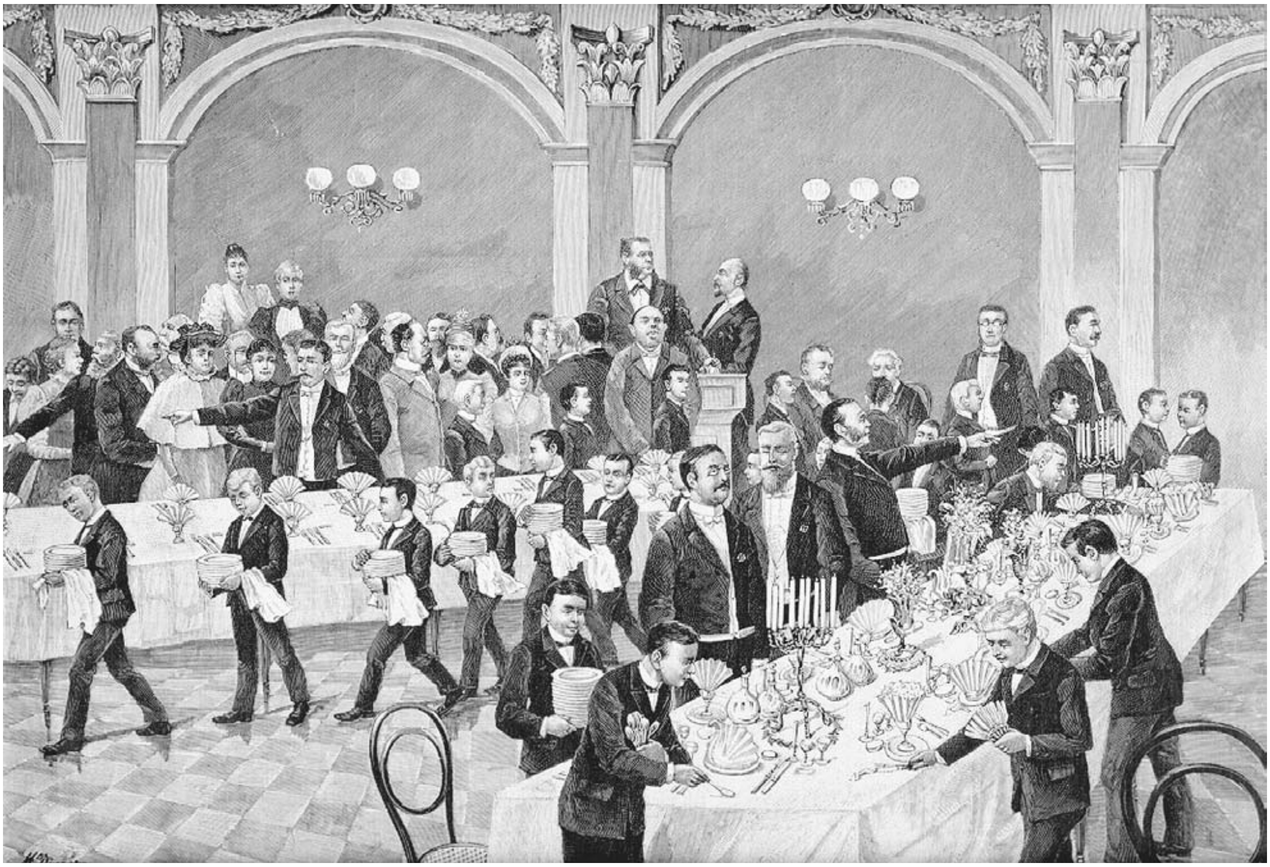
TIPPING

The origins of the term may be the phrase—To Insure Promptitude—or from the slang “tip,” to give. Tipping now operates as a tacit rule in most restaurants other than the fast-food chains and large-scale, self-service canteens. However, even though tipping is almost universal, the rules governing it are not. In the early part of the twentieth century, etiquette manuals offered lengthy advice about it, thereby indicating that it was a problematic exchange in a new, liberal era. Current tourist guides simply state that it is expected, even when there is a service charge already included. The iconic metropolitan comedian, Jerry Seinfeld, tells his urbane New York City audience that we tip in order to prevent violence, such as having our heads smashed into the glass-top table or being chased up the street by the “stiffed” waiter.

There are various contests for power and privilege going on in this setting. Orwell gives the example of personal appearance: the chef wears a moustache to display rank and show contempt for the waiters who do not wear a moustache, who in turn show their superiority by refusing to allow the *plongeur* or dishwasher to wear a moustache. Gerald Mars and Michael Nicod (1984) note the many strategies and tactics employed by waiters, diners, and management to gain advantages over one another. Each of them struggle, using tipping, fiddling (pilfering), and cutting corners, to display their superior status and power to one another.

Service

The great divide between American and European restaurant styles emerges with the industrialization of food, dating from the end of the nineteenth century, when grocery stores (then, supermarkets), factory production, mass marketing of snack foods, and fast-food and chain restaurants began to transform a minor retail activity into a major economic market. American women worked in restaurants after the 1940s (Pillsbury, 1990), making them less formal and more relaxed. Dolores Dante, a waitress of twenty-three years (Terkel, 1972) reported on the pride she took in her work despite the



Final exam for a waiters' school in Berlin, from a wood engraving circa 1880. The parents of the young men watch as they are clocked to set a banquet table in five minutes. ROUGHWOOD COLLECTION.

taunts and insults received from male clients, who mistakenly used the threat of not tipping as a way of gaining her attention and service.

The role of the waiter and waitress has held constant fascination for novelists and social investigators, all of whom comment on the highly charged relationship between the diner and waiter. In formal restaurants, knowledgeable waiters can intimidate diners they consider out of place or presumptuous. Lone women diners, or those with young children, for example, may find the formal restaurant inhospitable because the waiter expects a negligible tip and judges them not to be worth their effort. In short, the pleasures of dining out rest largely on the performance of the waiter.

American Economics vs. European Craft

Americans mostly favor small diners, self-service, or fast-food chain restaurants where the level of service is low and the expectations of customers limited. At the other end of the spectrum, there are prestigious, celebrated, and expensive restaurants where the waiter is required to indulge the demands of diners. Between these extremes is the increasingly popular range of casual restaurants and bistros that often advertise themselves as emulating the more luxurious restaurants. However, in doing so, they create expectations in their customers which, in reality, they cannot deliver. The waiter (and more often waitress) in such restaurants is caught between the efficiencies demanded from the restaurant management and the customers' expectations. In this gap, waiters and waitresses learn short cuts; they may finger the food in order to improve the presentation on the plate; wipe off dirty dishes and cutlery rather than replace them; dilute coffee by making two from one serve and so on. The waiter is caught in a perennially conflict-infused relationship with the management, chef, and diner over presentation, quality, and speed of service (Hughes, 1958; Whyte, 1949).

Dining in America can be theatrical, with gimmick and theme restaurants that require waiters and waitresses to deliver food on roller-skates or to dress in colorful uniforms or theme costumes. With such attractions and diversions, the American restaurant locates itself within the entertainment industries. Accordingly, the waiter or waitress is a performer, spruiking the attractions of the menu, providing amusement, and creating the illusion of service. (Spruiking is a style of advertising in which the waiter is trying to convince his customer about the delights of a certain portion.) Included in the job might be salary incentives for selling the greatest numbers of desserts or menu specials. The European waiter does not traditionally work in such an environment where the numbers of clients and settings determine his salary. The waiter's interests are to enhance the pleasures of eating; thus a European diner in a formal restaurant expects the waiter to demonstrate impeccable manners and elegant style, and not to promote certain dishes. A greater degree of informality exists between the American diner and waiter; more conversation takes place that has little to do with the food and menu and more to do with the sociability of the event. The displays of food craft from waiters such as carving meats, serving portions at the table, and setting cutlery, have largely vanished from the restaurant scene in America, and only re-emerge now and then as part of the entertainment of dining in expensive, formal, elegant restaurants.

See also **Delmonico Family**; **Kitchens, Restaurant**; **Places of Consumption**; **Restaurants**.

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Joanne Finkelstein

WALES. *See* **British Isles.**

WASTE. *See* **Food Waste.**

WATER.

This entry contains three subentries:
Water as a Beverage and Constitutent of Food
Water as a Resource
Safety of Water

WATER AS A BEVERAGE AND CONSTITUENT OF FOOD

The human body has a water content that represents from 65 to 70 percent of its total mass. This means that a 70-kilogram (154-lb.) adult male has a fluid content of 45 to 50 liters of water. Only 3.6 to 4.0 liters or 8 percent of this fluid is in the bloodstream. Of the body's total water content, 60 to 70 percent is within the cells, and an additional 20 percent is in the intercellular space. These fluid compartments differ with respect to certain important constituents such as ions (electrolytes) that play an important role in cell function. The maintenance of homeostatic balance in each of these fluid compartments requires finely tuned interactions of the endocrine system and the organs involved in the absorption and excretion of minerals and other nutrients. The chemical properties of the food and water consumed can have profound effects on the function of the organs maintaining this balance. An extreme example of imbalance with fatal consequences is the dehydration that follows the consumption of salty seawater. When this occurs, the kidneys are forced to increase urine production to rid the body of the excessive salt, with the result that blood and intercellular fluid volume are reduced. In extreme cases such loss can disrupt fluid homeostasis sufficiently to result in death.

Hydration

Humans differ from other primates in relying heavily on evaporative cooling achieved through the sweat response to maintain normal body temperature under increased heat loads. Sweat contains proteins and minerals in addition to water. Heavy, sweat-inducing exercise, especially under warm, humid conditions and in untrained individuals, can result in the loss of excessive salt in sweat. Water loss exceeding twenty liters per day, sometimes as much as three liters per hour, can result from vigorous exercise under desert conditions. Replacement of fluids under such circumstances often requires forcing fluids since the human thirst response lags behind actual requirements, resulting in what has been termed "voluntary dehydration."

Athletes engaged in ultra endurance competition are especially subject to the risk of dehydration, since they typically do not satisfy their fluid requirements while exercising. On the other hand, forced consumption of plain water can, under such circumstances, result in overhydration. Insufficient salt intake can also produce a serious impairment of performance. Under such circumstances, fluids containing electrolytes are necessary to sustain performance. In addition to electrolytes, glucose, or glucose-containing carbohydrates, can enhance water absorption as well as supply supplemental energy for muscle metabolism. However, a carbohydrate concentration exceeding 5 percent weight per volume may actually reduce the rate of water absorption (Rehrer, 2001). Athletic training for endurance competition routinely includes emphasis on increasing the ability to consume sufficient fluids.

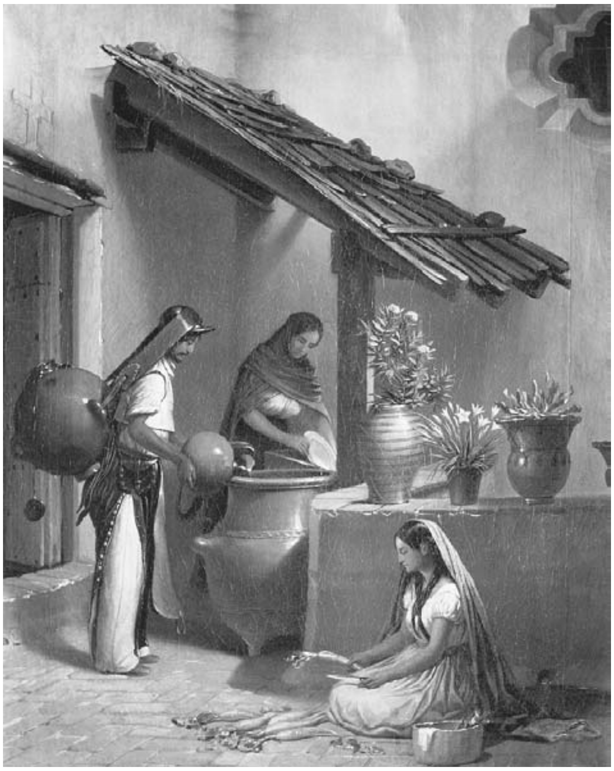
Minerals in Water

In addition to their needs for energy, proteins, and fats, humans require a number of vitamins and minerals. Some of these nutrient requirements, especially those for minerals, can be partially and sometimes totally satisfied through the consumption of drinking water (Costi et al., 1999). The water people drink varies greatly from one area to another. Some communities rely on surface water drawn from rivers and lakes, often stored in reservoirs. Other communities rely on groundwater drawn from subterranean aquifers. Both surface water and groundwater can bear significant loads of salts and other minerals. Water purification systems are usually designed to keep the salinity of drinking water within prescribed limits in areas where water supplies tend to be salty. However, sodium can be detected in most water supplies, sometimes in surprisingly high concentrations. In cities such as Jiddah, Saudi Arabia, that depend entirely on desalinated seawater, the salinity of the drinking water is quite noticeable to the visitor.

Because of its unique chemical properties, water is seldom if ever found in its pure state. Even rainwater contains contaminants absorbed from the atmosphere while in the vapor phase and during its descent to Earth in its liquid phase. However, rainwater is generally considered to be "soft water," since its mineral content is lower than that of most other sources. Water "hardness" is often associated with its calcium content, since drinking water is drawn from aquifers associated with limestone deposits in many parts of the world. In these areas precipitated water percolates through topsoil rich in organic compounds, becoming increasingly acidic in the process. When this acidic water comes into contact with the calcium carbonate of the limestone bedrock, it gradually dissolves the rock and carries its soluble constituents with it into the aquifer. Depending upon the length of time over which this process occurs, the water that finally finds its way into the aquifer can carry a substantial load of calcium and carbonates. Such water may require "softening" if it is to be used to launder clothing, since it tends to precipitate soaps. However, hard water of this sort is potable and may indeed be considered quite desirable as drinking water.

Sources of Drinking Water

While the palatability of drinking water is literally a matter of taste, it is unlikely that pure, distilled water would be considered a desirable beverage. When comparisons of drinking water are made, the samples generally considered most desirable are invariably ones that bear a significant mineral content. For example, the drinking water of New York City, piped in from reservoirs in upstate New York, is considered of superior taste as a result of its mineral content. In other parts of the United States, groundwater drawn from ancient deposits is considered a precious but diminishing resource. A case in point is that of Tucson, Arizona, where Pleistocene water deposits are being withdrawn at a rate faster than normal recharge. Consequently the growing needs of this urban area are projected to be satisfied through increasing use of Colorado River water diverted to Phoenix and Tucson by the Central Arizona Project (CAP). Community resistance to the use of Colorado River water has resulted in a program focused on the "blending" of groundwater with CAP water in an effort to avoid an abrupt change in the perceived quality of the drinking water.



The Water Carrier, nineteenth-century painting by Mexican artist Edouard Pingret. In the age before indoor plumbing, the water carrier was the primary source of drinking water in most cities and towns. Private Collection, Mexico. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

The features of CAP water that have most troubled the Tucson Water Authority are the substantial load of sediment it bears as well as its different mineral composition. The expense of purification to achieve a standard comparable to that of the Pleistocene groundwater long taken for granted has been prohibitive. In an initial attempt to convert to exclusive use of CAP water in a number of Tucson neighborhoods, tap water was found to be turbid, and according to many residents, it had a distinctly unpleasant flavor. It was eventually determined that part of the problem arose from the release of mineral deposits from the water pipes both within and outside residences subsequent to sustained exposure to water having a significantly different chemical profile. The release of these deposits sometimes caused leakage that resulted in property damage and claims for compensation. The problems encountered by the Tucson Water Authority were the result of an unusual set of circumstances coupled with concern for the damage that could occur if the depletion of the local groundwater supply should progress to a point where subsidence caused structural damage to buildings. Concern for the risk of subsidence was

Traditional *cantaro* or water jar. Nicaragua, twentieth century. Brownware pottery. This ancient Mediterranean form was brought to the New World by Spanish settlers. It is still common in Central America. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

well-founded, since parts of Interstate 10 less than fifty miles from Tucson have required repeated repair due to damage directly attributable to subsidence.

The problem of subsidence is of concern in many parts of the world where increasing need for drinking water has led to the depletion of aquifers. It is a concern in the central United States, for instance, in an extensive area overlying the Ogalalla Aquifer. Although the falling water table in this region is largely the result of agricultural use of water, urban growth has had a deleterious impact on aquifer recharge with the result that drinking water supplies are increasingly drawn from surface water sources. The long-term consequence is a decline in both the quality and quantity of drinking water in a number of cities. In coastal areas, depletion of aquifers has led to saltwater incursions that seriously impact the quality of drinking water. As is sometimes the case in midcontinental regions, damage to aquifers in coastal areas can be irreversible, necessitating reliance on alternative sources of drinking water. In the event of a rise in sea level associated with global warming, such reliance will become increasingly widespread. In almost every case the mineral profile of the alternative source will differ from that of the original groundwater, often in ways that alter the taste of drinking water.

Contaminants

Reliance on surface water sources for drinking-water supplies presents numerous problems. Surface water is subject to forms of contamination not usually found in groundwater. During the time it takes for water to percolate from the surface into the aquifer, most of its organic contaminants are left behind. Generally minerals take their place. The array of minerals present in the soil and bedrock determine the character and taste of the groundwater. As a rule the oldest deposits are the deepest. Therefore water pumped up from deep wells is less likely to bear organic contaminants. Additionally, deep wells provide a more stable supply of water since they draw on supplies that are less dependent upon recharge to maintain a constant flow. Shallow wells, such as the tube wells in many parts of Asia, for the most part trap surface water during a rainy season for use during the dry season. Water from such wells resembles surface water more than groundwater and may therefore contain a substantial load of organic contaminants.

The organic contaminants found in the surface water in many parts of the world include agricultural fertilizers and pesticides. Agricultural runoff, which finds its way to the larger streams and rivers before eventually reaching the oceans, contaminates freshwater bodies at all points along the line. In many cases the rich mixture of organic fertilizers entering lakes and rivers stimulates the growth of microorganisms, such as algal blooms. Eutrophication, the overgrowth of algae and other plant life, depletes the water of oxygen. Oxygen depletion limits the range of aquatic species that can inhabit these bodies of freshwater. The eutrophication of freshwater lakes is a serious problem in many parts of the world. It has a serious impact on the quality and quantity of drinking water wherever it occurs.

At least in part because of general distrust in the quality of drinking water, the consumption of bottled water has increased. The commoditization of the drinking-water supply is a fairly recent phenomenon in many parts of the industrialized world. The quality of water available from this source is highly variable. Some is drawn from mountain springs, where the mineral content is consistent and organic contaminants are virtually absent. Other commercially marketed bottled water comes from more dubious sources and may contain a variety of contaminants, including pathogenic organisms in unacceptably high concentrations.

Certain mineral waters, especially those purported to have therapeutic value, have long had a market. These mineral waters were originally consumed at their sources, often at spas, where hot springs produced highly mineralized, often sulfurous water thought to have medicinal properties when consumed or used as a bath. The Romans sought thermal springs throughout the areas they occupied in Europe, and they constructed baths that served as focal points of the communities.

The Romans were well aware of the benefits of a reliable supply of pure drinking water even in the absence of thermal springs, as the many aqueducts in Europe attest. The Romans did not face the problems associated with chemical contamination that accompany modern agricultural methods. However, they were aware of the risk of disease associated with contaminated drinking water and consequently preferred to draw their water supplies from mountain sources whenever possible. To what extent this preference reflects awareness of superior taste as a beverage is not known with certainty, but Roman literature includes many references to the desirable properties of the drinking water in specific parts of the empire.

The widespread marketing of drinking water in industrialized countries reflects in part an increasing awareness of the risks of contamination of conventional sources. This awareness comes at a time of increasing concern for the future supply of potable water for a steadily growing world population. Clearly, water is a basic requirement of life. Freshwater is not evenly distributed over the face of the planet. It is most abundant in places where few people live, and the transport of large amounts of water to the arid and semiarid areas of high population density presents a serious technological challenge. Contamination, both by chemical agents and by pathogenic organisms, is a problem that requires serious attention at every governmental level. Even in the United States, where the safety of the drinking water supply is usually assumed to be assured, occasional events, like the outbreak of a waterborne disease in Milwaukee, point up the fact that surface water supplies in particular are vulnerable. However, recognition of the urgency of the problem has increased public awareness of the necessity of preserving and protecting a fundamental resource, and it appears that drinking water is receiving the level of appreciation it deserves.

See also **Food Supply, Food Shortages.**

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William A. Stini

WATER AS A RESOURCE

The central role played by water in the origin of life has long been acknowledged. As early as the seventeenth century, geologists recognized the extent to which water shaped and reshaped the landforms on the earth's surface. More recently, it has been argued that water plays a fundamental role in the formation of stars (Nisini, "Water's Role in Making Stars"). According to this account of the process of star formation, water may be present in two of its physical states, ice (a solid), and water vapor (a gas) in the earliest stages of the birth of a new star. During this phase, ice on the surface of dust particles contributes to the cooling of circumstellar gases by removing excess energy released during protostellar collapse. At the same time, water vapor serves as a reservoir of oxygen in the warmer sectors of accumulating mass. Certain of the peculiar physical and chemical properties of water to be discussed later make water uniquely qualified to participate in this seminal cosmological event.

Since stars form as the result of the gravitational collapse of dense molecular clouds, almost all of the water present in its earliest stages is found in the ice coats of dust grains. A small amount, however, is produced as vapor through a series of reactions beginning with H_3^+ and O and resulting in the formation of H_2O and O_2. As star formation proceeds and gravitational collapse accelerates, increasing amounts of radiation energy are released. Consequently, the ambient temperature rises dramatically, and the temperature of the dust grains attains a level where water is released by evaporation. As the temperature continues to rise, all available atomic oxygen is rapidly transformed to water by the following reactions:

1. $O + H_2 \longrightarrow OH + H$
2. $OH + H_2 \longrightarrow H_2O + H$

As the process of star formation moves into its later stages, these equations are reversed with the release of OH and atomic oxygen. However, some of the water produced is deposited on dust grains in the form of ice, where it may remain while planets are formed. Thus, newly formed planets have continued access to water during their evolution. Within our own solar system, there is considerable evidence that liquid water was abundant at some earlier stage in the history of Mars. The erosion patterns still visible on the planet's surface bear a striking resemblance to some found on earth. Many astronomers are also convinced that liquid water is still present on Saturn's moon, Titan, and under a deep layer of ice on Jupiter's moon, Europa.

The Reshaping of Landforms

Geologists have long been aware of the role water plays in the reshaping of the earth's surface. The uniformitarian theory of the earth's history explicated by Charles Lyell in the early nineteenth century recognized that the surface of the earth is essentially a chronicle of its reshaping by water erosion. Some of the most informative strata for the reconstruction of past events are those that contain sedimentary deposits. These deposits, formed in lake beds and ocean floors, often contain fossils of species extant at a specific time, and can therefore be used, along with chronometric methods, to estimate the age of a given deposit and its contemporaneity with other deposits bearing similar fossils.

The formation of sedimentary deposits provides one of the bases for determination of relative dating sequences through the comparison of fossil inclusions. However, it is the gradual wearing down of mountains and other landforms by rain and snowfall and the transport of particles of rock and soil to the sea that are continually altering earth's topography. Water erosion, combined with tectonic forces at work beneath the earth's crust, is ultimately responsible for environmental changes that occasionally trigger major evolutionary events. In some areas, such as the Grand Canyon of Arizona, long sequences of the earth's history can be reconstructed through examination of strata exposed by the action of Colorado River water.

When major geological events such as the collision of tectonic plates occur, marine deposits sometimes end up in mountains, while other segments of the sea floor may be returned to the magma layer in zones of subduction. Mountain building may have profound effects on rainfall patterns. Under the appropriate circumstances, alterations in atmospheric conditions associated with major events such as the collision of the plates that joined the Indian subcontinent to the Asian landmass have the potential to trigger significant climatic changes. Changes in rainfall patterns, glaciations, and altered temperature gradients may be implicated in the onset of epochal events such as the Pleistocene "Ice Age," with worldwide effects on the evolution of plant and animal species.

Water and Weather

The possibility of a worldwide change in climate associated with the rapid building of a major mountain range arises from the central role that the oceans of the earth play in the distribution of heat energy received from the Sun. Approximately 70 percent of the earth's surface is covered by water. Because of the tilt in the earth's axis, the waters of the equatorial zone receive the Sun's radiation more directly than areas in the higher latitudes. Consequently, more of the wavelengths of solar radiation that are subject to reflection, scatter, or absorption in the atmosphere actually reach the earth's surface in the tropics. Much of their energy serves to warm the oceans. The energy so received sets up warm ocean currents that flow away from the equatorial zone. Ultimately, the warm currents flowing out of the tropics mix with colder currents originating in the polar regions, but not before heat energy has been widely distributed over the oceans and landmasses of the temperate zones.

The warming of the oceans in the equatorial zone has the additional effect of evaporating ocean water.

Thus, water vapor enters the atmosphere. In the tropics, some of the moisture-bearing warmed air rises until it is sufficiently cooled to form precipitation. The result is the return of fresh water to the surface. The circulation of moisture-bearing atmosphere through the action of thermal gradients and prevailing winds allows some of it to flow to the cooler, drier areas at higher latitudes as well. Thus, the supply of fresh water is continuously replenished on the continental landmasses of both the Northern and Southern Hemispheres. The large number of plant and animal species that require access to fresh water for survival is evidence that the distribution of fresh water through the atmosphere has played a major role in the evolutionary process.

The mixing of ocean waters and the direction of currents produce a complex pattern that is influenced by factors beyond the dissipation of heat energy absorbed in the tropics. The salinity of seawater varies from one area to another according to the amount and composition of the silt emptied into the oceans by rivers and streams. Since very salty water is heavier than fresh water, streams of water flowing away from the mouths of rivers tend to sink. This tendency sets up a network of crosscutting currents that affect the temperature of water at various depths. Temperature and salinity both affect the mix of marine organisms present in the ocean biome (ecological community). Generally, estuaries are some of the richest and most diverse of the marine habitats. Exploitation of fisheries such as the one that formerly produced abundant catches of sardines in the Mediterranean Sea off the mouth of the Nile River provided local human populations with an important source of dietary protein for many millennia. Other areas, such as the zone of nutrient upwelling off the west coast of South America, are illustrative of the way in which the combination of geological factors and ocean currents can create a major source of food for human populations that have learned how to exploit them.

Although the vast majority of the earth's water is too salty to drink for many animals, including humans, evaporation and precipitation provide a constantly renewing source of fresh water. In addition, the atmospheric recirculation of water modifies the climate in the higher latitudes to such an extent that life can exist in areas that would otherwise be uninhabitable. Moreover, along with rainfall, atmospheric circulation plays an important role in the carbon cycle and nitrogen fixation, both essential to the maintenance of life.

The Physical and Chemical Properties of Water

Through its role in the formation of stars, the reshaping of the earth's surface, the absorption and release of solar energy, and the provision of marine and aquatic habitats, water is essential for the existence of life as we know it. However, as important as each of these factors has been in shaping the evolutionary pathways that produced contemporary species, the physical and chemical properties of water have resulted in a much more intimate relationship between water and the processes of life than the mere provision of an appropriate environment. Water molecules and the molecules of living organisms interact in ways that would make the existence of life, as we know it, inconceivable in the absence of water. Understanding the nature of certain properties of water provides important insights into the nature of life itself, since organisms can quite properly be categorized as aqueous chemical systems.

Water has an unusually high boiling point, melting point, and heat of vaporization. Thus, the transition from solid to liquid and liquid to gaseous phases requires a high energy input. Functionally, this attribute makes water an effective heat absorber. The aforementioned capture and distribution of solar energy by the oceans is one result of this attribute. Moreover, the density of water is greatest when it is in its liquid phase. Therefore, ice floats. The formation of a layer of ice on the surface of a lake or pond serves as insulation for the water beneath it, with the result that aquatic life can continue even through the long, cold winters of the higher latitudes. While it is certainly possible for small bodies of water to freeze solid during prolonged periods of severe cold, most large, deep lakes and rivers sustain a thriving population of fish and other aquatic species through even the most severe winters.

Water molecules have a strong attraction for each other. Therefore, water has surprisingly high surface tension and exhibits the properties of cohesion and adhesion. Its ability to form hydrogen bonds is extraordinary. This ability comes into play in a variety of ways during many biochemical reactions. Water's tendency to adhere to a surface and to attract other molecules underlies the biologically important process of capillary action whereby water has the capability of moving against the force of gravity under certain circumstances. An illustration of this capability is seen in the capillary action that pulls water from soil through the roots and ultimately to the leaves of even the tallest trees.

Water is also a very effective solvent. In fact, it is so effective in the dissolution of other substances that it is only rarely present in the pure, unadulterated state. The solvent properties of water have significance in both the geochemical and biochemical context. The nature and rate of erosion occurring in different kinds of rock will produce changes in the physical geography of the land as well as the chemical nature of silt borne by rivers and streams. The dissociation of mineral compounds can be of special significance when the solute is one of a number of salts that dissociate into ions in water. Ionization of salts converts water into an effective conductor of electricity. Many biological processes, including transmission of nervous impulses and contraction of muscle fibers, depend upon a mild salt solution's ability to conduct an electrical current under controlled conditions.

The explanation for the extraordinary properties of water can be found in its previously mentioned unparalleled ability to form hydrogen bonds. Structurally, an individual water molecule is made up of two hydrogen atoms covalently bonded to one oxygen atom. That is, each hydrogen atom shares a pair of electrons with the oxygen atom. As a result, the molecule has a nonlinear shape and has electrical polarity because of a net positive charge on the hydrogen atoms and a net negative charge on the oxygen atom, creating a dipole moment. Water can serve as both a hydrogen donor and a hydrogen acceptor during hydrogen-bond formation, with each water molecule having the potential to form four hydrogen bonds. The intermolecular attraction inherent in this property accounts for water's high boiling point, melting point, heat of vaporization, and surface tension. The hydrogen bonds between water molecules are relatively weak and are continually broken and reformed with different partners. In liquid water, the average lifetime of the hydrogen bond between two water molecules is only 9.5×10^{-12} seconds (Garrett and Grisham, 1999). As a result, there is dynamism in a water solution that intensifies the diffusion of the products of dissociation. This continuous movement of water molecules enhances its solvent effect. Water also forms hydrogen bonds with a wide range of polar solutes. This permits nonionic but polar molecules such as sugars also to dissolve effectively in water.

Certain nonpolar substances, categorized as hydrophobic, interact with water much differently than the hydrophilic ones discussed up to this point. When such substances are dissolved in water, the surrounding water molecules reorganize to encapsulate the solute molecules in a hydration shell. Hydrophobic molecules trapped in these structures are attracted to each other. The tendency of fats and oils, both hydrophobic in nature, to form closed aggregations when submerged in water arises from this tendency. On the other hand, the tendency for oil to spread out into a thin film when poured on the surface of water reflects its hydrophobic nature in a situation where the lowest free energy state occurs when each molecule has minimum contact with neighboring water molecules. The composition of cell membranes, which characteristically combine a hydrophobic phospholipid bilayer with hydrophilic protein and carbohydrate receptors, provides an example of the manner in which the presence of an aqueous environment can be used to govern the movement into and out of the cell's interior.

Life Requires the Presence of Water

All living organisms require the presence of water to satisfy their metabolic needs. Even in such simple organisms as bacteria, metabolic processes requiring maintenance of solute concentrations inside the cell membrane that differ from those outside are essential to survival. In more complex organisms, the ability of water to absorb and diffuse solutes, create a potential electrical charge, and diffuse heat energy involves a variety of tissues, organs, and organ systems. These systems must communicate and support each other to satisfy the demands created by greater size and differentiation. Each organism, whether simple or complex, is dependent upon the unique properties of water to metabolize, survive, and reproduce. So intimate is the relationship between water and the structure and function of living organisms that the phenomenon of life as found on this planet is inconceivable in the absence of water. There is no concrete evidence of life anywhere else at this time. However, there is good evidence that water is abundant in the universe. Therefore, it is likely that if living organisms are ever found elsewhere, they will share many characteristics with those found here on earth, because of the inextricable relationship between life and water.

See also **Biodiversity; Evolution; Fish; Nutrients**.

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SAFETY OF WATER

The understanding that some water caused disease while other water sources did not has long prompted human civilizations to attempt to make water safe to drink. Sanskrit medical lore from around 2000 B.C.E. mentions boiling foul water, exposing it to sunlight, and filtering through charcoal. It is possible that the Asian custom of drinking tea made with boiling water was an early method to make water safe to drink. Cyrus the Great in the sixth century B.C.E. took vessels of boiled water with his troops when they traveled to do battle. Residents of Alexandria, Egypt in 50 B.C.E. drank Nile River water brought to the city through a series of underground aqueducts to cisterns where it was clarified by sedimentation. Other parts of the Egyptian empire used single, double, and even triple filtration to purify water. Sextus Julius Frontinus, water commissioner of Rome in 97 C.E., wrote the first detailed description of a public water system in his *Two Books on the Water Supply of the City of Rome.* While these early water engineers had no understanding of bacteria and were probably treating water to decrease its cloudiness and improve its looks and taste, they nevertheless developed the earliest water treatment systems.

In one of the earliest cases to link a specific disease to the water supply, Dr. John Snow demonstrated in 1855 how cholera spread through water pumps during a large outbreak of the disease in London. He noticed that people who obtained their water from a particular well were more likely to become ill than those drawing their water from another well. He persuaded city officials to remove the pump handle from that particular well, forcing inhabitants to draw water from another well, and the number of cholera cases dropped immediately.

The U.S. Water Supply

In 1799 Philadelphia became the first U.S. city with a public water system that pumped water from a surface source and distributed it through a series of pipes to residents. By 1900 there were more than 3,000 public water systems in the United States. Rather than guaranteeing a safe water supply, some of those systems actually contributed to major disease outbreaks in the early 1900s. If the water supplies were contaminated, the pumped and widely distributed water provided a means for spreading bacterial disease throughout communities. Federal regulation of the nation's drinking water began in 1914 when the U.S. Public Health Service (PHS) imposed bacteriological standards for drinking water. These standards were revised in 1925, 1946, and 1962 and were eventually adopted by all fifty states. After World War II, industrialization and the use of fertilizers on crops began to pollute the quality and safety of the nation's water. A 1969 survey showed that only 60 percent of water systems delivered water that met PHS standards. A study in 1972 detected thirty-six chemicals present in already treated water taken from the Mississippi River. This increased awareness of the problems with the water supply led to the passage of federal environmental and health laws dealing with polluted water, hazardous waste, and pesticides.

Current water use in the United States averages about 100 gallons per person per day, more than just about any other country. A very small proportion of this, approximately two gallons, is actually used for drinking and cooking. Drinking water comes from either surface water or groundwater. Surface water includes rivers, lakes, and reservoirs, while groundwater is pumped up from wells drilled into aquifers, underground geologic formations that contain water. Over half the nation gets its drinking water from groundwater sources.

The more than 170,000 water systems in the United States are either private or public. Private water systems do not draw water from a public water supply and serve

BOTTLED WATER

As news reports of contaminated municipal water supplies proliferate, more and more Americans are purchasing bottled water. Between 1976 and 1997 yearly sales of bottled water skyrocketed from 500,000 gallons to almost 3.5 million gallons. Even though the cost of bottled water is 240 to 10,000 times more per gallon than that of tap water, the industry continues to grow at a rate of 8 to 10 percent per year. Many people buy bottled water with the assumption that it is safer than regular tap water.

Bottled water is considered a food and as such is regulated by the FDA under the Code of Federal Regulations Title 21, Part 165, Section 110. FDA considers carbonated water and seltzer water to be soft drinks, and thus regulates them as such. FDA regulations only apply to products that are sold in interstate commerce. Therefore, FDA does not regulate bottled waters that are packaged and sold within the same state, an estimated 60 to 70 percent of all bottled water sold in the United States. States regulate bottled water to varying degrees. One-fourth of bottled water is actually bottled tap water, which may or may not be further treated. EPA regulates tap water.

In its 1999 report, *Bottled Water: Pure Drink or Pure Hype?,* the Natural Resources Defense Council (NRDC) found that, while most of the bottled waters they tested were of high quality and safe, some brands were contaminated. The NRDC also believes that EPA regulations governing tap water are more stringent than the FDA regulations for bottled water. The NRDC concluded that bottled water is not always safer than tap water.

FDA has also established current good manufacturing practice (CGMP) regulations for processing and bottling drinking water, which apply to all waters sealed in bottles, packages, or other containers. Under the CGMP regulations for bottled water, the water to be bottled must be from an approved source and must be processed, packaged, transported, and stored under safe and sanitary conditions. The International Bottled Water Association has also produced a voluntary model code for use by its members.

only one or a few homes. Public water systems include community water systems and those at schools, factories, campgrounds, and some restaurants that have their own water supply. Community water systems deliver water to people year-round in their homes. In most community water systems, a network of underground pipes transports water under pressure to smaller pipes that then enter individual homes.

Hazards to the Water Supply and Treatment Methods

Because water is the universal solvent, many chemicals and other materials easily dissolve in it. Water supplies become contaminated through many different channels—chemicals can migrate from disposal sites; animal wastes and pesticides may be carried to lakes and streams by rainfall runoff; human wastes may be discharged to receiving waters that ultimately flow into water used for drinking. Other sources of contamination include discharge from industry, erosion of natural deposits, corrosion of household plumbing systems, and leaching from septic tanks. Nitrates, inorganic compounds that can enter water supplies from fertilizer runoff and sanitary wastewater discharges, are especially harmful to young children. Naturally occurring contaminants are also found in drinking water. For example, the radioactive gas radon-222 occurs in certain types of rock and can seep into groundwater. It would be impossible to remove all contaminants from our water supply. It would also be unnecessary since at very low levels many contaminants are generally not harmful.

Most outbreaks of waterborne disease are due to contamination by bacteria and viruses, mostly from human or animal waste. Two pathogens commonly associated with drinking water are *Cryptosporidium parvum* and *Giardia lamblia*. Both are protozoa that cause gastrointestinal illness and have cysts that are difficult to destroy. *Cryptosporidium* in particular may pass through water treatment filtration and disinfection processes in sufficient numbers to cause health problems. *Cryptosporidium* was first documented as posing a threat of infection to humans in 1976. A 1993 outbreak of cryptosporidiosis in Milwaukee, Wisconsin, is the largest outbreak of waterborne disease to date in the United States. Milwaukee's water supply, which comes from Lake Michigan, is treated by filtration and disinfection. Due to an unusual combination of circumstances during a period of heavy rainfall and runoff, water treatment was ineffective. An estimated 403,000 persons were affected by the disease, 4,400 were hospitalized, and at least 50 died. The original source of contamination is still unknown. Although *Cryptosporidium* had previously been found in surface water, it was not expected to appear in treated water from a municipal water supply that met state and federal standards for acceptable water quality. Increased awareness of the parasite has led to increased testing for it, and, not surprisingly, increased prevalence has been discovered. In addition to drinking-water outbreaks, *Cryptosporidium* is associated with swimming pools and amusement park wave pools. This is particularly important as *Cryptosporidium* is highly resistant to chlorine and other chemical disinfectants. This is a new parasite showing up in new environments with new resistance capabilities.

Runoff from farms is another source of hazards to the nation's drinking water. In 1994 the Environmental Working Group released *Tap Water Blues*, a report in which the group identified over ten million individuals who had been exposed to five herbicides at levels above the Environmental Protection Agency's (EPA) negligible cancer risk standard of one additional case per million individuals. A second report in 1995, *Weed Killers by the Glass*, analyzed herbicides in the tap water of twenty-nine Midwestern cities. Again, their results show that Americans are exposed to harmful pesticides in their drinking water at levels far above federal health standards.

The Centers for Disease Control (CDC), the EPA, and the Council of State and Territorial Epidemiologists collaborate to maintain a surveillance system that collects data on waterborne disease outbreaks (WBDOs) from drinking and recreational water. This program seeks to determine what pathogens in the water supply cause illness, how many people become ill, and how and why outbreaks occur. The data are submitted on a voluntary basis and most likely underestimate the true incidence of WBDOs. More WBDOs occur in the summer months, and the cause is often unidentified. WBDO outbreaks peaked between 1979 and 1983 and have been declining ever since. This decrease could be due to improved implementation of water treatment regulations, increased efforts by many water utilities to produce drinking water substantially better than EPA standards require, and efforts by public-health officials to improve drinking-water quality. Of the waterborne disease outbreaks reported to the CDC from 1974 to 1996, about 12 percent were caused by bacterial agents, 33 percent by parasites, 5 percent by viruses, 18 percent by chemical contaminants, and 31 percent by unidentified agents.

During 1997 and 1998 there were seventeen outbreaks in drinking water, resulting in 2,038 people becoming ill. Six (35.3 percent) of the illnesses were caused by parasites (4 by Giardia, 2 by Cryptosporidium); four (23.5 percent) by bacteria (three by *E. coli* O157:H7 and one by *Shigella sonnei*); five (29.4 percent) were of unidentified origin; and two (11.8 percent) were attributed to chemical poisoning. Both chemical poisonings were from copper. Eight (47.1 percent) of the seventeen WBDOs were associated with community water systems. Of these eight, three were caused by problems at water treatment plants, three were the result of problems in the water distribution systems and plumbing of individual facilities, and two were associated with contaminated, untreated groundwater. Five (29.4 percent) of the seventeen WBDOs were associated with noncommunity water systems; all five were from groundwater (i.e., a well or spring) systems. The four outbreaks (23.5 percent) associated with individual water systems were also from groundwater.

Also during 1997 and 1998, eighteen outbreaks associated with recreational water caused 2,138 people to become ill. Nine (50 percent) were caused by the parasite *Cryptosporidium.* The other outbreaks were due to *E. coli* O157:H7 (three outbreaks or about 16.7 percent), *Shigella sonnei* (one outbreak or 5.6 percent), Norwalk-like viruses (two outbreaks or 11.1 percent), and unknown causes (three outbreaks or 16.7 percent). Slightly over half (55.6 percent) occurred in treated water—pools, hot tubs, or fountains; the others occurred in fresh-water lakes, rivers, or hot springs.

Depending on the conditions and types of contaminants likely to be found in a particular water source, most water suppliers use a combination of two or more treatment processes. Major water treatment processes are:

> **Flocculation/sedimentation.** Flocculation is the process of getting small particles to combine into heavier particles called floc. The heavier particles can then be removed by letting them settle out as sediment. Once settled, the particles combine to form a sludge that is later removed.
>
> **Filtration.** Filtration removes particles from water by passing the water through a permeable fabric or porous bed of materials. Groundwater is naturally filtered as it flows through porous layers of soil. Some filtration processes can remove very small particles, including microorganisms.
>
> **Ion exchange.** Ion exchange processes remove inorganic constituents such as arsenic, chromium, excess fluoride, nitrates, radium, and uranium if they cannot be removed adequately by filtration or sedimentation. Electric current is used to attract negative and/or positive ions to one side of a treatment chamber for removal.
>
> **Adsorption.** Adsorption involves making organic contaminants that cause undesirable color, taste, or odor stick to the surface of granular or powdered activated carbon.
>
> **Disinfection.** Disinfection refers to killing harmful microorganisms. The three most commonly used methods of disinfection are chlorination, ozonation, and ultraviolet treatment. Chlorination is the method most often used in the United States while ozonation is very common in Europe.
>
>> **Chlorination.** Chlorine kills bacteria by forming hypochlorus acid, which attacks the respiratory, transport, and nucleic acid activity of bacteria. Most bacteria are very susceptible to chlorine while viruses are less so. Cysts from *Giardia lamblia* are very resistant to chlorine, and *Cryptosporidium* cannot be readily killed by chlorination. Of concern with this method of disinfection are the by-products (DBPs), particularly trihalomethanes (THMs), formed when chlorine reacts with organic matter that is in the water. Long-term exposure to some DBPs may increase the risk of cancer or have other adverse health effects. THMs are cancer group B carcinogens, which means they have been shown to cause cancer in laboratory animals. EPA regulations limit the amount of these by-products allowed in drinking water.
>>
>> **Ozonation.** Ozone is created by passing air through an electric current. The ozone gas is then dissolved in water, where it acts as an oxidant to destroy microorganisms. The ozone is removed before the water is used. As there is no residual antimicrobial effect, it is still necessary to chlorinate the water after ozone treatment. Ozone has received increased attention because it appears to be the only disinfectant that is effective against *Cryptosporidium.*
>>
>> **Ultraviolet light.** Ultraviolet light (UV) does not actually kill bacteria. Instead, it effectively sterilizes them, making it impossible for them to reproduce. The use of ultraviolet light is only practical for small water systems due to the need for the microorganisms to be close to the radiation source. UV does not inactivate *Giardia* or *Cryptosporidium* cysts.

With so many different bacteria that can cause illness, it is not possible to test the water supply for each of them separately. Instead, indicator organisms are used. Coliform bacteria are the most popular indicator organisms for drinking water as they are easily detected in water. Coliforms are a group of bacteria common in the environment and in the digestive tracts of humans and animals. While these organisms are themselves harmless, their presence indicates possible contamination with human and/or animal waste. The effectiveness of disinfection is judged by analyzing water supplies for total coliform bacteria. Presence of coliform bacteria is not acceptable in public water supplies and is a sign that disinfection is required.

Regulation

Local governments, public water systems, the states, and the EPA work together to ensure that all public water supplies are safe. Local governments have a direct interest in protecting the quality of their drinking-water source, be it groundwater or surface water. Part of the governments' job in protecting the water supply is to oversee land uses that can affect the quality of untreated source water. State public health and environmental agencies have the primary responsibility for ensuring that federal drinking-water quality standards, or more stringent ones required by the state, are met by each public water supplier. Municipal water systems test their own water systems for residues but do not regulate or test private wells. For households on private wells, state and local health departments usually have some standards for the drinking water, but it is generally up to the homeowner to maintain the quality of the drinking water.

An increased awareness of the vulnerability of the nation's water supply led to the passage of the 1974 Safe Drinking Water Act (SDWA). Prior to 1974 each state ran its own drinking-water program and set local standards. As a result, drinking-water protection standards differed from state to state. The act authorized the EPA to establish national enforceable health standards for contaminants in drinking water, encouraged federal-state partnerships in protecting the nation's water supply, and required notification to alert customers to water-system violations. In 1986 the act was strengthened through the Surface Water Treatment Rule, which requires public water systems to filter and disinfect all surface-water supplies. In 1996 amendments to the act extended the protection of drinking water from source to tap. Provisions in the 1996 amendment include the following:

- Consumers must receive more information about the quality of their drinking-water supplies. Water suppliers must notify customers within twenty-four hours of violations of EPA standards "that have the potential to have serious adverse effects on human health as a result of short-term exposure." If such a violation occurs, the system must announce it through the media and provide information about potential adverse effects on human health, steps taken to correct the violation, and the need to use alternative water supplies (such as boiled or bottled water) until the problem is corrected. When microorganisms such as those that indicate fecal contamination are found in drinking water, water suppliers may be required to issue "boil water notices." At least 725 communities, including New York City and the District of Columbia, have issued boil water notices affecting over 10 million people.
- The SDWA amendments also require public water systems to prepare Consumer Confidence Reports. These are to inform consumers about the source of their water supply, contaminant levels detected in their water, and the health effects of contaminant levels that are above the established safety limit. Beginning in 1999, systems are to prepare and distribute the reports annually.
- Under the new amendments, each state must develop a program to identify potential contamination threats and determine the susceptibility of drinking-water sources to activities that may harm the source water.
- The 1996 SDWA Amendments provides up to $9.6 billion over six years to improve drinking-water infrastructure. Water systems can apply for low- and no-interest loans to upgrade their facilities and ensure compliance with drinking-water standards. Other sources of funding are also available to water systems through the U.S. Department of Agriculture's Rural Utility Service (RUS). As part of the Water 2000 initiative, which is aimed at providing clean, safe, and affordable drinking water to all rural homes, RUS administers a water and wastewater loan and grant program. Under the RUS programs, rural areas and small cities and towns can receive loans or grants to restore a deteriorating water supply, upgrade a water or wastewater facility, or develop new systems.

TABLE 1

Sample monitoring schedule

Contaminant	Minimum monitoring frequency
Acute Contaminants	
Bacteria	Monthly or quarterly, depending on system size and type
Protozoa and Viruses	Continuous monitoring for turbidity, monthly for total coliforms, as indicators
Nitrate	Annually
Chronic Contaminants	
Volatile Organics (e.g., benzene)	Groundwater systems, annually for two consecutive years; surface water systems, annually
Synthetic Organics (e.g. pesticides)	Larger systems, twice in three years; smaller systems, once in three years
Inorganics/Metals	Groundwater systems, once every three years; surface water systems, annually
Lead and Copper	Annually
Radio nuclides	Once every four years

General requirements may differ slightly based on the size or type of the drinking-water system.

SOURCE: Environmental Protection Agency (EPA). July 1997. *Water on Tap: A Consumer's Guide to the Nation's Drinking Water.* Washington, D.C.: Environmental Protection Agency, Office of Water, 1997. Available at http://www.epa.gov/OGWDW/wot/ontap.html

The EPA Office of Water sets standards for pesticides and other chemicals in drinking water and issues Maximum Contaminant Levels (MCLs), which limit the amount of each substance that can be present in drinking water, for more than eighty contaminants. Scientists use a process called risk assessment to set drinking-water quality standards. When assessing the cancer and noncancer risks from exposure to a chemical in drinking water, the first step is to measure how much of the chemical could be in the water. Next, scientists estimate how much of the chemical the average person is likely to drink. This amount is called the exposure. In developing drinking-water standards, the EPA assumes that the average adult drinks two liters of water each day throughout a seventy-year life span. MCLs are set at levels that will limit an individual's risk of cancer from that contaminant to between one in 10,000 and one in 1,000,000 over a lifetime. For non-cancer effects, risk assessment provides an estimate of an exposure level below which no adverse effects are expected to occur. The EPA also takes into account the ability of various technologies to remove the contaminant, their effectiveness, and the cost of treatment.

To comply with MCLs, public water systems may use any state-approved treatment. According to 1996 statistics, 7 percent of community water systems, or 4,151 systems, reported one or more MCL violations, and less than 2 percent (681 systems) reported violations of treatment technique standards. The table shows the major groups of contaminants and the minimum frequency with which water systems must test for them.

Finally, Healthy People 2010, a national health-promotion and disease-prevention initiative, has two goals for water quality:

1. Increase the proportion of persons served by community water systems who receive a supply of drinking water that meets the regulations of the Safe Drinking Water Act. The current baseline is 73 percent; 2010 goals are to increase that to 95 percent.
2. Reduce waterborne disease outbreaks from drinking water among persons served by community water systems. Currently an estimated six outbreaks per year originate from community water systems. The goal is to decrease that to two outbreaks per year.

See also **Food Safety**.

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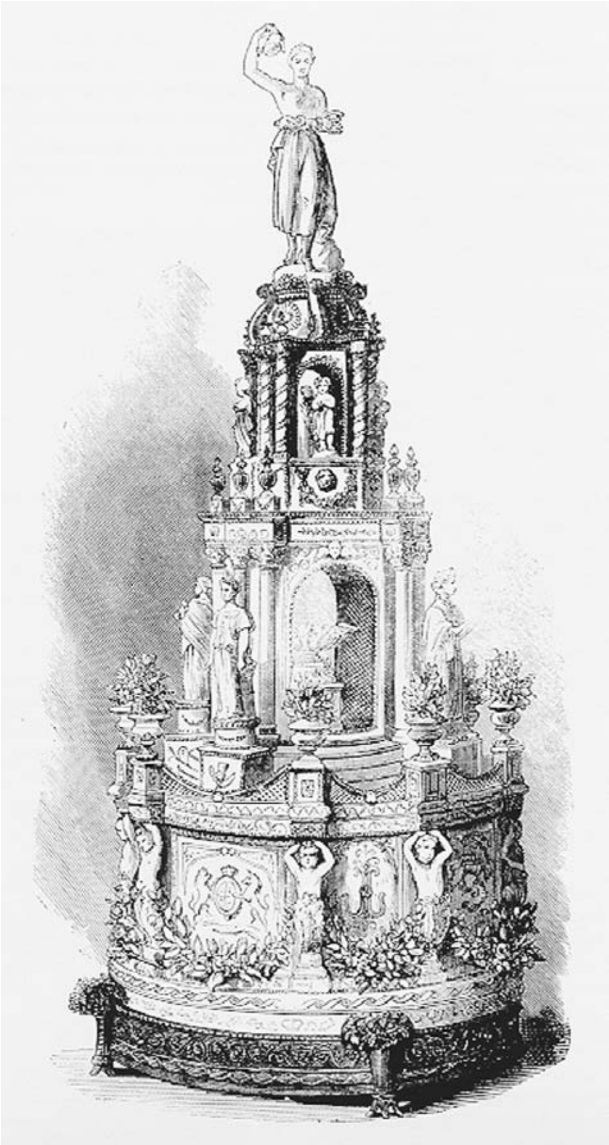
Cynthia A. Roberts

WEDDING CAKE. Wedding cakes are elaborate constructions, each standing for a particular marriage and each used in the wedding that establishes it. The link between cake and wedding, the distinctiveness of its form, its derived uses, and the meanings attached to it have all been most complexly and influentially developed in the English-speaking world. A classic form was commercially established in Britain and the United States in the early years of the twentieth century. An exceptionally large, rich fruit cake, as much as twelve inches in diameter and twenty pounds in weight, was used as a base for pillars supporting a similar but smaller cake. A third, still smaller cake layer was mounted on another set of pillars above that. The three tiers were each covered with hard white "royal" icing, which also was used for a characteristically formal decoration of piped icing. The whole was crowned with flowers, natural or in a variety of artificial materials, or a limited range of other appropriate ornamentation that might also adorn the sides. This form traveled widely in the course of the twentieth century and was modified locally in relation to changing tastes and the development of new decorative potentials and uses. Though the classic form was especially tenacious in Britain, the knowledge of alternatives, contributed by different European traditions, spread with increasing rapidity. The significance of the cake shifted from representing marriage as a fixed reality into which each couple entered to representing the individuality and even originality of the couple celebrating.

Historic Sources

The classic form had three sources, the use of loaves at Christian marriage rites, the appearance of "subtleties" and later sugar sculpture in medieval and Renaissance banquets in Europe, and the development of the English form of the substance "cake," mainly in the seventeenth century. Decorated loaves had been carried to the church in pre-Reformation wedding processions to be blessed



The royal wedding cake created at Windsor Castle in 1871 for the marriage of Princess Louise and the Marquis de Lorne. This cake, which stood over five feet tall, is crowned with a figure of a vestal virgin. It was one of the first wedding cakes to introduce the idea of tiers and height and became a prototype of the many-tiered wedding cakes of today. Wood engraving from the *Illustrated London News,* 1 April 1871. ROUGHWOOD COLLECTION.

and then returned to be eaten at a popular celebration following. Possibly earlier, and certainly later, there were baked but unleavened items more like Scottish oatcakes and shortbread: the "infare cake" is well known in the literature. These cakes were to be broken over the bride's head and/or eaten at the marriage feast. How widespread such practices were is not known, but these were among the variety of things to which the term "bride cake" has been applied over the centuries.

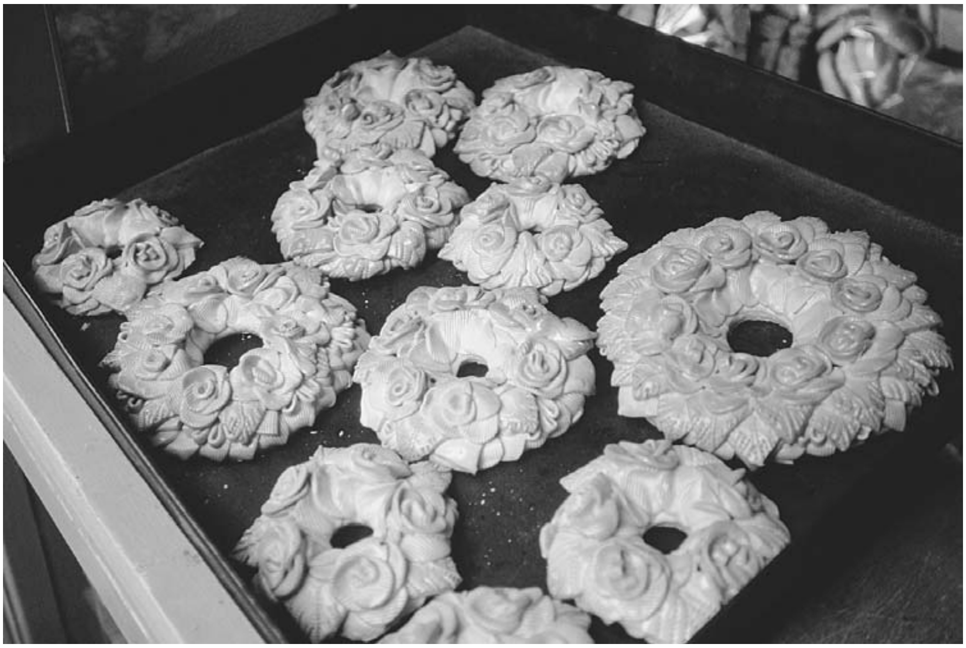
A clearer continuity is represented by the rich fruitcake developed in England by a process of enriching breads with sugar, spices, and dried fruits. The transformation was achieved by the mid-seventeenth century, providing a luxury that might be baked for wedding celebrations in the homes of the wealthy. Icing for cakes followed, and in 1769 a Manchester confectioner, Elizabeth Raffald, included the recipe for an iced "bride cake" in her cookery book, *The Experienced English Housekeeper.* This recipe was for a distinctive rich fruitcake covered with two layers of icing, a naturally pale yellow almond icing encased in a hard outer layer of plain white icing. Over the next century this became the distinguishing formula for British celebration cakes of increasing variety.

The subtleties of medieval Europe were, like modern wedding cakes, display items designed to impress and amaze as well as to be at least marginally consumable as food. The tradition culminated in the production of sugar sculpture for some of the greatest court festivities of the Renaissance period. They had no specific link with wedding feasts, but when revived in the enthusiasm for historic forms and styles in the nineteenth century, they acquired it. Led by the British royal establishment, for the weddings of Queen Victoria's children superstructures of sugar architecture and sculpture were raised on bases of cake, transforming them into tall centerpieces for the tables of wedding banquets. The decoration was characteristically white, and made symbolic references to the royal alliance. By the end of the century their example had stimulated leading baker-confectioners and enthusiasts for the art of piping into commercial developments leading directly to the three-tier classic. Typically only wealthy customers could initially afford the product, but in the course of the following half-century it became the standard for all.

Meanings and Uses

The classic form of the cake was impersonal, excluding written inscriptions or any direct reference to the personal tastes or interests of the couple marrying. Decorative motifs were confined to the most genteel of references to love and constancy. White, and if not white, silver, predominated. The cake was indeed a prime component of the white wedding. This, though it has not been well studied, appears to have developed at a period when public attention was increasingly drawn to sex and when, among the respectable classes, embarrassment on this score in the context of marrying was strong. The formality of the white wedding and of the style of the classic cake with it was, it has been argued, a strategy for diverting attention from the sexual implications of marrying to the decorous purity of the bride.

The cake acquired a particular relationship with the bride in two ways. It was heir to popular traditions that centered weddings on the transition the bride was making. As noted above, this sometimes involved breaking baked items over the heads of brides. Unmarried young



Traditional wedding cakes baked in the shape of floral wreaths. Rethymnon, Crete, 1996. Most very old types of wedding cakes like these were little more than enriched bread, although elaborately ornamented. © GAIL MOONEY/CORBIS.

people often obtained fragments to dream on to discover their own life partners. The second link arose when cakes spread more widely in the social scale in the mid-nineteenth century, from the aristocratic wedding banquet to the modest domestic wedding breakfast. In this new context, the bride in her new married status was called on to cut the cake for her guests. Cut pieces could then take on the old use for divination. In the twentieth century cake cutting became one of the major popular rites of marrying, but it developed into a joint action by the new husband and wife together. In Japan this theme was developed to the exclusion of edibility. The joint insertion of a knife into a slot in an enormous wax cake provided a striking photo opportunity as part of a complex sequence developed in commercial wedding halls. In the United States a mutual feeding of cake by bride and groom extended the symbolic use in another direction.

More esoteric meanings have at times been discovered for the wedding cake and its uses. The complexity of the classic form and its apparently traditional nature often encouraged speculation on the contrast between the dark interior and the whiteness of the exterior and on the meaningfulness of ingredients and their flavors. The almond, appearing in one layer of icing as well as in the mixture inside, attracted particular attention. Most spectacular has been the identification of the white, tiered cake with the bride in her wedding costume and the joint cutting of the cake as a symbolic consummation of the marriage. As forms have diversified, the scope for such symbolic interpreting has declined.

See also **Bread**; **Cake and Pancake**; **Candy and Confections**; **Epiphany**; **Weddings**.

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Simon Charsley

WEDDINGS. Weddings are a universal life cycle event where rituals and ceremony display a group's interest, whether conspicuously or obscurely, in economics, organizational balance, power, and social forms. Nuptials allow families and couples to establish a new status in society; this is especially true for the bride as she is now an adult woman, belonging to her husband's family and responsible for perpetuating his (and now her) lineage. Upon marrying, the groom also gains a new status of respectful adulthood, a full member of society.

One major role of food in this rite of passage is the show of opulence and social status. For example, the

My small-leaf basil
and my marjoram
it is you who will separate me
from my mother
Come to the window
girl, the one with the glass pane
to see your face
[which is as white as] flour
The stairs you ascend
[I wished] I ascended too
and at every step
to give you sweet kisses

Traditional song sung by village musicians reserved for the women as part of the nuptial festivities (Argyrou, Tradition and Modernity in the Mediterranean, *p. 69).*

English nobility of the late Middle Ages had their own ideas regarding the proper wedding feast: boar and lamb were served as a first course, followed by venison in broth and antelope served with a spiced, sweet pudding containing rice flour. The third course contained fish and a baked meat and began with lozenge and almond cream in syrup; cheese, hot bread, a sweet, and other dishes were the fourth course.

Weddings in Greece

As Vassos Argyrou writes in *Tradition and Modernity in the Mediterranean* (pp. 60–110), weddings in Cypriot and other small villages of Greece were five- to six-day affairs in the 1930s. The nuptial rites customarily began on a Friday or Saturday with the preparation of the *resi*, a dish particular to the Limassol and Paphos areas. The communal preparation of the *resi* is the first of many fertility rituals; here the crushed wheat, pork, chicken, and other meats represent the abundance and fertility of the land upon which the couple would make their home. First, a group of village women cleaned the wheat by removing inedible portions and stones. Then, having placed the cleaned wheat in large wooden vessels, *skafes*, and covered these bowls with red shawls, the women, led by musicians, proceeded to the village fountain. After washing the wheat seven times in a step called *efta plimmata*, the wheat was returned to the bride's house in the same processional fashion, where it was pounded until crushed by using a *faouta*, a rectangular paddle with rounded edges. While the *resi* would not be served until the Sunday feast, the lengthy preparation process customarily started on Friday, and the dish was cooked on Saturday.

After the church ceremony, *stefanoman*, on Sunday, the couple and their guests returned to the newlyweds' home to perform one of the many rituals of that day. In response to good wishes from guests, the couple sprinkled the guests' hands with rosewater. Afterwards, men were served a glass of homemade wine, while the women were given a dish of fruit preserved in syrup, *ghliko*. An elaborate feast followed, attended by many people of the village. They dined on the traditional *resi*, potatoes *yakhni* (cooked in tomato sauce), *kolokasi* (a root vegetable similar to a sweet potato), salads, beets, and meats. The traditional beverage selection was limited to homemade wine and *zivania* (grappa).

On Monday, food such as *kanishia*, potatoes, olive oil, cheese, pasta, chicken, and wine was brought by people of the community to the couple's home. These gifts would unofficially set the guest list for the dinner served later that evening; in addition, they served as a hospitality gift to the couple's families with implications of future reciprocity.

The final rituals of the week were *to kopsimon ton makarounion* (the cutting of the pasta) and *to sinaman ton ornithon* (the collection of the chickens). These events took place on Tuesday and were attended by those who could not participate in Sunday or Monday's festivities. Accompanied by live musicians at the couple's home, the women rolled small pieces of dough between their palms, producing long, thin pieces which they then cut into small pieces. The collection of the chickens began after cutting the pasta, where young men gathered chickens from various village households (usually homes of invited guests). Also part of a musical procession, the youths brought the chickens home to be slaughtered and prepared with the pasta for the evening meal.

Greek weddings in the 1930s were not a small family affair; weddings were public celebrations, as almost all community members were considered friends and members of the family. Fathers of the bride and groom also felt their family name required a worthy nuptial celebration; thus, in Paphos, weeks before any actual celebrations, the two families distributed a special bread called *yiristarka* as an invitation.

Weddings in India

In an 1899 article titled "The Hill Tribes of the Central Indian Hills," William Crooke describes the Hindu-based wedding customs of several tribes. These customs emphasize the role of food in carrying out rites promising fertility, happiness, and abundance. An initial marital rite takes place when the parents of the newly betrothed couple drink together out of vessels made from the leaves of a holy tree. For brides of the Majhwâr tribe, entry into the couple's new home is forbidden until she and her husband eat rice boiled in milk. A young Dhobi male will not consume boiled rice before his wedding feast so as to preserve the sacred meaning of this ritual. Some Bengali tribes practiced a custom where blood was drawn from the husband's finger and mixed with betel and eaten by the bride. Rice also enters the nuptial customs as five mounds of rice are placed on a stone and the bride is made to knock them down with her foot symbolizing her departure from her natal family and her entry into the family of her husband.

Grains continue to represent fertility across the world's cultures as special wheaten cakes are prepared for the newlyweds to walk on; women throw betel and barley over the groom as he enters his new home; and the bride's brother pours wheat, rice, or barley over the bride as she turns around.

Boiotian Weddings

Ancient Boiotian weddings were secondarily presented and analyzed in the nuptial iconography of several vases found in the Kanapitsa cemetery of Thebes. Researchers believe the fertility ritual of *katachysmata*, where the bride and groom are showered with cakes, figs, apples, nuts, and other fruits, is depicted, as well as the practice of the bride consuming a quince, apple, or other fruit to signify her public transition into her new role as a married woman.

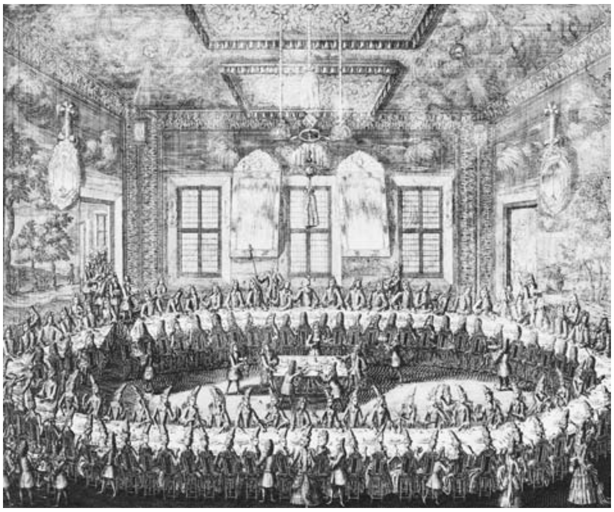
In Greek Orthodox wedding ceremonies, the bride and groom sip wine from the same cup as a symbol of the shared cheer and unpleasantness they will experience in their life together.

Chimbu Weddings

The Chimbu of the New Guinea highlands live in a world where transactions define all relationships and interpersonal interactions. These dynamic operations—gifts, tolls, assistance—carry many implicit meanings which test loyalty and create intergroup balance. Chimbu weddings provide opportunities for groups to participate in transactional gift-giving and feasting; sweet potatoes are given or exchanged at weddings, as are bean roots and nuts when available. Marriages often occur at the height of a pig ceremony where numerous pigs are sacrificed, *bulga kande*, and cooked at a ceremonial ground; also at this time, male dancers enact a fertility rite, blessing the women, pigs, and sweet potato vines. Along with the gift of vegetable produce, the widely traditional cooked pig meat is distributed among those who cooked it and individual kinsmen.

Nias Weddings

The wedding feasts of the Nias people—Nias is the largest chain of islands off the west coast of Sumatra—also include a large amount of pork. Preparation for the traditional feast at the bride's house begins when the groom's party begins a procession over the hills involving gongs and drums and a small herd of about six pigs. Upon arrival at the bride's house, the men are served betel. Many hours and ritual transactions later, two pigs (*bawi huku*, law pig, and *bawi vangovalu*, wedding pig) are slaughtered by an elder or member of the bride's party to commence the main attraction of the feast. Provided by the groom, the raw pig is ceremoniously and carefully butchered into portions; the lower jaw, the most prized portion, is divided into four. The bride's father and his close relatives and elders of the bride receive a portion running the whole length of the pig. A small quantity is cooked for the bride's relatives, and the remaining raw portions are given to the chief, wife-givers, and butchers.



The state wedding feast of Peter I of Russia is detailed in this 1712 engraving by Alexei Zubkov. © THE STATE RUSSIAN MUSEUM/CORBIS.

The host reciprocates the gift of the wedding pig with another larger pig, *bawi daravatö*. Once again the pig is split among the guests; the groom takes one leg and a hind-part (about one-quarter of the animal) home to his village, the groom's speaker receives one back section, and the host is entitled to a leg and the lower jawbone as a token of the evening. The remaining parts are cooked and served to all other guests. The groom and his family members receive the lower jaw, belly, and heart served on a large mound of rice, while he and his bride eat from the same plate. Status determines the size and type of portion; thus, only the elders of each group are entrusted with the duty of distributing the meat.

The betrothal of a Nias couple is solidified with *feamanu*, the eating of the chicken. Provided that specific omens which can break the contract are not encountered, the couple will eat the cooked chicken as their first meal together, and a small pig will accompany the meal. Raw and cooked portions, especially the lower jaw, are cut and given to the groom's father.

Weddings in China

The marriage customs observed in 1938 of the Chinese in the town then known as I Chang, located on the north bank of the Yangtse River, required preparations to begin at least one year in advance. During this time, pigs must be fattened, rice and other foods accumulated, and goats and chickens prepared. About one week before the wedding ceremony, final preparations for the wedding

A Hungarian immigrant wedding held near Wilkes-Barre, Pennsylvania, about 1906. The bride and groom are standing behind the bride's parents on the right. ROUGHWOOD COLLECTION.

feast began. The feast, which lasted four hours, included nine courses; the first course was cuttlefish or sea slugs and wine; the roundness of the meatballs of the fifth course represented a coming together of the groom greeting his guests; the ninth course also included fish, *yü*, which also means surplus, ending the meal with an omen to abundance in the couple's future.

In *The Wedding Day in All Ages and Countries* by Edward J. Wood published in 1869, Wood writes on the various wedding rituals throughout the world. In Athenian tradition, sweetmeats, symbolic of abundance, were gingerly thrown upon the couple as they walked into a house for the nuptial feast. Later on, a quince was shared by the pair in hopes that their marriage would be agreeable. A man in Algiers placed fish at his new wife's feet for good luck. Past Chinese tradition called for a quilt, held by her relatives, to be placed in front of the bridal chair and as the bride sat there, four bread cakes were thrown into the air so that they would land on the quilt; this ritual also represents good luck.

Later in the course of this days-long elaborate marriage ritual, tea and poached eggs with sugar were served three times to the guests. The groom and his party only feign partaking of these refreshments since actual consumption would violate social etiquette. Numerous tea ceremonies take place, often followed by a serving of tobacco.

While preparing the nuptial bed, two women selected by the groom's family place cakes, dried *lungan* nuts, red-stained peanuts, and ginko nuts in the bed. Young girls search for these goods and eat them in hopes of future fertility. In a ceremony to finalize the marriage, the bride and groom are each given a glass of wine; they drink half the contents, exchange the cups, and finish consuming the rest of the wine; the same ritual is done with pieces of candy after the wine.

To ensure that as a wife the bride will be thorough in completion of her duties, she places a pre-prepared fish in the stove with the head pointing toward the front of the stove, and the tail in the back. This ritual, *yu tou yu wei*, says that she will be thoroughly dutiful. In addition, a dish of steamed vegetables mixed with rice flour, *chêng tsai*, is prepared by the bride, symbolizing abundance.

Contemporary Hindu Rituals

Contemporary Hindu wedding rituals also involve food at almost every stage in the ceremony. In a prenuptial rite at the bride's and groom's homes, male and female guests heat the couple's bodies to ready them for sexual intercourse by rubbing them with turmeric. In another preliminary ritual, the groom's party is served a light *pakka* (fried) meal at the bride's house, then the bride sits behind a mound of rice, and the groom's father places coconuts and sweets (believed to be auspicious) and money in her lap.

During the main nuptial ritual, the priest pours rice into a small tray held in the bride's right hand. The groom places his arm around her shoulders and knocks the rice onto the ground seven times. After the ceremony is completed, *Muhajayana* takes place. During this rite, the bride fills a metal tin with uncooked rice and holds it on the ground for the new husband to kick over seven times. The disturbance of the raw grain by the male in these two practices places him in an active role for reproduction.

Also during *Muhajayana*, the wife cooks a mixture of rice and pulse, *khichri*, for the groom and his younger brothers. When the husband is full from his portions, he hands the leftovers to her for her to eat. This act embodies the belief that the leftovers of a superior confer a blessing on the subordinate who consumes them.

See also **Anthropology and Food; Feasts, Festivals, and Fasts; Nutritional Anthropology; Wedding Cake.**

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Dalila Bothwell

WHEAT.

This entry includes two subentries:
The Natural History of Wheat
Wheat as a Food

THE NATURAL HISTORY OF WHEAT

Wheat's beginnings can be traced to a clan of wild grasses called *Triticeae*, the seeds of which had a flavor that was pleasing to primitive people. *Triticeae* included wheat, barley, rye, their wild relatives, and a number of important wild grasses. The Fertile Crescent, at the core of western Asia and northern Africa, is the center of origin and early diversification of this clan. Wild einkorn and emmer, which have been known for roughly 75,000 years, are credited as wheat's earliest ancestors. The ripple effect of these grains has been immense, since wheat is the most widely produced and consumed cereal grain in the world.

Through the archeological evidence left by nomadic humans in west Asia, researchers have learned that humans adapted from hunting animals to also gathering seeds for food. Periods of glaciers no doubt inspired this move by reducing available game. The early gatherers were also the first millers and selected grains that could be most easily released from their glumes or husks and prepared. People parched, simmered, and ground these grains and prepared flat cakes. Thus, using grains as food changed the way early ancestors lived their daily lives, in addition to providing basic sustenance. The evolution of agriculture and cultivating seeds for harvest (which occurred about 9,000 to 10,000 years ago) changed not only the available food supply but how people moved about. Human beings' ability to process (mill), store, cultivate, and trade grain marked the beginnings of civilization.

Beyond Grass: The Early Use of Wheat

As mentioned earlier, early wheat was part of a clan called *Triticeae* and is classified under the Old World genus *Triticum*. Wheat's early relatives had seed heads that were brittle and easily broken apart and the hulls clung to the grains. This made the seeds better for re-seeding but also difficult to thresh.

Primitive women who were responsible for the tasks of gathering, threshing, grinding, and cooking would have selected heads with the largest grains and sought out those that were easiest to thresh or separate from the hulls. Some early wheat species grew as tall as six feet, but modern varieties average two to three feet in height. Domestic wheat is selected and bred for strong seed heads that do not shatter easily and that release the glumes or hulls so the kernels are bare.

Einkorn (*Triticum monococcum*) is considered to have been the first wheat gathered and cultivated. Its centers of early distribution were Armenia, Georgia (in the former Soviet Union), and Turkey, where it is still grown and eaten. Impressions of einkorn are found in Neolithic pottery as far north as Great Britain and Ireland, but there are no prehistoric records of it in India, China, or Africa.

All plants are identified by their chromosomes. Every variety of wheat grown today has arisen from wild, fourteen-chromosome wheat, undoubtedly einkorn. Einkorn and fourteen-chromosome wild grass crosses created twenty-eight-chromosome (tetraploid) wheats. Only one twenty-eight-chromosome species can be found in nature: wild emmer (*T. dicoccoides*). It grows in

EARLY BEGINNINGS

Archeologists look for certain evidences of early agricultural society. These include tools for pounding or grinding grain; pottery or means of quantity grain storage; remains of a permanent settlement; tools for planting, sickles or scythes for harvest; and related religious symbols. Some of the earliest finds include the following.

Pre-agriculture (Early wheat ancestors—wild einkorn and emmer—are gathered and ground.)

- 75,000 years ago—Simple roundish stones one-and-one-quarter-inch thick and four inches across, with flat working surface, such as the Arugnacian combination grinding stones, found in La Combe, France.
- 20,000 years ago—Mortar stones are an improvement, such as a dip to contain the product while grinding/pounding, found in Magdalenia, Vezere valley, France.
- 12,000 years ago—Pounder-rubber for grain and possible sickle-like blade from Azilian culture, found in Mas d'Azil, France; also found in Danish Maglemose period.
- 10,000 years ago—Pounder-rubbers—found in Pinto Basin, Riverside County, Calif., and Oak Grove Natives, Santa Barbara, Calif.

Early agricultural period

- 10,000 years ago (Stone Age)—Einkorn cultivated in southeastern Turkey.
- 9,500 years ago—Clustered mud-brick houses, cultivation tools, saddle stones (found in Abu Hureyra village, northern Syria).
- 8,700 years ago—Swiss cave dwellers provide evidence of eating wheat in flat stone-baked cakes.
- 8,050 years ago—Sickle blades coated with silica patina from grain stems; sandstone milling stones and mortars, baked pottery (Ghar-I-Kamarband or Belt Cave, northern Iran).
- 8,000 years ago—Goat grass (*Aegilops tauschii*) and wheat (*Triticum turgidum*) cross for the rise of bread wheats.
- 7,500 years ago—Pottery is invented.
- 7,000 years ago—Pottery is used in grain storage and cooking; tools—Natufian culture, Palestine and Sialk, northern Iraq; sickle, Fayum, Egypt; einkorn found in Jarmo, northern Iraq.
- 6,000 years ago—Unbaked clay grain bins—Hassuna, west of Sialk; planting tools, pottery, grain drying kilns, grain storage—Jericho, Dead Sea, and Abydos, Egypt.
- 3000 B.C.E.–2,737 B.C.E.—First plows depicted on monument in Egypt and China.
- 2600 B.C.E.—Egyptians develop fermentation and bread-baking.
- 2500 B.C.E.—Bread wheat emerges in Mohenjo-Daro India, Hungary, and China.
- 2470 B.C.E.—Tomb bas-reliefs of royal bakery and baking pottery remnants are placed in the Old Kingdom pyramids, Giza, Egypt.
- 2000–1100 B.C.e—Old Testament refers to Joseph overseeing Egyptian grain stores (1800 B.C.E.), Hebrew people enslaved in Egypt (1700–1250 B.C.E.), and Ruth on the threshing floors (1210 B.C.E.).
- 1100 B.C.E.—Iron plowshares used.
- 700 B.C.E.—In Greece, Solon's constitution develops agriculture and "Bread and Soil" cult under goddess Demeter; raised barley; imported wheat from Sicily, shores of Black Sea and Egypt; quern mill in use in Egypt and Far East.
- 200 B.C.E.—Flour milling methods improved lever mills, Greece and Roman hourglass mills, using two rotary stones turned by slaves and animals.
- 150 B.C.E.—Roman bakers' guilds formed.
- 100 B.C.E.—Roman water mills evident in Pontus and Thessalonica, Asia Minor.

the region comprising northern Israel, west Jordan, Lebanon, and adjoining southern and southeastern Turkey, western Iran, northern Iraq, and northwestern Syria.

Emmer (*T. dicoccum*), which closely resembles wild emmer, is the oldest and was once the most widely cultivated twenty-eight-chromosome wheat. Well-preserved spikelets of emmer have been found in Fifth Dynasty Egyptian tombs—the bread bakeries from that period in Egypt's history used emmer flour. Remains and impressions are also common in Neolithic sites in continental Europe, Great Britain, and Ireland. Durum wheats that are grown today for pasta and couscous are derived from emmer wheat crosses.

The Emergence of Bread Wheat

Varieties of wheat that have forty-two chromosomes are the most recently evolved and most used types of wheat. All of these varieties have been cultivated by humans (as opposed to growing wild). They are hybrids of twenty-eight-chromosome wheats and wild fourteen-chromosome wheats or grasses. Early bread wheat was the result of the crossing of goat grass (*Aegilops* *tauschii*) with *Triticum turgidum*. Modern bread wheat varieties have forty-two chromosomes and evolved from crosses between emmer and goat grass, which is the source of the unique glutenin genes that give bread dough the ability to form gluten. Goat grass grows abundantly in the region stretching from Greece to Afghanistan. Descriptions of the fourteen species of wheat that yield the thousands of wheat varieties grown today are provided here.

Distinct Species of Wheat

The thousands of wheat varieties grown today rose from crosses in these fourteen species (Mangelsdorf, pp. 2–11).

Fourteen chromosomes

- *Triticum aegilopoides* (wild einkorn)
- *T. monococcum* (einkorn)

Twenty-eight chromosomes

- *Tritcum dicoccoides* (wild emmer)
- *T. dicoccum* (emmer)
- *T. durum* (macaroni wheat; first appeared first century B.C.E., Greco–Roman period)
- *T. persicum* (Persian wheat; of no great commercial importance today)
- *T. turgidum* (rivet wheat; of no great commercial importance today)
- *T. polonicum* (Polish wheat; of no great commercial importance today)
- *T. timopheevi* (has no common name; grown on only a few thousand acres in western Georgia [in former Soviet Union])

Forty-two chromosomes (First three species—true bread wheats—account for about 90 percent of all wheat grown today.)

- *Triticum aestivum* (common wheat)
- *T. sphaerococcum* (shot wheat)
- *T. compactum* (club wheat)
- *T. spelta* (spelt; grown on only a few thousand acres in western Georgia [former Soviet Union]; once the principle wheat of central Europe)
- *T. macha* (macha wheat; grown on only a few thousand acres in western Georgia [former Soviet Union])

SOURCE: Mangelsdorf, Paul C. “Wheat.” *Scientific American* (July 1953): 2–11.

CONTRIBUTIONS: W. J. Raupp, Senior Scientist. Kansas State University, Wheat Genetic Research Center. Available at http://www.oznet.ksu.edu/wgrc.org.

The Diffusion of Wheat

The fact that prehistoric people accomplished selective breeding of wheat is a testament to their powers of observation and curiosity. Through their efforts and, much later, through the development of the laws of heredity by nineteenth-century Moravian monk Gregor Mendel, wheat began to diversify.

Up through the Middle Ages and into the seventeenth century, the varieties of wheat grown in different parts of the world were often “landrace” (native wheat or wheat grown for centuries in a region) varieties. People carefully selected the biggest and best grains at harvest for seeding the next crop. Through trade routes and immigration, new varieties of wheat were sold or shared by people from different regions. If a type of wheat grew well (in other words, if it resisted soil or airborne diseases, insects, and variations in rainfall or climate), people were likely to continue growing it.

As people emigrated to the Americas and Australia, the varieties of wheat grown in their mother countries were the first seed stock cultivated in the new frontiers. If these crops failed, people tried raising other crops or experimented with wheat seed others had from another region.

Six Wheat Classes

The wheat foods that we enjoy today are all produced from varieties of wheat bred from the first fourteen species. The wheat industry divides the thousands of varieties available today into six wheat classes: hard red winter, hard red spring, soft red winter, durum, hard white, and soft white wheat. Each wheat class has qualities that millers and food processors seek for specific products. Farmers grow varieties from classes that will grow in their location.

Spring wheat classes (hard, soft, and durum) are planted in the spring and harvested in the summer. Winter wheat is planted in the fall, grows several inches, and may even be grazed by livestock before the grain head develops. Winter wheat lies dormant through the winter, continues growing in the spring, and is harvested in the summer months. Sometimes varieties of spring wheat are planted in the fall, as is the practice in some locations in China.

In general, the hard wheat classes (spring and winter) contain higher quantities of the proteins needed to produce bread, buns, pasta (durum), pizza crust, and other bread products. Soft wheat contains lower quantities of protein than hard wheat, and it is conducive to producing tender cookies, cakes, pastries, crackers, Asian noodles, and steam breads.

The white wheat classes are desirable because they lack a red gene in the bran that contributes to a darker color and a slightly bitter flavor to the whole grain. Hard and soft varieties of white wheat are grown increasingly in the United States and Australia.

New Varieties of Wheat

Developing and planting wheat varieties that resist diseases and insects is essential for a secure food supply, human health, and reducing the use of chemical controls. For example, fungal diseases like Karnal bunt, leaf rust, or smut will ruin entire wheat crops. In the Middle Ages European rye hosted a disease called ergot and was the cause of a horrible plague when the rye was mixed with wheat flour in breads. In more recent times, problems with Karnal bunt have rendered large portions of India's wheat harvest useless, and thousands of acres of Minnesota spring wheat were tilled under due to plant-disease damage.

Wheat hybridization occurs naturally and through human assistance. Wheat breeding has been practiced since people first selected the biggest seeds that were easiest to thresh and stored them for planting. In a formal sense, favorable characteristics such as disease resistance, large kernels, short straw, and cold hardiness are selected in two parent wheats, which are then crossed to form a hybrid.

For example, northern wheat hybrids were first made in Ontario, Canada, in 1885. North Dakota followed this trend in 1892. The early spring wheat varieties that were brought to North America had heads that shattered easily, and farmers needed them to ripen faster. Dr. William Saunders, organizer and first director of the Dominion Experimental Farms, produced a Canadian cross between an Indian wheat (Red Calcutta) and a popular Polish spring wheat (Red Fife) that gave rise to Marquis, a hard spring wheat. Marquis was put into production in 1909 and was soon grown over 90 percent of the northern United States and Canadian plains. It helped alleviate food shortages during World War I.

Another source of many new varieties of wheat is Turkey Red, which was hand-picked and carried to Kansas in 1874 by Mennonites from Crimea, Russia. Turkey Red wheat once covered over 90 percent of wheat acreage in the Great Plains. Winter-wheat research at Kansas State University has given rise to new winter wheat varieties and crosses grown all over the world.

Wheat breeders in centers around the world collect, conserve, and utilize wheat plant materials. Japan first began collecting wheat plant material in the early 1900s. Since the 1960s, wheat research centers have been formed (through private and government funding) in wheat regions all over the world.

It takes ten to twelve years of lab and field tests at a cost of around $500,000 per new variety of wheat before a seed wheat can be released to farmers for production. There are perhaps 100,000 unique varieties of wheat derived from the six classes worldwide. A variety will commonly be grown for about ten years before a new variety may be needed.

Genetically modified (or GM) wheats were not to be released until the early twenty-first century. The primary benefit of GM wheat technology is the precision it allows in adding desired wheat characteristics located at specific points on wheat's chromosomes. With wheat breeding or hybridization, all the genetic material from both parents is present in the cross. The resulting variety must be grown in order for researchers to see what attributes are included in the cross. Through genetic mapping, specific traits may be added, such as disease resistance to wheat streak mosaic or the addition of nutritive elements. With GM wheat technology, the testing time for new varieties of wheat may be reduced to as little as two years versus the ten to twelve years needed in traditional breeding programs.

Centers for wheat research also preserve early wheat and grass germplasm while new crosses and genetic research are performed. Wheat research is shared for the improvement of agriculture and food-production systems in all countries.

Wheat Production

Through centuries of seed selection and modern wheat breeding, wheat can be grown in every temperate climate in the world. World wheat production is perennial, that is, wheat is being harvested in some part of the world in every month of the year.

Wheat is seeded anywhere from sea level to elevations of ten thousand feet. A ninety-day growing season is needed for wheat growth, and a period of dry, sunny weather is preferred for the ripening period. Rainfall between ten and thirty inches annually is required, and soils that range from sandy loam to clay are used to grow wheat. The plant averages between two to three feet in height, and some varieties reach five to six feet.

Advances in Wheat Production

From 7500 B.C.E. to 1840 C.E. there were surprisingly few mechanical advances in the production of wheat. The invention of the iron plowshare, sickles for cutting ripe wheat, and the use of oxen or horses for tilling and threshing are considered the main advances during this time. With their reliance on human and animal labor and without the availability of machines, agricultural practices greatly limited how much wheat was produced. Fields were left fallow (unplanted) for a year to improve their moisture, and animal manure was used to enrich the soil. Many fields were planted to hay in order to feed essential work animals. Eventually soils were exhausted in Europe, Asia, and other regions where grains had been cultivated for thousands of years.

Three major advances were vital in the expansion and development of wheat production and consumption. First, in the early 1800s, the first soil-chemistry studies were performed. European soil chemists Sir Humphry Davy (from England), Albrecht von Thaer (from Prussia), and Justus von Liebig (from Germany) provided farmers with evidence that the soil had been "robbed" or depleted and that fresh sources of specific chemicals were

PERENNIAL WORLD WHEAT HARVEST

Wheat is harvested somewhere in the world every month. The world's top wheat producers are China, United States, Romania, Czech Republic, Slovakia, Russia, Canada, Germany, and France.

- January: Argentina, Chile, Australia, New Zealand
- February and March: Egypt and India
- April: Egypt, Asia Minor, Mexico
- May: Algeria, Central Asia, China, United States
- June: Turkey, Spain, France, United States, Italy
- July: Romania, Czech Republic, Slovakia, Austria, Russia, Germany, Switzerland, France, England, Denmark, Poland, United States, Canada, Italy
- August: Holland, Belgium, England, Denmark, Poland, United States, Canada
- September: Scotland, Sweden, Norway, Russia
- October: Scotland, Sweden, Norway, Russia
- November: Peru, South Africa
- December: India, Argentina

needed for crops to flourish again. The manure that farmers were using was not enough for healthy crop production. The inorganic minerals the researchers identified as essential were nitrogen, potassium, lime, and phosphoric acid. By 1843, Dawes in England began producing chemical fertilizers for the exhausted soils of Europe.

The second advance surrounding wheat production involved major improvements in milling technology. James Watt invented the steam engine in 1769. Oliver Evans began automating the milling process in 1785, and by 1834 steam-driven steel roller mills had been introduced in Europe. Steel roller mills were capable of milling the harder spring and durum wheats grown in Canada and the United States. By 1870, superior flour production and a new process called middling purification (created by Edmond La Croix) had created growing wheat demands.

A third major advance, convenient to the homesteading of vast expanses of untilled land in North America in 1862, was the mechanization of U.S. agriculture. In 1842, the Pennock brothers launched a mechanical sower called a drill, and the McCormick reaper was rolling out of factories in 1861. The invention of steam-driven threshing and self-binders meant that, by 1940, producing a bushel of wheat took only sixteen minutes, whereas in 1850 manual labor produced a bushel in four and a half hours. This meant there was no longer a risk of losing crops that were waiting to be harvested by hand. With machines, more ground could be seeded to wheat instead of animal feed as long as there was adequate rainfall. Delivery of wheat was greatly improved by the advent of cross-continental railroad service. Between 1866 and 1900 U.S. wheat production increased from 175 million bushels to 655 million bushels. Exporting wheat became a new trade opportunity.

Challenges in the Wheat Industry

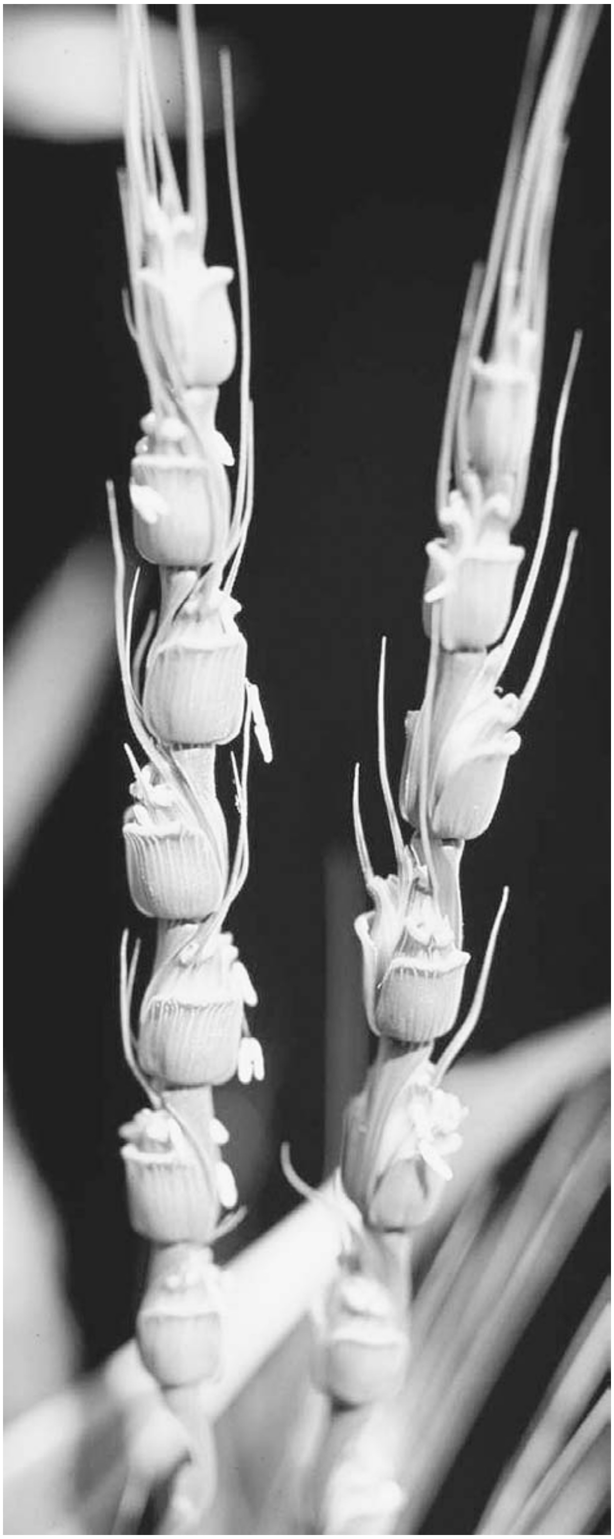
For thousands of years, all wheat, regardless of variety, was grown, harvested, and co-mingled in storage. As milling and the wheat food industry became increasingly sophisticated, companies became aware of the uniqueness and importance of wheat varieties. They now wanted to keep different classes and varieties of wheat separate at harvest and to identify which were best for what end use. For example, millers, bakers, and farmers all looked for different qualities in wheat. Thus, wheat manufacturers asked the question: Who should determine what qualities would be developed in new varieties?

Milling. Early millers were the first to begin to distinguish the unique qualities of different wheat species. They could tell in the milling process that all wheat was not the same. For example, some varieties of wheat were difficult to mill, produced less usable flour, and produced more "animal feed." Their customers also had increasingly sophisticated needs as baking became more mechanized. Cereal science isolated specific wheat and flour characteristics, and milling as a science and food technology had begun.

Baking and wheat food industry. Those who bake or prepare pasta, Asian noodles, crackers, tortillas, cakes, steam breads, and many other wheat foods long ago determined that all flour is not the same. Certain characteristics in various flours performed better when producing specific end products. Food companies need dependable flour for consistent products. After thousands of years, baking and wheat food industries have their specifications down to a science in regard to starch and protein content and a wide variety of other performance factors in various types of flour.

Agriculture. The farmer recognizes and needs wheat varieties that are resistant to plant, and soil, and airborne diseases and insects, that are suited to certain climates, and that are able to produce adequate bushels for the cost of production. There is very little monetary incentive provided by the food industry for specific wheat attributes. A farmer's source of profit is the production of the quantity of bushels that generate profitability for the farming operation.

Gauging wheat quality. Solutions to the various tensions surrounding wheat quality began in 1937. Under the bipartisan leadership of Mennel Milling in Michigan and Nabisco in New York, legislation was written that formed four wheat quality laboratories in the United States. These Agricultural Research Service laboratories



Goatgrass wheat is an ancient relative of cultivated wheat. PHOTO COURTESY OF THE WHEAT GENETIC RESEARCH CENTER AND KANSAS STATE UNIVERSITY.

operate under the direction of the U.S. Department of Agriculture. Their goal is to guide the development of new wheat varieties to meet functional and nutritional needs of food processors while considering agricultural parameters for the growing regions they serve. In addition, representatives from milling, wheat food production and agriculture collaborate through the Wheat Quality Council.

Changes in World Wheat Production

The world's yield per acre of wheat continually improves with the evolution of better wheat varieties and practices. World wheat production has nearly tripled since 1955 and has grown an average of 2.3 percent annually since 1951 (World Wheat Facts and Trends, 1998–1999).

Wheat needs continue to change. Great Britain traditionally grew soft wheat and once needed to import 2.75 million tons of higher protein wheat for bread flour from North America. Through wheat breeding, Great Britain now grows varieties suitable for bread flour and imports only 300,000 tons.

Many developing countries seek to be self-sufficient in their wheat needs. Over the past fifty years, India has achieved self-sufficiency and is now a wheat exporter. China, with nearly the same number of wheat-growing acres as India, has boosted its yields over a span of fifty years, becoming less dependent on imports. It is now the leading wheat producer in the world. Yields have increased from eight bushels per acre to thirty-five to sixty bushels per acre.

In past century in the United States there has been a dramatic decline in the number of farmers. In 1840, 70 percent of all Americans were engaged in farming. That number dropped to 12 percent by 1950 and to less than 2 percent by 2002. The cost of wheat production is simply not matched by returns in the marketplace. Despite having fewer farmers than it once did, the United States is second in world in production with Canada, Australia, the European Union, and Argentina being other major wheat contributors. Even thought the faces involved in wheat production have changed, world wheat production continues to meet population growth and steady consumption demands.

The Wheat Trade

The wheat trade reflects the unique ability of wheat to produce a wide variety of staple foods within diverse cultures. Wheat has come a long way from stone ground flat cakes baked on hot rocks, or gruel simmered over a fire. Asian noodles and steamed breads, chapattis, naan, baguettes, bagels, pasta, buns, crackers, biscuits, tortillas, and more all sustain the world's strong daily demand for wheat.

The wheat trade is not driven by market demand for wheat as an animal feed. Only an average of 16 percent of wheat is fed to animals worldwide. This number falls to less than 4 percent in developing countries and may be as much as 35 percent in developed countries. Other commodities tend to fuel new industrial uses of wheat, such as ethanol and plastics production.

Early wheat trade. The early wheat trade followed trade routes in the Mediterranean, with Greece and Roman civilizations being some of the earliest importers of wheat from west Asian countries and Egypt. Wheat was undoubtedly carried on trade routes throughout those empires and into China via the Silk Road. Evidence of wheat in sunken cargo ships, religious writings, on pottery, and in the agriculture of northern Europe and Asia indicates the existence of an early wheat trade.

In the Middle Ages, the wheat trade became tied more closely with milling. For example, in Great Britain, the value of wheat was in its edible form, starting with flour. This tie was very pronounced from the ninth to eleventh centuries. Tenant farmers were compelled to mill their grain at their landlord's mill, and a "soke" of one-sixteenth of the production was kept by the landlord. Until the soke system died out in 1791, wheat was not sold much beyond the landlord's domain. Millers were tied to buying the varieties of wheat that were grown in their region. They welcomed the end of the soke system so they could import the wheat of their choice. In modern times some governments still restrict wheat imports by requiring their millers to buy domestic wheat, even if these varieties do not perform well in the end product.

The English Magna Carta (1215), borrowing from moral law, influenced the measures used in dealing in wheat over time. European countries had various systems of controlling the sale of wheat through warehousing, fixed prices, loans, and speculation (futures).

Developing a world wheat trade. After having wheat bread as a staple in Europe for thousands of years, settlers in the New World found no wheat upon their arrival. These setters were dependent on imported flour from Europe, most often England, until they were able produce wheat on their own. Though maize or Indian corn saved the early settlements, many English settlers viewed it with disdain. Out of necessity they would bake a bread called "thirds" to extend the precious imported wheat flour. This bread was prepared from one-third wheat flour, one-third rye, and one-third cornmeal.

Unlike silk or spices, shipping wheat throughout the world was not considered profitable. By the 1740s the United States was successfully exporting wheat to England from the northern fields of New York, New Jersey, and Pennsylvania. Shipments of wheat and flour were also sent, against British regulations, by defiant colonists to British, Dutch, and French colonies in the West Indies.

The role of the United States as a wheat exporter rose substantially after the American Revolution. European countries needed U.S. wheat due to crop failures in 1790 and 1807, and later in 1860–1862. Napoleonic wars and, later, World Wars I and II created record wheat demands.

TABLE 1

Per capita wheat consumption (1994–1996), in pounds per year

Kazakhstan	1,023
Bulgaria and Czech Republic	772
Turkey	705
Ukraine	683
France	666
Ireland/Canada	584/593
Israel	487
Australia/United Kingdom	439/443
Italy	403
Argentina/Chile	306
United States	276
China	207
South Korea	163
India	148
Japan	117
Mexico/Central America	112
World average	220

Government trade practices and agreements. U.S. wheat exports experienced the largest decline in seventy years during the Great Depression and Dust Bowl era in the early twentieth century. Exports rebounded somewhat in the late 1930s until the rebuilding of Europe following World War II. As wheat production rose worldwide, wheat demand slackened.

The second half of the twentieth century saw enormous changes in world wheat production and the resulting wheat trade. Countries that were once centers in wheat production, self-sufficient for their wheat needs, became wheat importers. For example, west Asian countries, which were the cradle of wheat production (Afghanistan, Iran, Iraq, Saudi Arabia, Syria, Turkey, Yemen) and the earliest exporters of wheat to the Mediterranean and other early trade routes, imported 9.7 million tons of wheat in 1997. Countries such as India, not formerly known for wheat production, became notable wheat exporters. A new era began in the United States once wheat surpluses occurred. The U.S. government began to assume new importance in balancing the wheat trade.

All major wheat exporters employ a variety of trade-enhancement programs to maintain or increase their market share. Politics are an extremely important aspect of the functioning of these programs. Just one example is the grain embargo the United States placed on the Soviet Union in the 1970s. The United States watched its 49 percent market share of exports steadily fall to about 28 percent in 1998.

EXAMPLES OF U.S. TRADE ENHANCEMENT PROGRAMS

- 1938: The U.S. government price-support program, the Commodity Credit Corporation, was formed.
- 1949: The International Wheat Agreement specifies quantities of wheat that could be sold abroad at a fixed range of prices.
- 1954: Agricultural Trade Development and Assistance Act or Public Law 480 allowed the U.S. government to make agreements for wheat sales or barter.
- 1959: Public Law 480 was amended to include long-term agreements and credit extensions for sales of surplus farm products.
- 1990: Export Enhancement Program (EEP) created.

How Wheat Is Traded

Trade begins just after the wheat is loaded onto a grain truck or cart at harvest. Trade may even begin before the crop is grown if it is sold on futures or by contract. The following are the steps wheat takes in the market.

Field to elevator or bin storage. Wheat travels from the combine harvester in the field via truck or grain cart to storage bins on farm or a grain elevator (it may be a country cooperative elevator or a terminal elevator). Elevators are large storage facilities named for the moving belts used to move or "elevate" the grain. The elevator operator may purchase the grain or the farmer may store it for future sale. The wheat will be purchased according to its test weight, dockage, and grade.

Grain inspection. A seller would not want a buyer to refuse his or her grain due to a high level of moisture (14 percent maximum) or the presence of foreign material (FM). If either of these things occurs, the price paid will be "docked" and it will have to be cleaned prior to storage or sale. These factors also promote insect infestation, decay, and other problems in shipment or storage.

TABLE 2

Top five wheat exporters

	Wheat production	2000 exports (in millions of tons)
United States	69 4	31.9
Canada	29	19.2
Australia	21.6	17.6
European Union	104.2	16.5
Argentina	12.3	12.5

SOURCE: U.S. Wheat Associates. www.uswheat.org.

TABLE 3

Top importers of wheat (1995–1997, in millions of tons):

China	9
Belarus	6.9
Brazil	6.8
Thailand	5.8
Indonesia	4.3
Mexico	1.5

SOURCE: May 2002, www.CIMMYT.org.

Government or private inspectors examine samples from each load of wheat to record the wheat class, protein, moisture, and percentage of FM in the sample. Inspectors also grade the wheat for quality.

Trade options: Cash for export or domestic use or futures contracts, government price supports. A variety of wheat sales methods exists in the world. In the United States, wheat is traded on the floor of a grain exchange, which is where U.S. grain buyers and sellers meet. The grain exchange does not buy or sell wheat; rather, grain exchange members represent either the buyers or individuals or companies that sell grain. Buyers include millers, brewers, feed manufacturers, and exporters. The largest grain exchanges are in Chicago, Minneapolis, and Kansas City. Wheat is then purchased on either a cash or a "futures" basis. Futures markets originated with the Dutch tulip bulb trade in the 1600s. In the United States futures trading developed in Chicago prior to the U. S. Civil War. Selling wheat on a futures basis provides the producer a guaranteed price for a contracted future grain delivery date.

In many countries, if the price a farmer receives is too low to cover the cost of production it may be subsidized through a government agreement. Some governments subsidize grain transportation. In the United States, the subsidization is called a "deficiency payment." An average cost of production is calculated and the difference between market price and the cost of production is the amount that the government will subsidize, within pre-set limits.

Transporting grain to the customer. After it is purchased, wheat will be moved out of or across the country to its destination via ship, train, or truck. Prior to delivery and upon arrival, the wheat is inspected for the specific tolerances of FM, moisture, and the class and grade listed in the contract. The wheat must be of a single class—no buyer will want wheat classes that have mingled.

Fair trade practices. International trade agreements are written by representatives from the trading nations involved. Representatives from trading countries negotiate trade practices through the General Agreement for Tariffs and Trade (GATT). The North American Free Trade Association (NAFTA) set guidelines for fair trade practices in that region. The European Union has laws and policies for fair trade. The agreements are meant to avoid the "dumping" of low-priced grain or price support practices that give one country an unfair advantage in the marketplace.

The Future of Wheat

Ongoing wheat research and technological developments continue throughout the world. New wheat foods emerge weekly. Nutrition research continues to support wheat's role as a food staple. Wheat components, such as fiber, starch, and gluten, are used in a wide variety of food products and pharmaceuticals. Wheat holds an important food-security role in a growing world population.

Ongoing wheat research includes many industrial applications in packaging, plastics, horticulture, and ethanol production, to name just a few. One of grain producers' highest research priorities is finding a way out of the world's reliance on petroleum.

See also **Bagel; Barley; Biscuit; Bread; Rice; Russia; United States.**

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Sharon Davis

WHEAT AS A FOOD

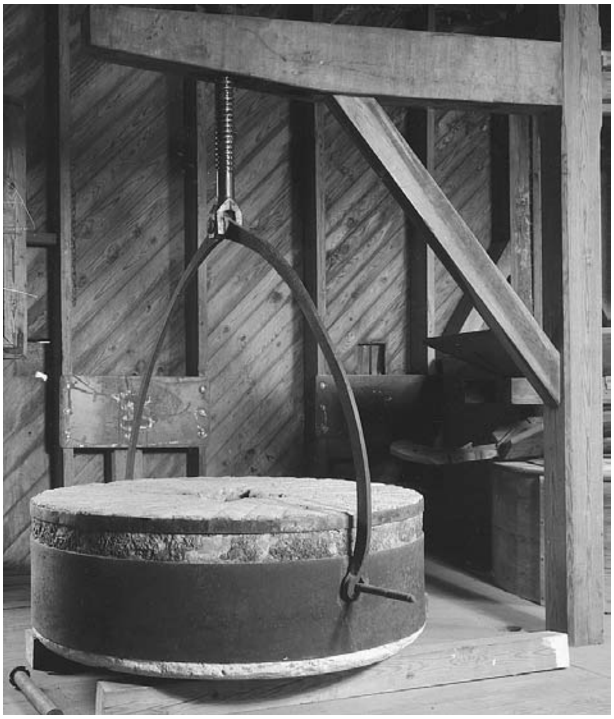
The development of civilization may be directly connected to the cultivation of wheat. When humans no longer needed to roam the land to find animals, wild berries, and grains, villages arose. People could grow wheat in the warm months, store it throughout the winter for food, and set some aside for planting the next spring. It is not certain when civilization and the cultivation of wheat began, but anthropologists speculate it may have started in the Fertile Crescent of western Asia around 6000–8000 B.C.E. or earlier. This area between the Tigris and Euphrates Rivers is home to modern-day Iraq.

History of Wheat as a Food

In about 17,000 B.C.E., human ancestors' consumption of wheat consisted of chewing the hard kernels for sustenance. Eventually, they doubtless soaked whole or cracked wheat in water until it softened and swelled, making a porridge of sorts or providing the basis for a mixed dish much like tabbouleh salads. Pastes made from flour and water or milk were most likely one of the first staples of the early human diet. In about 10,000 B.C.E., the earliest recipe for a type of flat bread was invented: "pound wheat into flour, add water and bake." Similar flat breads are still made in India (chapati), Mexico (tortillas), and in the Middle East (pita bread).

Einkorn, an ancient relative of wheat, was eventually domesticated and was popular until about 4000 B.C.E. There is evidence that more emmer (a wheat cousin) than wheat was grown at that time; emmer can still be raised in poor-quality soil in France, Italy, Turkey, and Yugoslavia. Einkorn and emmer were most likely eaten as a porridge before bread making was developed. After bread making became increasingly important, *Triticum vulgare*, another type of wheat, replaced einkorn and emmer. *Kamut*, which was found in King Tut's tomb and is thus nicknamed "King Tut's wheat," was also cultivated in the Fertile Crescent area. It is still grown in limited quantities in the United States and is a registered trademark. *Kamut* is an ancient Egyptian word meaning "wheat."

Egyptians are credited with having invented leavened bread. Archaeologists discovered what might be one of the oldest bakeries in the Giza Plateau of Egypt, dating back to around 4500 B.C.E. In his article "The Lost City of the Pyramids," Mark Lehner speculates that such bakeries might have served workers building the pyramids. Honey was eventually added to bread for sweetening, and other flavorings such as salt, herbs, and seeds were also



Wheat becomes food when it is milled; thus, mills have been a center for wheat processing since ancient times. In colonial America, the miller acted as banker, since wheat was also used instead of cash for transacting business. This shows the old millstone in the restored nineteenth-century Murray Mill in Catawba County, North Carolina. COURTESY OF THE CATAWBA COUNTY HISTORICAL ASSOCIATION.

added. A form of this traditional bread recipe is often used to make sourdough breads either by airborne yeast or by adding yogurt with live active cultures.

The Romans discovered leavened bread long after the Egyptians. During the Second Punic War (218–201 B.C.E.) wheat was imported to Italy, and in the first century B.C.E. public bakeries were common. Wealthy Romans ate bread made from very finely ground flour, while the common people and soldiers survived on very coarse flour that was usually blended with other grains and broad bean flour.

Religious Significance of Wheat

There are more than twenty references to bread in the Old Testament and over thirty in the New Testament. The first Biblical reference to wheat appears in Genesis 18: when three angels visit Abraham, he runs to his tent to ask his wife, Sarah, to make “cakes” of “fine meal.” (Fine meal probably referred to wheat flour that had been finely ground between stones.) Grinding stones have been found throughout the Middle East, as have sieves made from horsehair. References to wheat and bread also appear in sacred texts of Judaism, Hinduism, and Islam.

The Jewish people celebrate the eight days of Passover with unleavened bread, in the form of matzoh, to commemorate the Exodus from Egypt when they took only unleavened dough in their haste to flee. The Haggadah (a Jewish prayer manual) instructs its followers to declare: “This is poor man’s bread; the bread our forefathers ate when they were enslaved in Egypt.” During the rest of the year, every Jew is required to eat three meals on Shabbos, or the Sabbath: one on the night when Shabbos begins and two the following day, each of which must contain bread over which a specific blessing called the *motzi* is made. The traditional bread used at Shabbos is challah, an egg-enriched braided loaf (Fohrman, personal correspondence).

The Roman Catholic and Protestant churches usually use unleavened bread and wafers for the sacrament of Holy Communion; however, some churches (such as the Greek Orthodox Church) use leavened bread. In Islam, although they are not required by the Qur’an, the bulgur wheat-based soups *Jary* and *Shorobat Il-Jereesh* are traditionally used to break the fast during the observation of Ramadan (Solley).

Worldwide Consumption of Wheat

Wheat is the most consumed grain in the world, with rice being a close second. China is the world’s largest producer of wheat. Almost every country in the world has some form of wheat-based bread, soup, or mixed dish in its culture. Numerous products overlap various countries and cultures because of migration. The following is by no means a complete list of all wheat-based foods that are available, rather it is a list of only some of the more well-known wheat products.

Asia. *Chapati*, a tortilla look-alike, is common in northern India and is usually made from whole-wheat flour and cooked on a *tava*, which resembles a grill. *Naan* is also an Indian bread that can be found in the Middle East and surrounding countries. It is a very soft round bread that is often coated with flour.

Asian noodles are often made from wheat, although they can also be made from buckwheat and rice as well. They do not contain egg and can be broadly divided into Japanese and Chinese types. Japanese noodles use regular salt whereas Chinese noodles use alkaline salt. Pot stickers are a popular Japanese dish whose base is wheat flour. They are small envelopes containing minced meats and vegetables and are fried or steamed.

Europe. Bagels originally came from Austria in 1683. Folklore says a baker was grateful to the King of Poland for saving Austria from invading Turks. He reshaped a local bread into the shape of the king’s stirrup and called it a *beugel*, derived from the German word for stirrup, *Bügel*. As bagels were brought to America, the word was changed to bagel.

Cookies came from the Dutch word *koekje*, meaning ‘little cake’. The British adopted them in the nineteenth century and call them biscuits. Cookies eventually became a favorite in American diets.

English muffins are flat rounds of yeast-raised breads that are chewy with air pockets. One of its ancestors may have come from tenth-century Wales, called *bara maen*. English muffins are now popular throughout the Western world.

Gyro bread is a Greek pita bread that is wrapped around meats and vegetables to make the popular gyro sandwiches.

Pasta is an Italian word meaning paste, since it is made from durum wheat and water. The dough is then put through a variety of shaped sieves (there are over four hundred shapes worldwide) and cooked until dry. It can be served fairly plain with butter or olive oil or have any numbers of sauces piled on top. It can also be made into soups or casserole dishes such as lasagna. There is some controversy in regard to where pasta originated. Some have credited Marco Polo with bringing pasta back from China in 1255 C.E.; however, there is evidence that it was a staple in Italy before that time. Thomas Jefferson brought pasta to America, where it has also become a staple, in the late eighteenth century.

Pizza may have originally come from Italy, but it is no longer a strictly Italian product. Italian pizzas are much simpler than those found in the British Isles, Australia, New Zealand, and the United States. While traditional Italian pizza is not much more than a crust, tomato sauce, and sometimes cheese, the rest of the world heaps numerous meats, vegetables, and a variety of cheeses on their pizza crust.

Rye bread is a popular product in Northern and Eastern Europe. Rye crispbread is an essential part of Finnish army life and family diet even today. Soft, round, flat loaves with a hole in the middle, which in the old days were stored on horizontal poles under the ceiling in farmhouses, are made from rye through a fermentation process. The specialties of southwestern Finland and the archipelago are the soursweet loaf and malt bread. Island-baked bread is dark in color, and its northern counterpart may also have animal blood as an ingredient.

The Middle East. A variety of flat breads and bulgur soups are commonly eaten in the Middle Eastern countries. Bulgur (bulgar) is cracked, pre-cooked wheat that has about 5 percent of bran removed in processing. However, bulgur is still considered a whole grain product. It is the basis for tabbouleh salad and many stews and soups, and it can be eaten as a breakfast cereal. Bulgur can also be added to breads and muffins for extra texture and nutrition.

Fatayer are small bread-dough pies filled with meat, spinach, cheese, tomato, or onion. These are made especially for parties (Abourezk, p. 26). *Fettoush* was originally created to use up stale pita bread, but is now made from fresh, toasted pita bread. It is a salad of lettuce, tomatoes, peppers, radishes, onions, squares of pita bread, olive oil, lemon juice, and several spices (Abourezk, p. 59).

Lagymat is a sweet mixture of flour, oil, leavening, yogurt, spices, and water. The batter is fermented and then spoonful portions are deep-fried. The golden brown products are cooled and dipped into syrup, which is usually flavored with cardamom and saffron.

Pita bread is a yeast-leavened flat bread that contains an internal pocket formed when steam puffs the bread up and then collapses before baking. Pita is often used as a "scoop" for dips or for stuffing with vegetables and/or meats as a sandwich.

Tabbouleh is a popular salad in the Middle East that has found a home in the Western world. It contains cooked bulgur, tomatoes, parsley, onions, and spices. Tabbouleh is often made as a social group activity as it requires a lot of chopping.

Africa. Couscous is very common in northern Africa but is not usually eaten in the rest of the continent. Couscous is a small, round product made from the same ingredients as pasta: semolina and water. It is precooked and needs only soaking in hot water to be ready to eat. Its bland flavor is often enhanced with spices and vegetables. It can be eaten as a breakfast cereal. Couscous is also becoming quite popular in North American restaurants.

Kishk (*kashk*) is often eaten in northern Africa and in the Middle East. It is a dried mixture of ground wheat and a heavily fermented dairy product. It is added to a variety of meals for taste and flavor. Moroccan whole-wheat bread is yeast leavened and actually is part white flour and is made into a round, flat bread.

North America. Biscuits were originally made in Europe and were twice-cooked, hard cakes that were the staple of sailors and soldiers for centuries. They are now a popular staple throughout southern United States and are light and flaky because of the fat content and the air beaten into the dough.

Cakes are popular sweet desserts and are used in traditional celebrations of birthdays and anniversaries. There are two basic types of cakes: those with fat (butter cakes) and those without (foam cakes). Angel food cake is the most common foam cake, whereas there are numerous popular butter cakes: chocolate, carrot, layered, and even some that contain frozen ice cream.

Corn bread is a favorite in the southern United States and Mexico. It usually contains some wheat flour as well as the cornmeal for volume and texture. It is often cooked in a hot iron skillet or corn bread mold for a darker, crisper crust.

Fry bread is a Native American bread that is still eaten in various parts of the country. The yeast-leavened bread dough is cut into squares and fried in hot oil and served with butter and sometimes honey.

The Roman goddess, Ceres, who was deemed protector of the grain, gave grains their common name today—cereal.

*

The Chinese are more likely to steam or boil wheat foods rather than bake them. Steamed breads, pao, cakes, dumplings, and noodles are prepared in steamers or boilers rather than ovens.

*

Even though airborne yeast was used as the leavening agent for thousands of years, it was not until the 1800s that yeast was actually identified as the organism that provided the leavening.

*

A bushel of wheat weighs about 60 pounds (27 kg) and contains approximately one million individual kernels.

Pancakes are thin flat cakes made from a batter of water, flour, eggs, and leavening (usually baking powder or soda or a combination of the two). Pancakes are usually eaten for breakfast and sometimes called flapjacks, wheatcakes, or griddlecakes. Some form of pancakes can be found in most cultures.

Pies are a favorite dessert and come in all sizes and flavors. Fruit pies, such as apple, peach, and cherry are made in a pastry flour crust. They are usually eight inches in diameter and baked in a pie pan in the oven. Cream pies such as chocolate, coconut or banana are generally made in a flour crust or graham cracker crust.

Quick breads, such as zucchini, carrot, and banana breads, are sweet loaves that are leavened with baking powder and/or soda and appear to be native to the United States. Muffins are also considered a quick bread although they are made in individual muffin pans or paper cups for single servings.

Sourdough became a staple for the gold miners and other pioneers in the west and northern parts of North America. These individuals could carry a “starter” of yeast, flour, and water from camp to camp and then add water and warmth at the next campsite to make bread. From each batch they would save a starter for the next batch. This practice earned miners, sheepherders, and mountain dwellers the nickname “Sourdoughs.”

Tortillas are probably the fastest growing wheat product in North America. The original unleavened flat bread was made from corn in Mexico and Central and South America. Wheat tortillas are now the largest category sold in the United States. The word tortilla comes from the Spanish word *torta*, which means ‘round cake’.

White pan bread, hamburger, and hot dog buns are the major wheat products sold in North America. One hundred percent whole-wheat products consist of less than five percent of sales, but sales of whole wheat and partial whole grain products are growing faster than white breads.

Australia and New Zealand. In this part of the world, wheat flour is used in the production of many Western products in addition to their unique meat pies and sausage rolls. Meat pies are usually about three to four inches in diameter, may be square or round, and consist of a pastry base and cover that encloses a filling of cooked minced meat (often beef) and gravy. Sausage rolls are usually about four inches long and about one-and-a-half inches wide and consist of seasoned sausage filling that is rolled in flaky pastry and then baked.

South America. *Alfajores* are desserts popular in Peru and Chili. They are made from wheat flour and vegetable shortening and baked. When served, they are layered with *manjar blanco* and topped with confectioner’s sugar. *Manjar blanco* is condensed milk that is slowly cooked until it thickens and becomes brown.

Empanadas are baked or fried and filled with a variety of meats, cheeses and vegetables. Empanada literally means ‘wrapped in bread’, although it is often a pastry dough rather than a bread dough.

The South American *paneton* is similar to the Italian Christmas cake. It is a wheat bread containing pieces of citron and sugar-glazed on top. In Peru, it is eaten on Christmas Eve with hot chocolate beverages.

Classes of Wheat

A variety of wheat classes are grown throughout the world, but six major varieties are grown in the United States. They are:

Hard red winter wheat—This is primarily grown in the “bread basket,” the Midwestern states of Kansas, Nebraska, Oklahoma, Texas, Colorado, and Wyoming. South Dakota and Minnesota also raise some hard red winter wheat. It is primarily used for breads and all-purpose flour.

Hard red spring wheat—This type of wheat is grown mostly in the upper, colder states such as North Dakota, Minnesota, and Montana. It is primarily used for breads and croissants.

Durum wheat—Durum wheat is grown primarily in North Dakota, with additional supplies coming from Montana, South Dakota, and Minnesota. Arizona and California grow a desert durum variety. Durum is used primarily for pasta.

Hard white wheat—This is the newest class of wheat grown in the United States. It is raised to some extent in all of the major wheat states and is used for breads and Oriental noodles.

Soft white wheat—This wheat is grown primarily in the northwest states of Washington, Idaho, and Oregon. This wheat is used for pastries, crackers, cereal, cakes, cookies, and Oriental noodles.

Soft red wheat—Soft red wheat is grown in eastern parts of the United States, it is used in cakes, cookies, and crackers.

Kinds of Wheat Flours

Commercial bakers require several types of flours to be milled to specification for use in the end products they will produce. Home bakers are most likely to use all-purpose, cake, bread, and whole-wheat flour. Serious bakers will even use pastry and semolina in their baking.

All-purpose flour—This is the finely ground endosperm of the wheat kernel and is often a blend of hard and soft wheat that produces a flour suitable for many types of products. All-purpose flour is usually bleached, which does not affect the nutritional value, but it does improve the baking qualities for cakes and cookies.

Bread flour—This flour comes from hard wheat, because of its strong gluten strength that will hold the framework of a loaf of bread. Bread flour is usually unbleached.

Cake flour—Cake flour is the finely ground endosperm of soft white and soft red wheat. It is usually bleached and is used for cakes, cookies, crackers, quick breads, and some pastries. It has a lower gluten content, which makes the products more tender.

Durum flour—The finely ground endosperm of durum wheat, durum flour is usually found in specialty sections of supermarkets or health food stores. It is used primarily for making noodles.

Gluten flour—Gluten flour is milled from hard wheat and is a high-protein (gluten) flour. It contains about 45 percent protein, whereas bread flour is usually about 12–14 percent protein. Gluten flour is added in small amounts, one tablespoon per one pound loaf, when making bread at home. Commercial bakeries use it to strengthen their bread flour if necessary.

Pastry flour—This type of flour is not as common for the home baker as it is for the wholesale baker. It also is made from soft wheat to make a tender, fluffy pastry crust.

Self-rising flour—Self-rising flour originated in the southern part of the United States and is the oldest "mix" found in America. It is an all-purpose flour with appropriate amounts of leavening and salt added to make quick breads. A cup contains one-and-a-half teaspoons of baking powder and a half-teaspoon of salt.

Semolina—Semolina is a coarsely ground endosperm of the highest quality durum wheat and is used for making pasta, although it can be used for making bread because of its high gluten quality.

Whole-wheat flour—Whole-wheat flour is also called graham flour and stone-ground flour. Whole-wheat flour is ground from the entire kernel containing the bran, germ, and endosperm.

Nutritional Value of Wheat

Wheat is the most consumed grain in the world, providing both calories and nutrients for the growing population. Wheat is a significant source of complex carbohydrates, dietary fiber, plant protein, phytochemicals, antioxidants, vitamins, and minerals. On a per-capita basis in 1995, Germans consumed 187 pounds of bread, while U.S. citizens ate only 53 pounds each. Many countries consume a considerable amount of wheat each year. The United States eats about 150 pounds of wheat flour per person annually, whereas Chile consumes 214 pounds; Pakistan consumes 334 pounds; the European Union averages 160 pounds; the East Africa region eats about 250 pounds; and China consumes an average of 221 pounds per person annually.

Whole-wheat products such as cereals, breads, pastas, tortillas, English muffins, and other products are extremely healthy. The American Dietetic Association recommends consuming three servings a day of whole-grain product foods (wheat, barley, oats, corn, rye, etc.).

In July 2000, the following whole-grain health claim was approved by the U.S. Food and Drug Administration (FDA) Center for Food Safety and Applied Nutrition: "Diets rich in whole grain foods and other plant foods low in fat, saturated fat and cholesterol may reduce the risk of heart disease and certain cancers." In addition to helping to prevent heart disease and some cancers, preliminary research shows that whole grains might also help prevent the onset of type II diabetes.

In some countries throughout the world, refined grains are offered to the consumer without any nutrient enrichment. This is a disservice to the public since the product, in that state, has fewer nutrients to offer. In some countries, however, vitamin A is added to help prevent blindness in children. In several Western countries, three B vitamins—thiamine, riboflavin, and niacin—and iron are added in the same amounts found in whole-wheat flour. In 1998, the United States required that enriched grains also be fortified with folic acid, a B vitamin that (among other benefits) may reduce the chances of certain birth defects. Between 1998 and 2001, after the mandatory fortification of wheat was put into effect, neural tube birth defects dropped 19 percent in the United States (Honein et al.). Preliminary studies have also shown that folic acid is effective in reducing homocysteine levels in the blood. High levels of homocysteine are believed to contribute to heart disease, strokes, and Alzheimer's disease. Although more research must be done, there is positive indication that folic acid may also be effective in helping to prevent cleft lip and palate, Down's syndrome, and several cancers.

Enriched flours are often bleached for two reasons: to lighten the flour and to improve baking qualities. Bleaching oxidizes the gluten slightly and therefore makes cakes and pastries more tender. Breads, on the other hand, need strong gluten, so bread flour and gluten flour are rarely, if ever, bleached. When flour is bleached, it is exposed to chlorine gas and benzoyl peroxide. No residues of these substances are left in the flour, however, so there is no nutritional difference between unbleached and bleached flour.

A small percentage of people cannot tolerate the gluten (protein) in wheat because they lack the enzymes to digest it. This disease is known as non-tropical celiac sprue, and those who have it cannot eat wheat, rye, or barley. Some experts recommend they eliminate oats also; however, the latest thinking is that oats may be safe.

Biotechnology and Wheat

As of the start of the twenty-first century, no genetically engineered wheat was available on the market, but such products were in development. The first genetically engineered wheat would primarily benefit the farmer and the consumer by using fewer pesticides during the growing period.

See also **Bagel; Bread; Noodle in Asia; Noodle in Northern Europe; Pasta; Pastry.**

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WHISKEY (WHISKY).

The spelling "whiskey" is common for Irish whiskeys and the vast majority of U.S. whiskeys. The spelling "whisky" is sometimes used for Scotch, Canadian, and other whiskeys and occasionally for some U.S. whiskeys. The word "whisky"/"whiskey" is derived from the Irish and Scottish Gaelic *usquebaugh* or *uisge beatha*, meaning 'water of life' (compare the French *eau-de-vie*). Whiskey is of course a high-alcohol beverage ("spirit") produced by the distillation of grain-based lower-alcohol fermentations.

Origins and Social History

The art of distillation of various fermented brews, most often wine-based, dates back to ancient civilizations, including Chinese, Indian, and Egyptian. Much of the European Middle Ages saw distilled alcohol used medicinally, but undoubtedly a proportion of early distillations was consumed as a warming, mood-uplifting drink. It is likely that whiskey-type distillation originated in Ireland, possibly as early as 500 to 800 B.C.E. and mainly within monastic communities. Irish Gaels emigrated to western Scotland and beyond, and it is likely they took their craft with them. Distilling the brews of grains, usually from their own land, was largely a home-based craft among Highland clans for personal consumption. What is referred to as Scotch whisky was first specifically listed in print around 1500.

Home distilling for personal consumption remained legal until 1784, but long before then whisky was sold or traded illicitly. However, greater problems developed with the introduction of taxes on spirits. Following the "union of the Crowns" in 1603 (King James VI of Scotland inherited the English throne as King James I of England and Scotland), whisky distilled in Scotland became more popular in England. However, England and Scotland maintained separate Parliaments with individual legal systems and laws. The "republican" English government (the Commonwealth years of Oliver Cromwell) imposed the first tax on spirits in 1643. Under duress, the Scottish Parliament followed suit the following year and levied an additional high duty in 1693. The British monarch Charles II also attempted to tax Irish whiskey in 1661 but with little success.

The Act of Union (the union of the Scottish and English Parliaments to become the British government in London) in 1707 brought more serious problems for Scottish (and, to a lesser extent Irish) whisky in the eighteenth century. More duties were levied, but the vast majority of distillers avoided paying taxes. The numerous excisemen found collection difficult as most distilling was still small scale, often in remote Highland glens, and illegal stills were easy to dismantle and relocate. Smuggling, often undertaken during darkness, was widespread. Even when illicit distillers were brought to court, magistrates were often sympathetic and lenient, imposing low fines.

A selection of American whiskies distilled in or near Bardstown, Kentucky. PHOTO BY PHILIP GOULD, 1991. © PHILIP GOULD/CORBIS.

Robert Burns, Scotland's national bard worked as an exciseman for some eight years before his death in 1796. He was a devotee of whisky and its warm, merry, and creative effects. He wrote several poems and songs in praise of whisky, such as "The Deil's Awa' Wi' th' Exciseman" (The devil's away with the exciseman). A few choice lines give the flavor (English equivalents of Scots words are in parentheses).

> We'll mak [make] our maut [malt], and we'll brew our drink,
> We'll laugh, sing, and rejoice, man, . . .
> . . . There's threesome reels, there's foursome reels,
> There's hornpipes and strathspeys [dances] man,
> But the ae [one] best dance e'er [ever] cam [came] to the land
> Was the deil's awa' wi' th' Exciseman.

By 1823 new legislation completely altered the development of Scotch whisky distilling. The change from heavy taxation, calculated by volume, to a reasonable license fee encouraged larger distilleries in more permanent locations.

A somewhat similar history applies to American whiskey. Following the English Pilgrims, further immigrants included Scots and Irish, who spread westward to farm. As their yields of grains increased, many settlers made their own whiskey from barley, rye, and upon further expansion west, corn. British taxes were introduced as early as 1684, with little success in collection. In 1791 Pennsylvania passed a law requiring registration of all distilling equipment. A few years later an outright rebellion erupted in Pennsylvania, including destruction of property and capture of excisemen, that was only quelled by the militia. As in Scotland, larger commercial distilleries, including those in Pennsylvania, Tennessee, and Kentucky, began to take over during the nineteenth century.

Raw Materials and Basic Processes

Scotch whisky can be divided into two basic types, malt whisky and blended whisky. The former, original type uses barley exclusively, whereas blended whisky combines malt whisky with spirits from other cereals.

Malt whisky. The harvested and dried barley is first "malted," that is, the grain is allowed to germinate to a certain point. This is achieved by soaking in water for a controlled period (two to three days), draining the water, and airing and turning the germinating grains at a controlled temperature (around 60ºF). The last process usually involves large revolving drums. The grains are soft, and germination is stopped. During germination, enzymes convert insoluble starch to soluble. This "green malt" is dried, which in most cases includes various periods of peat-fire smoke (peat originates from the decomposition of vegetable matter). The dried malt is coarsely ground, and hot water is added. This process of "mashing" converts soluble starch to the sugar maltose. The liquid is drawn off, cooled to around 70ºF, and run into fermentation vessels along with yeast, mainly from brewers but often including cultures of selected strains.

Distilling *poteen* (illegal whiskey). The home distiller is shown here straining the mash. Photo by Michael St. Maur Sheil, taken at an undisclosed location in the Republic of Ireland, 1996. © MICHAEL ST. MAUR SHEIL/CORBIS

Fermentation is vigorous and rapid, usually thirty-six to forty-eight hours, with the yeast converting sugars to alcohol (7 to 8 percent).

This liquid is then distilled in pear-shaped copper ("pot") stills, first in large stills to produce crude "low wines" with around 30 percent alcohol. This is redistilled in smaller stills with precise care to minimize impurities (such as alcohols higher than ethanol), producing pure but immature spirits of around 70 percent alcohol. A few Scotch and most Irish spirits are distilled a third time, finishing as lighter whiskeys.

These "rough" spirits require maturation and are transferred to oak barrels, often with water added to reduce the alcohol content to around 63 percent. Various types of oak barrels, such as bourbon, sherry, and Madiera casks, contribute color and flavor from the wood. Although by law the minimum storage is three years, five years is more common (mainly for blending), and most superior malts are matured ten to fifteen years or longer.

Blended whisky. This type added enormously to the amount of Scotch produced in the nineteenth century with the design of a much larger still. The blends are a mixture of a wide variety of malt whiskies with "grain whisky," which is distilled from a range of grains, including corn, rye, wheat, and barley, mainly unmalted. The large stills used are modified versions of the Coffey stills (patented in 1830), which distill continuously and produce a purer 90 percent alcohol. Blending the many types of malt whiskies is a skilled occupation, accomplished by an experienced nose. Generally lighter- to fuller-flavored blends are related to the increasing proportion of malt whiskies used.

Twentieth-Century Developments

Apart from new varieties of barley and other cereals, centralized and mechanical maltings, and novel designs of Coffey stills, whiskey production is essentially traditional. In the twentieth century prohibition in the United States provided opportunities for increased production of Scotch, Irish, and Canadian whiskeys. Whiskey production has spread to many countries, especially Japan, which already had a traditional base and which offers brands that are prized among the world's elite. Larger companies and mergers have also resulted in conglomerates. Surprisingly, given the long tradition, production and marketing of single malt Scotch whiskies increased strongly only since the 1960s. Quite a number of malt whisky distilleries in Scotland are owned by U.S., Canadian, and Japanese companies, for example, Jim Beam, Seagrams, and Suntory respectively.

See also **Alcohol**; **Barley**; **Cereal Grains and Pseudo-Cereals**; **Fermentation**; **Spirits**.

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WIC (WOMEN, INFANTS, AND CHILDREN'S) PROGRAM. The Special Supplemental Nutrition Program for Women, Infants, and Children, commonly referred to as WIC, is a Federally funded nutrition-intervention program administered by the Food and Nutrition Service of the U.S. Department of Agriculture. WIC began as a two-year pilot program in 1972 under an amendment to the Child Nutrition Act of 1966, and was made permanent in 1974. Its mission is to provide supplemental food, nutrition education, and health-care referrals to low-income pregnant or postpartum women, their infants, and children up to the age of five, to improve their health outcomes.

WIC is available in all fifty states, the District of Columbia, thirty-two Indian Tribal Organizations, Puerto Rico, the Virgin Islands, American Samoa, and Guam. WIC is the third-largest national food assistance program, following the Food Stamp and National School Lunch programs, and accounts for 12 percent of total Federal expenditures in this area. In fiscal year 2001, WIC served an average of 7.3 million participants per month, 75 percent of whom were infants and children; annual expenditures exceeded $4 billion (see Table 1). WIC does not guarantee participation for all eligible women, infants, and children who apply, and the number of people the program serves is determined by annual levels of Federal funding. In recent years, WIC has been fully funded, and all eligible persons have been able to participate.

To qualify for WIC, applicants must first meet income guidelines and a state residency requirement, and they must be at nutritional risk as determined by a doctor, nurse, or nutritionist. Guidelines state that the gross income of the applicant must fall at or below 185 percent of the Federal poverty-guideline figure, although each state can reduce income-limit standards. Participants in other benefit programs such as the Food Stamp Program, Medicaid, or Temporary Assistance for Needy Families automatically meet income requirements. To be at nutritional risk for WIC, one must have either a medically based risk such as underweight, anemia, or previous poor pregnancy outcomes, or a diet-based risk such as a dietary pattern deemed inadequate compared with U.S. Dietary Guidelines.

Participants in WIC receive benefits in the form of checks, vouchers, or electronic benefits transfer (EBT) cards that are redeemable monthly at certain retail food stores. In 2001, average monthly benefits per person were about $34. Participants may use these benefits to purchase specific foods designated as important to supplementing the diet of this population. Only nutrient-dense foods that are high in one or more of particular nutrients—protein, calcium, iron, and vitamins A and C—are included, although the food package is not intended to fulfill all of the nutrient needs of the participants. Examples of foods available using WIC include iron-fortified infant formula, iron-fortified infant and adult cereals, fruit or vegetable juice rich in vitamin C, eggs, milk, cheese, peanut butter, dried beans or peas, tuna fish, and carrots. Foods are substituted where there are medically necessary dietary modifications. Participants also receive nutrition education and necessary referrals to health-care services.

WIC is one of the most cost-effective and successful nutrition-assistance programs in U.S. history. Several studies have concluded that, for every $1 spent on pregnant women under WIC, between $1.77 and $3.13 in Medicaid costs were saved over the first sixty days after childbirth. Research consistently shows that WIC participation results in improved birth outcomes and savings in health-care costs, improved diet and diet-related outcomes, improved infant-feeding practices, increased immunization rates, and improved cognitive development for children.

WIC Program Participation and Costs

Fiscal Year	Total Participation (Thousands)	PROGRAM COSTS (Millions of Dollars)			Average Monthly Benefit Per Person (Dollars)
		Food	NSA	Total	
1974	88	8.2	2.2	10.4	15.68
1975	344	76.7	12.6	89.3	18.58
1980	1,914	584.1	140.5	727.7	25.43
1985	3,138	1,193.2	294.4	1,489.3	31.69
1990	4,517	1,636.9	478.7	2,122.2	30.20
1995	6,894	2,516.6	904.9	3,441.4	30.41
2000	7,192	2,852.2	1,102.6	3,971.1	33.05
2001 (P)	7,306	3,007.8	1,114.3	4,153.0	34.31

NSA = Nutrition Services and Administrative costs. Nutrition Services includes nutrition education, preventative and coordination services (such as health care), and promotion of breastfeeding and immunization. In addition to food and NSA costs, Total (under Program Costs) includes funds for program evaluation, Farmers' Market Nutrition Program (FY 1989 onward), special projects, and infrastructure.

SOURCE: Data as of 25 April 2002. Fiscal year (FY) 2001 data are preliminary; all data are subject to revision.

See also **Class, Social**; **Food Pantries**; **Food Stamps**; **Government Agencies, U.S.**; **Poverty**; **School Meals**; **Soup Kitchens**.

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WINE.

This entry includes five subentries:

Overview
Wine in the Ancient World
Wine from Classical Times to the Nineteenth Century
Wine in the Modern World
Wine, Nongrape

OVERVIEW

Wine is an alcoholic beverage made by fermenting grape juice. Although the juice of other fruit, berries, and vegetables can be fermented to create alcohol, fruit wines are generally qualified by the name of the produce used, such as gooseberry wine and blueberry wine. The word "wine" when used alone refers to an alcoholic beverage made from grapes. Wines come in various colors (red, white, rosé) and many types, which include dry and sweet, still and sparkling, and wines fortified with grape spirit (brandy). There are also many wine-based drinks, such as wine coolers and sangria.

Grape Varieties

Although wine can be made from any kind of grape, not all grape varieties are suitable for making good quality wine—wine with acceptable taste and capable of lasting in good condition for several years. Most of the world's wine is made from one species, *Vitis vinifera* (meaning "a wine-bearing vine"), which is native to Europe and the Middle East. Most of the grapes used for making commercial wine are members of this species, and they include such common varieties as Chardonnay, Riesling, Sauvignon Blanc, Merlot, Pinot Noir and Cabernet Sauvignon, and Syrah/Shiraz.

Other grapes also used for making wine include varieties such as Concord, Alexander, and Catawba, which are members of the *Vitis labrusca* species that is indigenous to North America. Additional varieties have been created by breeding two varieties of the same species (called crosses) and by breeding two varieties of different species (called hybrids). Thus the Dornfelder variety was bred from two *Vitis vinifera* varieties and is a cross, while Baco Noir, bred from a variety of *Vitis vinifera* and a *Vitis riparia*, is a hybrid.

The many reasons for breeding new varieties include creating grapes with particular flavor profiles, grapes that ripen early (important in regions with short growing seasons), or vines that are tolerant of colder climates. In addition to crosses and hybrids, vines generate clonal variations spontaneously, with each clone having slightly different growing, taste, or other characteristics.

Many hundreds of grape varieties can successfully be used for making wine, and the list seems even longer because some varieties can have different names in different places. For example, the grape known as Syrah in France is called Shiraz in Australia, while the Malbec variety has many alternative names, including Cot, Pressac, and Auxerrois. Some variations in name simply reflect language (Pinot Gris is known in Italy as Pinot Grigio) while others reflect the origins of the grape (Burgundy's Pinot Noir is known in Germany as Spätburgunder).

It is likely that wine was originally made (in the Neolithic period, 7,000 years ago) from wild grapes, and that when farmers began to cultivate vines for wine, they selected grapes that seemed particularly suitable. The selected grapes would have had a high ratio of pulp to seeds and might have given better flavors than other grapes.

Characteristics of the Grape

Grapes contain or bear everything that is needed to produce wine; each grape is effectively a microwinery. The most important parts of the grape are the pulp, which contains water, sugar, fruit acids, and pectin, and the skin, which contains color pigments, flavors, and tannins. The skin also carries wild yeasts that occur naturally in the vineyard. The other parts of the grape, which are less often important for winemaking, are the stem (which contains tannins) and the seeds or pips (which contain tannins and bitter oils).

Tannins are compounds that occur naturally in grapes and other products and that give a drying feel when they come into contact with the mouth. Swishing cold, strong black tea, which is high in tannins, will make the mouth and gums feel as if they are contracting with dryness. Tannins are preserving agents (used to tan skin and turn it into leather), and in wine they are a natural preservative that allows a wine to age without degrading. Young wines meant for long-term cellaring can be high in tannins and, over time, the feel of tannins softens.

Although the winemaking process is very important, such that the same grapes made into wine by two different winemakers can taste significantly different, the grape variety is the single most important factor. Like other fruit, varieties of grapes differ from one another in a many ways. Some have thick skins and some have thin, which can be important for their relative ability to withstand disease and for the degree of flavor and tannins they have. Some varieties develop a higher ratio of acid to sugar (just as more acidic Granny Smith apples differ from the sweeter Red Delicious variety). Some grapes (such as Cabernet Sauvignon) naturally have more tannins than others (such as Gamay). The sum of each grape variety's characteristics is the primary influence on the character and flavor of the finished wine it makes.

Environment

A second set of influences on wine is the environment in which the grapes grow: especially the soil and climate. The total environment is sometimes referred to as the *terroir*, a term that includes the composition of the soil (topsoil, bedrock) and its nutrient, drainage and heat-retention properties; climate (annual temperature, hours of sunshine, precipitation, frosts, winds); geographical features (such as forests, mountains, rivers, bodies of water) that influence climatic patterns; the slope of the vineyards (on steep or gentle slopes or on plains); and aspect (angle to the sun, direction of slope).

Slope can be important because the most interesting and complex grapes seem to grow on vines that are stressed, which is to say that they must struggle for water and nutrients. The best soils for vineyards are not the rich, fertile humus suitable for other produce, but often hard, stony or sandy soils that are well drained (which is why slopes are often ideal). Vines can also be stressed by planting them closer together so that each has to compete with others.

Terroir has become an article of faith for many producers, who argue that the flavors and other qualities of a wine express the *terroir* in which the grapes were grown. Some producers (particularly in regions like Burgundy) insist that wines made from vines grown a few feet apart taste distinctly different. Some ardent advocates of *terroir* include in it not only the physical and environmental character of a specific site, but also the tradition of vine growing and the soul of centuries of winemakers.

Viticulture

Cultivation practices (viticulture) are also very important in that they can modify the environment. Density of plantings and types of trellising can have an impact on the exposure of vines to nutrients and sunshine. Canopy management, the removal of some foliage, can increase the ripening potential of grapes. Irrigation (which is not universally permitted) can make up for shortages in natural water supply, while excess water can be dealt with by burying drainage tiles to increase the flow of water away from vine roots. Some viticulturalists even modify the soil by digging in rocks (which absorb heat during the day and radiate it at night) and spreading dark soil, which attracts more heat than lighter-colored soils.

Wine is not only a beverage but is also used as an ingredient in cookery. This nineteenth-century American cake tin was used for making Madeira cake, a popular food for teas and fancy suppers. ROUGHWOOD COLLECTION. PHOTO CHEW & COMPANY.

Yield

An important influence on grape character is yield, which is often expressed as the number of tons of grapes harvested per acre of vines or the number of hectoliters (one hectoliter is 100 liters) of wine per hectare (about 2.4 acres) of vines. In general terms, the lower the yield, the more flavorful and complex the wines. Yields are often reduced by "green harvesting," which involves picking (and throwing away) a proportion of the bunches of grapes on each vine before they begin to ripen. This allows the smaller number of bunches remaining to benefit from all the nutrients the vine absorbs. Some national and regional wine laws (see below) set maximum yields on vines.

The same principle underlies the value attributed to "old vines," a quality that is sometimes shown on labels. As vines age, they begin to bear fewer bunches so that, without human intervention (like green harvesting), their fruit tends to be of higher quality. There is, however, no regulated definition of what constitutes an old vine, and, depending on varietal and producer, it can mean a vine from fifteen to eighty and more years old.

Pests and Diseases

Finally, viticulturalists have to decide on what methods to use to deal with vineyard pests and diseases. Pesticides and other chemicals (notably sulfur) are widely used to control insect infestation and vine diseases but, for environmental and financial reasons, their use is declining in many regions. Some producers have adopted organic practices and, depending on wine or agricultural law, can label their wines organic.

Climate

Clearly *terroir* and cultivation practices interact with grape variety in that some varieties do best in specific climatic and other growing conditions. Riesling, for example, does best in cool climates that preserve the acidity so highly valued in Riesling wines, even if the alcohol level is often below 12 percent. Zinfandel, on the other hand, thrives in warm regions where it produces wines high in alcohol (often 14 percent and higher) with rich, ripe fruit flavors and relatively low acidity.

All these characteristics have an important bearing on the quality of the grapes grown in any specific region. In general terms, warmer regions (like South Africa and many regions in California) produce riper grapes with higher sugar content that have the potential of producing deep-colored, high-alcohol wines (13% and higher). Cool climate regions with shorter growing seasons (like Germany and northern France) tend to produce paler, more acidic wines that are lower in alcohol (12.5% and less). Vines on south-facing slopes in the Northern Hemisphere benefit from more sun, but there are some places (in Greece, for example) where vines are grown on north-facing slopes so as to moderate the effect of the sun's heat.

Terroir is not constant. Although soil characteristics change very slowly over time (unless there is human intervention), climate experiences annual variations that range from modest to dramatic. One summer in a given region might be dry and hot, the next cool and wet. There might be a late frost, a summer hailstorm, and an early winter or Indian summer. These variations can affect and make diseases of the vines more or less likely. Hot, humid conditions can lead to molds and mildews. Weather conditions can lead to lower or higher yields and can affect the ability of grapes to ripen and develop the desired levels and balance of sugars, acids, tannins, and other properties.

Annual weather variation is the reason that so much attention is paid to vintage. The vintage of a wine is the year the grapes were harvested, and knowledge of the weather conditions in a region in a given year will reveal much about the potential quality of the wine made in that region that year. Some years stand out for the quality of the wine produced, whether it is good or bad. For example, 1997 is considered to be an excellent year for Tuscan wines (including Chianti) but a poor year for most of the districts in Bordeaux. But weather conditions that might be negative for one grape variety can be less so for another. So in a region like Bordeaux, where three principal red grape varieties are grown, and where the red wine is a blend of up to five different varieties, producers can consider the quality of each variety when deciding on the blend.

Harvesting

Decisions about vine variety, vineyard location, and cultivation practices are made so as to maximize the quality of the fruit at the point that it is judged optimal for harvesting. Harvesting itself involves myriad decisions. Grapes can be harvested by hand or by machine, by bunch or by individual berry. Some vineyards are entirely harvested in one go, while others are harvested in several runs (*tris*) over a period of days, with only the ripest bunches or grapes being picked each time. Most harvesting is done during the day, but some producers practice night harvesting, when the cooler temperatures allow grapes to be picked and transported to the winery in temperatures that help preserve their freshness.

It is a cliché among winemakers that "wine is made in the vineyard." This means that good quality wine can be made from only good quality fruit, and that what goes on in the vineyard is more important to wine quality than what happens in the winery. Yet just as the quality of the grapes results from scores of decisions related to grape variety, vineyard site, and cultivation practices, so the winemaker makes scores of decisions that affect the quality and character of the finished wine. It takes an able winemaker to make high-quality wine from even the best quality grapes.

Fermentation

Wine is made by crushing the grapes so that the yeasts on the skin (or cultured yeasts introduced by the winemaker) come into contact with the sugars in the pulp. This initiates fermentation, the process by which the yeasts consume the sugar and produce alcohol and carbon dioxide. Fermentation is the central part of winemaking but it is preceded and followed by several other stages, and the methods of carrying them out influence the taste and character of the finished wine.

The grapes are first crushed or pressed so as to extract the juice. Old methods of treading grapes by foot or pressing them in manually operated screw presses have virtually disappeared, and most commercial wines are made from grapes crushed in mechanical presses. Many producers prefer pneumatic bladder presses, which crush the grapes gently and do not release the bitter oils in the pips.

If white wine is being made from black or other dark-skinned grapes (nearly all of which have pale-colored pulp), the must (unfermented grape juice) is quickly drawn off the skins and other solids so that the color pigments they contain do not dye it. For red wine (which can be made only from dark-colored grapes), the must is left in contact with the skins so as to draw color from them. Winemakers who want to make very dark wines (which are increasingly popular) sometimes use enzymes to extract all possible color from the skins so as to dye the juice deep red.

Naturally occurring yeasts can be used for fermentation, but because they tend to be unpredictable (in terms of when they start fermentation and the speed of fermentation), many producers use more reliable and predictable cultured yeasts. Length of fermentation can affect the flavor of wine, as can the temperature. Fermentation is a naturally hot process, and some wines are "cool fermented," meaning that the fermentation tanks or barrels are artificially cooled during fermentation. Cool fermentation tends to preserve the fresh, fruity flavors in wine.

Most fermentation takes place in stainless steel vats, but some wines are fermented in oak barrels. This adds additional flavor to the wine although it does not, as many people expect, make the finished wine taste "oakier" than wines that are simply aged in oak barrels. Whether in vat or barrel, the carbon dioxide produced during fermentation is allowed to dissipate into the air.

Fermentation is generally complete when the yeasts have consumed all the sugar, resulting in a wine that is "dry" because it contains no residual sugar. But fermentation can also terminate when the alcohol level in the wine reaches a level that kills the yeasts, generally at an alcohol level of about 16 percent. Any sugar not fermented by that stage remains in the wine, giving it a degree of sweetness depending on the percentage of residual sugar. In some specific wines, fermentation is deliberately terminated before all the sugar is fermented. For example, Port and some other sweet, fortified wines are made by adding grape spirits (brandy) during fermentation. This raises the alcohol level and kills the yeasts before they ferment all the sugar in the must, resulting in a wine that is sweet and has a higher alcohol level than it would have achieved without the added spirits.

Wines can also undergo secondary fermentation. The most common is malolactic fermentation (MLF) in which the harsher malic acid in the wine is turned into softer lactic acid. This is commonly used for white wines and produces the softer feel of the wine in the mouth that is sometimes described as "buttery." Some red wines also undergo malolactic fermentation.

Champagne and sparkling wines made in the "Champagne method" or traditional method undergo secondary fermentation in the bottle. Sugar and yeast are added to a base wine in the bottle so that fermentation re-starts, but the bottle is capped so that the carbon dioxide produced during the process is trapped inside rather than dissipating. Unable to escape, the gas is dissolved into the liquid. Later, the dead yeast cells are removed and the bottle is topped up and corked, all without releasing the gas. It finally escapes, in the form of bubbles, when the cork is removed.

The sugar level of the grapes at the time of harvest determines the potential alcohol level of the finished wine. Several different scales are used to measure the concentration of grape sugars (the must weighty). A widely used (American) scale is Brix, and in approximate terms, grapes make wine with a percentage of alcohol roughly half the Brix level. More precisely, grapes with 23.7 Brix will make wine with a potential alcohol of 12.5 percent. Other scales for measuring must weight are degrees Oechsle (used most widely in Germany) and Baumé.

In many wine regions, producers can supplement low levels of sugar in their grapes by adding sugar or concentrated (and naturally sweet) grape juice, called *Süssreserve* in Germany. The addition of sugar is often known as chaptalization after Chaptal, one of Napoleon's ministers who advocated (but did not invent) the technique, but it is increasingly called enrichment. Wine laws generally regulate the degree of permitted enrichment. In Burgundy, sugar may be added to raise potential alcohol by about two percent.

In addition to sugar, producers can (depending on wine law) add acid and tannins to make up for deficits in the grapes. Just as sugar is added to compensate for low sugar concentrations in cool climate regions, acidification is practiced in warm climate regions where grapes ripen well and have high levels of sugar but have low acidity. Without some correction the wines would be unbalanced. Wine laws forbid both enrichment and acidification of the same wine.

Aging

Beyond sugar, acid, and tannin, additives are not permitted and the only nongrape flavoring comes from wood. This is generally added during the aging process in oak barrels, but in one specific case, the production of Retsina wine in Greece, pine resin is added to the must during fermentation. It gives the Retsina an aroma and taste reminiscent of turpentine or pine.

Following fermentation, wine is generally racked (drawn off any remaining solid matter) and aged. Some wines, however, are left on the lees, the dead yeast cells that fall to the bottom of vat or barrel when fermentation is complete. Perhaps the best known of these *sur lie* ("on the lees," or sediment) wines, which often have a yeasty note to their flavors, is Muscadet sur lie from the Atlantic coastal region of the Loire Valley in France.

Depending on the wine and the prevailing wine law, aging before bottling can be a short process of a few weeks or as long as several years. In general, white wines are aged for shorter periods than reds, although some reds get little aging and are bottled very soon after fermentation is complete. This is the case with *primeur* or *nouveau* wines that are put on the market within months of the harvest. The best known is Beaujolais Nouveau, a light, fruity wine from southern Burgundy that is released throughout the world on the third Thursday of November each year, only two months after the grapes are picked. It now has many imitators from other wine regions throughout the world.

Other wines sold young include the *Heurigen* (literally, "the season's") wines of Austria, spritzy wines that can officially be sold after November 11 of the vintage year.

But there are also wines that are sold for consumption while they are still fermenting, like Austrian *Sturm* or German *Federweiss* ("white feather" from the cloudy appearance of the still-fermenting beverage in the glass).

Such young wines are the exception, however, and most wine undergoes a period of aging for at least a couple of months to give the flavors and other properties of the wine (like acids and tannins) an opportunity to integrate. Depending on the varietal and style, wine can be aged in an inert vessel (such as a concrete or stainless vat that imparts no additional flavor to the wine) or in a wooden container that might add flavors and tannins to the wine it contains. Some varietals, such as Riesling and Sauvignon Blanc, are almost always made and aged in stainless steel. Others, such as Cabernet Sauvignon and Pinot Noir, are almost always aged in wood. Varieties like Chardonnay are aged in stainless steel or wood, depending on the style the winemaker is aiming for.

Most barrel-aged wine is kept in small 225-liter barrels called *barriques*, whose size ensures a high ratio of wood to wine. There are, however, barrels that hold tens of thousands of liters of wine. New barrels give the greatest flavor and tannins to wine, and barrels contribute less and less with each year of use until, after about five years, they become effectively inert. The insides of barrels are "toasted" by direct flame during construction and the degree of toasting (light, medium, heavy) influences the degree to which the wood can flavor the wine.

Although barrels have been made of various kinds of wood, the most favored is oak because of the flavors it contributes and because the tightness of the grain makes oak less porous than other wood. It thus holds the wine in and keeps the air out, although wine in barrels does experience loss through evaporation and absorption, and must be topped up now and again when aged over a long period. The two principal sources of oak are France and the United States, but there is increasing use of eastern European and Russian oak, too.

The flavors oak barrels give to wine vary according to the wine itself and to the provenance, age, and toasting of the barrel. In general, American barrels are said to give sweeter, vanilla notes to wine, while French barrels contribute more savory flavors. Both may contribute toasted notes to a wine's flavor profile.

Because of the cost of barrels, barrel aging is an expensive proposition, and producers of mass-produced wines have devised less expensive methods of giving oak flavor to their wine. One is to use oak chips, small particles of oak that are mixed into the wine and then filtered out. Some tasters believe that oak chips give the wine an oily texture. An alternative method is to age the wine in steel tanks and to suspend oak planks into it. This has some of the same effect as barrel aging, but it does not expose the wine to oak in the same ratio and nor does it bring the wine into contact with small amounts of air as barrel aging does.

Some aged wines are known as Reserve wines and in Spanish, Italian, and Greek wine law Reserve (*Riserva* or *Reserva*) wines must be aged for specified minimum periods in oak and bottle. The word "Reserve" on the labels of most countries and regions has no regulated meaning, but is generally intended to signify a premium wine that had had a longer period of aging that its non-Reserve counterparts.

Fining and Filtering

Other processes in winemaking include fining and filtering. Fining involves clarifying and stabilizing wine by dropping into it substances like egg whites, fish bladders, or specific clay deposits. Particles adhere to these substances and fall to the bottom of the container. Solid particles may also be removed by filtering, usually by forcing the wine through paper filters. Some wines are not filtered because the process not only removes unwanted particles but can also remove some color and flavor compounds.

Blending

Before or after barrel aging, wines may be blended. A blend may combine wines of different varieties so as to make, for example, a Cabernet Sauvignon Merlot or a Semillon Chardonnay blend. (In any declared blend, the predominant variety is stated first.). Most of the world's great wines are blends of more than one variety. Red Bordeaux, for example, must be a blend of between two and five specific grapes, Châteauneuf-du-Pape can include up to thirteen varieties, and Australia's premier cult wine, Penfold's Grange, is almost all Shiraz with a little Cabernet Sauvignon. Blends are designed to create an integrated, harmonious wine that is greater than the sum of any of its constituent varieties.

Blending can also involve bringing together wines that have been aged differently. Many Chardonnays are blends of wines that have variously been aged in French and American oak, or that have been partly aged in stainless steel, partly in oak.

Aging can also take place in the bottle (bottle aging), and some Spanish and Italian wine laws regarding wines such as Rioja and Barolo require a minimum period of barrel and bottle aging before the wine can be released for sale. Most wines, however, are ready for sale as soon as they are bottled (or, in some cases, put into plastic bladders and sold as "box wine" in large formats).

Bottling

Wine intended for long-term cellaring (*vin de garde* or "keeping wine") is kept in bottles. Depending on the wine, it may be cellared for decades and its components will continue to integrate over the long term. Bottles should be kept on their side so that the cork does not dry out, in an environment that is, ideally, dark and with a constant temperature between 50º–57ºF (10°–14°C). Over time, tiny amounts of air do get through the cork, and it is believed that this is important to the aging process. Wines kept over the very long term (as in the libraries of wine producers) have their corks renewed about every twenty-five years.

There has been increasing concern about the rate at which corks are vulnerable to infection and contaminate the wine they are in contact with. Estimates of corked wine range from 5 to 10 percent. Producers are increasingly substituting corks (which are made from the bark of the cork tree) with synthetic stoppers and even screw caps. Such closures seem ideal for wines intended for consumption while young (the vast majority of wines), but it is thought that a wine with a synthetic stopper would not allow the air that seems crucial to proper aging.

Standard wine bottles hold three-quarters of a liter (75 cl or 750 ml) of wine, but common alternatives are half bottles (375 ml) and magnums (two-bottle size, or 1.5 liters). Magnums of premium wine generally cost a little more than twice the price of a single bottle, partly because it is believed that wine ages better in the magnum volume than in standard bottle format.

Bottle shape does not affect aging, but it can be an important part of a wine's branding or image. There are two major bottle types: the Burgundy bottle with long, sloping shoulders, and the Bordeaux with more square shoulders. Much German wine is sold in long, slender flutes, while wine from Germany's Franken region is bottled in a squat green bottle called a Bockbeutel. Beyond patterns such as these, individual producers sometimes develop bottles with distinctive shapes and colors to identify their brands.

Appellation

Bottles are labeled so as to indicate their contents, but not all labels carry the same information because they reflect the prevailing wine law. The great majority of winemaking regions and countries have wine laws that govern such things as food safety (additives that may be used) and what must be shown on a wine label. Laws vary, sometimes radically, but almost all regulate what is broadly called appellation. The appellation is a wine-producing region whose geographical boundaries are legally defined such that only wine made from grapes grown in the region can use the name. Thus a sparkling wine can be called Champagne only if it is made from grapes from the Champagne region of France (and if it has been made according to the rest of the Champagne wine law).

The word "appellation" comes from the French practice of regulating the names of products according to where they are made. Thus a St. Emilion wine from the Bordeaux region must be made of grapes from St. Emilion, and Camembert cheese can only be made in Camembert. Through a series of agreements, European appellations have now obtained near-monopolies over their names, such that sparkling wines made outside Champagne cannot be called Champagne. Wines made in Australia, California, and New Zealand that used to be called Burgundy or Chablis (both French appellations) have been renamed. Sherry and Port (Spanish and Portuguese appellations respectively) will eventually follow.

Many European wines are labeled only by appellation. Examples are Burgundy, Rioja, and Chianti. But because the wine laws of each appellation specify the varieties of grapes that can be grown in the regions, the appellations are a kind of coded grape variety. Thus red Burgundy can be only Pinot Noir, white Burgundy can be only Chardonnay, Rioja is mostly made from the Tempranillo variety, and Chianti is mostly Sangiovese. In most of the non-European wine world, however (and parts of Europe), wine is labeled by variety (these are varietal wines) because wine laws do not limit the kinds of grapes that can be grown. Italy is a mixture of appellation and varietal labeling, as is Spain, but most German wine is labeled by variety.

Appellation regulations take different forms in different countries. Legally defined appellations in the United States are called American Viticultural Areas (AVAs), while in Australia they are called Geographical Indications (GIs). In order to identify a wine by an AVA, such as Napa Valley, Willamette Valley or Bell Mountain, a wine must be made of grapes 75 percent from that AVA. Countries such as Australia and Canada (Ontario) require 85 percent grown in the stated wine region. In addition, wines laws require a varietal wine to be a minimum percentage of that variety. A California Chardonnay must be at least 75 percent Chardonnay and it can be up to 25 percent of the other varieties.

Vintage and Alcohol Level

Vintage years and alcohol levels stated on labels can be equally flexible. A New Zealand wine labeled 1999 needs only be 85 percent of that vintage (there could be 15 percent of 1998 or an earlier vintage). And the alcohol level needs be only within one percentage point either way of the stated level, so that a wine labeled 12.5 percent can have between 11.5 percent and 13.5 percent alcohol. Almost all wine laws allow this kind of flexibility.

Some wine laws also differentiate among different quality levels. In Europe there are three: a basic table wine (French *vin de table*, Italian *vino di tavola*) made according to few restrictions; regional wines (like French *vin de pays* and Spanish *viño de la tierra*) made with more restriction and meant to reflect the wines of a specific region; and quality wine (French *Appellation d'Origine Contrôlée* and German *Qualitätswein*), which is the highest rank of all. In reality these are only guidelines: some table wines are of higher quality than so-called quality wines, but do not qualify for the highest rank because they use grapes not permitted by wine law for that category.

Styles of Wines

There are many different styles of wine, allowing wine to satisfy a wide range of individual tastes and occasions, and permitting wine to accompany many styles of food. Most table wines are dry in the technical sense that they contain no residual sugar because all the sugar that was in the grapes (or added to the must) has been fermented out. Even so, wines can feel sweet in the mouth because of their fruit flavors, and many varietals like Chardonnay, Shiraz, and Zinfandel have a sweet fruit dimension to them. (Alcohol also tastes sweet, and a high alcohol level adds to the sweet sensation.)

Wine should be assessed in terms of the way all its component parts fit together. A white wine whose acidity and fruit flavors are balanced tastes better than one where there is an imbalance. Many inexpensive Chardonnays are so heavily oaked that it is difficult to detect the fruit. For many reds, it is a matter of achieving a good relationship among acidity, fruit, tannins, wood, and alcohol. Too high alcohol can ruin an otherwise good fruit-acid balance, as can too much oak.

But wines that are intended for long-term cellaring are often unbalanced when young, and the purpose of aging them is to allow time for them to integrate. Many new Bordeaux reds, for example, have such strong tannins that they are undrinkable for the first few years. But the great bulk of commercial wine is made for early drinking (within four or five years of vintage) and they are more likely to deteriorate rather than improve if kept much longer.

Food and Wine

Matching food and wine has preoccupied wine and food writers for centuries. Rules of thumb such as "white wine with fish, red wine with meat" used to be popular, but current thinking is much more flexible. In general there are two ways of thinking about the wine-food relationship. One is to match their flavors, so that dishes high in acid are accompanied by similar wines. Thus, tomato-based dishes (tomatoes being acidic) often pair well with many Italian wines that have high acidity. The second approach is to contrast food and wine. Thus a dish with a heavy, creamy sauce would not be paired with a heavy, buttery Chardonnay but with a substantial but leaner, even crisp wine whose acidity will cut through the fat in the dish and refresh the diner's palate.

Although there are no rigid rules for matching wine and food, useful principles are to match the weight of each and to consider the dominant flavors of the food. Just as some foods feel lighter or heavier in the mouth (compare sole and steak) so all wines fall on a spectrum of light to full bodied. Many young white wines (like Soave and Verdicchio) feel light, whereas older Semillons and Shirazes are full bodied. Matching the weight of the wine to the food creates a balance.

As for matching flavors, it is important to consider the dominant flavors in a dish. Roasted chicken with sage stuffing, barbecued chicken, chicken marsala, and chicken tandoori all have quite different flavors because of the herbs, spices and other ingredients used in their preparation, even though chicken is common to them all. Generally it is not the meat or fish that gives a dish its main flavors, and advice to match a particular wine to fish or chicken is not very useful. Instead, it is desirable to match wine to the strength, intensity, and quality of the ingredients that provide the main flavors.

Finding a perfect match of wine and food (called a marriage) is often a matter of trial and error, but there are some classic matches. They include Sauvignon Blanc with oysters or goat cheese, full-bodied red wine with simply prepared steak or full-flavored game, and Eiswein (ice wine) with strong blue cheese. Some foods are difficult to match with wine, including dishes whose flavors are heavily influenced by vinegar or citrus juice.

Advice on wine to accompany a meal at a restaurant should be available from the sommelier or server. A sommelier (who historically was employed by a king or noble to look after the pack-animals—the *bêtes de somme* —who carried the food and wine) should have full knowledge of the way a restaurant's dishes are prepared and should be familiar with all the wines on the wine list. He or she should know how hot or spicy a dish is and what the strongest flavors are.

A sommelier's tasks include developing a wine list appropriate for the restaurant's cuisine, and ensuring that the wine is properly kept and served. Once a diner has selected a bottle, it should be brought unopened to the table and presented to the diner to ensure that it is the correct one. The bottle should be opened and a small amount of the wine poured for the diner to taste. The purpose is to ensure that the wine is in good condition and not corked or flawed in any other way.

Drinking Wine

Flaws can generally be detected by smell alone, but it is a good idea to taste the wine, too, if only to check its temperature. White wines are often served too cold and reds too warm. There are no hard-and-fast rules about serving temperature, but white wines should not be so cold that they have no taste or so warm that they lose their feel of fresh acidity. And although it is a rule of thumb that red wine should be served at room temperature, many modern rooms are so warm that wine served at their temperature taste coarse and alcoholic. Although there is commonly a difference of about 15 degrees in the serving temperature of whites (wine straight from a refrigerator is about 39–43°F [4–6°C]) and reds (rooms are commonly 68°F [20°C] and warmer), the difference between them should be much narrower. In broad terms, white wine can be served at ideal cellar temperature (about 53°F [12°C]), while most reds do well at about 60–64°F (16–18°C), a difference of only four to six degrees.

Although many people insist on opening wine an hour or two before serving so that it can breathe, experiments show that merely removing the cork makes little difference to the taste or quality of the wine. Exposing some wines to air can improve and soften them, but this is best done by decanting the wine beforehand or simply swirling it in the glass. Special care should be taken with very old wines, which can begin to degrade very soon after they are opened.

The size and shape of the glass can make a difference to the experience of a wine. There are now glasses designed for every varietal and style of wine by companies such as Riedel. For ordinary use, the most satisfactory glasses have a mouth smaller than the widest point of the bowl, so that the aromas are trapped. The stem should be long enough that the glass can be held comfortably by it; holding a wineglass by the bowl can warm the wine and dirty the bowl.

Health Benefits

Beyond the sheer pleasure that wine can give, it appears to have health benefits if consumed in moderation. Historically, wine has been attributed myriad therapeutic properties, but for much of the twentieth century the stress was on its toxic properties and its ability to inebriate consumers. The discovery of the "French Paradox" revived interest in the relationship between wine and health. The paradox is that, given their level of wine consumption, the French ought to have a higher rate of heart disease than they do. An explanation was that wine actually protected against coronary disease. The weight of current research supports that conclusion, but doctors stress that it applies only to moderate consumption: about one or two glasses a day by men, one glass by women. More than that neutralizes the health benefits.

There are many guidelines for the maximum enjoyment of wine but, in the end, each individual finds the relationship with wine that she or he is comfortable with. Individuals have different taste preferences and varying tolerance of tannins and acids. Food and wine pairings that repel some, delight others. The great thing is that wine, the result of the complex interplay of work by countless humans and a seemingly infinite combination of natural circumstances, comes in such a wide range of styles that there is a wine to please everyone, to match any dish, and to suit any occasion.

See also **Fermentation**; **Food Production, History of**; **France**; **Fruit**; **Germany, Austria, Switzerland**; **Harvesting**; **Iberian Peninsula**; **Italy**; **Pleasure and Food**.

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Rod Phillips

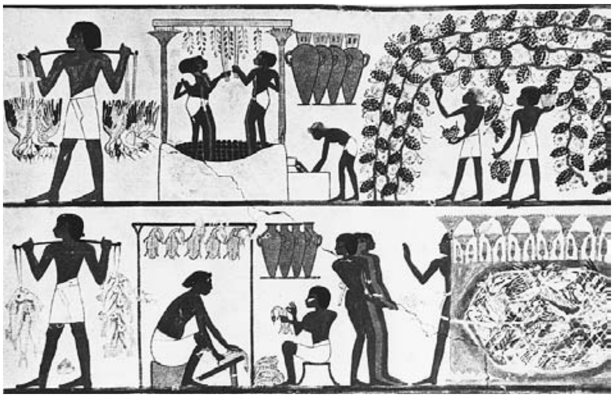
WINE IN THE ANCIENT WORLD

The earliest evidence of wine dates to about 5000 B.C.E. in the Middle East, where archaeologists have discovered earthenware jars and other vessels containing grape seeds and stems. Others contain deposits of tartaric acid and calcium tartrate that are almost certainly the residue of grape liquid because grapes are rare among fruit in that they accumulate tartaric acid. Any grape juice not consumed very quickly would have soon fermented into wine in the warm temperatures of the region.

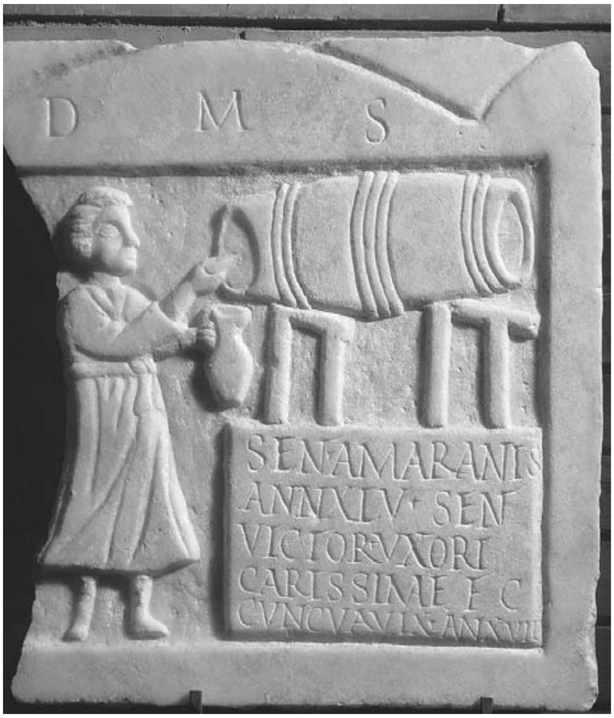
The earliest known wine jar (dated to 5000 B.C.E.) was found in the Zagros Mountains of modern western Iran. Excavations elsewhere in the region located 30- and 60-liter (7.92- and 15.85-gallon) earthenware jars, all with wine deposits, dating from 3500 to 3000 B.C.E. Similar evidence of wine-making at this time has been found at many locations in the Fertile Crescent (the region south of the Caspian and Black Seas and including parts of modern Turkey, Armenia, Georgia, and Iran).

Many scholars speculate that the first vintage was an accident, the result of fresh wild grapes being crushed accidentally and fermenting spontaneously. Over time, people began to crush the grapes deliberately and also began to select and cultivate varieties that produced better wine (such as grapes with a high pulp-to-pip ratio).

Many ancient accounts of the origin of wine stress its accidental character. One refers to the Persian king Jamsheed, who was so fond of grapes that he stored them in jars so as to have supplies out of season. When one lot



Winemaking in ancient Egypt, as depicted in the Tomb of the Nobles in the Valley of the Kings near Cairo. © OTTO LANG/CORBIS.



Wine shops were common throughout the Roman Empire. This bas-relief from the Museo Nacional de Arte Romano shows a shop owner pouring wine into a carafe in much the same way as beer is kept on tap today. © ARCHIVO ICONOGRAFICO, S.A./CORBIS.

fermented, he thought they had gone bad, and had the jar labeled "poison." When a woman from his harem, suffering headaches so bad that she wanted to die, drank the wine with the intention of killing herself, she fell asleep under the effect of alcohol. When she awoke, her headache was gone, and thus was born wine and its ancient reputation as a medicine.

Wine played a part in the diet and culture of all ancient societies from the Neolithic period onward. For the most part, it was a privileged beverage of the elites, while beer was the drink of the masses. A relief from seventh-century-B.C.E. Nineveh shows King Assurbanipal and his queen resting under a trellis of vines and drinking wine from cups. In Nimrud, a ration of wine was given to all six thousand members of the royal household. The basic male ration was 1.8 liters (3.81 pints) for ten men each day, while skilled laborers got twice that. The queen and her retinue received 54 liters (14.26 gallons) a day, but we do not know how many individuals shared it.

One reason for the special status of wine was its scarcity. Grain grew far more widely and easily than grapes, and beer (really liquid bread) could be made year-round as long as grain was available. But grapes grew only in certain localities and ripened only once a year, so that there was limited scope for wine-making. Moreover, each year's wine had to last a year, until the next vintage was ready for drinking. In regions where grapes did not grow, wine had to be imported, thus adding to its cost.

One of the earliest wine trade routes ran a thousand miles down the Tigris and Euphrates rivers from the vine-clad mountains of northern Mesopotamia to southern Mesopotamian cities like Ur, Babylon, and Sumer. This trade route lasted for thousands of years, and it appears that many regions began by importing wine and then proceeded to cultivate grapes and make their own wine. There is clear but uneven evidence of viticulture and wine making from 5000 to 3000 B.C.E., but they probably spread in a number of directions from the Fertile Crescent, one track taking them to the eastern seaboard of the Mediterranean and then south toward Egypt. The Middle Eastern climate around 3000 B.C.E. seems to have been wetter than today, allowing for cultivation is regions where it is no longer possible.

Egypt provides the most coherent image of an ancient wine culture. Hundreds of clay jars of wine (with a total volume of some 4,500 liters (118.78 gallons) were buried with one of the first Egyptian kings, Scorpion I (about 3150 B.C.E.). Analysis of the clay shows that the jars were made in the modern Israel-Palestine region.

Between 3000 and 2500 B.C.E., Egyptians began to grow their own grapes, mainly in the Nile Delta (where the earth was fertile and the heat was moderated by the Mediterranean), but also further south. The vines were owned by royalty and great officials and by priests, and a census taken about 1000 B.C.E. listed 513 vineyards owned by temples alone throughout the country.

Vines were often trained on trellises, irrigated, and fertilized with pigeon droppings. Wall paintings show the wine-making process in great detail. The grapes (almost always depicted as black) were trod by slaves in a vat and the juice was run off into fermenting jars. The must (unfermented juice) is usually colored red or black, which suggests there might have been some period of skin contact. The residual skins and other solids were squeezed in a sack to extract every drop of juice.

Fermentation took place in large clay jars that were sealed, apart from a small hole that allowed the carbon dioxide to escape. Each jar was identified with a clay seal, the forerunner of the label, that might give information on the year, the vineyard and the name of the winemaker.

The aroma, taste and texture of Egyptian wines are lost to us, but in any case the wine was often flavored with herbs and spices before being consumed. But they cannot have been very stable because the grapes were picked and crushed in August, were slowly crushed and pressed and then rapidly fermented, all in the summer heat. Moreover, the clay jars were slightly porous (unless they were coated with resin or oil), which would have led to a degree of oxidation. There was no premium on aging wine here, and there are records of wine going bad after twelve to eighteen months.

Wine cost about five times more than beer, the staple beverage of the Egyptian masses. It was consumed by powerful and wealthy individuals and by priests attached to temples that owned vineyards, who received wine as part of their salary. The elite status of wine is indicated by its prominence in the burial chambers of the kings. Thirty-six jars of wine were buried with the young King Tutankhamen.

Wine played an important role in Egyptian religion, as it did in religions in other parts of the ancient world, and it was poured as a libation or offering to the gods as prayers were said. Ramses III claimed to have presented 59,588 jars of wine to the god Ramon-Re. Some texts present wine as divine in origin: as the perspiration of Re, the sun god, or as the eyes of the god Horus. Wine was also used for medical purposes. Physicians prescribed it to increase the appetite, purge the body of worms, and treat asthma. It could also be applied externally to bring down swelling and to treat wounds.

By the time wine reached Egypt it had come to occupy a privileged place in the diet and culture of the elites. It is possible that viticulture was transferred from Egypt to Crete and from there to the European mainland. The ancient world thus established practices and attitudes that were adopted and adapted by later societies.

See also **Ancient Kitchen, The**; **Greece, Ancient**; **Mesopotamia, Ancient**; **Rome and the Roman Empire**.

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Rod Phillips

Wine from Classical Times to the Nineteenth Century

In the more than two thousand years between the Classical period and the nineteenth century, wine underwent changes in almost every respect. The geographical extent of viticulture (the cultivation of grapes), vine cultivation, wine making, trade, and the culture of wine consumption were all transformed as part of broader political, social, economic, and cultural transformations.

Wine-Making in Ancient Greece

The beginnings of wine-making in Greece by about 1000 B.C.E. were an important step in the history of wine. Until that point, wine had been a marginal product, made in relatively small volumes and consumed only by social elites. This had been the case in ancient societies like Mesopotamia and Egypt. In Greece, however, vineyards expanded rapidly from their initial sites near main population centers and markets to more distant islands like Thasos, Lesbos, and Chios, and by the third century B.C.E. there was a veritable wine industry in the region.

Wine was consumed at all levels of society and it became, along with oil and grain, one of the three main products of Mediterranean agriculture and commerce. Greek wine could be found in locations as diverse as France, Egypt, around the Black Sea, and in the Danube region. Moreover, the Greeks introduced viticulture to France (with limited plantings near modern Marseilles), southern Italy, and Sicily.

The extent of the Greek wine trade is evident in the many wrecked ships along the Mediterranean coast. One ship carried an astonishing ten thousand amphoras (six- to seven-gallon earthenware jars) that would have contained as much as 66,000 gallons of wine, or 400,000 standard modern bottles. It is estimated that 2.2 million gallons of Greek wine were shipped to France each year through the port that is now Marseilles.

The Greeks not only supplied foreign markets with wine, but they also consumed vast quantities domestically. Far from being an elite beverage, wine was consumed at all levels of society. This was an example of an egalitarian approach to drinking expressed by Euripides, who wrote that Dionysus (the Greek god of wine) had given "the simple gift of wine, the gladness of the grape" to "rich and poor" alike. Yet there were significant variations in the quantity and quality of wine consumed at different social levels. The affluent drank wine that was described as quite full-bodied and sweet. The poor drank a thin, low-alcohol, bitter solution made by soaking the skins, seeds, and stalks left over after the final pressing of the grapes.

Greek males of the upper social strata developed a specific institution for consuming wine: the symposium, meaning "drinking together." A dozen or more men, all wearing garlands on their heads, reclined on couches and drank diluted wine while conversing, being entertained by young men and women, and playing games that often involved wine. Symposia were idealized as occasions for elevated discussion and cultural activities, but often they were merely boisterous drinking sessions. Greek wine cups were often decorated with scenes of drunkenness and sexual activities at symposia.

Women were excluded from symposia (except as servers, entertainers, and prostitutes) and there is evidence in Greek writings of male anxiety about women drinking wine. Women were believed to become intoxicated more quickly than men and to behave immorally once in that state. These became persistent themes in Western culture, and they underpinned lower consumption rates of all forms of alcohol by women.

Although it was apparently a not uncommon occurrence in symposia, drunkenness was generally frowned upon in ancient Greece. Homer highlighted the dangers of drunkenness in the *Odyssey*, in which several characters meet their deaths in accidents caused by drunken men. Yet moderate consumption of wine was viewed as beneficial. Hippocrates, regarded as the founder of Western medicine, wrote extensively on the effects of different types of wine on the digestion. He criticized "dark and harsh" wines as difficult for the body to digest and expel, but praised "soft dark wines . . . they are flatulent and pass better by stool."

As for wine production, the Greeks paid serious attention to viticulture and wine-making. They adopted techniques of growing vines along trellises and up stakes to make the grapes more accessible during harvest. Vine-dressers, who were responsible for the vital pruning operations in the vineyard, became a recognized profession. It was the Romans, however, whose empire superseded that of the Greeks, and it was they who left the most coherent documentation on wine in the Classical period.

Wine-Making in Ancient Rome

A host of writers, including Cicero, Pliny, and Cato, described viticultural and wine-making practices in Rome and wrote extensively about the wines available to them in the last centuries B.C.E. In about 65 C.E., Columella described the principles of viticulture, including the recommended density of vines, the importance of selecting appropriate sites for vineyards, and the economics of vine-growing. For his part, Cato stressed the importance of sunlight to grape-ripening and outlined the basic principles of canopy management.

Roman writers also focused on wine-making and gave recipes for wines that would appeal to Roman tastes. Unlike modern wine-making methods, where additives are minimal, Roman wine was a grape-based concoction that might include sea-water, honey, and all kinds of herbs and spices. Additional flavors might be contributed by the pitch and resin sometimes used to seal the insides of earthenware jars, and sweetness could be added by boiling the grape juice in a lead vessel. Lead not only sweetened wine, but it also preserved it by killing some bacteria. (Lead's potential toxicity was recognized but was largely ignored until the seventeenth century.)

Roman wine writers paid attention to the quality of wines. They gave particular value to color, body, and sweetness, but they also noted wines that they believed had special medical properties. Athenaeus praised wines from Alexandria, which he thought were excellent, fragrant, not likely to go to the head, and which had diuretic effects. Strabo gave high marks to wines from Turkey and Aegean islands like Cos, Chios, and Lesbos. In the first century C.E., Pliny the Elder provided a catalogue of wines from various parts of the empire: ninety-one varieties of wine, fifty kinds of quality wine, and thirty-eight varieties of foreign wine. His list is notable for its stress on varieties rather than just provenance.

The engine of the Roman wine industry was Rome itself, which grew from 300,000 to over one million inhabitants between 300 B.C.E. and the beginning of the first century C.E. By that time, Romans were consuming an estimated 39.6 million gallons of wine a year, which was about seventeen fluid ounces a day for every inhabitant. Not only did the region around Rome provide this wine, but many other parts of the Italian peninsula shipped it as well.

The prominence of wine in the Roman diet was threatened when Mount Vesuvius erupted in 79 C.E., burying the wine port of Pompeii and destroying many vineyards and two vintages of wine (one in warehouses, the other still on the vines). The immediate shortage of wine led to such a rush to plant new vineyards that there was a glut several years later. The Emperor Domitian tried unsuccessfully to limit the land under viticulture in Italy and to reduce vineyards in Rome's overseas provinces such as Gaul. The ostensible reason for the policy was that vineyards were taking over land needed for grain production, but it is thought that Domitian was as much concerned with protecting Roman wine producers from competition.

Despite any pressure there might have been from wine producers in Italy who wanted to protect their export business, the Romans extended viticulture throughout Europe as their empire expanded. By the first century C.E., most of the famous French wine regions (including Bordeaux, the Rhône, and Burgundy) had been planted, as had areas in England, Germany, Hungary, and other parts of southeastern Europe. The Romans were thus responsible for the beginnings of the European wine industry.

As was the case in Greece, Rome's wine culture was generally inclusive, and everyone from the elites to slaves consumed wine. Cato proposed that slaves in chains should receive about 1.3 gallons of wine a week—not for pleasure but to give them strength to work. (The ration allotted to a sick slave was half that of a healthy, working slave.) Also as in Greece, in Rome there were vast differences in the quality of the wine consumed by different social groups.

In Rome there was also concern about wine consumption by women. One myth told of a husband who beat his wife to death with a stick for drinking wine, a punishment said to have been praised by Romulus, one of Rome's founders. For a brief time, Roman law allowed a man to divorce his wife for drinking wine, and women were associated with the cults centered on Bacchus, the Roman god of wine. The authorities concocted stories of wild, drunken orgies (Bacchanalia) in order to suppress the cults, which had become implicated in opposition to the government.

Drunkenness, whether on the part of women or men, was broadly condemned by Roman commentators. Cicero frequently labeled his opponents drunkards and alleged that his main rival, Mark Antony, started drinking early each morning. Others cautioned against excessive drinking for a variety of physical and mental reasons. Lucretius argued that wine could disturb the soul and weaken the body, while Seneca wrote that wine revealed and magnified character defects. Pliny the Elder praised quality wines, but he warned that many of the truths spoken under the influence of wine were better not expressed.

On the other hand, Classical medical opinion generally held that wine, alone or with other substances, had curative properties, particularly for gastric and urological ailments. Cato recommended certain flowers soaked in wine as effective for snakebite, constipation, gout, indigestion, and diarrhea.

If wine had achieved a privileged status at the center of the Roman Empire, some non-Roman populations on the margins of Roman control carved out their own relationship with the beverage. For Jews, wine was a powerful expression of divine power. When Moses sent out scouts to survey the Promised Land, they returned with a bunch of grapes so massive that it took two men to carry it. Grapes and wine were such important signs of the bounty provided by God to the Jews that the Old Testament frequently threatens that God will make the vines barren if Jews disobey God's word.

This intense symbolism of wine carried over to Christianity. The first miracle performed by Christ was to turn water to wine at the wedding at Cana. Wine became an integral part of Christian theology, ritual, and tradition. In the Christian sacrament of the Eucharist, wine represents the blood of Christ, and there are many representations of "Christ in the wine press," where Christ's blood, flowing from wounds inflicted during the crucifixion, mixes with the red juice flowing from the grapes as they are crushed.

Because the Eucharist required wine, Christianity and wine became so intimately connected that in the first centuries C.E., conversion from beer to wine became a sign of conversion from paganism to the new religion. Many religious houses had their own vineyards. Monasteries were centers of learning, not only in theology but also in the practical sciences, and for hundreds of years religious orders were at the forefront in developing new techniques in viticulture and wine-making.

Wine-Making in the Middle Ages

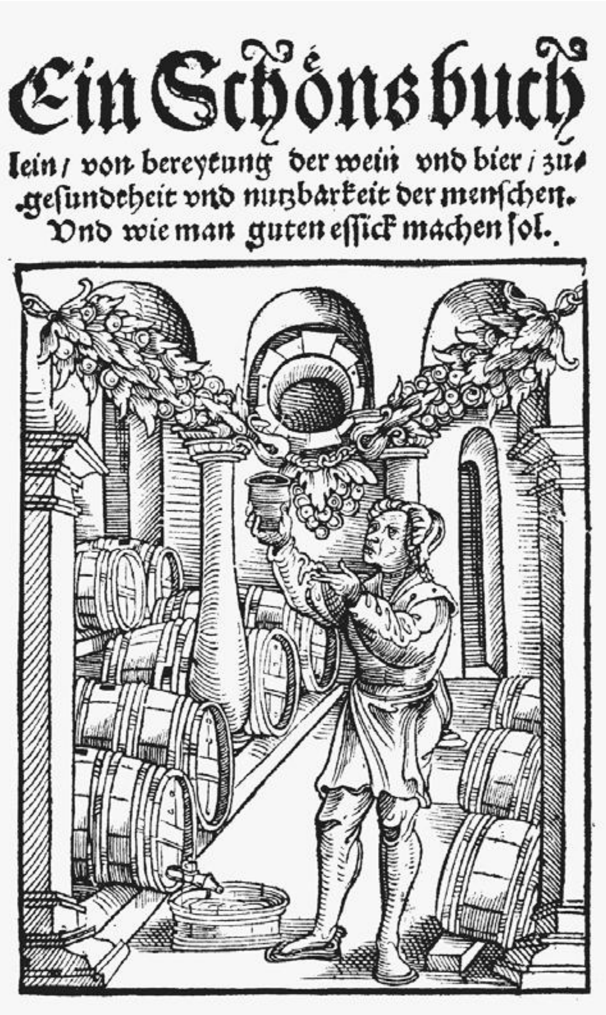
The invasion of the western region of the Roman Empire by tribes from central and eastern Europe from the fifth century C.E. did not affect European viticulture as dramatically as once thought. It is possible that some vineyards were abandoned, but overall it seems that Europe's new rulers were as interested in protecting viticulture as the Romans had been. What did suffer was the wine trade, as the single Roman Empire was broken up into smaller political units, each dominated by one of the invading tribes.

It is a mistake, then, to think of a Dark Ages of wine, and certainly misleading to suggest, as some scholars have done, that viticulture survived only because of the vineyards owned by the Christian Church and various religious houses. They were undoubtedly important and some were extensive: the Abbey of St.-Germain-des-Prés near Paris had 1–1.5 square miles of vineyards in 814 C.E. The Church also sponsored the expansion of vineyards in the important Rhine region and in Austria and Switzerland. Even so, many vineyards had secular owners, and viticulture and wine was not particularly threatened in this period. However, with a decline in trade, many regions began to cultivate their own grapes.

The real threat to wine (and alcoholic beverages generally) emerged not in Europe, but in the Middle East, the birthplace of wine. There the Islamic religion took hold in the seventh century, and within a hundred years it had extended its control across northern Africa, the Iberian Peninsula, and, for a short time, parts of southwestern France. The Prophet Muhammad forbade his followers the consumption of alcohol. Although he acknowledged that wine could make people happy and sociable, he believed that its threats to social order and morality were so great that alcohol should be banned. Wine production practically dried up in many parts of the Islamic empire, but in some parts (like Spain) it was generally tolerated and even acknowledged in so far as it was taxed by Muslim authorities.

Wine production and trade in Christian Europe began to boom around the year 1000 C.E. One reason was the creation of a large political unit in Europe under the Emperor Charlemagne. This not only encouraged commerce, but Charlemagne himself encouraged wine production. He is said to have given the hill of Corton (in Burgundy) to the Abbey of Saulieu; the wines from this estate are known as Corton-Charlemagne.

A further reason for the expansion of wine production from 1000 was the growth of population, cities, and trade that took place in Europe between 1000 and 1300. In northern Europe, northern Italy, and elsewhere, new urban middle classes of entrepreneurs and merchants emerged, all with a thirst for wine. Wine regions close to these new urban markets (like those in Tuscany and other regions of northern Italy) prospered. However, many of the new cities were in areas unsuitable for viticulture, and wine trade routes developed to serve them. Among the most important were the sea route from southwestern France (now the Bordeaux region) to England and the northern European ports, and the wine trade


Ein Schoͤnsbuch
lein / von bereytung der wein vnd bier / zu-
geſundeheit vnd nutzbarkeit der menſchen.
Vnd wie man guten eſſick machen ſol.

The interior of a German wine cellar as depicted in a Renaissance woodcut from the 1500s. COURTESY OF HANS WEISS. ROUGHWOOD COLLECTION

down the Rhine River from the vineyards of central and southern Germany to the North Sea and Baltic ports.

This boom period for the medieval wine industry ended with the Black Death that struck Europe from the mid-fourteenth century. The European population declined by as much as a third, and as markets contracted and vineyard workers died or fled the plague, many vineyards were abandoned. Production and trade began to recover as population and markets grew again in the sixteenth century. There were slight setbacks in this period, when religious reformers like Calvin and Luther accused the Church of Rome of being morally lax, including being tolerant of drunkenness. The Protestant religions tended to be hostile to social drinking, and it is interesting that the only European wine region to become Protestant was Switzerland.

Wine-Making Advancements and Expansion

During the sixteenth to the nineteenth centuries, there were many varied developments in viticulture and wine-making. Lead was abandoned as a means of sweetening wine, and adding sugar to raise the alcohol level of wine became a common practice. (It was later known as chaptalization, after Napoleon's minister of the interior, Chaptal, who recommended it to compensate for grapes that did not ripen fully.)

New styles of wine emerged, too. The technique of making sparkling wine evolved, and bottles and stoppers developed so that it could be conserved more reliably. Starting in the late seventeenth century there was increasing recognition of the individuality of wines from specific estates. The first wine to be marketed as an estate wine was Haut Brion from Bordeaux, which appeared on the London market in the 1660s.

Wine was, in this period, part of the daily diet in many parts of Europe. Reliable statistics on per capita consumption are hard to come by (because the information was not collected) but common estimates range from 17–101 fluid ounces a day. The impact of these volumes depends on the alcohol content of the wine, which was often diluted with water.

Wine was also part of some people's income or entitlement. Artisans employed by the Duke of Lorraine received an allotment of wine as part of their daily wages, and wine was a standard element in military rations. In 1406, the six men who guarded the Château de Custines each received two liters of wine a day.

It was during this period, too, that Europeans extended viticulture beyond Europe itself. The first major advance was the invasion of Central and South America by Spain in the sixteenth century. Vines were planted in Mexico in the 1520s, and viticulture rapidly spread down the west coast of South America in the wake of the invading Spanish armies and Jesuit missionaries. As mission stations were established, vineyards were planted, and the connection was so strong that the grape commonly planted became known as the Mission variety. By the 1550s, major vineyards had been established in Peru, Chile, and Argentina. During the 1600s, the Dutch established vineyards in what is now South Africa, and in 1788 the first vines were planted in Australia.

Viticulture in North America was far less successful. Settlers tried to make wine from native grapes from the 1600s and later tried unsuccessfully to grow European varieties. A combination of climate and disease condemned most of these attempts to failure, and even though Franciscan missionaries established vineyards in California in the eighteenth century, it was not until the nineteenth century that wine was produced in America in meaningful volumes.

The nineteenth century was a turning point for wine, in many respects. From the 1860s onwards, vineyards throughout Europe and other parts of the world were devastated by a North American aphid called *Phylloxera vastatrix*. Unable to eradicate the pest, vine-growers began to graft their vines onto the roots of native American vines that were tolerant of the aphid. The *Phylloxera* disaster affected European wine production for several decades, but it gave a boost to production elsewhere. California vineyards, which had expanded after the end of the Gold Rush, grew rapidly as producers eyed the disaster in Europe and imagined California taking over the world wine market.

The advent of the railroad was a boon to production in many countries. It made eastern markets available to California wine and enabled producers in the south of France to get their inexpensive wine to France's northern industrial cities.

At this same time, a wave of anti-alcohol sentiment swept across many countries. Temperance and abstinence movements had varying success in having alcohol laws tightened, and some American states introduced Prohibition. These movements were reinforced by the discovery (some scholars refer to it as the construction) of alcoholism in the mid-nineteenth century, which seemed to confirm the dangers of drinking any alcohol, including wine.

During the two millennia that separated the Classical period from the end of the nineteenth century, wine had changed from being an elite beverage to one shared by all sectors of many societies. It had spread globally, and it had sensitively reflected broad shifts in economies, societies, and culture. There were also continuities. Voices across this long period spoke to the dangers of excessive drinking, and others praised the health benefits of wine. The experience of wine in this period confirms the importance of understanding wine in its historical and cultural contexts.

See also **Beer**; **Christianity**; **Fermentation**; **Fermented Beverages Other than Wine or Beer**; **Grapes and Grape Juice**; **Greece, Ancient**; **Mesopotamia, Ancient**; **Middle Ages, European**; **Rome and the Roman Empire**.

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Rod Phillips

WINE IN THE MODERN WORLD

At the start of the twentieth century wine was a beverage with a very limited range. Essentially it was made as a bulk product by peasants in southern Europe and was consumed by all classes in the country of origin. A small amount of premium wine found its way to the tables of the rich in the capital cities of Europe and the European diaspora. Some outposts of production existed in the United States and the colonies of Europe, but they were insignificant both qualitatively and quantitatively. The Bordeaux vintage of 1900 was highly regarded, but the production and consumption of that style of wine was marginal to the substantive function of the drink.

The Years of Decline

Despite the great opening vintage, the first decades of the century were not happy ones for wine producers. By 1900 phylloxera had completed its devastation of the European viticultural landscape, often leaving vineyards replanted with low-quality hybrid vines that brought viral disease in their wake. Algeria was widely planted and produced large amounts of cheap *vin ordinaire* (ordinary wine). Agricultural depression and the flight of the population to the cities exacerbated the situation; then came World War I. Meanwhile, for the producers of prestige wines a continual flood of impostors from poor-quality viticultural regions seeking to gain the premium offered by reputation devalued that reputation and reduced their profits.

The response was to define a system that, it was argued, would protect both the producer and the consumer. By defining the boundaries of a given region and allowing only wine from grapes grown there to carry the name of the region, producers could maintain a price premium, and consumers could have certainty about the nature (and by extension the quality) of what they were drinking. The first nationwide appellation system was developed in Portugal, but it was perfected in France from 1935 onward in the *appellation controlée* system with the legal enshrinement of the definitions of "quality wine" and "table wine."

This codification of a classification system helped producers in prestigious regions but did little for the bulk producers, still almost all agricultural peasantry with little capital to invest in the technical advances in the winery. In these regions a strange combination of corporatist government and anarcho-syndicalism produced wine cooperatives that were controlled by local small-scale grape growers and to which they could sell their produce. Cooperatives in turn could raise the necessary capital to invest in production facilities.

The Technological Revolution

The development of both the science of biochemistry and the technology of agricultural engineering started a revolution in wine production that expanded even more rapidly after World War II. Originating in the work of Louis Pasteur in the second half of the nineteenth century, enology

Anise
Ginger
Grass
Green Pepper
Apple
Lime
Kiwi
Lemon
Grapefruit
Orange

A visitor to the Robert Mondavi Winery in Napa, California, attends a weekly class on wine tasting. Wine tastings have become an important tool for educating the public about wine and its different aromas and flavors. © CHARLES O'REAR/CORBIS.

and viticulture developed a rational, scientific base. It was no longer enough to continue practices merely because they had been adopted by one's forebears. Universities like Bordeaux and Montpellier in France and later the University of California at Davis and Adelaide in Australia began both to research wine and to teach those who would grow grapes and make wine. As the science developed, so did the wines. Control of yeast and bacteria meant that off-dry and medium-dry wines could be safely marketed. This allowed massive expansion of styles like German liebfraumilch, which dominated the white wine market in the United Kingdom until the 1980s. This technological change came late to wine, perhaps because it was an agricultural, often peasant-based product, but it became crucial as, with the development of the railways and the new markets of industrialized nations, wine had to travel some distance and had to remain stable enough to be drinkable.

Technical development involved three key areas. First was the understanding of the importance of anaerobic handling, the need to control oxygen contact both to preserve fruitiness in wine and to avoid bacterial spoilage. Second was the recognition of the significance of hygiene during wine making and handling, again to avoid spoilage. Underpinning both of these was an increased control of all stages of the process: temperature control, specially cultured yeasts, prepared bacteria to stimulate the malolactic fermentation, and the addition of enzymes that enhance the development of "natural" aromas in the wine (such as pectinase and apiosidase). A modern winery could be a tank farm with a central computerized control room that monitored what each batch of wine was doing.

Viticulture developed at the same time. Spurred originally by the need to combat phylloxera, then by the requirements of rapid new plantings in the Americas and Australasia, pest control, soil management, irrigation, and controlling the canopy of the vine to maximize sun exposure have been led by science. The result has been to raise the quality of the most basic wines, so even at the cheapest end of the market the consumer can expect to get a fruity, fault-free wine rather than one dominated by oxidative flavors and coarse tannins. The converse, some critics claim, has been to make wines more homogeneous. This, they argue, means that wines have lost their personalities, and wines from across the world increasingly resemble each other. Certain wine makers have reacted against such a clinical approach to let the wine develop in its own way. But even when producers indulge in so-called "dirty wine making" in pursuit of individuality, they do it from a position of knowledge, not faith, as their predecessors would have done.

A New World of Wine

At the start of the twentieth century the production of wine was firmly European. This was not so by the start of the twenty-first century. Although France, Italy, and Spain still dominated in quantitative terms, together producing over 50 percent of all the world's wine, their international reputations increasingly were challenged by the "new producing" countries, those of the New World. In the U.K. market, something of a yardstick, Australia became the second most popular country of origin after France.

This growing international reputation for the new producing countries reflected a rapid increase in their production. Consumption in the wine producing countries of Europe dropped dramatically, and at the same time national governments and the European Union pursued policies designed to reduce production, particularly in the bulk wine producing regions around the Mediterranean. In the new producing countries the reverse was true. From a low base, consumption rose, but production of wine grapes rose even more dramatically, driven not just by domestic demand but by the desire to penetrate new markets in northern Europe, North America, and eastern Asia.

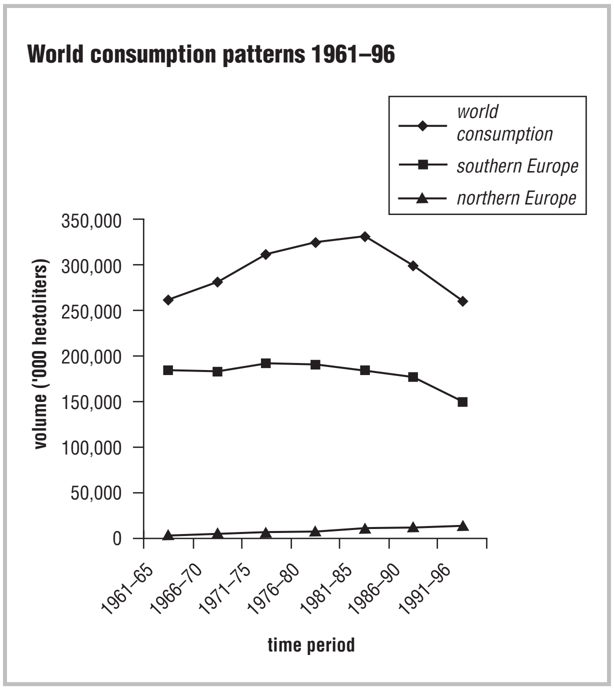
The newer wine producing countries have been at the forefront of structural changes in the industry. In the early twenty-first century Australia had over 56,000 grape growers, each with an average holding of 1.25 hectares (3 acres), making the industry highly fragmented. In New Zealand, the most concentrated of all producing nations at that time, the largest company (Montana) was responsible for over 60 percent of all wine made. The California producer E. & J. Gallo made more wine in a year than the whole of Australia or the whole of the Bordeaux region. This does not mean that Europe does not have large companies. At the beginning of the twenty-first century the French-based Louis Vuitton Moët–Hennessy produced more wine each year than any other company in the world. Nevertheless, Europe does have a more fragmented industry.

Wine production in the new producing countries tends to be dependent on access to capital rather than inheritance. This has had another consequence, for access to capital facilitates greater use of the equipment modern technology offers. The focus on control and hygiene mentioned above is particularly significant—some would say obsessively so—in these countries. Again it is not true that wine producers in Europe disdain technology, as some in the erstwhile colonies would claim. Some Bordeaux châteaus have state-of-the-art equipment, and the *champenois* (people of Champagne) are world leaders in the production of sparkling wine. Crucially, however, fragmentation makes widespread access both to the technology and the attitudes that accompany it less likely.

Changing Market

As the geography of production has changed, so has the geography of consumption. Changes in income patterns, reflected in the development of consumer culture, as well as travel, both voluntarily with holidays and forced in migration or war service, have made wine more accessible to many. Technology allows better wine to be made cheaper, and the blurring of class difference means wine is perceived less as the drink of the elite in many countries. A nascent wine culture in East Asia has offered the world's producers yet more opportunity to sell their wares and, with that region's focus on the label as a status symbol, has generated a rapid escalation in price of the world's most prestigious wines.

FIGURE 1



Wine in Society

While the consumption of wine has spread widely, so too have the forces opposed to it multiplied. Historically, opposition to wine was limited to the religion of Islam. Before about 1800, moderate consumption of alcohol was almost universally accepted in western Europe, although the religious maintained that drinking to excess was wrong. However, two social movements combined to change that widespread tolerance. The social anomie of industrialization and the shift to the city resulted in widespread abuse by the poorer classes. At the same time a new religious conservatism, allied to socially concerned evangelicalism, saw in alcohol the work of the devil. Temperance is a misnomer. It means restraint rather than prohibition, but the temperance movements came to work for prohibition. The movements were most successful in the United States with the passing of the Eighteenth Amendment to the Constitution in 1919. But the impact of temperance movements was felt in strict limits on alcohol use in places as diverse as New Zealand, Wales, Canada, and Scandinavia.

Formal prohibition failed, but its influence lived on in a neoprohibitionist approach, mainly in North America and to a certain extent in Scandinavia. Justifiable concern about the effects of driving under the influence of

Viticulture continues to spread outside the traditional wine growing regions. It has become a major source of agricultural income for South Africa. This vineyard is located on the Cape Peninsula. © LANZ VON HORSTEN; GALLO IMAGES/CORBIS.

alcohol is confused with an absolute need to protect people from themselves and to deny them the possibility of moderate enjoyment of wine.

At the end of the twentieth century, however, another factor came in into play, the relationship between wine and health. While abuse of alcohol contributes to a range of diseases, most notably cirrhosis, science has rediscovered what doctors have known down the centuries, that moderate consumption of wine can have positive health effects. Scientists have also provided the objective evidence for this, for instance, showing the impact red wine can have on improving the balance the beneficial high-density lipoprotein component of cholesterol in the vascular system. This change in outlook was typified by the broadcasting of "The French Paradox" on television in the United States in 1991. Sales of red wine jumped dramatically overnight, followed by a prolonged battle between the wine industry and the Bureau of Alcohol, Tobacco, and Firearms about the health labeling on bottles of wine.

The Twenty-first Century

What does the twenty-first century hold for the wine industry and the wine consumer? The pace of technological change is increasing. Disputes have developed over gene modification and the possibility of creating new varieties in the laboratory. Perhaps ultimately great wines will be recreated in test tubes. The mass production of 1961 Chateau Lafitte would horrify some but could please many.

The geography of production continues to change. The quality of wine produced in southern Europe has improved gradually, but many poor-quality sites have been abandoned because of a lack of markets for the wines. Meanwhile, as long as demand in the English-speaking and East Asian countries rises, the new producing countries will probably continue to raise their production. However, in the short term it is possible that they will suffer a glut of grapes for which no market exists. Then what happens when China begins to select appropriate sites for the production of high-quality wine?

Historically wines were sold on the basis of their geographic origins. Increasingly they are sold by the variety of grape used, and it seems likely that this trend will continue. Chardonnay and cabernet sauvignon currently dominate worldwide, but previously sherry and lambrusco reigned. The balance could yet shift to, for example, nebbiolo and manseng.

The current catchphrase is, people drink less but better. That probably hides the true shift in consumption, but it is a useful rule of thumb for how consumption changes. Critically in the late twentieth century, wine, like every other production industry, was taken over by marketing. That is not necessarily a bad thing, as part of the marketing manager's job is to ensure that consumers are satisfied with what they get. If that means more palatable wine, then consumers benefit. On the other hand, the tendency of marketing to "segment" its customers into large groups means that those who seek the unusual or the different may find it increasingly hard to find the grape variety or region of their choice in price-point driven supermarkets that command up to three-quarters of the retail market in many Western countries. The signs, however, indicate that the gradual shift back is to greater diversity.

See also **Alcohol; Beer; Fermentation.**

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Steve Charters

WINE, NONGRAPE

Winemaking is one of the most ancient of human endeavors. Archaeological evidence suggests that early winemakers began practicing their art nearly eight thousand years ago. Since then, efforts have been largely directed toward controlling the fermentation of the grape. United States regulatory agencies classify nongrape wines by their primary component into apple or pear, fruit or berry, citrus and agricultural wine. The latter includes wines made from honey, root crops, flower parts, cacti, and rice.

Successful fermentation of nongrape materials presents a variety of challenges. Most important is increasing the sugar content in the fruit or other component. At optimal maturity of any fruit, the sugar content is insufficient to yield a wine of 10+ percent alcohol. As a result, winemakers are allowed to add sugar, a process called chaptalization. A winemaker also needs to control acidity since fruit and vegetables are often deficient. The deficiency is corrected by addition of either citric or malic acids or by blending higher acid fruit or wine. In contrast, citrus and some berries may be too high in acidity, a defect that can be corrected by the practice of amelioration or regulated addition of water. Nitrogen deficiencies may arise from the fruit and/or processing and, if critically low, result in interrupted or stuck fermentation. Such fermentations require addition of exogenous nitrogen, typically in the form of diammonium phosphate (DAP). With the exception of berries, processing of fruit and vegetable products generally results in very poor juice yields. Pectinase enzyme preparations may be used to attack cell wall structure, liberating fluid. Alternatively, the fruit may be frozen and thawed before processing. Formation of ice crystals ruptures cell walls, which then release fluid and increase juice yield. However, this may result in premature oxidation and diminished fruit character. An alternative, fermentation of macerated pulp, rather than of expressed juice, will trap heat of fermentation and increase the probability of stuck fermentation. In contrast, fermentation of larger volumes of juice requires cooling capable of dissipating heat.

When making mead or honey wine, the principal component, honey, is typically 70 percent sugar or more, with the compositional balance reflecting type and origin of the flowers. Honeys may range in color and flavor from light, mild, and fragrant to darker and more strongly flavored. Since refined honeys have reduced character, due to thermal processing, mead producers prefer to purchase unprocessed or minimally processed honey. While intensified in flavor and aromatics, natural honey is prone to crystallization when stored at refrigeration temperatures. Although sensorially unapparent, honey is acidic (average pH 3.9). The primary acid is gluconic (5.7 g/L) with lower concentrations of other common acids, which reflect the honey's origins.

Pulque is fermented from the sap (*aguamiel*) of the Agave (Maguey), a succulent plant indigenous to the desert highlands of central Mexico. Bacteria, primarily *Zymomonas mobilis*, and yeasts have historically been responsible for alcoholic fermentation; however, modern producers use commercial yeast (*Saccharomyces cerevisiae*). Wine made from melons is not as successful as those made from other products. Unless cofermented or blended with more highly flavored fruits, melon wines are generally insipid. Further, color is colloidal: A variety of melon that is red when fermenting will become straw-yellow upon clarification and bottling.

Dandelion wine is probably the best-known example of wine made from flower parts. Although most view dandelions as a nuisance, the flower has a long history as a medicinal herb and teas. Petals are excised, boiled, and extracted in various formulations of sugar and acid (citrus fruit or juice) for several days prior to straining and addition of yeast. Since petals are typically low in available nitrogen, supplementation is required.

Berry fermentations from cultivated and native berries are relatively simple. Most have adequate to excess acidity and juice/wine yields are acceptable. Apple wine (cider, hard cider, apple jack) is also an ancient beverage, and consumption of fermented apple juice is well over two thousand years old. English colonists brought apple seeds to north America where both "hard" and nonalcoholic juice became their most popular drink. Pear wine, also known as perry or *poire*, has its origins in both the England and Normandy region of northern France. Compared with ciders, perrys have more refined and ephemeral aromas. Perry also contains a high level of the nonfermentable sugar-alcohol, sorbitol, resulting in a more full-bodied presentation.

Included in the stone fruits category are wines made from numerous varieties of peaches and nectarines, plums, apricots, and cherries. Each presents unique challenges. As noted above, the most significant issue is juice yield. Enzyme additions are helpful. Produced from either cultivated or native species, cherries yield a relatively distinctive and easily managed fruit wine. Cherry pits contain organic cyanides either as cyanogenic glycosides or hydrocyanic acid. Therefore, any cracked seeds should be separated from the pulp prior to fermentation. Among commercially available varieties, sour cherries, such as Montmorensay, are sought after due to their already high acidity. However, sweet cherries may also produce excellent wine upon blending or with acid supplementation. "Wild" or chokecherries are common to much of North America. Chokecherries derive their name from their extraordinary acidity or "sourness" compared with cultivated cherries.

See also **Alcohol; Apple; Beer; Berries; Fermentation; Fermented Beverages Other than Wine or Beer; Flowers; Fruit; Sugar and Sweeteners; Wine.**

K. C. Fugelsang

WOMEN AND FOOD. Although the subject of women and food is of vast importance, it is difficult to document. Unfortunately for women's history in general, early historians customarily focused on public events (usually male), and most women's records have been discarded or lost. Further, the material we have in greatest abundance is that of the wealthy, who were literate, had large properties and kitchens to manage, and kept records. If one generalization can be made from this uneven data, it would probably be the concept that family cooking was universally associated with women and was shaped by location, period, culture, and class. Because most changes in women's relationship to food are found in the middle status range, it will be the focus of this essay.

Women's Early Association with Food and Agriculture

From the earliest days of prehistory, women have not only nurtured society with their own kinds of cookery but also figured predominantly in the agricultural innovation that, to this day, feeds much of the world. Women's place in a pervasive gender food dichotomy has defined their power and status for millennia. In the earliest nomadic societies that subsisted on foraging and hunting, the foragers were almost always females. Men's contribution was through the hunt. Recent archaeological findings suggest that the diet was largely vegetative (female) and was not nearly as meat-centered (male) as surviving bone remains once seemed to indicate. Nevertheless, this diet sustained extremely healthy people. The extent of women's knowledge must have been vast, as they knew where, in their wanderings, specific plants were to be found at different times of the year and which parts of the plants were edible in different stages of their life cycle. This early gender-based pattern still exists, and survives in such nomadic cultures as the African Bushmen.

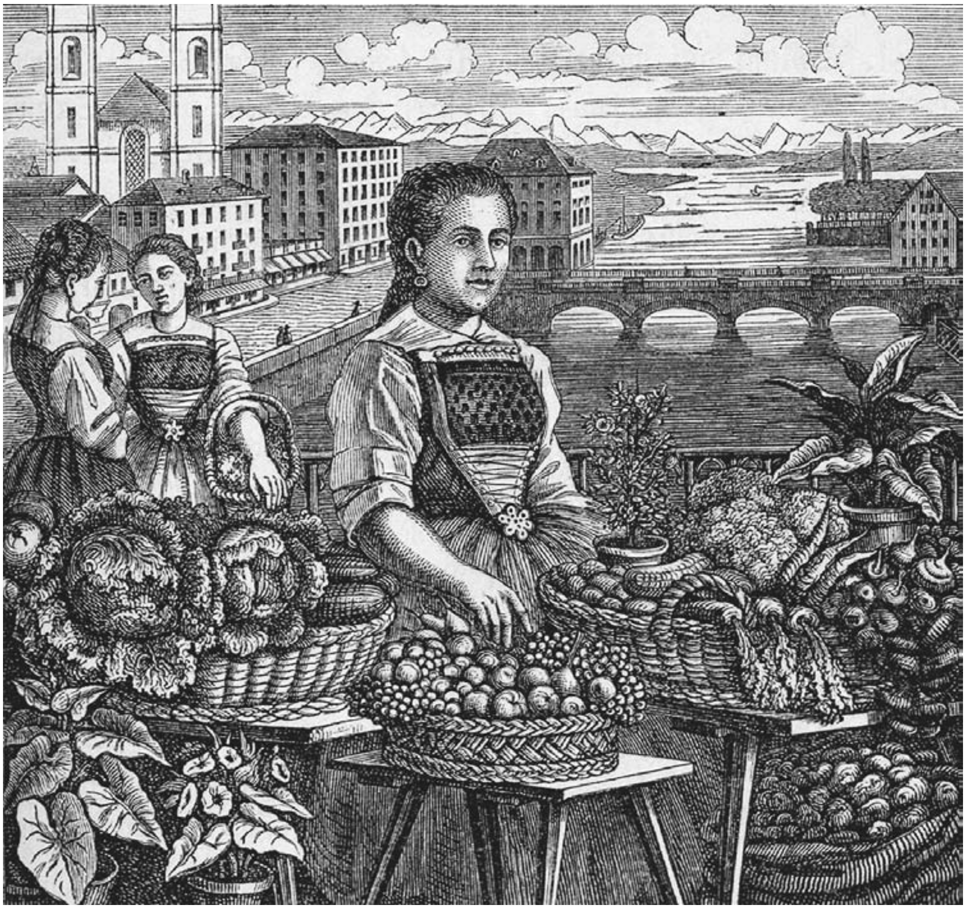
THE CORN GODDESS

Nearly all New World tribes had a Corn Goddess or Corn Maiden, an Earth Goddess who taught them how to grow food from her body. Often her body was sacrificed, as she demanded, so that her children could grow food on it. This became a constant reminder to her descendants to treat the land as their Mother. One of the most famous Corn Mothers was Central American Chicomecoatl, who also guarded women who had died in childbirth.

It has been suggested that the division of food responsibility was a consequence of women's limited mobility, resulting from childbearing and extended periods of childcare. In any case, their familiarity with plants and their own identification with creating new life (the male role having been as yet unrecognized) were undoubtedly factors in their monumental innovation, the formation of the first organized agriculture (c. 8000 B.C.E.).

Evidence of the high regard women earned is reflected cross culturally in the stories of universal origin even up to and including subsequent patriarchal systems. For example, in ancient Greco-Roman mythology, the story of Demeter (Ceres), the goddess of agriculture and fertility, and her daughter Persephone (Proserpina) acknowledge women's responsibility for developing agriculture, the origin of growing seasons, and the agrarian skills that they taught people. In distant Mexico people worshipped Ceres' counterpart, the pre-Aztec Great Corn Mother known as Chicomecoatl; variants of her story abound in tribes and nations throughout the hemisphere.

The new agriculture did more than feed people—it changed basic human society. Food could now be produced in one place and stored there for year-round avail-



Pictures of markets the world over reveal one common theme: women selling food. In nations where agriculture is small-scale, women are usually both food producers and food retailers. The twist in this nineteenth-century woodcut is that folk costume is being exploited as a marketing ploy to call attention to the agricultural products. Woodcut from the *Neues Illustriertes Schweizer Kochbuch* [New Illustrated Swiss Cookbook] published at Zurich in 1876. ROUGHWOOD COLLECTION.

ability, and it enabled the formation of permanent settlements that preceded the growth of civilizations.

Women's agricultural revolution was followed by men's parallel development of domesticated herds and large animal husbandry, today practiced by nomadic Masai of East Africa and the sheepherders of Central Asia. Their herds supplied not only food but also a reservoir of a different commodity—wealth and status.

During this time, women continued their long-established custom of cooking privately indoors to strengthen family ties and health. When men cooked, it was usually outdoors for other men, serving the religious, political, and social needs of the community. Each gender had its own kind of pots and specific areas of cuisine. Women slow-cooked moist dishes of grain and vegetable (sometimes flavored with small amounts of meat) in clay stewpots. Men tended to roast or grill meats with iron equipment. A vestige of this remains today in women's daily cooking and men's backyard barbecues. This simple division of food tasks by gender has changed very little with the centuries; the distinctive roles have blurred only as society itself has undergone major changes.

Women in Ancient Greece and Rome

One of these changes happened with the appearance of patriarchal societies. Gender food divisions among the ancient civilizations indicate not only women cooking at home, but also some men forming a professional class of chefs that cooked for the most privileged. In Greece and Rome, for example, these chefs were noted for their elaborate presentations for upper-class banquets and epicurean occasions. At the same time, the taverns and street vendors that provided a substantial amount of food to all levels of urban society were staffed by both men and women of lower status, but with unclear gender divisions. Women of all classes were considered by men to be inferior and were restricted to "lesser" domestic duties and family service at home, but they were still credited for

The Right to Cook

In 1677, Beatrice Plummer found herself in the Salem, Massachusetts, courthouse. She complained that her husband had denied her not only food provisions but also the right to perform her household responsibilities by cooking properly for the household. The court fined her husband for his "abusive carriages and speeches." The unequal division of spheres sometimes had its ironic side.—Cited in Laurel Thatcher Ulrich, *Good Wives* (1982).

their cookery. Women's place in the middle-class kitchens sometimes became more supervisory, as slaves were easily available, but their earlier place of power and honor was gone. Under ongoing patriarchal control, such gender divisions continued to be established and enforced for centuries.

The Middle Ages through the Early Modern Centuries

During the Middle Ages and the Renaissance, the gender divisions were increasingly reinforced by a growing system of secular and religious laws. Upper- and middle-class women remained relatively powerless at home under the rule and protection of male relatives and had no possibility of developing their own careers. There were, as always, a different set of culinary standards for male cooks, who sometimes achieved the prestigious positions denied to women. Manuscripts of their compiled recipes were written for other chefs and ultimately became the first cookbooks. Women who cooked in the urban marketplace were still working at lower-status work and may have filled a variety of positions, depending on fortune or skill. At one end of the gamut, they may have been hired as cooks in modest homes, and at the other as scullery maids. Like men, they also worked in taverns or as street vendors, perhaps as the ubiquitous and fanciful "Gingerbread Women" who sold spicy goodies at local fairs and festivals.

The rural world has always lived by its own code of gender rules. Like working-class women, farm women often participated in the workplace. In much of urban middle-class Europe, only men were permitted to function in public, where they represented their families' interests and worked to keep the community strong. Married middle-class urban women lived more privately under the umbrella of male authority and representation. However, women commonly functioned more independently within the rural corporate family, where they traditionally contributed to family decision-making and income. Their labors, beyond the customary cooking, kitchen gardening, preserving, caring for barnyard animals, etc., included the local sale of their own products, among them butter, eggs, cheese, fruit and vegetables, poultry, and perhaps cooked wares in season. They secured much-needed funds, as farm capital is usually tied up in buildings, stock, equipment, and cash is invariably scarce. Thus, farm women, even those of means, were early food entrepreneurs in the public market.

It should also be mentioned, in the interest of thoroughness, that women with high positions were rarely in the kitchen, apart from supervising menus or preparing occasional delicacies in honor of a special guest or occasion.

One of the few sources of material about women in this period is the world of art. Although such works are too sparse to provide a conclusive picture, they nevertheless suggest some parameters of gender roles. Many paintings from the sixteenth century show women cooking, but rarely in positions of authority. In a German print of 1507, a male chef adjusts flavorings, while a lower-status scullery maid washes (or peels) food. A Dutch image from 1510 shows important-looking men conducting business in the hall in the foreground while a woman cooks in the kitchen in the background. In eighteenth-century France, Chardin painted a series of female kitchen servants in low circumstances, depicting their fatigue and perhaps boredom. However, in the same period we see evidence of change: a Spanish painting shows two authoritative women in an elaborate Valencian kitchen, cooking and handing their platters to liveried butlers, presumably for an important feast. Likewise, the frontispiece of Eliza Smith's cookbook (London, 1727) shows in the foreground three women in charge of the kitchen, while in the background one sees the suggestion of a butler carrying a tray into the dining room beyond. This is consistent with an event in the American colony of Virginia, in which the English Governor Bottetourt hired a woman (unnamed in the records) to replace his retiring steward William Marshman. Over a century later, Isak Dinesen's short story "Babette's Feast" centered on a French female chef who embodied Dinesen's youthful professional dreams, perhaps indicating that such careers for women were becoming more conceivable. These isolated examples in themselves give suggestions of possible circumstances but obviously wield more clout when combined with sources such as cookbooks.

Women and Cookbooks

The printing press and other incipient technologies made a new genre of cookbooks possible, this time for a widening audience of middle-class urban women. They had begun to work with this audience by the late 1500s. In a field dominated by men, the first published works, under male *noms de plume*, guided affluent and literate women who presided over privileged estates and well-appointed home kitchens. Cookbook writing was essentially done in private; anonymity hid its entrepreneurial aspect and circumvented the social code. More often, male writers, such as Gervase Markham (*The English Housewife*, 1615) and Richard Bradley (*The Country Housewife and Lady's Director*, 1732), writing for this female audience used recipes from women's manuscripts without noting their sources.

By the eighteenth century, middle-class women driven by economic need began publishing cookbooks for other women under their own names. They often incorporated the knowledge and experience of their own kitchens with more complex hospitality food. In a few cases they were the work of the more privileged, who wrote as a social service. These cookbooks appeared in differing numbers throughout European cultures: England's strong middle class produced many, while France, with a different social and economic system, produced relatively few. Women of other established traditions, among them German, Polish, Dutch, Spanish, and Scandinavian, were also represented.

Many of these early cookbooks were carried around the world by emigrating colonists. For example, Eliza Smith's *The Compleat Housewife* (London, 1727) and Hannah Glasse's *Art of Cookery* (London, 1747) were used extensively in North American settlements. Amelia Simmons, author of *American Cookery*, the first American cookbook (1796), followed their lead with her commonly used English-American cuisine. Those who followed her were, interestingly enough, women of stature who were justly famous for their works on women's affairs and social and political reform. These culinary pioneers of the new American democracy presented a new public female image of independence, competence, and enterprise. By the mid-nineteenth century, growing literacy and lowering book prices made cooking manuals available in increasing numbers and by the century's end, they were owned in large numbers throughout the nation. Noted authors such as Marion Harland, Maria Parloa, Sarah Tyson Rorer, and Fannie Farmer also ran cooking schools, wrote newspaper and magazine columns, and lent their names and reputations to new product endorsements and advertisements. Their influence helped to mold a unified national American cuisine, and sometimes they used their culinary forum to support women's social or religious issues.

The changing nature and proliferation of women's cookbooks unwittingly documented a shift in women's general social and economic position. Many cookbooks were prefaced with dedications to brides and young matrons of the urban middle class, with the comment that young women were no longer learning housekeeping at home and were unprepared to run their own homes. The early years that girls had traditionally spent learning these tasks were now dedicated to education in public school, perhaps followed by finishing school or college, and then by jobs that lasted until marriage. Women were nevertheless expected to acquire domestic skills and to aspire to the idealized Victorian separation of gender responsibilities, the "Doctrine of Separate Spheres," under which women avoided involvement in the public world of work. One of their sanctioned spheres, that of service to the community, revealed indications of the changes to come.

ACTIVIST COOKS

Capable women who wrote cookbooks were often noted for their other public activities. Lydia Maria Child, author of *The Frugal Housewife* (1832) also wrote widely on social and political issues; Sarah Josepha Hale (1849) edited Godey's *Lady's Book*—the preeminent women's periodical of the time; and Catharine Beecher, who published *Domestic Receipt* in 1846, also campaigned widely for strong women's professions in education and the home.

Women in the Public Sphere

The growing female philanthropic movement used home-cooking skills to produce fund-raising cookbooks, church suppers, food festivals, and bake sales. Women's Exchanges supported middle-class women in straitened circumstances by selling their home-cooked foods, often in special lunchrooms. These educational and charitable activities taught basic business skills, which had hitherto been held only by men. By the early 1920s, their example (and the new automobile) inspired female tearooms and luncheonettes, run by and geared to women, and serving a feminine "dainty" cuisine. It is entirely likely that this major step in women's progress toward economic equality succeeded because it utilized the familiar, accepted, and integral bonds between women, food, and community service.

Cookbook writing was only one activity related to the growth of cities in the early nineteenth century. Yeoman farm women had spent much of their time in food work, but once transplanted to the city they found alternative opportunities in the emerging middle class, the cash economy, and entrepreneurism. For example, Pearl Rivers (whose real name was Elizabeth Jane Poitevent Nicholson), the first woman publisher of a major newspaper (*The Picayune*, New Orleans), used her position to organize field research, collect local home-based recipes, and preserve the disappearing but cherished Creole cuisine in *The Picayune Creole Cookbook*, 1900.

The amalgam of cultures in the United States allowed for differing women's roles. New England's separate spheres doctrine, promoted in women's writings nationally, kept middle-class urban women out of the marketplace, while New Orleans's internationally based culture encouraged them. For example, Madame Begue, an accomplished Bavarian chef relocated in New Orleans, earned an impressive reputation with her Creole food as both restaurateur and cookbook author (1900). She was, in many ways, like the skillful French matriarchs drawing on their own home cooking and running bistros. Some women ran boardinghouses and competed on the merits of their kitchens. They are credited with molding a generation of young farm men relocating in growing cities, and in many ways directing the course of the emerging middle class. Other work opportunities opened in higher education with the establishment of federally mandated land grant colleges (1862) and the developing schools of home economics at which food study was elevated to a more academic level. They trained middle class women for significant food careers in nutrition, social work, and education.

The Late Twentieth Century

The Great Depression, the World Wars, and the postwar return to normalcy did relatively little to change basic American cuisine or women's home responsibility for it. However, in the 1970s the women's movement began to weaken traditional gender divisions, and women at home were exposed to a new wave of highly visible professional female cooks and authors. Julia Child and Alice Waters familiarized homemakers with innovative food, and incidentally offered a model of the professional female. Inspired by such luminaries, a succession of TV cooking shows, and the growing feminist emphasis on business careers, numbers of capable young women began to operate their own restaurants, bakeries, and publications. Female journalists such as Mimi Sheraton, Gael Greene, and Ruth Reichl found a niche as food essayists, critics, and restaurant reviewers. In academia food became a more acceptable subject for professional attention as the social sciences began the study of women as foodgivers through the perspectives of history, sociology, anthropology, archaeology, and folklore.

The Twenty-first Century

While a good part of the undeveloped and developing world still identifies women with traditional home cooking, the food role of women in developed nations is in a period of change, a logical response to shifting economic opportunities and family structure. As women increasingly work away from home, they have, of necessity, reduced their customary domestic food preparations. Many men have accepted some of the responsibility for daily cooking (a new role for them), perhaps continuing to cook a special (often gourmet) menu for weekend guests.

As traditional domesticity becomes more scarce, Martha Stewart's style of home cookery has vindicated the ancient female role for those at home, assuring her female audience of renewed status and satisfaction. Many women know far less about cookery than their mothers did and have asserted their perceived liberation from household drudgery with the proud statement, "I don't cook." Fortunately or not, their daughters often lack basic skills and culinary understanding. Having experienced neither instruction nor the memory of food cooked from natural ingredients, they tend to associate good dining with the elusive processes of restaurants. As women establish a respected place in the professional work force and prepare the food that had been associated with men since antiquity, the old dichotomy of men's food and women's food has begun to slip. At the same time, fast food, convenience, and "take-out" foods, which are, in a sense, the traditional male cuisine, are replacing the comfort foods associated with women's home cooking. It would seem that economic progress has weakened associations between gender and cuisine and the link between women and food, leaving us to ponder the consequences.

See also **Anthropology and Food; Apicius; Child, Julia; Cookbooks; Fisher, M. F. K.; Food and Gender; Home Economics.**

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Alice Ross

WRAPS. *See* **Sandwich.**

YEAST, BREAD AND BREWER'S. *See* **Baking; Beer; Fermentation; Microorganisms.**

ZOROASTRIANISM. The prophet Zarathushtra (known to the Greeks as Zoroaster) founded Zoroastrianism, one of the world's oldest living religions, in northeastern Iran, probably between 1800 to 1000 B.C.E. Zoroastrianism became the state religion of the first Persian Empire in the sixth century B.C.E. after which its influence waxed and waned until finally it was supplanted by Islam in the seventh century C.E. In the tenth century B.C.E. a small group of Zoroastrians migrated to the Gujurat region of northwest India where they became known as Parsis (Persians). Today, the number of adherents is estimated at 274,000 worldwide with the largest community centered around Bombay and a smaller number in the Iranian homeland. Zoroastrians follow the creed of "good thoughts, good words, good deeds" and uphold virtues of honesty, charity and hospitality.

Ruins of ancient Persian fire altars at Naqch-E-Rostem, Iran. © Charles and Josette Lenars/CORBIS.

Role of Food in Zoroastrian Tradition

Dietary laws and food proscriptions are not part of original Zoroastrian teachings. Nevertheless certain ritual and symbolic uses of food have evolved over time, based on later Zoroastrian writings and as a consequence of interaction with other cultures and religions. For example, Zoroaster abolished the tribal custom of animal sacrifice, though it quickly reemerged and became incorporated in Zoroastrian rituals. Today it survives only amongst Iranian Zoroastrians during the festival of Mehregan, when meat and bread are distributed. Generally all foods are permitted and are consumed according to personal preference and local custom. For example, Zoroastrians often forgo pork and beef in deference to their Hindu and Moslem neighbors, or are vegetarian by choice. Certain foods may still be avoided because they belong to the evil counter creation. These include birds of prey and "hideous fish." Carrion is regarded as impure as is any food coming into contact with it.

The concept of purity versus impurity is central to Zoroastrianism. Cleanliness is highly regarded and purification rites are a part of most ceremonies. Formerly there were elaborate codes to preserve food from impurities such as skin, nail clippings, sweat, blood, and excreta. It was forbidden to eat or drink from a common cup, and priests would not accept food from non-Zoroastrians. Although cleanliness and purity remain as important values, ritual practices have declined amongst ordinary Zoroastrians. Constraints of contemporary urban life, and differing interpretations by orthodox and reform groups within the faith also contribute to variations in actual practice. It is also notable that fasting—a common religious discipline—plays no part in the faith. Asceticism and renunciation, of which fasting is an integral part, are forbidden.

Symbolism and Sacred Foods

Rituals are important in Zoroastrianism. They establish a connection between the material and spiritual universes. Food plays a part in rituals, as a thanksgiving to God and as a symbol of fellowship created through sharing of material bounty. There are certain foods that are symbolic of the various creations of Ahura Mazda and are therefore regarded as being superior and thus suitable for use in religious rituals and ceremonies. These include bread (*dron*), milk, water, ghee, rice, dates, and pomegranates. *Dron* is an unleavened bread made from wheat flour and ghee. It may be prepared only by a member of a priestly family. During the preparation of the bread the words *humata*, *hukhta*, *hvarshta* (good thoughts, good words, good deeds) are intoned three times, accompanied by placing a mark on the bread, for a total of nine marks. This bread of life is a source of spiritual strength. Haoma (*hom*) juice extracted from the haoma plant is used in a number of rituals. It contains a mild narcotic.

The pomegranate, being an evergreen, is a symbol of everlasting life and of the fecundity of nature. It is also a symbol of prosperity and plenty because of its numerous seeds. Pomegranate leaves are chewed during purification rituals at initiation ceremonies, marriages, after childbirth and by those who have come into contact with corpses. (There has been a modern decline in the latter practice). Rice, as in the Hindu tradition, represents happiness and prosperity.

Ceremonies and Ritual

Yasna is the most important of the Zoroastrian ceremonies. It is celebrated daily, but only in Iranian and Indian fire temples and only by qualified priests. Yasna is an "inner" ceremony, which only Zoroastrians may attend and is often specially commissioned by community members. Ritual materials used include haoma with pomegranate twigs, goat's milk, *dron* with ghee, water, and a presanctified mixture known as *parahom*. The water signifies health and wellbeing, while the milk represents the presence of Vohu Manah, the protector of the animal kingdom. The haoma twigs and pomegranate leaves are pounded with consecrated water and milk is

TABLE 1

Zoroastrian festivals

Name	Season	Description	Creation link	Dates
Maidh-yo-zarem	mid-spring	Fresh vegetables in plenty	Sky	April 30–May 4
Maidh-yo-shema	mid-summer	Time for harvesting corn	Water	June 29–July 3
Paiti-Shahem	early autumn	Harvesting of fruit	Earth	September 12–16
Aya-threm	mid-autumn	Sowing of winter crops	Plants	October 13–17
Maidh-ya-rem	mid-winter	Period of perfect rest	Cattle	January 1–5
Hamas-path-maedern	pre-spring	Equality of heat and cold	Man	March 16–20
Nou Rouz	spring	Renewal of life	Fire	March 21

The Zoroastrian year is based on a solar calendar and starts at the exact time of the vernal equinox.

SOURCE: Adapted from the website of the Ancient Iranian Cultural and Religious Research and Development Centre (www.ancientiran.com).

added to the mixture, some of which is then poured out into a well from whence it will flow out to strengthen the whole of creation. The remainder of the mixture is offered first to those present who endowed the ceremony and then to other observers.

One of the main Zoroastrian "outer" ceremonies, Afrinagan, may be performed in any suitable clean place and can be witnessed by Zoroastrians and non-Zoroastrians alike. Its purpose is to praise the bounty of Ahura Mazda and to request His blessings on members of the community. Ritual objects include a tray of food, usually fruit, wine, eggs, milk and water, which serves as a visible sign of Ahura Mazda's generosity and care for the wellbeing of his people. The main feature of the ritual is a threefold exchange of flowers between the officiating priests.

After giving birth, a woman should be confined with her baby for a period of forty days in order to allow the impurities she has contacted to dissipate. For modern urban Zoroastrian women this requirement not to leave the house for nearly six weeks is extremely difficult to fulfill. As a compromise the woman eats separately from the rest of the family. After forty days she takes a ritual bath that allows her to rejoin the wider community. The new baby may be given a drop of consecrated *hom* from a Yasna ceremony as a "strengthening drink." If this is not possible a drink may be made from *hom* twigs, pomegranate leaves and water.

Children are initiated into the Zoroastrian faith at age seven to eleven years (Parsi) or twelve to fifteen years (Iranian), at which time they become responsible for fully observing Zoroastrian practices. At the initiation ceremony (Naojote) the child receives a sacred white shirt (*sudra*) and a sacred cord (*kushti*). A ceremonial tray prepared for the ceremony contains a mix of rice, pomegranate, raisins, almonds, and slices of coconut. The officiating priest who blesses the child pours these over the head of the child. A banquet for family and friends follows the initiation ceremony.

Marriage ceremonies take place at the house of the bride or in public places where large crowds can congregate. Prior to the actual marriage ceremony the bridegroom, with family friends and priests, arrives at the bride's house. While the others enter the house the groom remains on the threshold where he is greeted with traditional symbols of welcome. An egg, a coconut, and a dish of water are successively passed around his head, then dashed to the floor. The groom may then enter the house and the marriage ceremony commences. During the ceremony the priest sprinkles rice on the bride and groom who also sprinkle each other with rice. A feast for family and friends follows the marriage ceremony.

After a death, consecrated food, such as *dron* or eggs is offered to sustain the soul of the newly departed. The family of the deceased may not eat meat for three days, a practice that may be linked to fear over impurities or to the idea that flesh food is more suitable for celebratory occasions. On the anniversary of a death the souls of the departed are offered cooked foods, milk, water, and fresh fruit. This food is subsequently given to charity. These observances, like others, may be in decline.

Holidays and Festivals

Zoroaster established a series of holy days and also assimilated existing traditional festivals and celebrations. There are six seasonal festivals known as Gahambars, which celebrate the six creations of Sky, Water, Earth, Plants, Cattle, and Man. Traditionally each lasted for five days, though now much curtailed, and included feasting, prayer and rejoicing. The most important festival is that of Nou Rouz—the New Year. Held at the spring equinox it celebrates the rejuvenation of nature and the beginning of new life, and is linked to fire—the seventh and most sacred creation of Ahura Mazda. It is marked by family and community gatherings, religious services, feasting, and gift giving. The ten days prior to Nou Ruz are for commemoration of the departed. A variety of grains and lentils are soaked so that they will germinate in time for the holiday. These green sprouts are added to a thanksgiving table that also holds a variety of other symbolic objects and foods such as bread, fruit, fresh vegetables, sugar cones, and decorated eggs.

Each day in the Zoroastrian calendar is dedicated to a particular divine being or important event, twelve of which also has its own month. Name-day feasts are held when month name and day name coincide. Adar, the ninth day of the ninth month, is celebrated as the birthday of fire and is a time to give thanks for warmth and light. Traditionally food is not cooked in the home, to give the fire a rest. Other festivals include the birth and death anniversary of the prophet and the feast of all souls (Muktad) for remembrance of departed family members.

See also **Death and Burial; Feasts, Festivals, and Fasts; India: Northern India; Iran; Middle East; Religion and Food**.

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APPENDIX: DIETARY REFERENCE INTAKES

The table on the pages that follow lists vitamins, their food sources, and adverse effects of overconsumption. The table gives recommended intake (RDA) and—a feature not available in previous RDA lists—shows tolerable upper levels that readers can use as a guideline to prevent excess consumption.

The reference values are referred to collectively as the Dietary Reference Intakes (DRIs) and include Recommended Dietary Allowance (RDA), Adequate Intake (AI), and the Tolerable Upper Intake Level (UL). A requirement, which can vary depending on age, gender, and life stage, is defined as the lowest continuing intake level of a nutrient that will maintain a defined level of nutriture in an individual. (The nutrient levels published in the DRI reports apply to the healthy general population. They are not expected to be sufficient for individuals who are already malnourished, nor would they be adequate for disease states known to have increased nutrient requirements.)

The table was developed by the Institute of Medicine's Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, in cooperation with Health Canada. In 1995 the Food and Nutrition Board of the Institute of Medicine—part of the National Academy of Sciences—appointed the committee to replace the tenth (1989) edition of the Recommended Dietary Allowances (RDAs) document.

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	RDA/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Biotin	Coenzyme in synthesis of fat, glycogen, and amino acids	Infants	(μg/d)		Liver and smaller amounts in fruits and meats	No adverse effects of biotin in humans or animals were found. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of biotin are limited, caution may be warranted.	None
		0–6 mo	5*	ND[b]			
		7–12 mo	6*	ND			
		Children					
		1–3 y	8*	ND			
		4 –8 y	12*	ND			
		Males					
		9–13 y	20*	ND			
		14–18 y	25*	ND			
		19–30 y	30*	ND			
		31–50 y	30*	ND			
		50–70 y	30*	ND			
		> 70 y	30*	ND			
		Females					
		9–13 y	20*	ND			
		14–18 y	25*	ND			
		19–30 y	30*	ND			
		31–50 y	30*	ND			
		50–70 y	30*	ND			
		> 70 y	30*	ND			
		Pregnancy					
		≤ 18 y	30*	ND			
		19–30 y	30*	ND			
		31–50 y	30*	ND			
		Lactation					
		≤ 18 y	35*	ND			
		19–30 y	35*	ND			
		31–50 y	35*	ND			
Choline	Precursor for acetylcholine, phospholipids, and betaine	Infants	(mg/d)	(mg/d)	Milk, liver, eggs, peanuts	Fishy body odor, sweating, salivation, hypotension, hepatotoxicity	Individuals with trimethylaminuria, renal disease, liver disease, depression, and Parkinson's disease may be at risk of adverse effects with choline intakes at the UL. Although AIs have been set for choline there are few data to assess whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.
		0–6 mo	125*	ND			
		7–12 mo	150*	ND			
		Children					
		1–3 y	200*	1000			
		4 –8 y	250*	1000			
		Males					
		9–13 y	375*	2000			
		14–18 y	550*	3000			
		19–30 y	550*	3500			
		31–50 y	550*	3500			
		50–70 y	550*	3500			
		> 70 y	550*	3500			
		Females					
		9–13 y	375*	2000			
		14–18 y	400*	3000			
		19–30 y	425*	3500			
		31–50 y	425*	3500			
		50–70 y	425*	3500			
		> 70 y	425*	3500			
		Pregnancy					
		≤ 18 y	450*	3000			
		19–30 y	450*	3500			
		31–50 y	450*	3500			
		Lactation					
		≤ 18 y	550*	3000			
		19–30 y	550*	3500			
		31–50 y	550*	3500			

[continued]

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	RDA/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Folate Also known as: Folic acid Folacin Pteroylpolyglutamates Note: Given as a dietary folate equivalents (DFE). 1 DFE = 1 μg food folate = 0.6 μg of folate from fortified food or as a supplement consumed with food = 0.5 μg of a supplement taken on an empty stomach.	Coenzyme in the metabolism of nucleic and amino acids; prevents megaloblastic anemia	Infants	(μg/d)	(μg/d)	Enriched cereal grains, dark leafy vegetables, enriched and whole-grain breads and bread products, fortified ready-to-eat cereals	Masks neurological complication in people with vitamin B_{12} deficiency. No adverse effects associated with folate from food or supplements have been reported. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of folate are limited, caution may be warranted. The UL for folate applies to synthetic forms obtained from supplements and/or fortified foods.	In view of evidence linking folate intake with neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant consume 400 μg from supplements or fortified foods in addition to intake of food folate from a varied diet. It is assumed that women will continue consuming 400 μg from supplements of fortified food until their pregnancy is confirmed and they enter prenatal care, which ordinarily occurs after the end of the periconceptional period—the critical time for formation of the neural tube.
		0–6 mo	65*	ND[b]			
		7–12 mo	80*	ND			
		Children					
		1–3 y	**150**	300			
		4 –8 y	**200**	400			
		Males					
		9–13 y	**300**	600			
		14–18 y	**400**	800			
		19–30 y	**400**	1,000			
		31–50 y	**400**	1,000			
		50–70 y	**400**	1,000			
		> 70 y	**400**	1,000			
		Females					
		9–13 y	**300**	600			
		14–18 y	**400**	800			
		19–30 y	**400**	1,000			
		31–50 y	**400**	1,000			
		50–70 y	**400**	1,000			
		> 70 y	**400**	1,000			
		Pregnancy					
		≤ 18 y	**600**	800			
		19–30 y	**600**	1,000			
		31–50 y	**600**	1,000			
		Lactation					
		< 18 y	**500**	800			
		19–30 y	**500**	1,000			
		31–50 y	**500**	1,000			
Niacin Includes nicotinic acid amide, nicotinic acid (pyridine-3-carboxylic acid) and derivatives that exhibit the biological activity of nicotinamide. Note: Given as niacin equivalents (NE). 1 mg of niacin = 60 mg of trytophan; 0–6 months = preformed niacin (not NE).	Coenzyme or cosubstrate in many biological reduction and oxidation reactions—thus required for energy metabolism	Infants	(mg/d)	(mg/d)	Meat, fish, poultry, enriched and whole-grain breads and bread products, fortified ready-to-eat cereals	There is no evidence of adverse effects from the consumption of naturally occuring niacin in foods. Adverse effects from niacin-containing supplements may include flushing and and gastrointestinal distress. The UL for niacin applies to synthetic forms obtained from supplements, fortified foods, or a combination of the two.	Extra niacin may be required by persons treated with hemodialysis or peritoneal dialysis, or those with malabsorption syndrome.
		0–6 mo	2*	ND			
		7–12 mo	4*	ND			
		Children					
		1–3 y	**6**	10			
		4 –8 y	**8**	15			
		Males					
		9–13 y	**12**	20			
		14–18 y	**16**	30			
		19–30 y	**16**	35			
		31–50 y	**16**	35			
		50–70 y	**16**	35			
		> 70 y	**16**	35			
		Females					
		9–13 y	**12**	20			
		14–18 y	**14**	30			
		19–30 y	**14**	35			
		31–50 y	**14**	35			
		50–70 y	**14**	35			
		> 70 y	**14**	35			
		Pregnancy					
		< 18 y	**18**	30			
		19–30 y	**18**	35			
		31–50 y	**18**	35			
		Lactation					
		≤ 18 y	**17**	30			
		19–30 y	**17**	35			
		31–50 y	**17**	35			

[continued]

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	**RDA**/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Pantothenic Acid	Coenzyme in fatty acid metabolism	Infants	(mg/d)	(mg/d)	Chicken, beef, potatoes, oats, cereals, tomato products, liver, kidney, yeast, egg yolk, broccoli, whole grains	No adverse effects associated with pantothenic acid from food or supplements have been reported. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of pantothenic acid are limited, caution may be warranted.	None
		0–6 mo	1.7*	ND[b]			
		7–12 mo	1.8*	ND			
		Children					
		1–3 y	2*	ND			
		4 –8 y	3*	ND			
		Males					
		9–13 y	4*	ND			
		14–18 y	5*	ND			
		19–30 y	5*	ND			
		31–50 y	5*	ND			
		50–70 y	5*	ND			
		> 70 y	5*	ND			
		Females					
		9–13 y	4*	ND			
		14–18 y	5*	ND			
		19–30 y	5*	ND			
		31–50 y	5*	ND			
		50–70 y	5*	ND			
		> 70 y	5*	ND			
		Pregnancy					
		≤ 18 y	6*	ND			
		19–30 y	6*	ND			
		31–50 y	6*	ND			
		Lactation					
		≤ 18 y	7*	ND			
		19–30 y	7*	ND			
		31–50 y	7*	ND			
Riboflavin Also known as: Vitamin B$_2$	Coenzyme in numerous redox reactions	Infants	(mg/d)	(mg/d)	Organ meats, milk, bread products, and fortified cereals	No adverse effects associated with riboflavin consumption from food or supplements have been reported. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of riboflavin are limited, caution may be warranted.	None
		0–6 mo	0.3*	ND			
		7–12 mo	0.4*	ND			
		Children					
		1–3 y	**0.5**	ND			
		4 –8 y	**0.6**	ND			
		Males					
		9–13 y	**0.9**	ND			
		14–18 y	**1.3**	ND			
		19–30 y	**1.3**	ND			
		31–50 y	**1.3**	ND			
		50–70 y	**1.3**	ND			
		> 70 y	**1.3**	ND			
		Females					
		9–13 y	**0.9**	ND			
		14–18 y	**1.0**	ND			
		19–30 y	**1.1**	ND			
		31–50 y	**1.1**	ND			
		50–70 y	**1.1**	ND			
		> 70 y	**1.1**	ND			
		Pregnancy					
		≤ 18 y	**1.4**	ND			
		19–30 y	**1.4**	ND			
		31–50 y	**1.4**	ND			
		Lactation					
		≤ 18 y	**1.6**	ND			
		19–30 y	**1.6**	ND			
		31–50 y	**1.6**	ND			

[continued]

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	RDA/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Thiamin Also known as: Vitamin B1 Aneurin	Coenzyme in the metabolism of carbohydrates and branched-chain amino acids	Infants	(mg/d)		Enriched, fortified, or whole-grain products; bread and bread products, mixed foods whose main ingredient is grain, and ready-to-eat cereals	No adverse effects associated with thiamin from food or supplements have been reported. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of thiamin acid are limited, caution may be warranted.	Person, who may have increased needs for thiamin include those being treated with hemodialysis or peritoneal dialysis, or individuals with malabsorption syndrome.
		0–6 mo	0.2*	ND[b]			
		7–12 mo	0.3*	ND			
		Children					
		1–3 y	**0.5**	ND			
		4 –8 y	**0.6**	ND			
		Males					
		9–13 y	**0.9**	ND			
		14–18 y	**1.2**	ND			
		19–30 y	**1.2**	ND			
		31–50 y	**1.2**	ND			
		50–70 y	**1.2**	ND			
		> 70 y	**1.2**	ND			
		Females					
		9–13 y	**0.9**	ND			
		14–18 y	**1.0**	ND			
		19–30 y	**1.1**	ND			
		31–50 y	**1.1**	ND			
		50–70 y	**1.1**	ND			
		> 70 y	**1.1**	ND			
		Pregnancy					
		< 18 y	**1.4**	ND			
		19–30 y	**1.4**	ND			
		31–50 y	**1.4**	ND			
		Lactation					
		< 18 y	**1.4**	ND			
		19–30 y	**1.4**	ND			
		31–50 y	**1.4**	ND			
Vitamin A Includes provitamin A carotenoids that are dietary precursors of retinol Note: Given as retinol activity equivalents (RAEs). 1 RAE = 1 μg retinol, 12 μg ß-carotene, 24 μg α-carotene, or 24 μg ß-crytoxanthin. To calculate RAEs from REs of provitamin A carotenoids in foods, divide the REs by 2. For preformed vitamin A in foods or supplements and for provitamin A carotenoids in supplements, 1 RE = 1RAE.	Required for normal vision, gene expression, reproduction, embryonic development and immune function	Infants	(μg/d)	(μg/d)	Liver, dairy products, fish	Teratological effects, liver toxicity Note: from preformed Vitamin A only.	Individuals with high alcohol intake, preexisting liver disease, hyperlipidemia, or severe protein malnutrition may be distinctly susceptible to the adverse effects of excess preformed vitamin A intake. ß-carotene supplements are advised only to serve as a provitamin A source for individuals at risk of vitamin A deficiency.
		0–6 mo	400*	600			
		7–12 mo	500*	600			
		Children					
		1–3 y	**300**	600			
		4 –8 y	**400**	900			
		Males					
		9–13 y	**600**	1,700			
		14–18 y	**900**	2,800			
		19–30 y	**900**	3,000			
		31–50 y	**900**	3,000			
		50–70 y	**900**	3,000			
		> 70 y	**900**	3,000			
		Females					
		9–13 y	**600**	1,700			
		14–18 y	**700**	2,800			
		19–30 y	**700**	3,000			
		31–50 y	**700**	3,000			
		50–70 y	**700**	3,000			
		> 70 y	**700**	3,000			
		Pregnancy					
		≤ 18 y	**750**	2,800			
		19–30 y	**770**	3,000			
		31–50 y	**770**	3,000			
		Lactation					
		≤ 18 y	**1,200**	2,800			
		19–30 y	**1,300**	3,000			
		31–50 y	**1,300**	3,000			

[continued]

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	**RDA**/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Vitamin B_6 Vitamin B_6 comprises a group of six related compounds: pyridoxal, pyridoxine, pyridozamine, and 5'-phosphates (PLP, PNP, PMP)	Coenzyme in the metabolism of amino acids, glycogen and sphingoid bases	Infants	(mg/d)	(mg/d)	Fortified cereals, organ meats, fortified soy-based meat substitutes	No adverse effects associated with Vitamin B_6 from food have been reported. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of Vitamin B_6 are limited, caution may be warranted. Sensory neuropathy has occurred from high intakes of supplemental forms.	None
		0–6 mo	0.1*	ND[b]			
		7–12 mo	0.3*	ND			
		Children					
		1–3 y	**0.5**	30			
		4 –8 y	**0.6**	40			
		Males					
		9–13 y	**1.0**	60			
		14–18 y	**1.3**	80			
		19–30 y	**1.3**	100			
		31–50 y	**1.3**	100			
		50–70 y	**1.7**	100			
		> 70 y	**1.7**	100			
		Females					
		9–13 y	**1.0**	60			
		14–18 y	**1.2**	80			
		19–30 y	**1.3**	100			
		31–50 y	**1.3**	100			
		50–70 y	**1.5**	100			
		> 70 y	**1.5**	100			
		Pregnancy					
		≤ 18 y	**1.9**	80			
		19–30 y	**1.9**	100			
		31–50 y	**1.9**	100			
		Lactation					
		≤ 18 y	**2.0**	80			
		19–30 y	**2.0**	100			
		31–50 y	**2.0**	100			
Vitamin B_{12} Also known as: Cobalamin	Coenzyme in nucleic acid metabolism; prevents megaloblastic anemia	Infants	(μg/d)	(μg/d)	Fortified cereals, meat, fish, poultry	No adverse effects have been associated with the consumption of the amounts of Vitamin B_{12} normally found in foods or supplements. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of vitamin B_{12} are limited, caution may be warranted.	Because 10 to 30 percent of older people may malabsorb foodbound vitamin B_{12}, it is advisable for those older than 50 years to meet their RDA mainly by consuming foods fortified with vitamin B_{12} or a supplement containing vitaming B_{12}.
		0–6 mo	0.4*	ND			
		7–12 mo	0.5*	ND			
		Children					
		1–3 y	**0.9**	ND			
		4 –8 y	**1.2**	ND			
		Males					
		9–13 y	**1.8**	ND			
		14–18 y	**2.4**	ND			
		19–30 y	**2.4**	ND			
		31–50 y	**2.4**	ND			
		50–70 y	**2.4**	ND			
		> 70 y	**2.4**	ND			
		Females					
		9–13 y	**1.8**	ND			
		14–18 y	**2.4**	ND			
		19–30 y	**2.4**	ND			
		31–50 y	**2.4**	ND			
		50–70 y	**2.4**	ND			
		> 70 y	**2.4**	ND			
		Pregnancy					
		≤ 18 y	**2.6**	ND			
		19–30 y	**2.6**	ND			
		31–50 y	**2.6**	ND			
		Lactation					
		≤18 y	**2.8**	ND			
		19–30 y	**2.8**	ND			
		31–50 y	**2.8**	ND			

[continued]

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	RDA/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Vitamin C Also known as: Ascorbic acid Dehydroascorbic acid (DHA)	Cofactor for reactions requiring reduced copper or iron metalloenzyme and as a protective antioxidant	Infants	(mg/d)	(mg/d)	Citrus fruits, tomatoes, tomato juice, potatoes, brussel sprouts, cauliflower, broccoli, strawberries, cabbage, and spinach	Gastrointestinal distrubances, kidney stones, excess iron absorption	Individuals who smoke require an additional 35 mg/d of vitamin C over that needed by non-smokers. Nonsmokers regularly exposed to tobacco smoke are encouraged to ensure they meet the RDA for vitamin C.
		0–6 mo	40*	ND[b]			
		7–12 mo	50*	ND			
		Children					
		1–3 y	**15**	400			
		4 –8 y	**25**	650			
		Males					
		9–13 y	**45**	1,200			
		14–18 y	**75**	1,800			
		19–30 y	**90**	2,000			
		31–50 y	**90**	2,000			
		50–70 y	**90**	2,000			
		> 70 y	**90**	2,000			
		Females					
		9–13 y	**45**	1,200			
		14–18 y	**65**	1,800			
		19–30 y	**75**	2,000			
		31–50 y	**75**	2,000			
		50–70 y	**75**	2,000			
		> 70 y	**75**	2,000			
		Pregnancy					
		≤ 18 y	**80**	1,800			
		19–30 y	**85**	2,000			
		31–50 y	**85**	2,000			
		Lactation					
		≤ 18 y	**115**	1,800			
		19–30 y	**120**	2,000			
		31–50 y	**120**	2,000			
Vitamin D Also known as: Calciferol Note: 1 μg calciferol = 40 IU vitamin D The DRI values are based on the absence of adequate exposure to sunlight.	Maintain serum calcium and phosphorus concentrations	Infants	(μg/d)	(μg/d)	Fish liver oils, flesh of fatty fish, liver and fat from seals and polar bears, eggs from hens that have been fed vitamin D, fortified milk products, and fortified cereals.	Elevated plasma 25 (OH) D concentration causing hypercalcemia	Patients on glucocorticoid therapy may require additional vitamin D.
		0–6 mo	5*	25			
		7–12 mo	5*	25			
		Children					
		1–3 y	5*	50			
		4 –8 y	5*	50			
		Males					
		9–13 y	5*	50			
		14–18 y	5*	50			
		19–30 y	5*	50			
		31–50 y	5*	50			
		50–70 y	10*	50			
		> 70 y	15*	50			
		Females					
		9–13 y	5*	50			
		14–18 y	5*	50			
		19–30 y	5*	50			
		31–50 y	5*	50			
		50–70 y	10*	50			
		> 70 y	15*	50			
		Pregnancy					
		≤ 18 y	5*	50			
		19–30 y	5*	50			
		31–50 y	5*	50			
		Lactation					
		≤ 18 y	5*	50			
		19–30 y	5*	50			
		31–50 y	5*	50			

[continued]

Dietary reference intakes: Vitamins

Nutrient	Function	Life stage group	RDA/AI*	UL[a]	Selected food sources	Adverse effects of excessive consumption	Special considerations
Vitamin E Also known as: α-tocopherol Note: As α-tocopherol. α-Tocopherol includes *RRR*-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the *2R*-stereoisomeric forms of α-tocopherol (*RRR*-, *RSR*-, *RRS*-, and *RSS*-α-tocopherol) that occur in fortified foods and supplements. It does not include the *2S*-stereoisomeric forms of α-tocopherol (*SRR*-, *SSR*-, *SRS*-, and *SSS*-α-tocopherol), also found in fortified foods and supplements.	A metabolic function has not yet been identified. Vitamin E's major function appears to be as a non-specific chain-breaking antioxidant.	Infants	(mg/d)	(mg/d)	Vegetable oils, unprocessed cereal grains, nuts, fruits, vegetables, meats	There is no evidence of adverse effects from the consumption of vitamin E naturally occurring in foods. Adverse effects from vitamin E containing supplements may include hemorrhagic toxicity. The UL for vitamin E applies to any form of α-tocopherol obtained from supplements, fortified foods, or a combination of the two.	Patients on anti-coagulant therapy should be monitored when taking vitamin E supplements.
		0–6 mo	4*	ND[b]			
		7–12 mo	5*	ND			
		Children					
		1–3 y	**6**	200			
		4 –8 y	**7**	300			
		Males					
		9–13 y	**11**	600			
		14–18 y	**15**	800			
		19–30 y	**15**	1,000			
		31–50 y	**15**	1,000			
		50–70 y	**15**	1,000			
		> 70 y	**15**	1,000			
		Females					
		9–13 y	**11**	600			
		14–18 y	**15**	800			
		19–30 y	**15**	1,000			
		31–50 y	**15**	1,000			
		50–70 y	**15**	1,000			
		> 70 y	**15**	1,000			
		Pregnancy					
		≤ 18 y	**15**	800			
		19–30 y	**15**	1,000			
		31–50 y	**15**	1,000			
		Lactation					
		≤18 y	**19**	800			
		19–30 y	**19**	1,000			
		31–50 y	**19**	1,000			
Vitamin K	Coenzyme during the sythesis of many proteins involved in blood clotting and bone metabolism	Infants	(μg/d)	(μ/d)	Green vegetables (collards, spinich, salad greens, broccoli), brussel sprouts, cabbage, plant oils and margarine	No adverse effects associated with vitamin K consumption from food or supplements have been reported in humans or animals. This does not mean that there is no potential for adverse effects resulting from high intakes. Because data on the adverse effects of vitamin K are limited, caution may be warranted.	Patients on anti-coagulant therapy should monitor their vitamin K intake.
		0–6 mo	2.0*	ND			
		7–12 mo	2.5*	ND			
		Children					
		1–3 y	30*	ND			
		4 –8 y	55*	ND			
		Males					
		9–13 y	60*	ND			
		14–18 y	75*	ND			
		19–30 y	120*	ND			
		31–50 y	120*	ND			
		50–70 y	120*	ND			
		> 70 y	120*	ND			
		Females					
		9–13 y	60*	ND			
		14–18 y	75*	ND			
		19–30 y	90*	ND			
		31–50 y	90*	ND			
		50–70 y	90*	ND			
		> 70 y	90*	ND			
		Pregnancy					
		≤ 18 y	75*	ND			
		19–30 y	90*	ND			
		31–50 y	90*	ND			
		Lactation					
		≤ 18 y	75*	ND			
		19–30 y	90*	ND			
		31–50 y	90*	ND			

[continued]

Dietary reference intakes: Vitamins

Note: The table is adapted from the DRI reports, see www.nap.edu. It represents Recommended Dietary Allowances (RDAs) in **bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*), and Tolerable Upper Intake Levels (ULs)[a]. RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover the needs of all individuals in the group, but lack of data prevent being able to specify with confidence the percentage of individuals covered by this intake.

[a] UL = The maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to lack of suitable data, ULs could not be established for vitamin K, thiamin, riboflavin, vitamin B_{12}, pantothenic acid, biotin, or carotenoids. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

[b] ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCE:: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); and *Dietary Reference Intakes for Vitamin A,Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001). These reports may be accessed via www.nap.edu.

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SYSTEMATIC OUTLINE OF CONTENTS

This systematic outline provides a general overview of the conceptual scheme of the *Encyclopedia*, listing the titles of each entry and subentry. The outline is divided into twenty-seven parts.

1 Foods: Staple Foods
2 Foods: Cooked, Processed, and Prepared
3 Icon Foods and Superfoods
4 Beverages
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7 Food Distribution
8 Food Preparation, Processing, and Disposal
9 Food Consumption
10 The Premodern World
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23 Feasts, Festivals, and Fasts
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27 Biographies

Because the section headings are not mutually exclusive, certain entries in the *Encyclopedia* are listed in more than one section.

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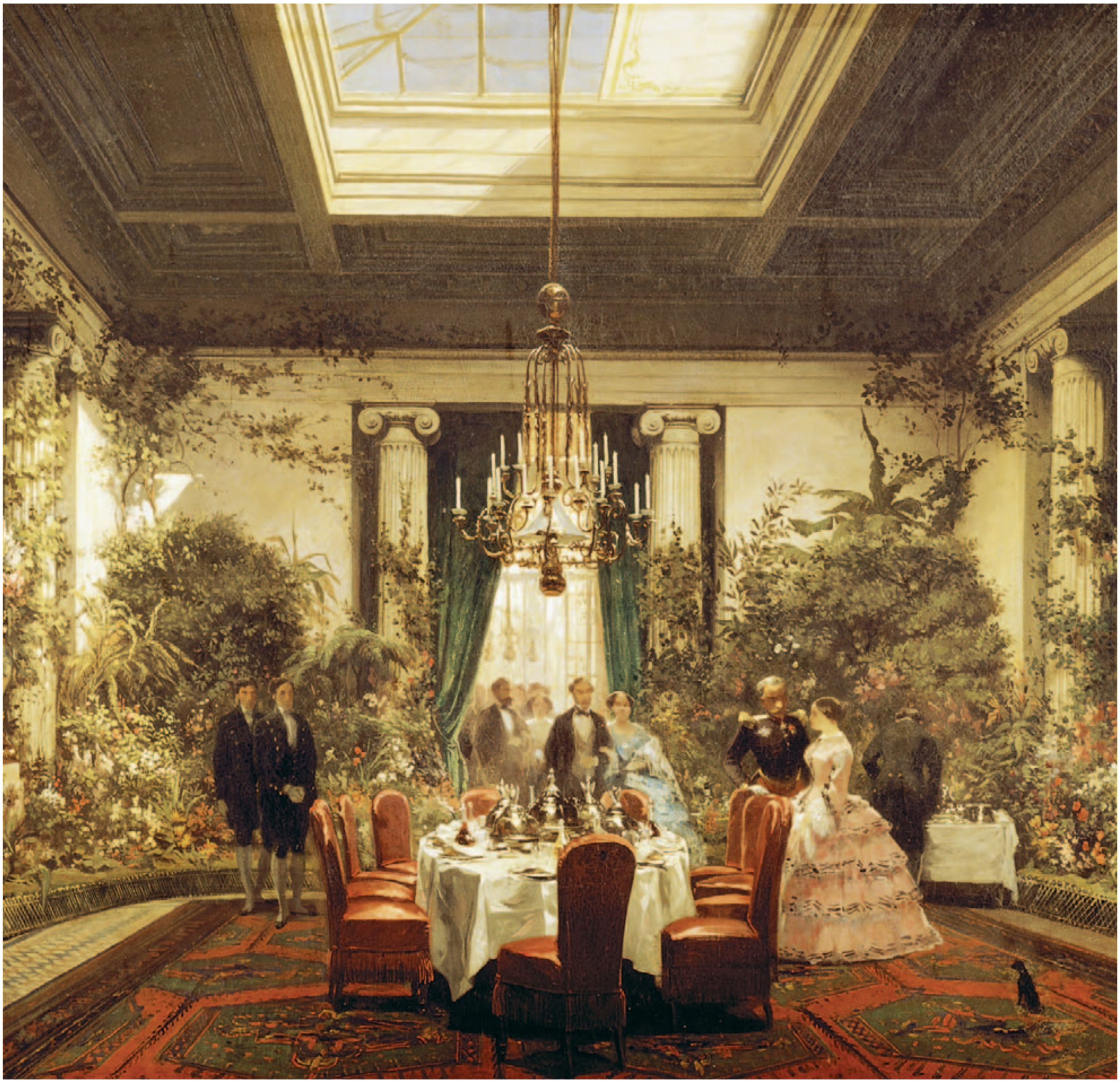
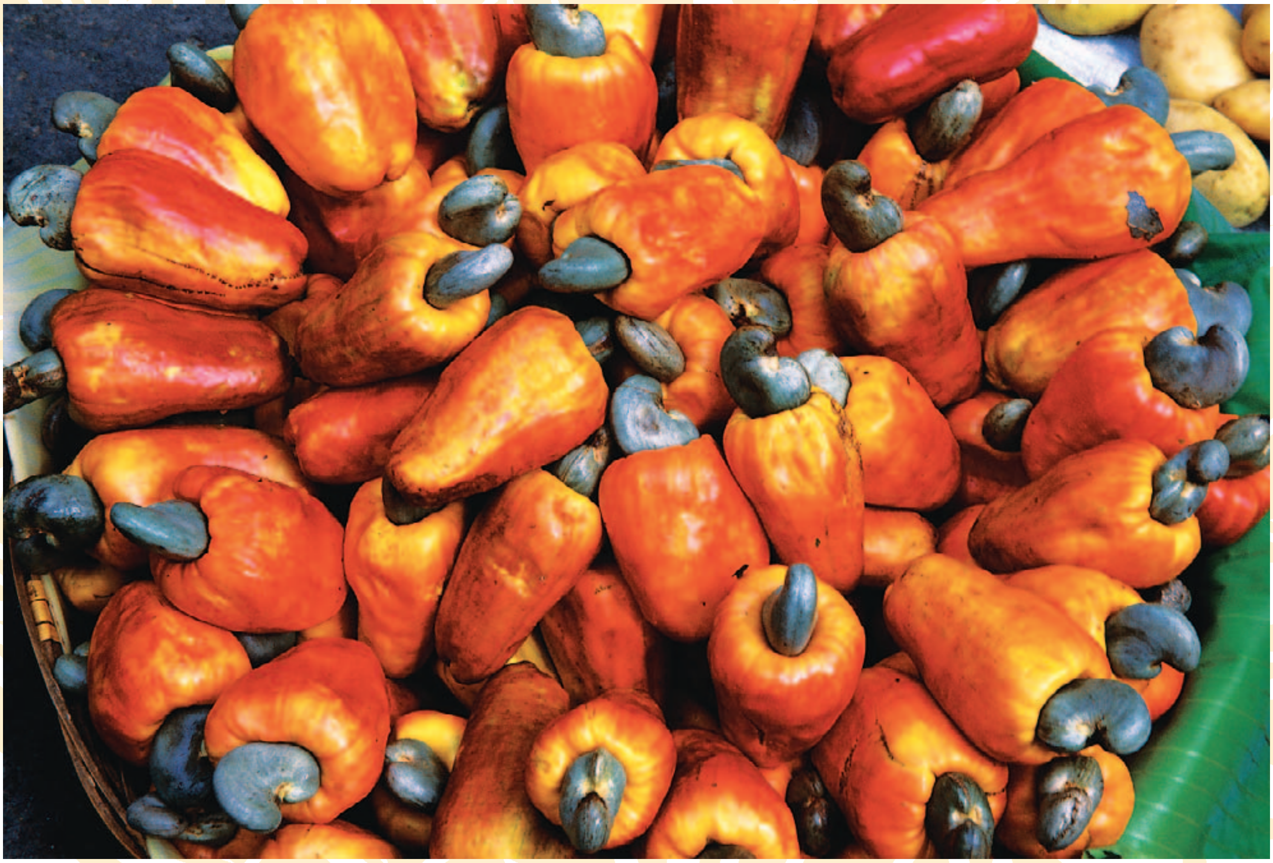


France Detail of a painting by Charles Giraud called *La Salle à manger de la Princesse Mathilde* (1854), showing the interior of a grand salon fitted out with carpets, plants, and a sumptuous dinner service under silver covers. Courtesy of the Musée national du Château Compiègne, France. ©Réunion des Musées Nationaux/Art Resource, New York.

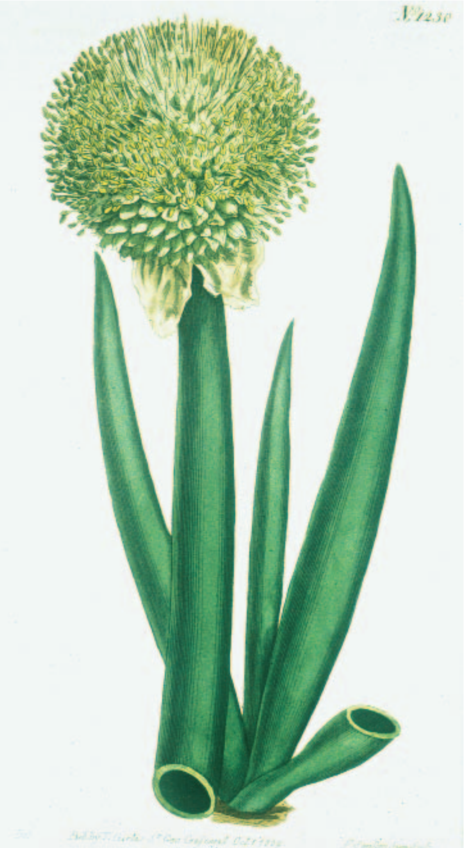


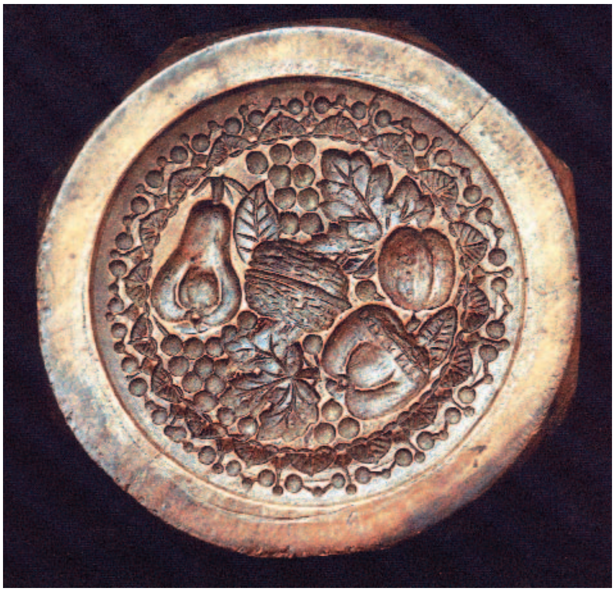
Nuts Cashew nuts in the market of Guatemala City, Guatemala. © Dave G. Houser/CORBIS.

***Top left:* Onions and Other Alliums** A Welsh bunching onion in the Roughwood Seed Collection. Photo by L. Wilbur Zimmerman.

***Top right:* Onions and Other Alliums** The earliest color depiction of the poor man's leek or Welsh bunching onion. From *Curtis's Botanical Magazine* (London, 1809). Some of the most accurate depictions of heirloom vegetables can be found in this annual, which is still published today. Roughwood Collection.

***Below:* Onions and Other Alliums** Shallots poached in Madeira. Food styling by William Woys Weaver. Photo by André Baranowski.



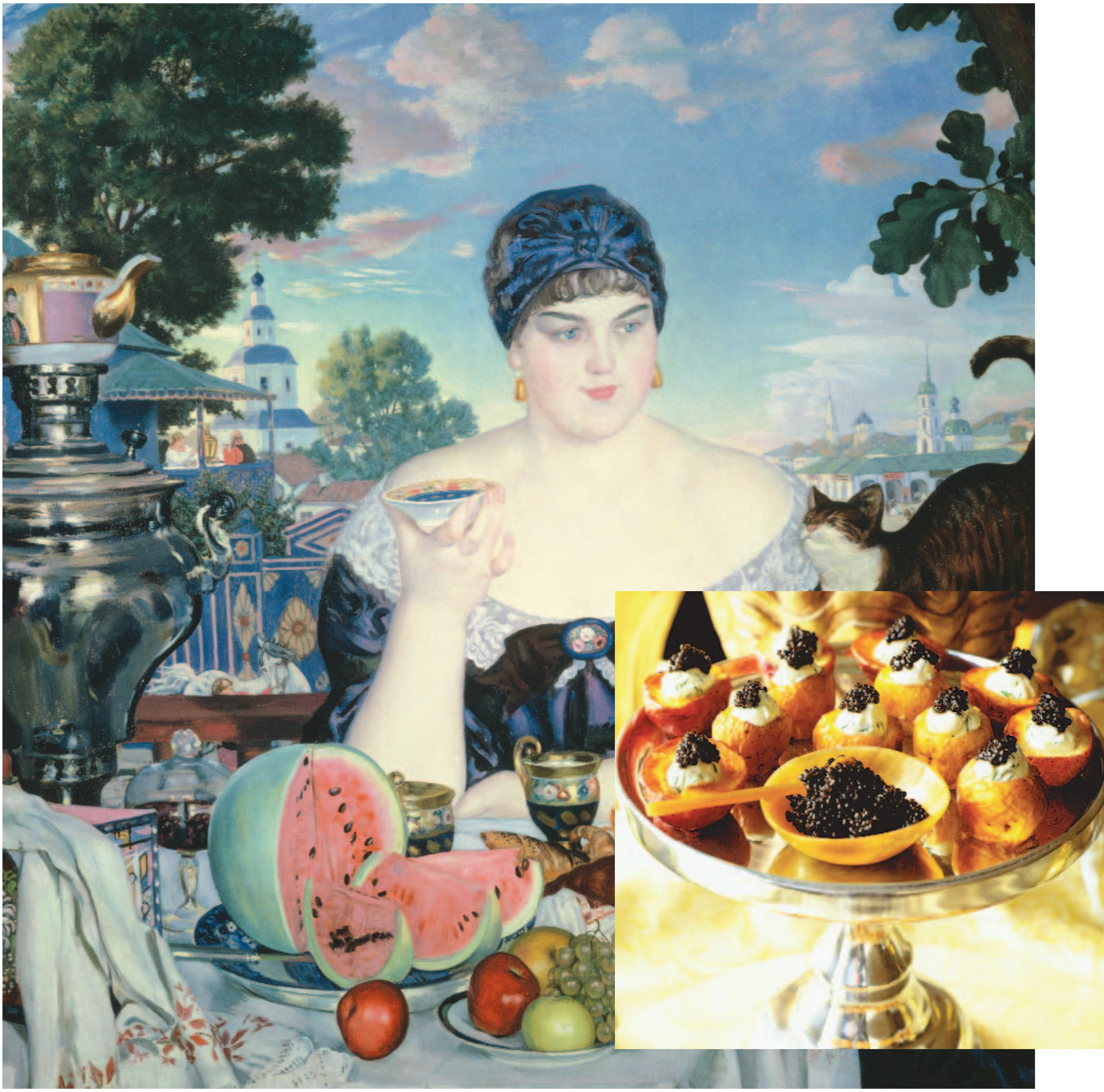


***Top:* Pastry** Marzipan mold depicting fruits and nuts. South German, circa 1750. Collection of Charles Thomas.

***Below:* Pastry** A selection of Tuscan pastries. Photo by André Baranowski.

Russia *Merchant’s Wife at Tea* (1918) by Russian painter Boris Kustodiev. In this portrait of contented overabundance, Kustodiev depicts all of the symbols of Russian culture. Courtesy of The Russian Museum, St. Petersburg.

Inset: **Russia** Caviar has been considered a luxury food since Byzantine times, although the eggs of several different species of fish have been employed in making it. The black Beluga caviar from sturgeon is the most highly prized by connoisseurs. It is served here Polish style with new potatoes and sour cream. Photo by André Baranowski.



Bottom: **South America** Market scene in Sucre (formerly Chuquisaca), Bolivia. Photo by R. E. Salazar.

Top right: **Tomato** Still life with tomato by Philadelphia painter Raphaelle Peale, circa 1795. This work is noteworthy not only because Peale's painting is one of the earliest depictions of the tomato in American art, but the tomato itself is a rare variety from the Amazon basin. Courtesy of Wadsworth Atheneum, Hartford, Connecticut. The Ella Gallup Sumner and Mary Catlin Sumner Collection Fund.

Top left: **Tomato** Detail of the so-called "Reisetomate" from the former botanical collection of the Duke of Braunschweig. This tomato, depicted in the Peale still life, was collected in Brazil during a botanical expedition in 1836. The Roughwood Seed Collection. Photo by Rob Cardillo.

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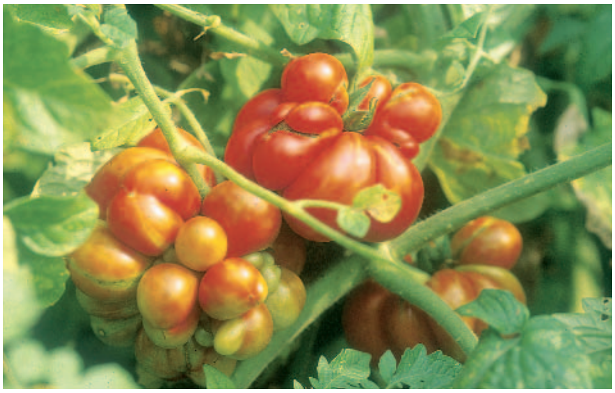
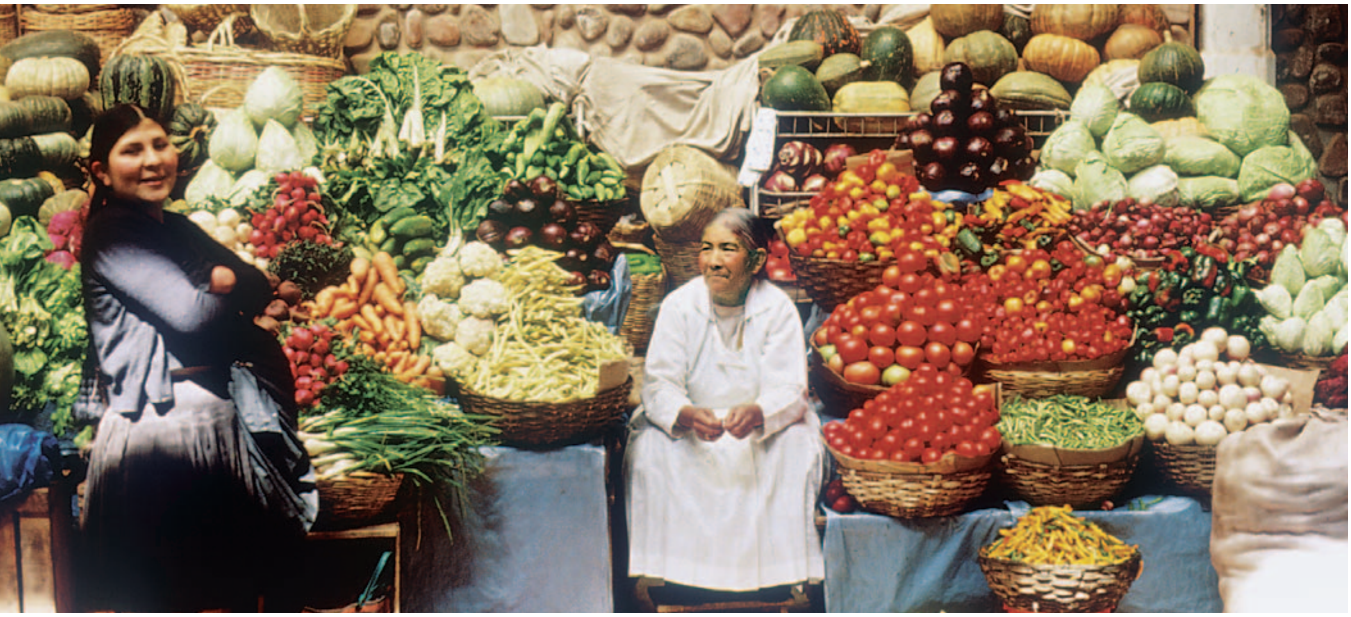


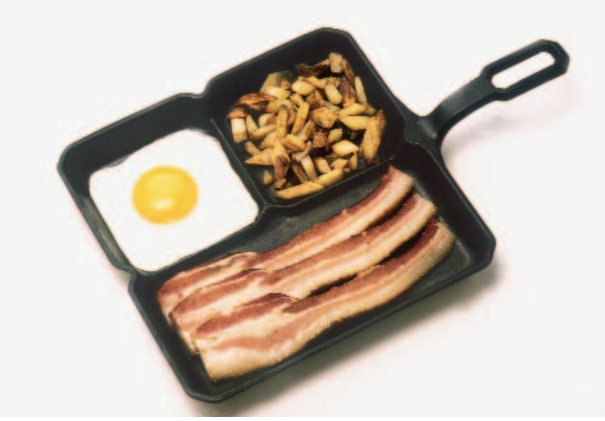


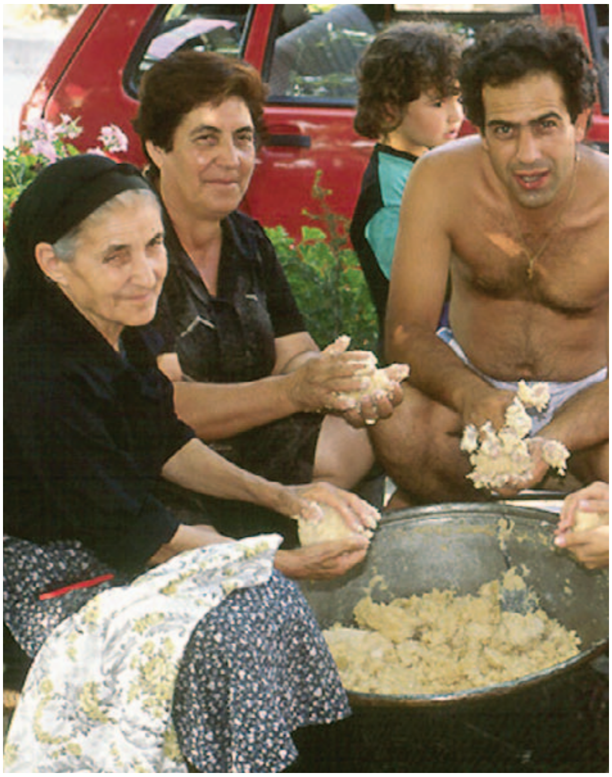
United States/Pennsylvania Dutch Food Duck Pond at Ronks, Lancaster County, Pennsylvania. A typical Old Order Mennonite farmstead in the heartland of the Pennsylvania Dutch region. Photo by William Woys Weaver.

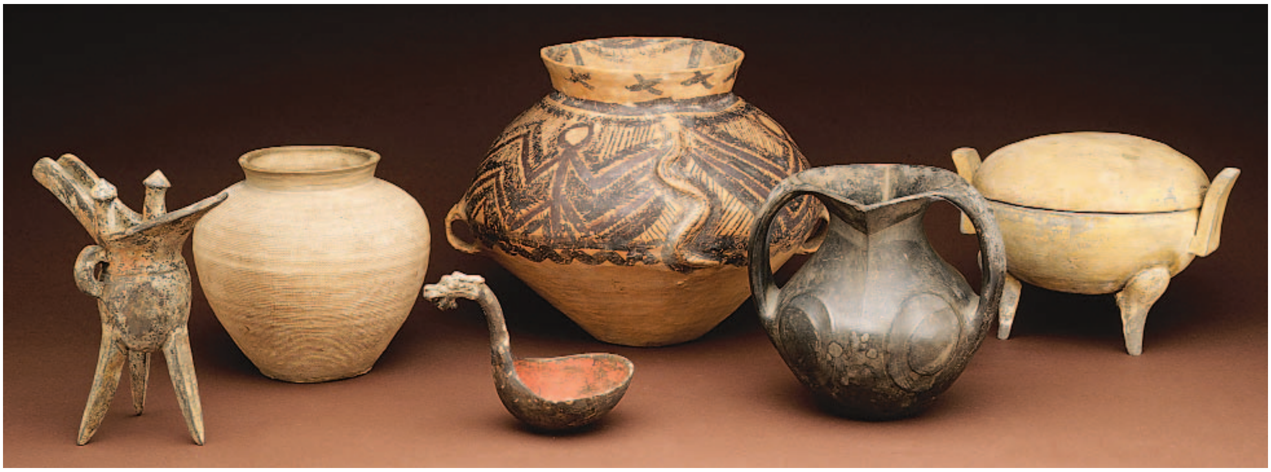
***Top left:* Utensils** The "Colonial Breakfast Skillet" made by the Griswold iron foundry in Erie, Pennsylvania, circa 1910. In this skillet the Victorian idealization of an entire colonial meal was condensed into an iron serving utensil that foreshadowed the TV dinner. Roughwood Collection.

***Bottom:* Utensils** Earthenware food vessels from ancient China. From left to right: late Anyang period *jue,* eleventh century B.C.E.; Han Dynasty jar with textile impressions, 206 B.C.E.–220 C.E.; Eastern Han Dynasty spoon, 25–220 C.E.; Machang phase of Majiayao culture jar with snakes, late third millennium B.C.E.; Western Han Dynasty two-handled jar, second century B.C.E.; Western Han Dynasty *ding,* 206 B.C.E.–24 C.E. © Royal Ontario Museum/CORBIS.

***Top right:* Wheat** Cypriot family making *trachanás,* cracked wheat cooked in goat's milk, then dried in the sun for use in soups during the winter. Photo by Charalambos Christodoulou.







Wine Rows of bottles of vintage wine in storage, like books on the shelves of an ancient library, or rows of crops ripening before harvest, symbolize both the cultivation and the eventual enjoyment of the fruits of labor. © Charles O'Rear/CORBIS.

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Bold page numbers (e.g., **3:437–439**) refer to the main entry on the subject. Page numbers in italics refer to illustrations, figures, and tables. Page numbers followed by the abbreviation *tab* indicate a table within the article. The abbreviation *col. ins.* refers to the color inserts in each volume. (The color inserts are arranged in alphabetical order.)

References to contributors of articles in this encyclopedia may appear in the index, but the best way to find a writer's article(s) is to look in the Directory of Contributors that begins on page 589; articles are listed under the person's name.

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